Does target country's climate risk matter in cross-border M&A? The evidence in the presence of geopolitical risk

Citation for published version:
Li, H, Liu, Y & Xu, B 2023, 'Does target country's climate risk matter in cross-border M&A? The evidence in the presence of geopolitical risk', *Journal of Environmental Management*, vol. 344, 118439.
https://doi.org/10.1016/j.jenvman.2023.118439

Digital Object Identifier (DOI):
10.1016/j.jenvman.2023.118439

Published In:
Journal of Environmental Management

Journal of Environmental Management 344 (2023) 118439

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

Does target country's climate risk matter in cross-border M&A? The evidence in the presence of geopolitical risk☆

Hao Li [a], Yue Liu [b], Bing Xu [c,*]

[a] Cardiff Business School, Cardiff University, Cardiff, CF10 3EU, UK
[b] University of Edinburgh Business School, 29 Buccleuch Place, Edinburgh, EH8 9JS, UK
[c] Edinburgh Business School, Heriot-Watt University, Edinburgh, EH14 4AS, UK

ARTICLE INFO

JEL Classification:
G34
Q54
G51

Keywords:
Climate risk
Cross-border mergers and acquisitions
Payment methods
All-cash offer

ABSTRACT

The impact of climate risk on the payment method in cross-border M&A remains largely unknown in the literature. Using a large sample of UK outbound cross-border M&A deals in 73 target countries from 2008 to 2020, we find that a UK acquirer is more likely to employ an all-cash offer to signal its confidence in a target's value if the target country faces a higher level of climate risk. This finding is consistent with the confidence signalling theory. Our results also suggest that acquirers are less likely to target vulnerable industries if target countries' climate risk is high. In addition, we document that the presence of geopolitical risk would weaken the association between payment method and climate risk. Our findings are robust to the use of an instrumental variable approach and alternative measures of climate risk.

1. Introduction

The COP27 has reached a breakthrough agreement to fund vulnerable countries' loss and damage in the event of climate disasters in November 2022. This is a significant commitment and achievement, considering the geopolitical backdrop after the outbreak of Russia-Ukraine war and soaring energy and raw material prices. Climate change poses significant risks to companies, industries, human society and wildlife, causing dire disruptions and displacements. Economic losses from extreme weather-related events have increased tenfold from the middle of the 20th century (Edenhofer, 2015; IPCC, 2018). A persistent increase in average temperature by 0.04 °C each year would reduce global GDP by 7.22% until 2100 (Kahn et al., 2019). Hence, it is not surprising to see the increased attention on the impact of climate risk on cost of capital (e.g., Balvers et al., 2017; Painter, 2020), firm performance (e.g., Huang et al., 2018; Addoum et al., 2020) and valuation (e.g., Park and Noh, 2017). Furthermore, Chen et al. (2021) show that the climate change risk would affect a country's aggregate level of clean energy investment. Andersson et al. (2016) present a portfolio investment strategy to effectively hedge climate risk. Derived from climate risk, climate policy uncertainty is documented to negatively affect non-renewable energy demand (Shang et al., 2022) and positively drive the performance of green energy stocks (Bouri et al., 2022). These studies provide overwhelming support that climate risk has significant financial implications. However, empirical evidence of the effect of climate risk on corporate investment decisions remains scarce. Climate change may affect managers' investment decisions because it can deteriorate firms' future cash flows through various channels, leading to a wider variances of investment returns (e.g., physical disruption on business operations, transition risks and liability risks). Hence, it is important to understand how managers respond to the climate risk in relation to their investment decisions.

Our paper contributes to this field of research by investigating the impact of target countries' climate risk on UK outbound cross-border mergers and acquisitions (hereafter: M&A). Climate risk can affect cross-border M&A through various transmission channels. First, climate risk can seriously damage the target country's economy, making the cross-border M&A riskier, especially if market access is the main motivation for the acquiring firm. Second, the target country's climate risk could have an impact on the cost of capital for the acquiring firm once takeover is complete. For instance, Painter (2020) documents that the cost of municipal bonds would increase by 33.3 basis points with a 1%

☆ Bing Xu acknowledges the UK Research and Innovation funding of the project "UKRI Interdisciplinary Centre for Circular Chemical Economy" (EP/V011863/1). The standard disclaimer applies.

* Corresponding author.
E-mail addresses: lih86@cardiff.ac.uk (H. Li), Yue.liu@ed.ac.uk (Y. Liu), b.xu@hw.ac.uk (B. Xu).

https://doi.org/10.1016/j.jenvman.2023.118439
Received 10 April 2023; Received in revised form 11 June 2023; Accepted 15 June 2023
Available online 24 June 2023
0301-4797/

increase in climate risk. This is sensible as investors would demand a risk premium for financing target firms located in a country where climate risk is high. Third, climate risk in the target country would impose litigation risk for the acquiring firm and related directors. Connolly and Goslin (2019) argue that the climate risk due diligence should cover the sensitivity of the target firm's business operation and supply chain exposure to climate related disaster (e.g., storm and flooding). Specific litigation risks could arise from investigation into climate-related disclosure, tort litigation (e.g., private nuisance, trespass, and negligence from the target firm) and National Environmental Policy Act of 1969 (NEPA) litigation (e.g., if the target firm is in the US). Although no commonly accepted standards and procedures exist for the climate risk due diligence exercise in cross-border M&A, scrutiny of the target firm's geographical location is vital (Connolly and Goslin, 2019).

If climate risk in the target country has significant financial implication for acquiring firms, we argue that it could also affect deal characteristics in cross-border M&A. Specifically, UK acquirers may employ different payment methods to address the risk concerns derived from target countries' climate risk. The literature has documented ample evidence of managers using different payment methods to hedge against risks related to target countries' characteristics, such as corporate governance and cultural differences (e.g., Cho and Ahn, 2017). The target country's climate risk can also be considered an institutional feature that has long-term financial consequences (Kahn et al., 2019). Therefore, we expect UK acquirers to carefully consider the appropriate payment methods in light of the target country climate risk.

The literature presents two potential explanations for the choice of payment methods in cross-border M&A. The *risk sharing theory* (e.g., Hansen, 1987) suggests that a cash offer is less likely to be used for a risky target because the cash offer would increase the overpayment cost, especially when the risk involved in the target is high. On the other hand, the *confidence signalling theory* (e.g., Fishman, 1989) argues that a cash offer is more likely to be employed for a risky target as it can signal the acquirer's confidence in the target, making the offer more appealing to target shareholders. However, empirical evidence on this matter is mixed (e.g., Chemmanur et al., 2009; Huang et al., 2016). Our paper seeks to answer the following question: Would risk sharing or confidence signalling better explain the choice of payment methods when the target country's climate risk is considered? To the best of our knowledge, this paper is the first to examine the relationship between climate risk and payment method in mergers.

In addition, we further examine the moderation effect of geopolitical risk on the climate risk in the event of cross-border M&A. Caldara and Iacoviello (2022) show that geopolitical risk could significantly reshape the firm and industry level investment activities. Jin et al. (2023) find a strong connectedness amongst climate risk, geopolitical risk, and the energy market, and call for further research on the interactive relation between climate and geopolitical risks. We argue that cross-border M&A serves as an interesting testing field for such an interactive relation. On the one hand, geopolitical risk may strength the impact of climate risk. A high level of geopolitical risk can restrict the resources available to combat climate risk in target countries. In this scenario, acquirer may be more sensitive to target country's climate risk when there is a high level of geopolitical risk presents. We take it as *strengthened effect hypothesis*. On the other hand, geopolitical risk may overshadow climate risk. Geopolitical risk can lead to war, civil unrest, and mass immigration, which affect target countries' economy in a nationwide scale immediately. For instance, the risk arising from Russia-Ukraine war and related sanctions could outweigh the climate risk when acquirers assess whether to choose Russia as a target in cross-border M&A decisions. In this scenario, acquirer would be less sensitive to target country's climate risk in the event of a high geopolitical risk. We refer to this as *weakened effect hypothesis*. In short, we aim to examine whether and how the geopolitical risk in the target country could reshape acquirers' responses to climate risk.

In this study, we focus on the UK data for three main reasons. First, the UK is one of the largest players in cross-border M&A, with a higher volume of outbound M&A compared to its European counterparts (e.g., Goergen and Renneboog, 2004)[1]. Second, there is a strong awareness and concern about climate change in the UK compared to many other countries (Gallup, 2020).[2] The latest UK government survey also confirms that three-quarters of adults in the UK are worried about the impact of climate change ONS, 20211), these may make the climate risk more likely to be considered in managers' decisions on cross-border M&A. Third, the UK has not suffered from extreme weather events as frequently and intensively as many other countries.[3] According to the risk-as-feeling theory, the subjective expectation of risk would affect the risk-taking decision significantly (Weber et al., 2013). In this context, it becomes important for UK acquirers to pay attention to target countries' climate risk, as they are highly likely to encounter target countries with a relatively high climate risk compared to the UK or perceive that climate risk in target countries could be higher.

To capture the climate risk in a target country, we use the average of the Climate Risk Index (CRI) provided by Germanwatch. The index measures the direct loss associated with climate change in different countries. A higher index score indicates a lower level of climate risk (i.e., safer) in a country. In addition, we construct a dummy variable to capture the relative climate risk by comparing target countries' CRI with the UK's CRI. We argue that a target country's climate risk, relative to the acquirer country's climate risk, could potentially play an important role in explaining the impact of such risk on cross-border M&A. We also employ the Global Conflict Risk Index constructed by the European Commission as a proxy of geopolitical risk in the target country.

Our findings are as follows. First, we observe a positive association between a target country's climate risk and the likelihood of an all-cash offer. This indicates that a UK acquirer is more inclined to use an all-cash offer to signal the value and confidence for the target if the target country faces a higher level of climate risk. This is consistent with the confidence signalling hypothesis. Our analysis of the marginal effect further reveals that the probability of all-cash offers could be reduced by 21.8% when moving from risky target countries (e.g., 10th percentile of the climate index) to safe target countries (e.g., 90th percentile of the climate index). These results suggest that the impact of climate risk on the choice of payment methods is both statistically and economically significant. Second, we find suggestive evidence of the association between climate risk and industry selection in cross-border M&A. The UK acquirers are less likely to target an industry which is vulnerable to climate change if the target country faces a higher level of climate risk. Third, we document that there is a positive association between the probability of the use of an all-cash offer and the interactive variable of geopolitical risk and climate risk. It is consistent with our weakened effect hypothesis that geopolitical risk would overweigh climate risk. All in all, we show that climate risk does have a significant impact on cross-border M&A activities.

To check the robustness of our results, we employ target countries' demographic and geographic characteristics as instrumental variables, including their population density and whether they are island

[1] The UK statistics authority, the Office for National Statistic (ONS) reports the total value of UK outbound M&A deals worth £1,040 billion from 1986 to 2019 (ONS, 2020). Source: https://www.ons.gov.uk/businessindustryandtrade/changestobusiness/mergersandacquisitions/datasets/mergersandacquisitionsuk.

[2] As shown in a survey for public awareness of climate change conducted by Gallop in 128 countries between 2007 and 2008, 69% of the British view climate change as a personal threat, compared to 63% of the American, 60% of the German, 29% of the Indian and 21% of the Chinese.

[3] According to Germanwatch's (2019) annual climate risk index, the UK is ranked 106th globally, whereas Australia, the US, Germany, and France are ranked 18th, 27th, 40th and 59th, respectively. Note that a lower rank indicates a higher level of climate risk. A country's absolute and relative climate risk can fluctuate significantly over time.

countries. The results of the instrumental variable (IV) two-stage models are consistent with our main findings, supporting the confidence signalling theory. In addition, the results remain similar when employing an alternative proxy for climate risk. Therefore, our results are unlikely to be driven by the endogeneity issue or specific measures of climate risk.

Our paper has significant implications for several stakeholders. Acquirer shareholders would demand improved information disclosure regarding target countries' climate risk in cross-border M&A. Managers of acquirers should carefully justify the cross-border takeover decision (including the choice of payment methods) when considering the target countries' climate risk. They should also incorporate target country's geopolitical risk when evaluating the impact of climate risk, as the geopolitical risk would undermine the association between payment method and climate risk. Furthermore, as cross-border M&A is one of the prominent forms of foreign direct investment (FDI), our results suggest that governments who encourage FDI should take more actions to combat climate change. Countries with a high level of climate risk may face more scrutiny from foreign acquirers, highlighting the importance of climate change mitigation strategies (e.g., reducing emissions; sustainable financing; adoption of circular economy principles).

The paper is organized as follows. Section 2 provides a brief review of prior literature. Section 3 introduces the methodology and the empirical design. Section 4 describes our data and provides summary statistics. Section 5 reports the results, presents robustness analyses, and discusses the findings. We conclude in Section 6.

2. Literature review and hypotheses development

Our research relates to several strands of prior studies that have examined cross-border M&A. This section provides an overview of the relevant literature in this filed.

2.1. Financial implications of climate risk

The risk associated to climate change has already materialized, as evidenced by the increasing frequency and severity of weather-related natural disasters such as flooding, droughts, and storms (IPCC, 2018). Climate change can exert its impact on the global economy and finance via three major transmission channels: 1) *physical disruption* on businesses (e.g., assets destruction and business disruption); 2) *transition risk* includes business relocation cost and devaluation of assets; and, 3) *liability risk*. Note that there are more than 400 climate change litigation cases recorded in the database of Climate Change Laws of the World.[4] Government, organizations and corporate directors have been sued on the claims of failure to mitigate, adapt, or disclose the impact of climate change.

There is growing attention on investigating the financial implication of climate and climate-related factors across the globe (e.g., Huang et al., 2018). One area of study examines the impact of climate risk on the *cost of capital*. These studies find that a higher level of climate risk would lead to increased costs of equity and debt (e.g., Painter, 2020; Kling et al., 2021). These findings highlight the significance of incorporating climate risk into asset pricing models. Another line of research investigates the influence of climate risk on *firm performance* (e.g., profitability; volatility of earnings) and *valuation*. The results suggest that a higher level of climate risk would lead to a substantially poorer firm performance and a lower Tobin's Q (e.g., Park and Noh, 2017). For example, Huang et al. (2018) show that if a country's annual climate risk score moves from the first to the third quartile, it would reduce this country's firm ROA (Return on Assets) by 1.8%. Hence, the adverse consequence of climate risk on firm level is tangible and sizeable. Previous studies also scrutinize the impact of climate risk on corporate strategies. Kling et al. (2021) argue that climate vulnerability led to a significantly higher cost of capital and curbs on access to finance. Firms (e.g., those in vulnerable industries) who are more sensitive to extreme weather risks may favour the use of long-term debts to mitigate short-run financial restraints caused by climate shocks (Huang et al., 2018). It is well known that climate risk is considered by corporate management when making crucial decisions. However, corporate disclosure regarding climate risk is more affected by corporate governance (e.g., Ben-Amar and McIlkenny, 2014). For instance, firms are more likely to disclose such information if more institutional investors are shareholders (Krueger et al., 2020).

Our survey of the literature on cross-border M&A points to the scarcity of research around the effect of climate risk. Cross-border M&A can be risky as this type of transaction usually involves dealing with many complex issues such as differences in accounting standards, the economy, formal and informal institutional factors (e.g., investor protection, law, and culture) between the acquiring and target nations (Li et al., 2020). Cross-border M&A is more likely to become a value-destroying deal if it is driven by non-synergy motivations such as CEO compensation (Choi et al., 2020). Koerniadi et al. (2015) show that the acquirer's default risk in the post-merger period is affected by several target characteristics, especially by the target industry risk. In this paper, we argue that the risk of the target firm could be associated with the climate factors in the target nation. Therefore, the acquirers should take the impact of the target country's climate change risk into consideration when making the cross-border M&A decision.

2.2. Choice of payment methods in mergers and acquisitions

There are two competing theories in explaining the choice of payment methods in the M&A literature. The first theory is *risk sharing*. Hansen (1987) predicts that a stock offer is more likely to be used in M&A if the target is difficult to value due to a high level of information asymmetry. Compared to the cash offer, the stock offer has the advantage of reducing the risk of potential overpayment because target shareholders will share the loss (if any) after receiving the acquirer's stock in the transaction. Consistent with Hansen's (1987) prediction, Huang et al. (2016) document that acquirers tend to use more stock offers in cross-border M&A, if the target country faces a higher level of corporate governance risk than the acquirer country. For instance, an all-cash offer is less likely to be used for a deal if the acquirer is from a common law country and the target is from a civil law country. The rationale behind this is that the level of investor protection would be stronger in common law than in civil law countries (e.g., La Porta et al., 1998), so the governance risk in the acquirer country (if it is a common law country) is lower than that in the target country (if it is a civil law country). Therefore, the acquirer has a stronger motive to use stock offers to reduce its relatively high governance risk through risk-sharing. Furthermore, Cho and Ahn (2017) find that a stock offer would benefit the acquirer more if the agency problem is severe in the target country, as equity would align the interests between the acquirer and the target after deal completion. Lee (2018) shows that if the target country faces more political uncertainties, the acquirers are more likely to use stock rather than cash offers in cross-border M&A. He argues that political risk in the target country could increase the acquirers' power of bargaining, leading to a higher probability of reaching agreement on the stock offer which is favoured by the acquirers.

The second theory is *confidence signalling*. Fishman (1989) believes that a distinguishing advantage of a cash offer over a stock offer is that the cash offer could signal the high value of the target, encouraging target shareholders to accept the deal. When employing a cash offer, the acquirers will bear the full cost if they overpay the targets. Therefore, the cash offer conveys a strong signal regarding the true value of the target. Consistent with Fishman's (1989) predilection, Chemmanur et al. (2009) document that the probability of a cash offer is higher if the

[4] Climate Change Laws of the World database has a global coverage (30 countries). Data are collated by institutes at the LSE and Columbia Law School. https://climate-laws.org/.

analysts' earnings forecast error on the target is larger. That is, a cash offer is more likely to be employed if the information asymmetry is larger for the target. The high level of information asymmetry for the target could encourage the acquirers to signal their private information and confidence about the value of the target. In this sense, the cash offer could serve as an explicit signal conveying such a message. Besides the acquirer shareholders, target shareholders would also prefer cash offers because the value of the cash offer carries more certainty compared to that of the acquirer's stock. This is especially the case in cross-border M&A when the acquirer's stock is listed in a foreign stock exchange and traded in the form of a foreign currency. Chakrabarti et al. (2009) demonstrate that all-cash payment is the optimal method when acquirer and target countries' cultures are disparate. They argue that a cash offer is a signal of better due diligence in the selection of targets. Rossi and Volpin (2004) document a negative association between the probability of an all-cash offer and the acquirer country's inventor protection level. This suggests that a cash offer is more common if the acquirer country is weak in investor protection. In other words, target shareholders would prefer a cash offer over a stock offer when the acquirer's stock is listed in a market where the protection for investors is weak. Eckbo et al. (2018) examine the impact of information asymmetry on payment methods. They document that if targets are poorly informed about the acquirers, they would accept a lower fraction of stock payment. Using European cross-border M&A data, Goergen and Renneboog (2004) document that the market reaction to the target's stock is affected by the choices of payment methods. The abnormal return for target shareholders is 20% in all-cash offers, compared to 14% in all-stock and 12.5% in hybrid offers. Their findings clearly support the preference for all-cash payment from the perspective of the target shareholder.

In summary, the target's risk may discourage the acquirer to use cash offers due to the high cost of potential overpayment. On the other hand, the risk of the target may also encourage cash offers because the acquirer is motivated to signal the target's value. Therefore, the choice of payment methods may depend on the trade-off between a cash offer's benefit (e.g., increasing the successful rate of a takeover) and cost (e.g., bear a higher risk of overpayment). If the acquirer's main concern is the risk of overpayment due to a high level of climate risk in a target country, they would be discouraged from employing a cash offer. This is our risk sharing hypothesis. Alternatively, if the acquirer intends to signal the high value of the target, and they are confident about the deal in a country with a high level of climate risk, they would be encouraged to employ a cash offer. This is our confidence signalling hypothesis.

In this study, our focus is on a specific type of payment method, the all-cash offer. First, the all-cash offer is the most common payment method in cross-border M&A. Based on European samples, all-cash offers represent 59% of the deals in Goergen and Renneboog (2004) and 68% in de La Bruslerie (2013). In our study of the UK sample, 64% of deals are conducted via all-cash offers. Second, an all-cash offer is the "corner solution" for testing both the risk sharing theory and the confidence signalling theory, because an all-cash offer could bring two certainties: a risk-free price for target shareholders and a 100% risk-bearing for acquirer shareholders (de La Bruslerie, 2012). In other words, an all-cash offer indicates the maximum level of confidence signalling with a minimum level of risk sharing. Therefore, we develop the following hypotheses:

H1. (risk sharing hypothesis): An acquirer is *less likely to employ an all-cash offer* if the target country faces a higher level of climate risk.

H2. (confidence signalling hypothesis): An acquirer is *more likely to employ an all-cash offer* if the target country faces a higher level of climate risk.

2.3. The moderation effect of geopolitical risk on climate risk in cross-border M&A

In this study, we also investigate the effect of climate change risk on M&A under the influence of geopolitical risk. We argue that the reaction of acquirers to the climate change risk in the target nation would be moderated by the geopolitics risk. There is a joint effect between climate risk and geopolitical risk on cross-border M&A.

First, it is believed that geopolitics risk could have significant implications for climate risk. Caldara and Iacoviello (2022) show that a high level of geopolitical risk would jeopardise the global corporation, a key strategy to combat climate risk. For instance, following the outbreak of Russia-Ukraine war in 2022, the UN climate change negotiating bloc ceased cooperation with Russia and Belarus. In addition, Zhao et al. (2023) demonstrate that geopolitical risk negatively affects the demand for renewable energy. They argue that geopolitical risk not only raises investment costs in the private sector but also alters government spending patterns, potentially resulting in the crowding-out effects for renewable energy sector. Zhang et al. (2023) find that increasing levels of geopolitical risk are linked to lower return of green finance, thereby discouraging the use of such a financial vehicle to tackle climate risk.

Second, climate risk could also affect geopolitical risk. Su et al. (2021) document that the use of renewable energy can elevate geopolitical risk. They argue that the renewable energy, as a crucial climate risk mitigation policy, has the potential to reduce political influence of traditional oil and gas exporter countries. This shift could lead to a reshuffling of geopolitical power dynamics. Bošnjaković (2012) surveys the literature and highlights several significant channels derived from climate risk to affect geopolitical risk. For instance, the climate risk would deteriorate the supply of food and water, causing cross-border immigration. Some emerging countries (e.g., China, India) may view the competition in renewable energy as an opportunity to enhance their relative geo-economic influence. Such an intension of breaking existing geopolitical balance may affect global peace and stability.

In our concern of cross-border M&A, the moderation effect of geopolitical risk on climate risk is interesting. On the one hand, geopolitical risk has the potential to amplify the impact of climate risk in target countries. For instance, high levels of geopolitical risk can result in instability and hinder resources allocated to addressing climate risk. In this case, we would expect acquirers to be more sensitive to climate risk of target countries in the shadow of geopolitical risk. Hence, we propose the following strengthened effect hypothesis:

H3. (Strengthened effect hypothesis): The association between the likelihood of employing an all-cash offer and target country's climate risk would be stronger, if the target country exhibits a high level of geopolitical risk.

On the contrary, the geopolitical risk may compete with climate risk when acquirers make the cross-border M&A decision. For instance, geopolitical risk may exert a greater impact on target countries' economy compared to climate risk. Wars, social unrest, and violence associated to geopolitical risk would have immediate and widespread effects on the economy of target countries, as demonstrated by the Russia-Ukraine war and subsequent sanctions. In this scenario, geopolitical risk would outweigh climate risk to affect cross-border M&A. Therefore, we would anticipate acquirers to be less sensitive to target countries' climate risk when geopolitical risk is high. Our weakened effect hypothesis is listed below:

H4. (Weakened effect hypothesis): The association between the likelihood of employing an all-cash offer and target country's climate risk would be weaker, if geopolitical risk is high in the target country.

3. Method

Using a sample of UK outbound deals, we conduct analyses to investigate the potential effect of climate change risk in cross-border M&A. The regression models and the variables are introduced in this section.

3.1. Baseline model

Our model assumes that an acquiring firm's ability and willingness to use an all-cash offer as their payment method depends on a list of factors. To explore the explanatory power of the climate risk in target country for the choice of payment methods, we start with a naïve logistic regression. The climate risk proxy (Climate Index) is the sole explanatory variable:

$$All\ Cash = \alpha + \beta Climate\ Index + \varepsilon$$

All Cash is a binary variable, which is equal to one if cash is the only form of payment and otherwise zero. We use two measures for climate risk: 1) a raw (absolute) average climate index of the target country named "Climate Index Average"; and, 2) a relative climate risk measure named "Relative Climate Dummy". Note that a higher Climate Index Average value indicates the target country bears a lower level of climate risk. To construct the relative measure, we first compute the difference ($\Delta ClimateIndex_t$) between the target country's average score of climate risk index and the UK's average score of index. Then the dummy variable is computed as:

$$Relative\ Climate\_Dummy = \begin{cases} 1, & if\ \Delta ClimateIndex_t > 0 \\ 0, & Otherwise \end{cases}$$

The relative measure allows us to capture the effect (if any) of the climate change risk difference between a target country and the UK on the method of payment. The detailed explanation of the climate score is presented in the data section.

It should be noted that the proxy for climate risk employed in this study is an ex-post measure based on realised losses from extreme weather events. This approach allows us to capture the tangible risk resulting from climate change as it focuses on the outcome effect (e.g., losses resulting from historical climate events). Another proxy that has been used to gauge carbon risk is an ex-ante measure based on carbon emission and energy use (e.g., Bolton and Kacperczyk, 2021). This measure focuses on the input effect (e.g., the factors resulting in climate change) and may capture indirect costs related to climate change such as risk of additional emission-related expenses and risk of potential legal and regulatory sanctions related to carbon emission. Considering that our research focus in this study is the effect of physical risk of climate change, we choose to use the ex-post measure. In future studies, it would be valuable to explore the potential effect using the ex-ante carbon emission and energy use measure.

Next, we augment another key variable in our model, which is Global Conflict Risk Index developed by the European Commission as a proxy for geopolitical risk. It is the predicted value of the possible conflict intensity and calculated as the maximum value between the intensity at the national and subnational levels in the target country. The indexing method captures six dimensions including political, security, social, economic, geography-environment, and demographical factors, which are closely related to the occurrence of violent conflicts. The index is scaled from between 0 (the lowest conflict intensity) and 10 (the highest conflict intensity) (Schvitz et al., 2022).[5] That is, a greater Global Conflict Risk Index value represents a higher geopolitical risk in a target nation; and vice versa. Our regression models include both industry-specific and year dummies. Furthermore, we employ the two-stage Probit model to mitigate the possible endogeneity problem, using two instrumental variables (*Population Density* and *NonIsland*) for the climate risk proxy. The rationale of choosing them to be the instrumental variables is discussed in Section 5.

[5] See Schvitz et al. (2022) for the prediction model and the technical details about the indexing method.

3.2. Other variables

Based upon the naïve model, we further incorporate deal, firm and country controls in our regressions to avoid misspecification errors:

$$All\ Cash = \alpha + \beta_1 Climate\ Index + \beta_2 Global\ Conflict\ Risk\ Index + \gamma_1 Deal\ Controls + \gamma_2 Firm\ Controls + \gamma_3 Country\ Controls + \varepsilon$$

Following prior studies in the literature, we use one year lag for firm-characteristics and use the value in the announcement year) for deal characteristics and target country controls. We include *Same Industry*, *Deal Value*, *Relative Size* and *Public Target* to control for deal characteristics. *Same Industry* is defined as a dummy variable which is equal to one if the acquiring firm and the target firm share the same first two digits of the SIC codes, and zero otherwise. *Deal Value* is the measure of the scale of the transaction. It is equal to *Ln* (transaction value ($mil) of a deal). We also control for the relative size ratio, which is equal to the deal size divided by the acquirer size. *Public Target* is equal to one if the status of the target is public, and otherwise zero. The control variables for acquirer characteristics include return on total assets (*ROA*), gearing ratio (*Gearing*), liquidity ratio (*Liquidity*), and *Tobin's Q*. The continuous variables of both deal and firm characteristics are winsorised at 5% level. We also control for the characteristics of target countries including the growth rate of GDP (*GDP Growth*), the size of the capital market (*Market Cap*), shareholder protection (*Shareholder Right*) and the accounting quality (*Accounting Rating*).

Besides the payment method, we also examine how climate change risk affects industry vulnerability and acquirer size. Therefore, we replace *All Cash* and employ another two dependent variables in further regressions: *Vulnerable Industry* and *Acquirer Size*. *Vulnerable Industry* is a dummy to indicate whether the target firm is in a vulnerable industry, which is equal to 1 for a vulnerable industry, and 0 otherwise. The classification of vulnerable industries is based on the literature on climate change and its financial impact. Some prior studies suggest that extreme weather could cause severe damage on physical assets or disruption of operations, consequently leading to losses in revenue (McCarthy et al., 2001). As there is significant variation in the level of physical assets and the sensitivity to operational stability in different industries, the vulnerability to climate risk could vary across industries. In particular, industries characterised by heavy fixed assets tend to be more vulnerable to climate risk as the production of goods or services relies greatly on the infrastructure or physical assets that could not be easily restored. *Energy, utilities, telecommunications, transportation*, and *healthcare* are typical industries that are vulnerable to climate risk due to their high long-term capital assets (McCarthy et al., 2001). While some industries rely less on fixed assets, they could still be vulnerable to climate risk due to their dependence on certain natural resources or conditions (Challinor et al., 2014). For instance, *agriculture* depends on the availability of land, water, and certain weather conditions (e.g., temperature and sunshine) that could be heavily influenced by climate change. Therefore, we classify *agriculture*, *business services*, *communication, energy (mines), energy (coal), energy (oil), food products, healthcare,* and *transportation* as vulnerable industries, following Huang et al. (2018). *Acquirer Size* is defined as *Ln* (acquirer's total assets) in last financial year.

4. Data and summary statistics

4.1. Data

Our sample covers the outbound acquisition deals conducted by the UK public firms between 1st January 2008 and 31st July 2020.[6] Deal

[6] The sample period starts from 2008 as data for climate risk indices are available only from that year.

information and characteristics are collected from the Securities Data Company (SDC) database via the Thompson Financial platform. Financial acquirers and targets are excluded as cross-border M&A in the financial sector could be heavily affected by regulations (Gulamhussen et al., 2016). We also require that the proportion of shares of the target acquired is greater than 50% to ensure that the deal is strategic and significant for the acquirer. These screening criteria provide an initial sample of 1083 deals. We also extract climate risk information from Germanwatch and acquirer characteristics from the FAME database. Merging climate risk with firm data yields a final sample of 932 UK outbound cross-border deals, covering 73 target countries.

In this paper, we measure the climate risk of a target nation by using Global Climate Risk Index (CRI) constructed by Germanwatch. It estimates the direct loss in the events that are related to extreme weather (e.g., floods, hurricanes, etc.)[7] for a specific country, using the global data collected by Munich Reinsurance - one of the world's leading reinsurance companies. This is constructed based on four main factors, including death toll, death number per hundred thousand residents, total losses in US dollar and direct losses per unit of GDP (Germanwatch, 2019). This index is among the best datasets concerning the impact of climate change-related weather phenomena. The CRI published its first annual edition in 2008 and the most recent 2020 index is the 15th edition of its annual analysis.[8] In each edition, they report two main sets of data: 1) annual scores; and, 2) long-term average scores based on the past twenty years. In our study, we primarily focus on the long-term risk because managers are likely to be more concerned about the target country's long-term risk than simply a snapshot of its risk.

Fig. 1 presents the scale of climate risk of 73 target countries covered in our sample of deals. We rate the average climate index value of each country on a scale of 1–9 and use colours to represent the nine scales in the map. The higher the scale, the higher the climate risk. Bangladesh, Indonesia, Thailand, India, China, France, Mozambique, Italy, and Germany are the nine target countries with the highest climate risk (scale = 9, colour = red), while Gambia, Singapore, Trinidad and Tobago, United Arab Emirates, Malta and Finland are the countries having the lowest climate risk (scale = 1, colour = dark blue). As the figure shows, our sample of cross-border deals comprises a significant variance in climate risk across target countries, which allows us to test the potential impact of climate change risk in different countries on the form of payment.[9] Our sample analysis shows significant variances for climate risk between countries (i.e., risk is different between countries) and within-group (i.e., risk is changing across years for the same country).

4.2. Summary statistics

Panel A of Table 1 presents target region distribution. The target countries of the UK outbound M&A cover all eight regions in the world, showing that our data have good global representation. North America is the most popular region for UK acquirers, with a total of 431 deals; Europe is the region with the most target countries (28 countries) and a second highest number of deals (268 deals). Our sample also contains 233 deals in other regions. This distribution is consistent with previous studies that suggest a preference of UK firms for developed and English-speaking countries in choosing targets (e.g., Conn et al., 2005). The distribution of target industries is provided in Panel B. High technology is the industry with the highest number of deals (222 deals), followed by industrials (157 deals), consumer products and services (130 deals), and materials (113 deals) . The panel also shows that the sample contains 521 deals in vulnerable industries, higher than the number of deals in non-vulnerable industries (411 deals). The distribution by year is presented in Panel C. The year with the highest number of deals is 2008 (128 deals), and 2020 is the year with the lowest number (17 deals) as our sample period ends on 31 July 2020. The numbers of deals in other years have a relatively low level of variance.

The summary statistics of variables are provided in Table 2. The mean climate index value of target countries is 60.535 with a standard deviation of 30.09 and a range of 19.5 (the highest climate risk) to 173 (the lowest climate risk), demonstrating that our data captures a wide climate risk spectrum across countries. Comparison with the acquiring country, the UK, as shown by the mean of the relative climate index dummy, the index value in the target country is higher (i.e., lower climate risk) in only 28.8% of deals, while it is lower (i.e., higher climate risk) in 71.2% of deals. This suggests that most deals in our sample are in target countries where climate risk is higher than the UK. Regarding the geopolitical risk, the mean value of global conflict risk index is 0.436 with a standard deviation of 1.748; and the range is between 0 (the lowest geopolitical risk) and 10 (the highest geopolitical risk). During our sample period, Ukraine (index value in 2020) and Israel (index value in 2019) are among the countries with the highest predicted geopolitical risk.

The statistic also shows that cash is the only form of payment in 63.5% of deals in our sample. This is consistent with several previous studies which suggest that cash is a preferred payment method in cross-border deals (Dos Santos et al., 2008). The proportions of deals targeting vulnerable industries and those targeting non-vulnerable industries are relatively balanced, although the prior is slightly higher (55.9% for vulnerable industries). *Ln* (acquirer's total assets) value ranges from 2.274 to 10.836, indicating that our sample covers deals with a wide acquirer size range.

4.3. Univariate analysis

Before running the multivariate regressions, we conduct a univariate analysis of the main variables by using all-cash payment vs. non-all-cash payment, vulnerable industry vs. non-vulnerable industry, and large acquirer vs. small acquirer sub-samples, respectively. We compare the means and medians of the climate index between sub-samples. The results are presented in Table 3. Panel A shows that the mean of the absolute Climate Index Average for the all-cash sub-sample (58.864) is lower than that for the non-all-cash sub-sample (63.453). The mean difference between them is −4.588 (sig. level = 5%), which suggests a significant correlation between the employment of the pure cash form payment and the target country's climate change risk. That is, the higher the climate change risk (i.e., the lower the absolute Climate Index Average value) in the target country, the higher the probability of using only cash to pay a deal. This finding is against our risk sharing hypothesis (H1) but supports the confidence signalling theory (H2) as proposed by Fishman (1989). When facing higher climate risk in the target country, the acquirer has a stronger motive to employ an all-cash offer to signal their confidence in the deal. To ameliorate the potential concern over the distortion of results due to the distribution of data, we next compare the medians. We report that the median of the absolute Climate Index Average for the all-cash sub-sample (47.5) is also lower than that for the non-all-cash sub-sample (50.17). The difference between them is −2.670 (sig. level = 5%). The significant difference in median further confirms our confidence signalling hypothesis.

In the univariate analysis based on industry vulnerability, we report that the mean value of the absolute Climate Index Average for the vulnerable industry sub-sample (62.689) is significantly (sig. = 5%) higher than the non-vulnerable industry sub-sample (57.81). This result

[7] This climate index only incorporates weather-related events.

[8] Note that there is a two years' lag between the time of publication and the risk year.

[9] In Appendix 1, we present the mean values of the extreme weather-related annual absolute total losses in US dollar, direct losses per unit of GDP, and death toll per hundred thousand residents in some countries across eight regions in our sample. It shows that extreme weather events have a significant and variant effect in terms of dollar losses and fatalities across different countries.

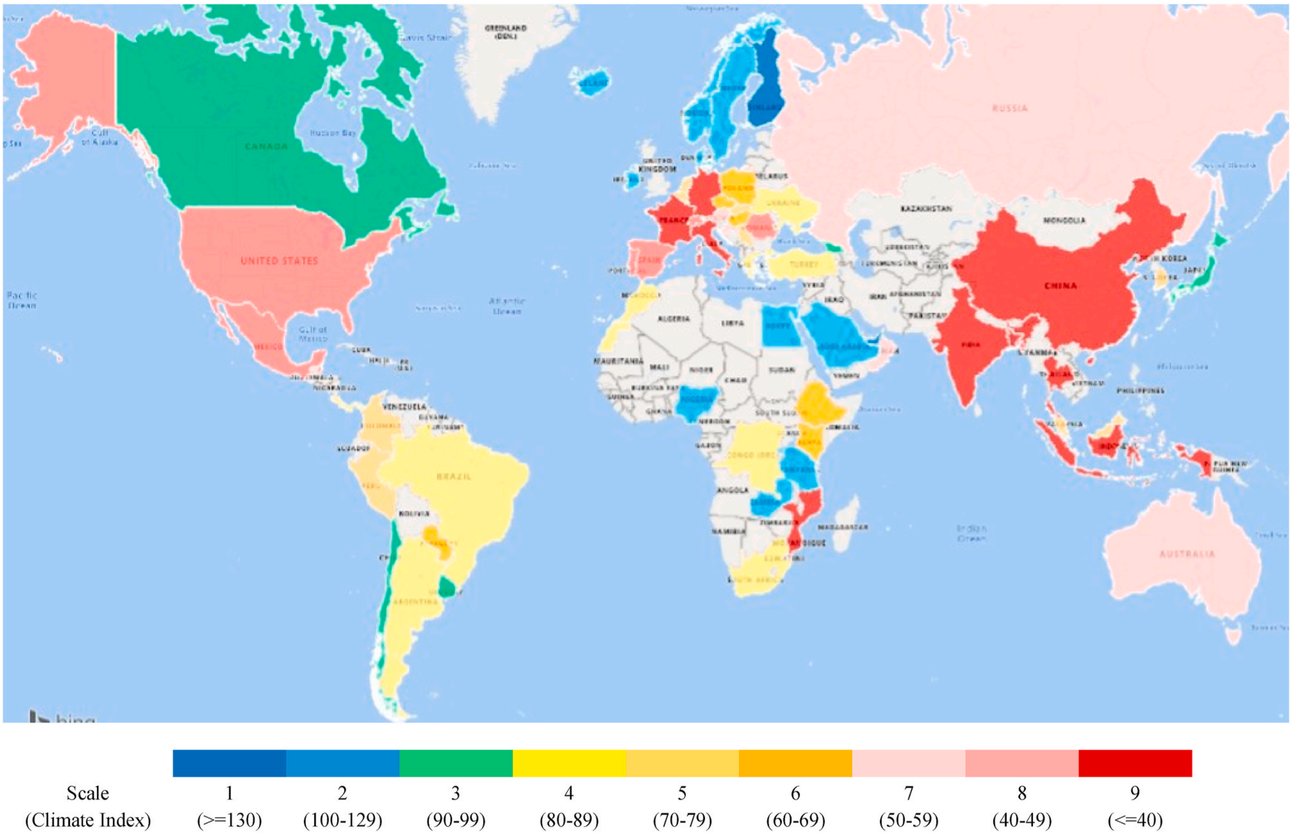

Fig. 1. Climate Risk of Target Countries in UK Outbound Cross-border M&A from 2008 to 2020. This figure shows the scale of the average climate index in 73 target countries covered in our study. The colours represent nine scales (1–9) of climate risk. A higher scale indicates a higher climate risk.

may suggest that acquirers may be more likely to choose a relatively "safe" (i.e., higher climate index, lower climate risk) country if their target industry is vulnerable, since the risk associated with the vulnerable industry could be relatively lower in a "safe" country than in a "risky" (i.e., lower climate index, higher climate risk) country. We also classify acquirers as "Large" ("Small") if the natural log value of the acquirer total assets is above (below) the median. We find that the mean of the absolute Climate Index Average for the large acquirer sub-sample (58.52) is significantly (sig. = 10%) lower than the small acquirer sub-sample (62.00). It seems that large firms are more likely (or have a stronger ability) to take the climate risk of the target country in cross-border deals, while such risk is much less affordable for small firms.

Besides the comparison of the absolute climate index value, we further compare the relative climate index value (i.e., Target Climate Index Average minus UK Climate Index Average) in order to capture the climate risk of target country relative to that of acquirer country. Panel B. shows that the mean of the relative Climate Index value for the all-cash sub-sample (−9.376) is lower than that for the non-all-cash sub-sample (−5.691). The mean difference between them is −3.685 (sig. = 10% level). This is similar to finding based on the absolute climate index, although the significance level is slightly lower. We also report the mean of the relative Climate Index value for the vulnerable industry sub-sample (−6.001) is significantly (sig. = 5%) higher than that for the non-vulnerable industry sub-sample (−10.606), and the mean of the relative Climate Index value for the large acquirer sub-sample (−10.501) is significantly (sig. = 5%) lower than that for the small acquirer sub-sample (−6.111). The median test result is similar to the finding when using the absolute proxy, except that the difference loses the significance when comparing all-cash with non-all-cash sub-samples. In general, most results are approximately in line with those based on the absolute Climate Index value, suggesting that the use of two different proxies for climate change risk does not change our results essentially.

5. Empirical findings and discussion

The purpose of this section is threefold. First, we report the empirical findings about the impact of climate risk on the selection of payment methods. Second, we discuss the results on how target countries' climate risk affects UK acquirers' decision-making processes on target selection and self-selection. Third, we present the robustness analyses.

5.1. Impact of climate risk on choice of payment method

Table 4 presents the logistic regression analysis of the effect of the target country's climate risk on payment method in outbound acquisitions. Both industry-dummy and year-dummy are included in all models. Columns (1) to (4) show results for our first Climate Index measure, which is the mean climate risk score for the target nation. Columns (5) to (8) show results for our alternative Climate Index measure (i.e., Relative Climate Dummy). For both measures, we first provide our results using the climate index only – see columns (1) and (5). Then we gradually include deal/acquirer characteristics and country characteristics into the regressions. Specifically, in columns (2) and (6), we add basic deal and acquirer characteristics, including *Same Industry*, *Deal Value, Relative Size*, *Public Target*, *ROA Gearing* and *Liquidity* variables. Then in columns (3) and (7), we add country characteristics into the regressions, including *GDP Growth* (e.g., Pablo, 2009), *Market Cap* (e.g., Erel et al., 2012), *Shareholder Right* and *Accounting Rating* (e.g., La Porta et al., 1998). Finally, we add *Tobin's Q* as an extra control in columns (4) and

Table 1
Sample distributions.

Panel A. Distribution by Region	Freq.	Percent	Cum. Percent
North America (3)	431	46.24	46.24
Europe (28)	268	28.76	75.00
Australia & Oceania (2)	104	11.16	86.16
Asia (9)	41	4.40	90.56
South America (7)	29	3.11	93.67
Africa (12)	29	3.11	96.78
Middle East (7)	24	2.58	99.36
Central America & the Caribbean (5)	6	46.24	46.24
Panel B. Distribution by Industry			
Target Industry			
High Technology	222	23.82	23.82
Industrials	157	16.85	40.67
Consumer Products and Services	130	13.95	54.62
Materials	113	12.12	66.74
Healthcare	102	10.94	77.68
Media and Entertainment	69	7.4	85.08
Energy and Power	53	5.69	90.77
Consumer Staples	31	3.33	94.1
Retail	28	3	97.1
Telecom	23	2.47	99.57
Real Estate	4	0.43	100
Vulnerable Vs. Non-vulnerable Industry			
Vulnerable Industry	521	55.90	55.90
Non-vulnerable Industry	411	44.10	100
Panel C. Distribution by Year			
2008	129	13.84	13.84
2009	57	6.12	19.96
2010	89	9.55	29.51
2011	94	10.09	39.59
2012	74	7.94	47.53
2013	66	7.08	54.61
2014	76	8.15	62.77
2015	83	8.91	71.67
2016	52	5.58	77.25
2017	64	6.87	84.12
2018	64	6.87	90.99
2019	67	7.19	98.18
2020	17	1.82	100

The table presents region (Panel A), target-industry (Panel B) and year (Panel C) distribution. The number of countries in each region is also reported in parentheses in Panel A.

Table 2
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Climate Index (Absolute Average)	932	60.535	30.09	19.5	173
Climate Index (Relative Dummy)	932	0.288	0.453	0	1
Global Conflict Risk Index	711	0.436	1.748	0	10
All Cash	932	0.635	0.482	0	1
Vulnerable Industry	932	0.559	0.497	0	1
Acquirer Total Assets (ln ($mil))	880	6.343	1.997	2.274	10.836
Same Industry	932	0.674	0.469	0	1
Deal Value (ln($mil))	932	3.26	1.653	0.453	7.646
Relative Size	709	0.220	0.551	0.001	3.151
Public Target	932	0.103	0.304	0	1
ROA	852	4.859	15.89	−64.019	24.981
Gearing	795	68.215	66.969	0.891	295.021
Liquidity	852	1.719	1.86	0.419	10.483
Tobin's Q	601	1.578	1.065	0.301	5.052
GDP Growth	925	2.226	2.56	−7.800	14.526
Market Cap	858	105.687	48.085	4.776	352.156
Shareholder Right	848	4.044	1.317	0	5
Accounting Rating	818	69.298	6.371	24	83
CCPI Score	883	47.608	12.973	8.82	76.28
Currency	929	0.257	0.437	0	1
Population Density	932	149.509	731.514	3	7894
NonIsland	932	0.945	0.228	0	1

The table reports summary statistics of the climate index, the geopolitical risk index, deal-related variables, and firm characteristic variables.

(8), respectively.[10] A higher Tobin's Q suggests the acquirer faces more investment opportunities, and the stock is more likely to be "overvalued". It is not surprising that the sample size decreases (i.e., from 932 to 340) due to data availability as more control variables are added into the model.

The coefficients of *Climate Index* are negative and statistically significant in all regressions. Our results indicate that the likelihood of all-cash payment is lower if the *climate index* is larger. In other words, an acquirer is more likely to employ an all-cash offer if the target country faces a higher level of climate risk (i.e. lower climate index scores). The results are consistent no matter what climate risk measure (absolute level or relative climate risk compared to the UK) we use. For instance, the coefficient of the average climate index (column (3)) is −0.016, which indicates that if the target country's climate index increases by one unit, the log of odds ratio (i.e., employing an all-cash offer over not employing an all-cash offer) would decrease by 0.016. We further investigate the magnitude of this impact by examining the marginal effect. Our result (in column (3) of Panel A in Appendix 2) shows that the likelihood of paying all-cash is decreased by 0.3% for per unit increase in climate index.[11] Thus, moving from risky countries (e.g., 10th percentile, 30.5) to safe countries (e.g., 90th percentile, 103.17) can reduce the probability of an all-cash offer by 21.8%.

When using the relative climate risk measure, we also report significant negative coefficients of the climate variable across all four specifications. For instance, the coefficient on relative climate variable (column (7)) is −0.973, suggesting that an acquirer is more likely to employ an all-cash offer if the target country has a higher level of climate risk than the acquirer country (i.e., the UK). We again examine the marginal effect, based on this relative climate risk measure. We report a significantly large difference in the marginal effect on payment forms. Specifically, the acquirer is 18.8% (in column (7) of Panel B in Appendix 2) more likely to use an all-cash offer when the target nation has greater climate risk than the UK. Moreover, our predictive margin results show that the average probability of an all-cash offer is 46.1% if the target country is safer than the UK in terms of climate risk, whereas it increases to 66.4% if the target country poses a higher level of climate risk than the UK. In addition, we find that the UK acquirers' profitability, measured by *ROA,* is positively related to an all-cash offer. The result is in line with some prior studies that suggest the profitable acquirers could have a rich cash reserve which may lead them to make all-cash offers (Martin, 1996).

In sum, our results support the confidence signalling hypothesis (H2), and suggest a positive association between the probability of an all-cash payment and a target country's climate risk. A UK acquirer is more likely to employ an all-cash offer to signal the value and confidence for the target if it is located where climate risk is high. Furthermore, it is well known that a cross-border takeover is a complex and risky investment decision (Erel et al., 2012). A higher level of uncertainty triggered by the target country's climate risk would further increase the variance of the distribution of the investment returns. Hence, acquirers may behave more conservatively to avoid using a payment method (e.g., stock) that has more long-term implications.

5.2. Impact of climate risk on industry selection

We have presented evidence that the target country's climate risk would affect the probability of an all-cash offer in outbound acquisitions. Given the importance of the climate risk, we predict that an

[10] Tobin's Q is introduced into the model separately as adding it significantly reduces the sample size.

[11] The results of the marginal effects and predictive margins are presented in Appendix 2.

Table 3
Univariate analysis: Climate risk, payment method, vulnerable industry, and acquirer size.

	Payment Method			Vulnerable Industry			Acquirer Size		
	All Cash (1)	Non-all Cash (2)	Differen ce(1)-(2)	Vul. Ind. (3)	Non-vul. Ind. (4)	Difference (3)–(4)	Large (5)	Small (6)	Difference (5)–(6)
Panel A. Climate Index Average									
Mean	58.864	63.453	−4.588**	62.689	57.810	4.878**	58.52	62.00	−3.475*
t-stat			(-2.244)			(2.463)			(-1.725)
Median	47.5	50.17	−2.670**	48.83	47.5	1.33**	47.5	48.5	−1
Wilcoxon z-stat			(-2.119)			(1.998)			(-1.600)
Panel B. Relative Climate Index Value (*Target Climate Index Average minus UK Climate Index Average*)									
Mean	−9.376	−5.691	−3.685*	−6.001	−10.606	4.605**	−10.501	−6.111	−4.389**
t-stat			(-1.717)			(2.217)			(-2.078)
Median	−18.67	−18.33	−0.34	−18.33	−19.67	1.34*	−19.585	−18.33	−1.255**
Wilcoxon z-stat			(-1.296)			(1.817)			(-2.244)
Observations	592	340		520	412		440	440	

The table compares means or medians of the climate index (absolute proxy in Panel A and relative proxy in Panel B) between sub-samples based on different payment methods (All Cash Vs. Non-all Cash), industries (Vulnerable Industry Vs. Non-vulnerable Industry) and acquirer size (Large Vs. Small). The two-sample *t*-test and Wilcoxon *z* test statistics are presented in parentheses. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 4
Impact of climate risk on choice of payment method.

Dep. Var. = All Cash	Climate Index Average				Relative Climate Dummy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Climate Index	−0.007***	−0.008**	−0.016***	−0.027***	−0.440***	−0.695***	−0.973***	−1.086***
	(0.002)	(0.003)	(0.005)	(0.007)	(0.163)	(0.212)	(0.287)	(0.351)
Same Industry		−0.207	−0.417*	−0.583*		−0.197	−0.424*	−0.587*
		(0.204)	(0.232)	(0.303)		(0.205)	(0.234)	(0.303)
Deal Value		0.018	0.058	0.097		0.019	0.069	0.097
		(0.073)	(0.081)	(0.095)		(0.071)	(0.080)	(0.093)
Relative Size		−1.372**	−1.381**	−0.972**		−1.359**	−1.391**	−0.924**
		(0.622)	(0.632)	(0.417)		(0.600)	(0.623)	(0.408)
Public Target		0.332	0.624	0.906*		0.325	0.607	0.804*
		(0.336)	(0.396)	(0.467)		(0.332)	(0.383)	(0.441)
ROA		0.041***	0.042***	0.027		0.042***	0.042***	0.028
		(0.013)	(0.015)	(0.018)		(0.013)	(0.015)	(0.018)
Gearing		−0.0004	−0.001	0.001		−0.0003	−0.001	0.001
		(0.001)	(0.002)	(0.002)		(0.001)	(0.002)	(0.002)
Liquidity		−0.031	−0.022	−0.053		−0.032	−0.033	−0.050
		(0.070)	(0.083)	(0.098)		(0.071)	(0.084)	(0.097)
GDP Growth			0.0183	−0.022			0.007	−0.054
			(0.072)	(0.111)			(0.071)	(0.109)
Market Cap			−0.002	−0.006			−0.001	−0.004
			(0.003)	(0.004)			(0.003)	(0.004)
Shareholder Right			−0.005	−0.037			−0.014	−0.054
			(0.105)	(0.136)			(0.106)	(0.138)
Accounting Rating			0.016	0.049*			0.003	0.037
			(0.020)	(0.028)			(0.021)	(0.027)
Tobin's Q				0.045				0.029
				(0.164)				(0.165)
Constant	0.770***	0.682	0.524	0.244	0.511**	0.379	0.707	0.031
	(0.281)	(0.439)	(1.333)	(1.890)	(0.253)	(0.413)	(1.323)	(1.846)
Industry control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	932	594	490	340	932	594	490	340
pseudo R^2	0.056	0.109	0.141	0.170	0.056	0.116	0.143	0.163

The table presents the logit regressions of the payment method on target country climate index. The dependent variable (All Cash) is equal to 1 for an all-cash offer, and 0 otherwise. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Robust-standard-errors are presented in parentheses.

acquirer may also consider it in other takeover characteristics rather than choice of payment method alone. Specifically, we examine the extent to which climate risk affects UK acquirers' decision-making concerning target industry selection.

The degree of firms' vulnerability to climate risk varies across industries. Certain sectors are more adversely affected due to potential damages on physical assets caused by the extreme weather events, which can significantly impair firms' operation capacity, and consequently reduce their revenues (McCarthy et al., 2001). The extra costs associated with replacing or relocating these assets further contribute to lower profitability. Obviously, firms in asset-heavy industries, especially those with long-lived and not-easily-deployable assets, are more vulnerable to these costs. Examples of such industries include energy (e.g. mining), utilities (e.g. electricity), and healthcare (e.g. hospitals). Other industries may also be particular vulnerable to climate change risk due to heavy reliance on weather conditions for production (e.g. agriculture), or their operation could be seriously disrupted by extreme climate events (e.g. transportation). On the other hand, although industries such as materials (e.g. chemicals) also sensitive to climate risk, but their level of susceptibility could be relatively lower compared to industries such as energy, utilities, and agriculture, due to a lower level of physical exposure to extreme weather events, more flexibility in adjusting their production processes and sourcing raw materials, and less influenced by short-term weather fluctuations. Therefore, we further scrutinize the potential relationship between the target industry selection of acquiring firms and climate risk of a target country.

In the logit model, we regress the probability of a target being in a vulnerable industry on climate risk. Building on the work of Huang et al. (2018), a vulnerable industry is characterised by its highly prone to physical damage on properties and assets, serious disruptions to business operations, and impairment of supply chains and infrastructures in extreme climate events. For instance, sectors like agricultural production, mining and oil extraction are highly sensitive to weather conditions. To be more specific, we define the "*Vulnerable Industry*" as a dummy variable, taking a value of one if the target industry is in the classification of vulnerable industry (including agriculture, business services, communication, energy (mines), energy (coal), energy (oil), food products, health care, and transportation), and zero otherwise.

Table 5 presents the findings. The coefficients of *Climate Index* are significantly positive across all models, indicating that acquiring firms are more likely to conduct a deal in a vulnerable industry if it is located in a country with a lower level of climate risk (higher climate index). A higher level of uncertainty induced by target countries' climate risk would increase the volatility of investment returns; therefore, the risk is likely to further intensify if such investment is in a vulnerable industry. Thus, it is not surprising to see acquirers behaving more conservatively in selecting their cross-border M&A partners. An acquirer would only choose a vulnerable industry if the target country is relatively safe in terms of climate risk. In other words, cross-border takeovers are less likely to happen in a target country that is vulnerable to climate risk. This is particularly the case if the target industry is also vulnerable to such a risk.

5.3. Climate risk and acquirer self-selection (size)

We next investigate the impact of climate change on self-selection in terms of acquirer size. We measure self-selection of size by using *Ln* (acquirer's total assets) in last financial year. Table 6 presents the climate risk effect on acquirer size using linear regression models with robust standard errors. In the first four columns, we report that the association between climate index and acquirer size is significantly negative. As far as self-selection is concerned, the acquirer is aware of the climate risk in the target nation when making the outbound acquisition decision. Our results based on the absolute measure of climate risk show that small and larger firms' attitudes towards climate risk seem significantly different. Our finding may suggest that small UK firms can be reluctant to acquire foreign targets if a target nation is facing severe threats from extreme weather conditions (i.e., measured by lower levels of climate scores). One possible interpretation of large firms being more likely to invest in countries that are prone to climate risk could be that they face fewer financial hurdles in conducting such acquisitions. That is, they have richer resources to monitor and manage the risk; and the potential losses could be more affordable for large rather than small firms in the worst-case scenario (Moeller et al., 2004). Furthermore, managers in large firms could be overconfident about their capability of managing the risk, considering that they could be more prone to hubris than those in small firms (Moeller et al., 2004). Therefore, managers in large firms could be less concerned about climate risk. It should also be noted that when using the relative measure of climate risk in the last four columns, the coefficients lose significance even though they are still negative. Hence, caution should be exercised when interpreting these results.

Table 5
Impact of climate risk on choice of vulnerable industry.

Dep. Var. = Vulnerable Ind.	Climate Index Average				Relative Climate Dummy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Climate Index	0.011***	0.011***	0.021***	0.026***	0.609***	0.636***	1.034***	1.062**
	(0.003)	(0.004)	(0.007)	(0.010)	(0.177)	(0.241)	(0.361)	(0.457)
Same Industry		0.546**	0.305	0.013		0.549**	0.302	0.008
		(0.244)	(0.266)	(0.347)		(0.245)	(0.266)	(0.351)
Deal Value		−0.116	−0.111	−0.121		−0.126	−0.114	−0.116
		(0.079)	(0.089)	(0.118)		(0.078)	(0.088)	(0.114)
Relative Size		0.641**	0.651**	0.517		0.658**	0.621**	0.489
		(0.294)	(0.292)	(0.361)		(0.281)	(0.279)	(0.355)
Public Target		0.374	−0.026	0.298		0.411	0.0248	0.365
		(0.365)	(0.398)	(0.502)		(0.363)	(0.396)	(0.482)
ROA		−0.019*	−0.006	−0.021		−0.019*	−0.007	−0.022
		(0.011)	(0.011)	(0.020)		(0.011)	(0.012)	(0.020)
Gearing		−0.002	−0.002	−0.003		−0.002	−0.002	−0.003
		(0.002)	(0.002)	(0.003)		(0.002)	(0.002)	(0.002)
Liquidity		0.099	0.105	−0.074		0.102	0.109	−0.074
		(0.071)	(0.079)	(0.099)		(0.072)	(0.079)	(0.098)
GDP Growth			0.101	0.138			0.130*	0.172*
			(0.078)	(0.102)			(0.077)	(0.100)
Market Cap			0.003	−0.002			0.002	−0.003
			(0.004)	(0.005)			(0.004)	(0.004)
Shareholder Right			−0.006	0.061			0.002	0.068
			(0.107)	(0.169)			(0.106)	(0.167)
Accounting Rating			0.031	0.014			0.042*	0.025
			(0.022)	(0.030)			(0.022)	(0.029)
Tobin's Q				0.310*				0.323*
				(0.178)				(0.177)
Constant	0.478*	1.129**	−1.764	−0.443	0.923***	1.594***	−1.631	−0.189
	(0.292)	(0.483)	(1.387)	(1.991)	(0.267)	(0.472)	(1.377)	(1.906)
Industry control	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Year control	Yes	Yes		Yes	Yes	Yes	Yes	Yes
Observations	932	591	490	340	932	591	490	340
pseudo R^2	0.168	0.265	0.288	0.322	0.165	0.264	0.285	0.318

The table reports the logit regressions of Vulnerable Industry on target country climate index. The dependent variable (Vulnerable Industry) is equal to one if the target industry is a vulnerable industry (including agriculture, business services, communication, energy (mines), energy (coal), energy (oil), food products, health care, and transportation); and for other industries, it is equal to zero. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Robust-standard-errors are presented in parentheses.

Table 6
Impact of climate risk on self-selection of acquirer size.

Dep. Var. = Acquirer Size	Climate Index Average				Relative Climate Dummy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Climate Index	−0.005**	−0.004**	−0.006**	−0.005	−0.025	−0.174	−0.206	−0.128
	(0.002)	(0.002)	(0.003)	(0.005)	(0.155)	(0.113)	(0.159)	(0.172)
Same Industry		−0.155	−0.212*	−0.184		−0.160	−0.222*	−0.187
		(0.110)	(0.120)	(0.138)		(0.111)	(0.121)	(0.138)
Deal Value		0.598***	0.577***	0.643***		0.604***	0.582***	0.643***
		(0.039)	(0.045)	(0.047)		(0.039)	(0.045)	(0.047)
Relative Size		−1.281***	−1.157***	−1.038***		−1.303***	−1.170***	−1.032***
		(0.325)	(0.347)	(0.373)		(0.329)	(0.352)	(0.375)
Public Target		0.352*	0.382*	0.385		0.336*	0.364*	0.364
		(0.184)	(0.206)	(0.249)		(0.187)	(0.207)	(0.256)
ROA		0.014**	0.015**	0.012		0.014**	0.015**	0.012
		(0.006)	(0.006)	(0.008)		(0.006)	(0.007)	(0.007)
Gearing		0.009***	0.009***	0.011***		0.009***	0.009***	0.011***
		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Liquidity		−0.075*	−0.144***	−0.042		−0.078*	−0.147***	−0.041
		(0.040)	(0.036)	(0.054)		(0.041)	(0.037)	(0.053)
GDP Growth			0.034	0.006			0.015	−0.005
			(0.037)	(0.051)			(0.037)	(0.051)
Market Cap			−0.0003	0.001			−0.0003	0.001
			(0.002)	(0.002)			(0.002)	(0.002)
Shareholder Right			0.100*	0.038			0.107*	0.040
			(0.054)	(0.068)			(0.055)	(0.071)
Accounting Rating			0.003	0.009			−0.002	0.008
			(0.012)	(0.014)			(0.012)	(0.014)
Tobin's Q				−0.081				−0.082
				(0.063)				(0.063)
Constant	6.922***	4.529***	4.085***	3.862***	6.661***	4.322***	4.122***	3.796***
	(0.247)	(0.259)	(0.766)	(1.008)	(0.221)	(0.243)	(0.771)	(0.985)
Industry control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	880	579	477	331	880	579	477	331
R^2	0.092	0.654	0.653	0.708	0.087	0.651	0.650	0.707

The table reports the OLS regressions of Acquirer Size on target country climate index. The dependent variable (Acquirer Size) is *Ln* (acquirer's total assets) in last financial year. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Robust-standard-errors are presented in parentheses.

5.4. The effect of geopolitical risk

As discussed in previous sections, global conflict risk and other national level uncertainties could have significant impact on outbound M&A activities and payment form (e.g., Caldara and Iacoviello,2022). Hence, we further investigate the effect of this risk factor. The *Global Conflict Risk Index* of the target country is used as the proxy for the target nation's geopolitical risk. In addition, we introduce an interaction term between the *Global Conflict Risk Index* with the *Climate Index* to examine the moderation effect of geopolitical risk on the relation between climate risk and payment method.

Table 7 presents the findings. The coefficient on *Climate Index* is significantly negative across all models, which is similar to the results in Table 4. It indicates that the high level of climate risk (low value in *Climate Index*) would encourage the all-cash payment. The coefficient on *Global Conflict Risk Index* is significant and negative across all models, indicating that the high level of geopolitical risk of the target country (high value in *Global Conflict Risk Index*) would lower the probability of the acquirer employing cash as the payment form in cross-border deals. The result suggests that UK acquirers would be discouraged to use an all-cash offer in a target country where a high level of geopolitical risk is predicted. We also report a significantly positive interaction term of climate risk and geopolitical risk. It supports our weakened effect hypothesis (H4) that geopolitical risk would weaken the association between pay method and the target country's climate risk.

Our results support that geopolitical risk paly a big role in firm-level investment decision. Previous literature documents that geopolitical risk would negatively affect a firm's R&D spending (Jia et al., 2022), capital expenditure (Alam et al., 2023) and a country's inflows of foreign direct investment (Nguyen et al., 2022). We contribute to this line of research by showing that not only the overall level of investment but also the specific payment method in cross-border M&A, could be influenced by geopolitical risk. Furthermore, while previous studies focus on the individual effects of climate risk and geopolitical risk (Su et al., 2021; Zhang et al., 2023), our study examines the combined effect of these two risks and highlight how managers would weigh the impacts derived from both factors. Our results suggest a moderating effect of geopolitical risk on the association between climate risk and payment method.

5.5. Endogeneity tests and robustness analyses

To ascertain our findings, we carried out further tests and robustness analyses. First, we examine the impact of the potential endogeneity problem in our study as unobserved factor(s) could affect both the choice of payment methods and the target country's climate risk. For instance, a target country's macroeconomic and cultural characteristics may affect its climate risk as well as a target's preference for a particular payment method. However, the target country fixed effect cannot be employed because it is correlated to our main independent variable, climate risk, for a specific target country. Therefore, we choose to use two instrumental variables and employ a two-stage model to run regressions parallel to those in Table 4. The first instrumental variable is one of the demographic features of a target country, *Population Density*. Huang et al. (2018) argue that population density is related to a nation's climate risk, while it does not have any significant correlation with firm characteristics. The second instrumental variable is one of the geographical features of a target country, *NonIsland*, which is equal to one if the target country is not an island, and otherwise zero. Veron et al. (2019) show that climate change has a greater impact on an island due to shifts in temperature, rainfall, and sea level. In short, these instrumental variables are expected to influence climate risk, while their direct impacts on the choice of payment methods are limited.

Table 7
The impact of climate risk and geopolitical risk on choice of payment method.

Dep. Var = All Cash	Climate Index Average				Relative Climate Dummy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Climate Index	−0.009***	−0.012***	−0.016***	−0.025***	−0.629***	−0.930***	−0.899***	−1.005**
	(0.003)	(0.004)	(0.006)	(0.008)	(0.215)	(0.285)	(0.335)	(0.415)
Global Conflict Risk Index	−0.277**	−0.462**	−0.661**	−84.91***	−0.172***	−0.173	−0.313**	−1.965***
	(0.120)	(0.224)	(0.301)	(12.080)	(0.066)	(0.107)	(0.148)	(0.132)
Climate Index* Conflict Index	0.003*	0.006**	0.010**	0.961***	0.243**	0.274*	0.630**	2.061***
	(0.002)	(0.003)	(0.004)	(0.135)	(0.101)	(0.157)	(0.271)	(0.268)
Same Industry		−0.203	−0.365	−0.621*		−0.185	−0.379	−0.648*
		(0.237)	(0.262)	(0.339)		(0.237)	(0.263)	(0.340)
Deal Value		0.035	0.091	0.131		0.047	0.111	0.139
		(0.082)	(0.088)	(0.103)		(0.081)	(0.088)	(0.101)
Relative Size		−1.812***	−2.181***	−1.817***		−1.826***	−2.278***	−1.757***
		(0.615)	(0.691)	(0.657)		(0.620)	(0.714)	(0.677)
Public Target		0.621	0.816*	0.868*		0.539	0.745*	0.756*
		(0.395)	(0.434)	(0.472)		(0.383)	(0.416)	(0.448)
ROA		0.041***	0.044**	0.027		0.042***	0.044**	0.028
		(0.015)	(0.017)	(0.020)		(0.015)	(0.017)	(0.020)
Gearing		0.0003	0.0000	0.001		0.0003	−0.0001	0.001
		(0.002)	(0.002)	(0.003)		(0.002)	(0.002)	(0.002)
Liquidity		−0.004	0.007	−0.035		−0.006	−0.004	−0.036
		(0.073)	(0.086)	(0.099)		(0.074)	(0.085)	(0.097)
GDP Growth			0.015	−0.126			0.002	−0.140
			(0.083)	(0.121)			(0.084)	(0.121)
Market Cap			−0.0001	−0.004			0.0002	−0.002
			(0.003)	(0.004)			(0.003)	(0.004)
Shareholder Right			0.139	−0.097			0.155	−0.043
			(0.190)	(0.275)			(0.186)	(0.274)
Accounting Rating			0.0163	0.029			−0.001	0.014
			(0.029)	(0.035)			(0.028)	(0.035)
Tobin's Q				−0.056				−0.048
				(0.196)				(0.193)
Constant	0.637*	0.514	−0.963	1.601	0.255	−0.032	−0.483	1.418
	(0.338)	(0.512)	(2.158)	(2.685)	(0.302)	(0.465)	(2.105)	(2.653)
Industry control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	710	453	406	289	711	453	406	289
Pseudo R-squared	0.090	0.139	0.176	0.194	0.092	0.140	0.176	0.181

The table presents the logit regressions of the payment method on target country climate index, global conflict risk index, and the interaction of them. The dependent variable (All Cash) is equal to 1 for an all-cash offer, and 0 otherwise. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Robust-standard-errors are presented in parentheses.

We present our Instrumental Variable (IV) regressions in Table 8. The first-stage results show a positive association between *Climate Index* and *Population Density*, while a negative association between *Climate Index* and *NonIsland*. In other words, a target country faces a higher level of climate risk (lower climate index) if it has lower population density and it is not an island. The negative coefficient on *Population Density* is consistent with the widely accepted view that areas having less extreme weather and climate conditions tend to attract more population than those having more extreme conditions. The second-stage regressions show that the coefficients of *Climate Index* are negative and significant in six out of eight regressions, except columns (1) and (8). This result is largely consistent with our finding in Table 4. That is, an acquirer is more likely to employ an all-cash offer if the target country faces a higher level of climate risk (low *Climate Index*). In addition, the Wald-Exogeneity-Test of instrumental variables indicates that endogeneity is unlikely to be a significant concern within our sample.[12]

Second, we run parallel regressions using the raw scores of the annual climate risk index instead of the average score and obtain similar but slightly weaker results in the unreported table. This is not surprising as cross-border M&A is a major and strategic investment decision which could affect firm performance in the long run. Therefore, it is more appropriate to base such decisions on the long-term rather than short-term climate risk (i.e., current climate risk) of the target country. In addition, we winsorize the top and lower five percentiles of our variables and re-run all regressions. The results are qualitatively similar.[13]

Third, we explore the possibility of a time lag in the awareness and incorporation of the climate index in decision-making process. That is, although the climate index data is available since 2008, it may take some time for managers and investors to be aware of the index and incorporate it in their decision-making process. Therefore, we consider a two-year lag and re-run regression based on the sample starting from 2010. Again, we find that there is essentially no change in the results as compared to our main findings.[14]

Finally, we check whether climate change performance and currency appreciation affect our results in Table 9. Note that the climate risk index used in our main analyses captures the actual climate risk (e.g. losses in extreme weather events), but managers' decision may not be driven only by such risk but also by how well the target country combats climate change. Hence, in the robustness check, we include an additional factor, climate change performance index (*CCPI Score*) in our models. The CCPI indicator evaluates the climate protection performance of each country by using four standardised criteria based on the following classifications: 1) Greenhouse-Gas-Emissions (forty percent of the total score), 2) Renewable-Energy (twenty percent), 3) Energy-Use

[12] In the Wald test, the p-values are all larger than 10%, suggesting that endogeneity is not a big problem in our research context. Our standard logit regression models would be preferable.

[13] To save space, we do not report those results, but they are available upon request.

[14] The results are available upon request.

Table 8
Impact of climate risk on choice of payment method (two-stage IV Probit regression).

Dep. Var = All Cash	Climate Index Average				Relative Climate Dummy			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Climate Index	−0.005	−0.010*	−0.019**	−0.027*	−0.592**	−0.954**	−1.231***	−0.972
	(0.003)	(0.005)	(0.008)	(0.014)	(0.281)	(0.378)	(0.456)	(0.628)
Same Industry		−0.110	−0.149	−0.241		−0.086	−0.183	−0.276
		(0.122)	(0.149)	(0.175)		(0.121)	(0.147)	(0.172)
Deal Value		−0.018	−0.051	0.005		−0.019	−0.047	−0.010
		(0.038)	(0.043)	(0.052)		(0.037)	(0.044)	(0.052)
Relative Size		−0.702**	−0.421*	−0.584**		−0.688**	−0.486**	−0.562**
		(0.284)	(0.240)	(0.234)		(0.270)	(0.235)	(0.235)
Public Target		0.229	0.305	0.548**		0.234	0.297	0.456*
		(0.189)	(0.204)	(0.253)		(0.183)	(0.210)	(0.250)
ROA		0.025***	0.019**	0.020**		0.025***	0.022***	0.0225**
		(0.006)	(0.008)	(0.009)		(0.006)	(0.008)	(0.009)
Gearing		−0.001	−0.001	−0.0002		−0.001	−0.0002	0.0002
		(0.001)	(0.001)	(0.001)		(0.001)	(0.001)	(0.001)
Liquidity		−0.031	−0.050	−0.016		−0.035	−0.026	−0.016
		(0.038)	(0.043)	(0.053)		(0.038)	(0.044)	(0.053)
GDP Growth				0.045				−0.011
				(0.052)				(0.043)
Market Cap				−0.002				−0.001
				(0.002)				(0.002)
Shareholder Right				−0.047				−0.056
				(0.075)				(0.083)
Accounting Rating				0.024				0.016
				(0.015)				(0.017)
Tobin's Q			0.0155	−0.026			−0.029	−0.028
			(0.077)	(0.092)			(0.084)	(0.098)
Constant	0.656***	0.998***	1.753***	0.598	0.512***	0.664***	0.939***	−0.006
	(0.211)	(0.356)	(0.503)	(1.412)	(0.085)	(0.192)	(0.251)	(1.251)
First-Stage Regression								
Population Density	0.009***	0.009***	0.013***	0.010***	3.00e-05***	3.77e-05***	9.66e-05*	−2.53e-05
	(0.001)	(0.001)	(0.002)	(0.001)	(8.99e-06)	(1.38e-05)	(5.66e-05)	(2.66e-05)
NonIsland	−35.62***	−33.11***	−29.49***	−29.67***	−0.572***	−0.509***	−0.481***	−0.852***
	(4.642)	(5.904)	(7.699)	(3.687)	(0.057)	(0.075)	(0.105)	(0.065)
Observations	932	594	404	340	932	594	404	340
Wald-Test (*p*)	0.52	0.36	0.10	0.41	0.18	0.18	0.14	0.64

The table reports the Two-Stage Probit regressions of the payment method on target country climate. The dependent variable (All Cash) is equal to 1 for an all-cash offer, and 0 otherwise. The results of first-stage regressions are presented at the bottom of the table. Two instrumental variables for the climate index are included: Population Density of the target country, and NonIsland which is equal to one if the target country is not an island, and otherwise zero. p values of the Wald-Test are also presented. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Robust-standard-errors are presented in parentheses.

(twenty percent), and 4) Climate-Policy (twenty percent). This measure is used as the proxy for the efforts a country makes to working towards achieving the climate protection goals. A high CCPI score indicates a strong climate protection in a nation.

Another factor we consider in the robustness check is currency appreciation (*Currency*). An increase or decrease in the value of the currency in a target country may affect an acquiring firm's selection of cash or stock payment method. Therefore, we add *Currency* as an additional variable to capture the currency effects. It is a dummy variable, which is equal to one if a target country has currency appreciation against US dollar in the year, and zero otherwise.

Table 9 presents this robustness analyses. It shows that including these two additional control variables does not change our main results. The associations between our two climate risk proxies (Climate Index Average and Relative Climate Index) and the likelihood of an all-cash offer are still significant and negative, while those coefficients on *CCPI Score* and *Currency* are insignificant in all columns. These results suggest that our findings are unlikely to be driven by the climate policies or exchange rates in the target countries.

6. Conclusions

Climate change imposes one of the greatest challenges of our times. There is a growing amount of literature examining how climate risk affects corporate operation, risk-taking and investment behaviours (e.g. Balvers et al., 2017; Huang et al., 2018). We complement this line of research by scrutinizing the effect of climate risk on the form of payment in cross-border acquisitions.

Using a sample of 932 outbound acquisitions conducted by UK firms in 73 target countries over the period of 2008–2020, our results show that acquirers are more likely to employ an all-cash offer if the climate risk in a target country is high. This finding provides the supportive evidence for our confidence *signalling hypothesis*. Furthermore, our findings suggest that climate risk is correlated with industry selection in outbound deals. An acquirer is willing to target a vulnerable industry only if the target country is relatively safe in terms of climate risk. Last, we document that the geopolitical risk could moderate the impact of climate risk. A target country's geopolitical risk could weaken the association between climate risk and payment method in cross-border M&A. The UK acquirer would be more likely to use an all-cash offer if the target country with a high level of geopolitical risk but a low level of climate risk. These results add complementary evidence to prior studies on geopolitical risk, climate risk and investment activities (Caldara and Iacoviello, 2022; Jin et al., 2023).

As one of the first studies concerning how climate risk affects payment form in outbound acquisitions, we also provide novel evidence that firms factor in climate-related costs triggered by extreme weather-related events when choosing the method of payments in cross-border M&A. Our results demonstrate the significant role of climate risk in shaping the corporate outbound M&A decisions. Our findings have important implications for shareholders, firms, and regulatory institutions. Climate risk is likely to further intensify in the future; hence, both the attractiveness of M&A investments in climate-vulnerable economies are bound to be much less attractive and the cost could

Table 9
Impact of climate risk on choice of payment method (CCPI and exchange rate controlled).

Dep. Var. = All Cash	Climate Index Average			Relative Climate Dummy		
	(1)	(2)	(3)	(4)	(5)	(6)
Climate Index	−0.009**	−0.017***	−0.028***	−0.742***	−0.989***	−1.096***
	(0.004)	(0.005)	(0.008)	(0.228)	(0.294)	(0.365)
Same Industry	−0.220	−0.405*	−0.568*	−0.217	−0.412*	−0.571*
	(0.209)	(0.233)	(0.306)	(0.210)	(0.235)	(0.306)
Deal Value	0.021	0.046	0.098	0.026	0.059	0.102
	(0.075)	(0.082)	(0.097)	(0.074)	(0.081)	(0.095)
Relative Size	−1.471**	−1.353**	−0.949**	−1.465**	−1.366**	−0.915**
	(0.687)	(0.650)	(0.443)	(0.667)	(0.642)	(0.427)
Public Target	0.331	0.672*	0.946**	0.317	0.653*	0.828*
	(0.341)	(0.400)	(0.479)	(0.338)	(0.386)	(0.445)
ROA	0.042***	0.043***	0.026	0.042***	0.043***	0.027
	(0.013)	(0.015)	(0.018)	(0.013)	(0.015)	(0.018)
Gearing	−0.000	−0.001	0.001	−0.000	−0.001	0.001
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Liquidity	−0.026	−0.029	−0.049	−0.026	−0.040	−0.046
	(0.070)	(0.080)	(0.100)	(0.071)	(0.081)	(0.099)
GDP Growth		−0.007	−0.054		−0.020	−0.073
		(0.076)	(0.119)		(0.075)	(0.120)
Market Cap		−0.000	−0.006		0.000	−0.004
		(0.003)	(0.004)		(0.003)	(0.004)
Shareholder Right		−0.066	−0.035		−0.069	−0.022
		(0.141)	(0.188)		(0.140)	(0.185)
Accounting Rating		−0.003	0.043		−0.016	0.033
		(0.022)	(0.031)		(0.022)	(0.030)
CCPI Score	0.001	−0.026	−0.010	0.004	−0.025	−0.002
	(0.011)	(0.018)	(0.024)	(0.011)	(0.018)	(0.023)
Currency		0.144	0.297		0.171	0.226
		(0.353)	(0.524)		(0.355)	(0.512)
Tobin's Q			0.055			0.045
			(0.164)			(0.166)
Constant	0.662	3.171	1.101	0.183	3.355*	0.160
	(0.704)	(1.995)	(2.895)	(0.714)	(2.010)	(2.812)
Industry control	Yes	Yes	Yes	Yes	Yes	Yes
Year control	Yes	Yes	Yes	Yes	Yes	Yes
Observations	572	486	336	572	486	336
pseudo R^2	0.112	0.147	0.174	0.119	0.150	0.166

The table reports the logit regressions of the payment method on target country climate index. In the models, we further control for climate change performance index (CCPI Score) and exchange rates (Currency) of target countries. The dependent variable (All Cash) is equal to 1 for an all-cash offer, and 0 otherwise. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Robust-standard-errors are presented in parentheses.

significantly increase. To mitigate this potential problem, there is a need for international support and collaboration (e.g., innovative risk transfer mechanisms) to allow climate-vulnerable developing countries to access finance and reduce the cost of capital, which could help enable private and public investments (Kling et al., 2021).

In summary, we highlight the importance for governments and businesses worldwide to prioritise climate risk mitigation strategies. These strategies include measures such as promoting sustainable financing for green technologies, escalating renewable energy consumption, and transitioning to a low carbon and circular economy to tackle climate change. By implementing these strategies, we can not only minimise the occurrence of future catastrophes but also create an environment that encourages investments and enhance competitiveness of businesses. Further exploring the potential impact of government interventions (e.g., circlar economy bill and caron pricing mechanisms) in the context of climate risk and cross-border M&A could be a promising avenue for future research. In particular, it would be interesting to investigate how litigation and regulatory changes affect the perception of climate risk in M&A decision-making. Additionally, our study calls for more research on the possible mechanisms through which climate risk can affect corporate decisions.

Credit author statement

Hao Li: Conceptualization; Validation; Methodology; Writing – Original Draft, reviewing and editing.; **Yue Liu:** Conceptualization; Methodology; Software; Investigation; Formal analysis; Data Curation; Writing – original draft, reviewing and editing.; **Bing Xu:** Conceptualization; Project Administration; Formal analysis; Validation; Writing – original draft, reviewing and editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix 1. Extreme Weather-Related Losses and Fatalities by Countries

Country	Losses (US$ Mil)	Losses/GDP (%)	Fatalities per 100,000
United States	47,844.380	0.298	864.386
China	25,702.910	0.249	0.095
India	14,988.110	0.280	0.172
Germany	2909.488	0.097	302.927
Colombia	2522.000	0.577	0.240
Australia	2147.163	0.254	178.664
Brazil	2048.714	0.081	0.147
Japan	1989.000	0.040	0.080
Argentina	1805.833	0.253	0.038
Canada	1578.820	0.108	12.347
Indonesia	1321.167	0.262	1033.340
Italy	1152.923	0.053	0.065
Bangladesh	1105.000	0.180	0.140
Spain	1056.087	0.069	0.037
France	1047.200	0.043	36.300
Russian Federation	1034.273	0.057	0.045
South Africa	508.313	0.081	10.009
Portugal	438.000	0.143	0.427
Israel	330.667	0.127	0.067
Austria	327.000	0.110	0.080
Netherlands	286.710	0.038	13.818
Mexico	274.500	0.020	0.040
Czech Republic	227.571	0.091	0.151
Switzerland	185.412	0.064	25.876
Peru	143.000	0.040	0.130
Poland	142.000	0.023	0.163
Nigeria	129.000	0.010	0.040
Ireland	127.850	0.050	0.858
Thailand	118.000	0.010	0.050
Mozambique	114.500	0.610	0.165
Belgium	102.500	0.021	0.934
New Zealand	91.000	0.056	0.034
United Arab Emirates	72.667	0.011	0.011
Sweden	69.800	0.021	11.122
Kenya	47.000	0.035	0.130
Norway	34.125	0.014	4.679
Denmark	32.900	0.011	0.000
Finland	31.800	0.016	0.002
Saudi Arabia	27.667	0.002	0.188
Chile	19.333	0.003	0.033
Singapore	3.875	0.001	0.000

The table reports the mean values of the extreme weather-related annual absolute total losses in US dollar, direct losses per unit of GDP, and death toll per hundred thousand residents in some countries across eight regions in our sample.

Appendix 2. Marginal Effects and Predictive Margins

Panel A. Climate Index Average	(1)	(2)	(3)	(4)
Average Marginal Effect (dy/dx)	−0.001*** (0.001)	−0.002** (0.001)	−0.003*** (0.001)	−0.005*** (0.001)
Observations	932	594	490	340
Panel B. Relative Climate Dummy	**(5)**	**(6)**	**(7)**	**(8)**
Average Marginal Effect (dy/dx)	−0.095*** (0.035)	−0.141*** (0.042)	−0.188*** (0.053)	−0.199*** (0.061)
Predictive Margin (Dummy = 0)	0.662*** (0.018)	0.653*** (0.023)	0.664*** (0.024)	0.692*** (0.029)
(Dummy = 1)	0.565*** (0.030)	0.505*** (0.037)	0.461*** (0.051)	0.473*** (0.060)
Observations	932	594	490	340

The table presents the marginal effects (or predictive margin) of climate risk on choice of payment method. Two climate risk measures are used. Panel A (B, respectively) shows the average marginal effect (and predictive margin, respectively) of Climate Index Average (Relative Climate Dummy, respectively). The column numbers correspond to those in Table 4. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. The unconditional-standard-errors are stated in parentheses.

References

Addoum, J., Ng, D., Ortiz-Bobea, A., 2020. Temperature shocks and establishment Sales. Rev. Financ. Stud. 33 (3), 1331–1366.
Alam, A.W., Houston, R., Farjana, A., 2023. Geopolitical risk and corporate investment: how do politically connected firms respond? Finance Res. Lett. 53, 103681.
Andersson, M., Bolton, P., Samama, F., 2016. Hedging climate risk. Financial Anal. 72 (3), 13–32.
Balvers, R., Du, D., Zhao, X., 2017. Temperature shocks and the cost of equity capital: implications for climate change perceptions. J. Bank. Finance 77, 18–34.
Ben-Amar, W., McIlkenny, P., 2014. Board effectiveness and the voluntary disclosure of climate change information. Bus. Strat. Environ. 24 (8), 704–719.
Bolton, P., Kacperczyk, M., 2021. Do investors care about carbon risk? J. Financ. Econ. 142 (2), 517–549.
Bošnjaković, B., 2012. Geopolitics of climate change: a review. Therm 16 (3), 629–654.
Bouri, E., Iqbal, N., Klein, T., 2022. Climate policy uncertainty and the price dynamics of green and brown energy stocks. Finance Res. Lett. 47, 102740.
Caldara, D., Iacoviello, M., 2022. Measuring geopolitical risk. Am. Econ. Rev. 112 (4), 1194–1225.
Chakrabarti, R., Jayaraman, N., Gupta-Mukherjee, S., 2009. Mars-venus marriages: culture and cross-border M&A. J. Int. Bus. Stud. 40, 216–236.

Challinor, A.J., Watson, J., Lobell, D.B., Howden, S.M., Smith, D.R., Chhetri, N., 2014. A meta-analysis of crop yield under climate change and adaptation. Nat. Clim. Change 4 (4), 287–291.

Chemmanur, T., Paeglis, I., Simonyan, K., 2009. The medium of exchange in acquisitions: does the private information of both acquirer and target matter? J. Corp. Finance 15 (5), 523–542.

Chen, X., Fu, Q., Chang, C., 2021. What are the shocks of climate change on clean energy investment: a diversified exploration. Energy Econ. 95, 105136.

Cho, H., Ahn, H., 2017. Stock payment and the effects of institutional and cultural differences: a study of shareholder value creation in cross-border M&As. Int. Bus. Rev. 26 (3), 461–475.

Choi, J., Genc, O., Ju, M., 2020. Is an M&A self-dealing? Evidence on international and domestic acquisitions and CEO compensation. J. Bus. Finance Account. 47 (9–10), 1290–1315.

Conn, Robert L., Cosh, Andy, Guest, Paul M., Hughes, Alan, 2005. The impact on UK acquirers of domestic, cross-border, public and private acquisitions. J. Bus. Finance Account. 32 (5–6), 815–870.

Connolly, A., Goslin, T., 2019. Climate change consideration in M&A transaction. The Lexis Practice Advisor Journal.

de La Bruslerie, H., 2012. Corporate acquisition process: is there an optimal cash-equity payment mix? Int. Rev. Law Econ. 32 (1), 83–94.

de La Bruslerie, H., 2013. Crossing takeover premiums and mix of payment: an empirical test of contractual setting in M&A transactions. J. Bank. Finance 37 (6), 2106–2123.

Dos Santos, Marcelo, B., Errunza, V.R., Miller, D.P., 2008. Does corporate international diversification destroy value? Evidence from cross-border mergers and acquisitions. J. Bank. Finance 32 (12), 2716–2724.

Eckbo, B., Makaew, T., Thorburn, K., 2018. Are stock-financed takeovers opportunistic? J. Financ. Econ. 128 (3), 443–465.

Edenhofer, O. (Ed.), 2015. Climate change 2014: mitigation of climate change, (Vol. 3).. Cambridge University Press.

Erel, I., Liao, R.C., Weisbach, M.S., 2012. Determinants of cross-border mergers and acquisitions. J. Finance 67 (3), 1045–1082.

Fishman, M., 1989. Preemptive bidding and the role of the medium of exchange in acquisitions. J. Finance 44 (1), 41–57.

Gallup, I., 2020. Top-Emitting Countries Differ on Climate Change Threat.

Germanwatch, 2019. Global Climate Risk Index 2019.

Goergen, M., Renneboog, L., 2004. Shareholder wealth effects of European domestic and cross-border takeover bids. Eur. Financ. Manag. 10 (1), 9–45.

Gulamhussen, M.A., Hennart, J.F., Pinheiro, C.M., 2016. What drives cross-border M&As in commercial banking? J. Bank. Finance 72, S6–S18.

Hansen, R., 1987. A theory for the choice of exchange medium in mergers and acquisitions. J. Bus. Res. 60 (1), 75.

Huang, P., Officer, M., Powell, R., 2016. Method of payment and risk mitigation in cross-border mergers and acquisitions. J. Corp. Finance 40, 216–234.

Huang, H., Kerstein, J., Wang, C., 2018. The impact of climate risk on firm performance and financing choices: an international comparison. J. Int. Bus. Stud. 49 (5), 633–656.

International panel on climate change (IPCC) Special Report. 2018. Global Warming of 1.5°C. Available at: https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/.

Jia, S., Yang, L., Zhou, F., 2022. Geopolitical risk and corporate innovation: evidence from China. J. Multinatl Financ 66, 100772.

Jin, Y., Zhao, H., Bu, L., Zhang, D., 2023. Geopolitical risk, climate risk and energy markets: a dynamic spillover analysis. Int. Rev. Financ. Anal., 102597

Kahn, M., Mohaddes, K., , C Ng, R, Pesaran, M., Raissi, M., Yang, J., 2019. Long-term macroeconomic effects of climate change: a cross-country analysis. SSRN Electron. J.

Kling, G., Volz, U., Murinde, V., Ayas, S., 2021. The impact of climate vulnerability on firms' cost of capital and access to finance. World Dev. 137, 105131.

Krueger, P., Sautner, Z., Starks, L., 2020. The Importance of climate risks for institutional investors. Rev. Financ. Stud. 33 (3), 1067–1111.

Koerniadi, H., Krishnamurti, C., Tourani-Rad, A., 2015. Cross-border mergers and acquisitions and default risk. Int. Rev. Financ. Anal. 42, 336–348.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., 1998. Law and finance. J. Polit. Econ. 106, 1113–1155.

Lee, K., 2018. Cross-border mergers and acquisitions amid political uncertainty: a bargaining perspective. Strat. Manag. J. 39 (11), 2992–3005.

Li, W., Wang, C., Ren, Q., Zhao, D., 2020. Institutional distance and cross-border M&A performance: a dynamic perspective. J Int Financial Mark 66, 101207.

McCarthy, J., Canziani, O., Leary, N., Dokken, D., White, K., 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability: Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press.

Martin, K.J., 1996. The Method of payment in corporate acquisitions, investment opportunities, and management ownership. J. Finance 1227–1246.

Moeller, S.B., Schlingemann, F.P., Stulz, R.M., 2004. Firm size and the gains from acquisitions. J. Financ. Econ. 73 (2), 201–228.

Nguyen, T.T.T., Pham, B.T., Sala, H., 2022. Being an emerging economy: to what extent do geopolitical risks hamper technology and FDI inflows? Econ. Anal. Pol. 74, 728–746.

Office of National Statistics (ONS). Three-quarters of adults in Great Britain worry about climate change. https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/articles/threequartersofadultsingreatbritainworryaboutclimatechange/2021-11-05.

Pablo, E., 2009. Determinants of cross-border M&As in Latin America. J. Bus. Res. 62 (9), 861–867.

Painter, M., 2020. An inconvenient cost: the effects of climate change on municipal bonds. J. Financ. Econ. 135 (2), 468–482.

Park, J., Noh, J., 2017. The Impact of climate change risks on firm value: evidence from the Korea. Global Bus. Rev. 22 (3), 110–127.

Rossi, S., Volpin, P., 2004. Cross-country determinants of mergers and acquisitions. J. Financ. Econ. 74 (2), 277–304.

Schvitz, G., Corbane, C., Van Damme, M., Galariotis, I., Valli, I., 2022. The Global Conflict Risk Index 2022: Revised Data and Methods. Publications Office of the European Union, Luxembourg. https://doi.org/10.2760/041759. JRC 131326.

Shang, Y., Han, D., Gozgor, G., Mahalik, M.K., Sahoo, B.K., 2022. The impact of climate policy uncertainty on renewable and non-renewable energy demand in the United States. J. Renew. Energy 197, 654–667.

Su, C.W., Khan, K., Umar, M., Zhang, W., 2021. Does renewable energy redefine geopolitical risks? Energy Pol. 158, 112566.

Veron, S., Mouchet, M., Govaerts, R., Haevermans, T., Pellens, R., 2019. Vulnerability to climate change of islands worldwide and its impact on the tree of life. Sci. Rep. 9 (1), 1–14.

Weber, M., Weber, E., Nosić, A., 2013. Who takes risks when and why: determinants of changes in investor risk taking. Rev. Finance 17 (3), 847–883.

Zhang, D., Chen, X.H., Lau, C.K.M., Cai, Y., 2023. The causal relationship between green finance and geopolitical risk: implications for environmental management. J. Environ. Manag. 327, 116949.

Zhao, Z., Gozgor, G., Lau, M.C.K., Mahalik, M.K., Patel, G., Khalfaoui, R., 2023. The impact of geopolitical risks on renewable energy demand in OECD countries. Energy Econ. 122, 106700.