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Climate theory & managerial decisions on cross-border mergers

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ABSTRACT

We explore the significance of climate theory concerning managerial decisions in cross-border mergers. We report that temperature offers a good familiarity proxy showing that country pairs that experience little (large) distance in temperature experience relatively more (less) acquisitions. A one-unit decrease in the difference of the temperature in a country pair is linked with an increase in the number of cross-border mergers by 1.09%. We then highlight the significance of relatively warm temperatures on managerial decisions: We find that (i) the relationship is driven by the Summer months; during June–August for country pairs in the Northern hemisphere and December–February for pairs in the Southern hemisphere, (ii) relatively more cross-border mergers occur towards countries with modestly warmer temperatures showing evidence of managerial affinity towards warmer places, and (iii) country pairs with relatively high temperatures exhibit more acquisitions. Overall, this study highlights a new perspective in the field of climate finance.

1. Introduction

Several studies have explored the field of climate finance in recent years. We explore in this study the role of the absolute distance in temperatures as a determinant of cross-border mergers. A temperature is a natural approach to capturing cross-country familiarity considering the impact that temperature has on our behavior and decisions (e.g., Bernstein et al., 2019; Choi et al., 2020; Dell et al., 2014; Dessaint & Matray, 2017; Ginglinger & Moreau, 2023; Gu & Hale, 2023; Hong et al., 2019; Huynh & Xia, 2021; Painter, 2020; Pankratz et al., 2023; Van De Vliert, 2007, 2013; Wormley et al., 2022). Managers are thus likely to be influenced by when deciding the nationality of overseas target firms.

We think that cross-border mergers offer the ideal context to explore the role of temperature. Cross-border mergers are an important context economically-speaking considering that approximately one-third of the mergers involve firms from different countries, and this proportion has increased over time with over 50% of the acquisitions being overseas since 2010 (e.g., Erel et al., 2012). Cross-border mergers also represent most of the foreign direct investment according to the Organization for Economic Co-operation and Development (2007). Several studies (e.g., Ahern et al., 2015; Erel et al., 2012; La Porta et al., 1998; La Porta et al., 2008; Siganos & Tabner, 2020) have previously explored determinants of overseas target selections and so in this study, we explore the significance of temperature above all these control variables. Differences in temperatures also tend to be significantly larger amongst countries, rather than in different regions within a typical country, which motivates the exploration of the significance of temperature in cross-border decisions.

Managers may select countries with close familiarity either to reduce potential friction amongst staff after the merger announcement (e.g., Ahern et al., 2015; Alexandridis et al., 2022; Erel et al., 2012; Shenkar, 2012) or subconsciously due to heuristics

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such as affinity (e.g., Lichtenstein et al., 1978; Slovic et al., 2007). Media often broadcast global weather forecasts, and so managers are expected to be aware broadly speaking of international temperatures. The expectation is that the country pairs with close temperatures, and thus with high familiarity, to exhibit a relatively large number of acquisitions. The country pairs with distant temperatures, and thus with low familiarity, are instead to exhibit a low number of acquisitions.

We indeed find that there is a negative relation between the number of cross-border mergers and the distance in the average temperature in the corresponding country pairs. We find that a one-unit decrease in the difference of the temperature in a country pair is linked with an increase in the number of cross-border mergers by 1.09%, and so the relation is economically significant. To validate our variable, we find that the distance in temperature is related to some country familiarity variables used earlier in the literature. We find for example that country pairs with large distances in their capitals exhibit large distances in their temperatures. Countries in which their citizens share the same language, religion, and legal origin exhibit small distances in their temperatures. We also find that the significance of temperature is empirically valid in several other contexts such as in the magnitude of the momentum returns (Jegadeesh and Titman, 1993). Country pairs with little distance in temperature exhibit a similar magnitude of momentum returns showing that the distance in temperature indeed captures similarities among populations.

Interestingly, we find that managers seem to be influenced by the potential risks as a result of climate change. Country pairs with relatively high distances in climate risk exhibit fewer cross-border mergers showing that managers may avoid countries with relatively high climate risk. Still, we also find that managers are happy to operate in countries with high pollution. More importantly for our study, we find that our main result on the significance of the temperature on the number of cross-border mergers remains strong after controlling for climate risk, emissions, and a country's environmental performance.

We further demonstrate that temperature can assist us to understand seasonality patterns in international decisions. According to Burke et al. (2018) and Deschênes and Greenstone (2011), high temperatures increase suicide rates and in general the number of deaths, respectively. Several studies (e.g., Burke, Hsiang, & Miguel, 2015; Ranson, 2014) report that temperature even influences the level of conflict in a country, and as an example, it is more likely to experience violence on hot days since temperature influences our aggressiveness (Tiihonen et al., 1997). Managerial decisions are then expected to be influenced the most in periods with high temperatures since managers' riskiness attitude increases. We are not aware of the timing that merger negotiations may have started and the length of the negotiations may have differed significantly. Still, relatively hot temperatures are expected to influence the riskiness level that managers are happy to accept when finalizing merger deals. We use a unique context, which offers evidence of causality, to empirically report the seasonality effect on the decision-making process. Countries in the Northern hemisphere experience summer (winter) in the same months that countries in the Southern hemisphere experience winter (summer). We indeed find that relatively warm temperatures influence the magnitude of the relation. This period is between June and August for country pairs in the Northern hemisphere, and between December and February for country pairs in the Southern hemisphere.

We also demonstrate the significance of analyzing the temperature of the number of cross-border mergers for both directions in a country pair. We test for example the difference in the UK minus US temperature in association with the number of mergers of US firms acquiring UK firms. We are keen on relatively warmer temperatures. Andrade et al. (2011) report that citizens tend to be more tolerant towards relatively warmer temperatures rather than cooler temperatures within an experimental setting. This preference may be linked to the likelihood of their survival (Van De Vliert, 2013) which is best in most occasions in relatively warmer temperatures. We thus expect that more cross-border mergers tend to occur in relatively warmer countries. We indeed support empirically this relation that disappears towards countries with significantly warmer temperatures. We also find that country pairs with relatively high temperatures exhibit more acquisitions offering further support for the role of warmth in managerial decisions. Overall, this study highlights the importance of climate theory to explain managerial decisions.

The remainder of this paper is structured as follows: Section 2 reviews briefly relevant literature. Section 3 discusses the data used and the methodology followed. Section 4 reports the empirical findings. Finally, Section 5 concludes this study.

2. Literature review

2.1. The role of climate on decisions

The premise that temperature influences us is actually old, with early evidence available from the Ancient Greeks such as in the writings of Hippocrates. Several interdisciplinary studies have previously shown the significance of climate on decisions.[1] The temperature has most often been used as a proxy of climate. Both rational and irrational mechanisms have been used to explain the impact of climate.

Studies have shown that climate can influence our health. Deschênes and Greenstone (2011) report that the mortality rate increases in extremely hot and cold weather. Each day with extreme heat temperatures over 32 °C increases for example the annual rate of mortality by 0.11%. Temperature also influences energy consumption, with more consumption evidenced on days with extreme temperatures. Climate conditions are also related to the level of conflict and political stability. Low rainfall and high temperatures are linked with more conflict (Burke et al., 2009). It is found that 1 °C higher temperatures are linked with 4.5% more conflicts. Riots and property crimes are also more likely to occur on relatively warmer days. There may be a biological pathway for this relation according to which temperature influences the rate of serotonin neurotransmission in the brain that influences aggression (Tiihonen et al., 1997).

[1] Dell et al. (2014) offer a comprehensive review of the significance of climate in the field of Economics.

There is plenty of evidence showing that climate also influences the growth of an economy. Van De Vliert (2013) develops the climato-economic theory, according to which it was suggested that the ideal temperature is 22 °C. People seek to maintain this temperature subject to unexpected conditions and wealth. Studies (e.g., Dell et al., 2009; Gallup et al., 1999) have shown that temperature is negatively related to GDP per capita and so countries with high temperatures are often linked with low economic growth due to low labor productivity. High temperatures (above 25 °C) are often been linked with poor performance due to the difficulty to perform (e.g., Park, 2022). It has been reported that climate conditions can explain around 60% of the variation in income amongst countries. Extreme weather shocks can also influence migration movements (Boustan et al., 2012; Hornbeck, 2012). Significant storms stripped the topsoil from farmland reducing the productivity of the locations, with workers and farmers moving to different locations to find a job. Also, tornadoes in the 1920s and 1930s in the US had an impact on migrant moving to different locations.

Several studies have also shown that climate influences our financial decisions. Bernstein et al. (2019) find that homes close to the sea are traded at a significant discount due to global warming. Prices are approximately 7% discount for homes near at sea and this discount has grown over the years as a result of sophisticated buyers' transactions regarding global warming. The discount is lower for rented properties, still at a significant rate of 4%, for those properties that are not expected to be flooded in the next 100 years. Painter (2020) reports that climate change has had an impact on the pricing of log-term municipal bonds. Climate changes have had no impact on short-term bond valuation, only in long-term issuance since the release of the 2006 Stern Review on climate change. Choi et al. (2020) show that investors are aware of climate change showing that there is more Google search volume for 'global warming' in cities that they recently experienced extremely high temperatures. Such investors tend to sell carbon-intensive stocks that tend to underperform likely as a result of their awareness of climate change. Huynh and Xia (2021) report that investors overreact to climate risk natural disasters by pushing stock and bond returns to a lower level, reporting evidence of a reversal in their prices in the future. Finally, Pankratz et al. (2023) report that high temperatures decrease firms' income. These decreases are more pronounced than analyst expectations showing that market participants often face difficulties in fully predicting the negative consequences of extremely hot temperatures.

Finally, studies have shown that climate can even influence managerial decisions which is the closest field to our work. Dessaint and Matray (2017) show that managers tend to temporarily overreact to risks after hurricane strikes by increasing firms' cash holdings when the actual risk is unchanged. They attribute this reaction of the managers as unnecessary considering that the actual risks remain unchanged. There is thus an increase in the perceived rather than the actual risk. They find that this managerial sudden reaction reduces in the years following while the perceived risk reduces and the bias gradually disappears. Hong et al. (2019) also report that the prices of food stocks underreact to climate change risks. They use the Palmer Drought Severity Index to explore the profit growth for firms in a country and show that the prices of food underestimate the severity of climate change. Ginglinger and Moreau (2023) also find that after 2015, climate risk influenced managerial decisions on their firms' capital structure. Managers tend to reduce their firm leverage from their optimal levels. Finally, Gu and Hale (2023) report that firms respond to extreme weather events and policies by changing their presence in countries where they operate showing further evidence that managers are aware of the risks involved due to climate change.

We use in this study temperature as a natural approach to capturing cross-country familiarity considering the impact that temperature has on our behavior and decisions. In the most recent literature, Van De Vliert (2007; 2013) discusses the significance of temperature in our overall behavior and our general lifestyle. Temperature influences our external bodily appearance, the way we are dressed, and the way we live our lives such as the magnitude of physical activity undertaken (Obradovich & Fowler, 2017). Using data between 2002 and 2012 amongst US participants, it was reported that extreme cold and hot temperatures as well as high levels of precipitation reduce physical activity. According to Murray et al. (2013), using European data, they find that the climate has an impact on our everyday decisions. The level of happiness tends to be lower within regions with relatively low sunshine and high humidity. Citizens living in the Mediterranean for example spend a relatively long-time outdoors which has a positive impact on people's level of health and happiness. Temperature can influence the type of work that we do and the work circumstances. Temperature can even influence our attitude toward the number and severity of germs that we face (Fransolet et al., 1985). Hot temperatures are for example linked with high hospital infections. Wormley et al. (2022) even use climate conditions to measure culture distances amongst nations and directly compare their cultural dimensions proxies with previously developed dimensions highlighting their advantages. Citizens in countries with low distances in temperature tend thus to exhibit amongst others similar external appearance, clothing, lifestyle, culture, and behavioral attributes to many dimensions such as the level of risk they are used to experiencing. To the extent country familiarity influences managerial decisions (that will be discussed in the next two sections), it is expected that the distance in temperature is related to cross-border mergers.

2.2. Typical determinants used in international M&A literature

Studies (e.g., Ahern et al., 2015; Erel et al., 2012; La Porta et al., 1998; La Porta et al., 2008) have developed several determinants to understand international decisions in numerous fields. In this section, we review some of the most commonly used determinants in this literature. Broadly speaking, the cross-border determinants can be split into three categories.

The first category of cross-border determinants is based on geographical proximity. The two most typical measurements are whether the country pair shares a border and the distance between their capital cities. The distance between the capitals may be large but still, two countries may share the same border. The incorporation of both variables is thus necessary. Studies (e.g., Ahern et al., 2015; Erel et al., 2012) tend to report that nearby countries exhibit more cross-border mergers.

The second category is regarding similarities across populations. Studies (e.g., Ahern et al., 2015; Erel et al., 2012; Stulz & Williamson, 2003) usually measured this by considering whether the citizens share the same main language, religion, and legal origin. It is

also very common to control for cultural distance, most commonly by using Hofstede's cultural dimensions (Hofstede, 1980; Hofstede & Bond, 1988; Hofstede et al., 2010). Hofstede was the first in the academic literature who measured culture and is most commonly used in the literature. Studies (e.g., Ahern et al., 2015) find that more cross-border mergers take place within countries where citizens share similar characteristics ie when the distance in culture is short, and when the citizens share the same language, religion, and legal origin. We discuss in the next section the potential mechanisms behind the relation in the first two categories that most closely capture country familiarity and cross-border mergers.

Finally, the third category of cross-border determinants includes economic determinants (e.g., Ahern et al., 2015; Erel et al., 2012). Firms are keen on operating in high-growth overseas countries, with large GDP per capita. Also to operate in countries with relatively low levels of tax rate. Firms are also keen on operating in countries that share the same currency since currency fluctuations could influence significantly the level of their profitability. More acquisitions may also take place within countries that have experienced a significant reduction in their local exchange rates since they are relatively cheaper to overtake. The level of internationalization in a country can also influence the level of investment received from overseas. Countries with high internationalization are more likely to be related to a high number of cross-border mergers due to the measures that political parties have undertaken over the years to attract capital or due to the strategic geographical position of a country.

2.3. The mechanism behind managers selecting firms in nations with close country familiarity

We focus in this section on the managerial motivation to select firms in nations with a close familiarity that is linked with our main variable (the distance in temperature) and the first two categories of cross-border determinants discussed in the previous section: geographical proximity and similarity across populations. Studies have theoretically attributed two potential reasonings why country familiarity may influence managerial decisions. On the one hand, the rationale reasoning states that managers tend to select countries with close familiarity to reduce potential friction among staff after the merger announcement (e.g., Ahern et al., 2015; Erel et al., 2012; Shenkar, 2012; Xu et al., 2021). According to surveys (e.g., Coopers & Lybrand, 1993), managers consider the issue of cultural distance between nations an important determinant of whether a deal will succeed or fail, and so they are more likely select firms from countries with short distances to reduce future problems between staff in the two entities.

On the other hand, there is evidence that managerial decisions are not always cold-blooded while at times chaotic (Elton & Eddigen, 2006). Several studies in psychology (e.g., Lichtenstein et al., 1978; Slovic et al., 2007) have also shown that decisions are also often influenced subconsciously by heuristics such as affinity. Anecdotal evidence even exists indicating that two CEOs met over dinner agreeing to a merger deal, leaving it for their vice presidents to rationalize the deal regarding value creation (Sudarsanam, 2010). Evidence shows that mergers tend to destroy the wealth of bidding shareholders (e.g., Conn & Connell, 1990), still, managers tend to announce their mergers on Mondays – the merger Monday phenomenon - as most often they consider them good news (Louis & Sun, 2010). Finally, a theoretical counterargument even states that high diversity in the staff's backgrounds may be a source of strength for a firm having staff with richer perspectives to solve problems. Mergers with low country familiarity may thus be encouraged (Ghoshal & Haspeslagh, 1993).

There is very little empirical evidence on the relation between country familiarity and stock abnormal returns of the bidding firms especially amongst studies in the field of finance. The few and far studies available that have tested this relation produced mixed evidence. Ahern et al. (2015) show for example some evidence that cultural distance is related to abnormal stock returns. Two out of the three cultural dimensions used were significant showing that little cultural distance is related to stronger abnormal stock returns. However, we noticed that some of the other country familiarity variables used by Ahern et al. (2015) such as shared religion or the geographical distance between the capital cities were insignificant. Schoenberg (2000) also reports no evidence that cultural distance is related to bidding firms' performance. The difficulty to show robust results is likely due to that most country familiarity variables are constant over time while bidder stock returns on the merger announcements may vary significantly in the same country pair. Focusing on investor reactions to the merger announcements also assumes that markets are efficient and that investors respond to the correct sign and magnitude of the news. This may not be always the case considering that studies have previously shown that if any, managers often take advantage of irrational investors (e.g., Cooper, Dimitrov, & Rau, 2001; Shleifer & Vishny, 2003; Baker & Wurgler, 2004). The exploration of long-term abnormal stock returns or firm profitability does not necessarily resolve these issues considering the difficulty to control for several factors that may influence stock returns and profitability in the years following the merger, and the general criticism of the reliability of accounting values.

Due to the previous reasons, and that our distance in temperature variable is constant in each country pair, we do not test empirically in our study the relation between temperature and the abnormal stock returns of the bidding firms. We do not believe that this is a test that would offer any robust conclusions. Three of the additional tests that we estimate offer some indication of the motivation of the managers to select firms with close country familiarity. As stated earlier we use the context of the Northern versus Southern hemispheres and find that relatively hot temperatures seem to influence the riskiness level that managers are happy to accept when finalizing merger deals. We find that the relation is most pronounced during the summer months. We also test the relation separately for each direction of a country pair (ie UK minus US temperature and US minus UK temperature) and find that more cross-border mergers tend to occur towards modestly warmer countries. Finally, we find that country pairs with relatively high temperatures exhibit more acquisitions. It is difficult to contemplate how these managerial decisions indicate strategic thinking, showing thus some evidence of biases in their decisions.

2.4. Why is our climate determinant important in the academic literature?

We contribute to the recently developed climate field (e.g., Bernstein et al., 2019; Boustan et al., 2012; Choi et al., 2020; Dell et al., 2009; Dessaint & Matray, 2017; Gallup et al., 1999; Ginglinger & Moreau, 2023; Gu & Hale, 2023; Hong et al., 2019; Hornbeck, 2012; Huynh & Xia, 2021; Painter, 2020; Pankratz et al., 2023; Van De Vliert, 2013) by reporting the significance of the distance in temperature to understand international decisions. Regarding the existing studies that have already explored the significance of temperature mostly in the field of Economics, we focus here on cross-border effects that have previously received little attention as highlighted by Dell et al. (2014, p. 790): "Despite the broad range of outcomes already studied, there are plausibly important channels that have, to date, received comparatively little study. One dimension is cross-border effects". Unlike previous literature, we do not demonstrate the significance of temperature as an absolute number i.e. 22 °C, but we test the significance of the distance in temperature between international capital cities. To our knowledge, this is the first study that explores managerial decisions by using temperature as a proxy of country familiarity and as an affinity measure towards warmer places.

We also contribute to existing studies that explore cross-border determinants within various fields (e.g., Beugelsdijk et al., 2017; Chui et al., 2010; Erel et al., 2012; Kirkman et al., 2006). Typical cross-border determinants used in cross-border decisions face limitations. (i) It is previously assumed that the sign and magnitude of the impact of these determinants are stable in both directions within a country pair. There is thus the illusion that there is symmetry when exploring the significance of a variable between country *i* towards country *x*, and country *x* towards country *i*. However, there is no theoretical support for this symmetry illusion and for example, the cultural distance may differ for each side in a country pair (Shenkar, 2012). (ii) Typical determinants of international decisions assume that decisions remain stable during a calendar year. However, there is evidence that decisions and our risk attitude may as well differ seasonally. We become for example relatively more risk-seeking in warmer weather (e.g., Dell et al., 2014). (iii) Several of these determinants (e.g., shared language, religion, and border) are dummy variables that have the potential to explain only a small percentage of decisions considering that they cannot capture the magnitude of the impact. Finally, some of these determinants offer data for only a few countries. Hofstede's cultural dimensions are for example available for merely 111 countries. The development of cultural dimensions is costly and time-consuming since they are based on surveys that can only capture the perceptions of a relatively small percentage of the population within a country.

Temperature offers significant advantages in comparison to the typical cross-border determinants. We report evidence of seasonality in decisions, with the most pronounced pattern during the summer months. We also find evidence that the direction of the cross-border flows matters, with more overseas acquisitions taking place towards moderately warmer countries. Managers thus show an affinity towards warmer places. Temperature is a continuous variable exploring the full magnitude of the relationship while the typical proxies used are mostly dummy variables. Our data availability is significantly larger than that of cultural measurements. Temperature can be easily developed through freely available online data. There is no need for costly and time-consuming surveys that cultural dimensions are typically based on.

3. Data and methodology

3.1. Data sources

We employ several datasets in this study. Table 1 offers the descriptive statistics of the main variables used and Appendix 1 offers the definitions of all the variables used in this study and the data sources employed. We download the cross-border mergers from Thomson OneBanker for all the countries where data are available to be matched with temperature. We estimate the number of completed mergers per available country pair for the period between January 2000 and September 2019, with at least 50% of shares acquired. Firms from all industries are included in the estimations. The number of observations shown in Table 1 for mergers indicates the number of country pairs available with merger data rather than the number of total mergers. Our initial sample has 11282 country pairs which include all possible country pairs. However, most of the pairs (76%) had no merger deal undertaken. We thus exclude from the main analysis countries such as Liechtenstein and Tanzania that there is very little if any, likelihood that a cross-border merger between these two nations may take place.[2] Large-size firms mostly undertake overseas acquisitions and so most managers are expected to have the necessary heating/air-conditioning while at work. Only the difference in outside temperatures may influence their decisions.

We download available temperature data from Weatherbase which is a source often used in this field (e.g., Li, 2014).[3] This variable indicates the absolute distance in the average temperature (°C) in capital cities between country pairs over the available sample period. Country pairs with high (low) distance in temperature indicate pairs with potential low (high) country familiarity. We regress data at a country level, rather than for each merger deal separately, so there is an approximation of the distance in temperature per country pair. There may be a significant variation in temperatures within the same country, especially in countries with a very large land size such as Russia, China, and the United States of America. Such countries are much larger than Europe which consists of many nations. Most substantial firms are likely to be situated nearby the capital, for example over 70% of FTSE100 firms are located nearby London.[4] The merger advisory firms can also influence decisions (e.g., Rau, 2000) that their location may differ. The temperature in the capital cities

[2] For robustness we also report results later when including all country pairs. We find that our conclusions are unaltered.
[3] https://www.weatherbase.com/.
[4] https://en.wikipedia.org/wiki/List_of_companies_based_in_London.

Table 1
Descriptive statistics.

	Average	Median	Min	Max	N
Dependent variable					
Mergers	39.94	3.00	1.00	9107.00	2640
Main independent variable					
Temperature distance	7.64	6.40	0.00	27.00	2640
Additional weather variables					
High minus low temperature	2.60	2.00	0.00	10.00	2595
Main control variables					
Shared border	0.09	0.00	0.00	1.00	2640
Capital distance	5993.44	5162.50	29.00	19835.00	2640
Shared language	0.10	0.00	0.00	1.00	2640
Shared religion	0.18	0.00	0.00	1.00	2640
Shared legal origin	0.37	0.00	0.00	1.00	2640
Culture distance	2.46	1.72	0.00	16.25	1575
Shared currency	0.05	0.00	0.00	1.00	2640
Tax distance	2.07	2.21	0.00	3.54	2640
GDP per capita	28061.34	26547.68	1287.82	104617.70	2640
GDP growth	0.09	0.08	0.00	0.19	2640
GDP distance	23620.35	20070.46	1.87	115278.50	2640
International trade	89.51	79.72	26.13	335.99	2640
Additional variables					
Average temperature	15.43	15.50	−0.20	27.35	2640
Climate risk	43.36	36.00	0.00	154.50	2625
Emissions	7.49	6.65	0.11	37.09	2640
Environmental performance	19.49	17.10	0.00	56.60	2586

This table shows the descriptive statistics of the variables used in this study. Appendix A offers the definitions of the variables and the sources used.

likely reflects the climate that a significant percentage of managers and their advisors experience while at work and may even be earlier in their lives. Fig. 1 portrays the histogram of the absolute distance in temperature for all countries used in our sample showing that there is a wide range of differences in temperatures. The minimum absolute distance in temperature is 0 °C and the maximum 27 °C.

3.2. Methodology

Our dependent variable is non-integer and positive. We thus undertake the following Poisson estimation for the main analysis.[5] We use robust standard errors across all our estimations.

$$LnMergers_{ij} = constant + b_1\, TemperatureDistance_{ij} + b_2\, SharedBorder_{ij} + b_3\, LnCapitalDistance_{ij} + b_4\, SharedLanguage_{ij} + b_5\, SharedReligion_{ij} + b_6\, SharedLegalOrigin_{ij} + b_7\, LnCultureDistance_{ij} + b_8\, SharedCurrency_{ij} + b_9\, LnTaxDistance_{ij} + b_{10}\, LnGDPPerCapita_{ij} + b_{11}\, LnGDPGrowth_{ij} + b_{12}\, LnGDPDistance_{ij} + b_{13}\, InternationalTradeDP_{ij} + u_i \quad (1)$$

The dependent variable is *Lnmergers* which is the logarithm on the number of overseas mergers between countries *i* and *j*. Our main independent variable is the *temperature distance* which indicates the absolute distance in the average temperature (°C) in capital cities between country pairs over the available sample period. As highlighted by Camargo and Hsiang (2016, 2016), we do not follow a log transformation for any of our climate measurements due to the difficulty to interpret physical phenomena. To support our expectation, the b_1 parameter coefficient should be significantly negative which would indicate that country pairs with high (low) temperature distance exhibit a relatively low (high) number of cross-border mergers. We use in our estimations the long differences in temperature i.e. we have one observation for temperature per country pair, with the corresponding number of mergers in each pair.

We control for several variables that have been found in the literature to influence cross-border flows (e.g., Ahern et al., 2015; Erel et al., 2012; La Porta et al., 1998; La Porta et al., 2008; Siganos, 2023; Siganos & Tabner, 2020). First, we control for a country's geographical location since it has been shown that there are more acquisitions in countries that are nearby geographically. We measure the geographical distance per country pair to the extent countries share the same border, and we download the distance (in kilometers) between their capitals.

We also control for proxies of citizens' similarity considering that studies have previously shown that countries in which their citizens share similarities exhibit more acquisitions. We estimate whether citizens share the same primary language, religion, and legal origin (i.e. German, Scandinavian). We also control for culture using the logarithm of the $\frac{\sum_{k=1}^{2}[(\mathbf{Country_i}-\mathbf{Country_j})^2/\mathbf{V_k}]}{2}$ where k is each dimension: long-term orientation, and indulgence and V is the variance of each of these two dimensions. We select these two cultural dimensions by Hofstede to measure culture because they offer the most country data available. It is expected that country pairs that share similarities in citizens exhibit more acquisitions.

[5] For robustness, we estimate later results using OLS. We find that our conclusions are the same.

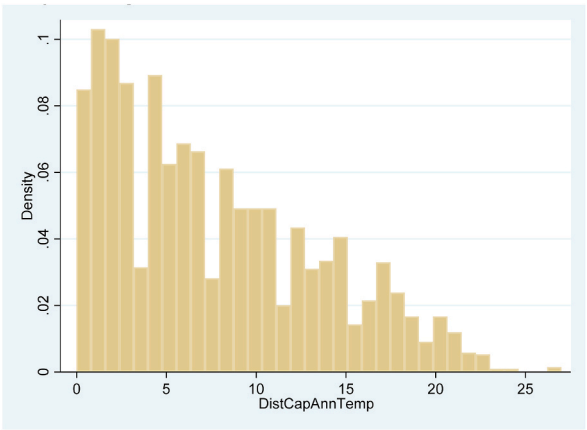

Fig. 1. Histogram of temperature.
This figure shows the histogram of our main independent variable, temperature, which shows the absolute distance in the average temperature (°C) in-country pairs. It reflects the distance in temperature for the capital cities.

Finally, we control for firms' economic incentives. We expect that countries sharing the same currency are more likely to experience more acquisitions to avoid exchange rate risk after the completion of the deal. We estimate the differences in the average taxation between country pairs and their GDP per capita. Country pairs with a large distance in the tax rate are for example expected to exhibit more acquisitions for firms to potentially take advantage of tax differences in different regions. We also control for GDP per capita and GDP growth with firms more likely to be keen on operating on large size economies, with large growth in the economy. Tax and GDP data are collected from the averaging available data per country between 2000 and 2019. We also average the percentage of trade which is the sum of exports plus imports between 2000 and 2019 to their GDP. We use the logarithm for any variable (other than the distance in temperature as discussed earlier) that is continuous to reduce the impact of extreme values in the reported results. We restrict in our main analysis country pairs with data available for mergers (with at least one merger deal), temperature, and all the control variables other than culture due to the significantly lower number of observations available.

4. Empirical results

4.1. Determinants of the distance in temperature

We first intend to offer some empirical validity of the distance in temperature as a country familiarity proxy. We test here its relation with other country familiarity proxies previously used in the literature. To test this, we undertake an OLS analysis where the dependent variable is the absolute distance in the temperature in our country pairs. Column (1) of Table 2 reports the univariate results, while columns (2) to (4) the multivariate results. We only report the beta coefficient in the univariate estimations for space consideration. Column (2) reports multivariate results with other country familiarity variables other than culture, while column (3) with all familiarity variables. Culture has many missing observations and we thus report results with and without it. Finally, column (4) reports results with all the control variables that include also economic variables for complete analysis considering the control variables that will be used in the later sections. We know that temperature influences many economic activities (e.g., Dell et al., 2014), but notice that the relations are theoretically the reverse and so the distance in temperature should have been the independent rather than the dependent variable used in this last estimation.

Our empirical evidence indicates that the distance in temperature is related to some country variables used earlier in the literature, and so it makes some sense to use it in our empirical setting in the following sections. The relations are more pronounced in the univariate analysis since several of these variables attempt to capture theoretically the same proxy (ie country familiarity) and are thus highly correlated. This is not necessarily a concern considering the purpose of this testing. We find that country pairs with large distances in their capitals exhibit large differences in their temperatures. Country pairs that share a border have less distance in their temperature distance. Similar citizen characteristics seem also to be related to the distance in temperature. Countries where their citizens share the same language, religion, and legal origin, exhibit small distances in their temperatures. Country pairs with small distances in their temperatures exhibit also higher levels of GDP per capita. We find that all the control variables together can only explain 25.4% of the variability in the distance of the temperature which offers a motivation to explore empirically the role of temperature in relation to cross-border mergers in the following sections.

4.2. The distance in temperature as a determinant of cross-border merger decisions

We expect that country pairs with close temperatures exhibit many cross-border mergers and that country pairs with far temperatures have a relatively small number of mergers. More overseas acquisitions would take place within country pairs that managers

Table 2
Determinants of the distance in temperature.

	Temperature distance			
	Univariate regressions	Multivariate regressions		
	(1)	(2)	(3)	(4)
Shared border	−4.266***	−0.351	0.093	0.882**
	(-15.96)	(-1.25)	(0.29)	(2.47)
Ln Capital distance	2.202***	2.072***	2.317***	2.498***
	(26.08)	(20.75)	(19.85)	(18.26)
Shared language	−1.232***	0.373	−0.764	−0.019
	(-3.80)	(1.03)	(-1.39)	(-0.04)
Shared religion	−2.027***	−0.471	0.075	−0.056
	(-7.96)	(-1.63)	(0.24)	(-0.17)
Shared legal origin	−1.502***	−1.019***	−0.730***	−0.880***
	(-6.66)	(-4.62)	(-2.77)	(-3.29)
Ln Culture distance	0.154		−0.196**	−0.263***
	(1.49)		(-2.03)	(-2.72)
Shared currency	−2.790***			0.691**
	(-8.91)			(2.11)
Ln Tax distance	0.678***			0.268*
	(4.80)			(1.70)
Ln GDP per capita	1.274***			−1.513***
	(7.50)			(-4.78)
Ln GDP growth	−0.966***			−0.916*
	(-2.84)			(-1.66)
Ln GDP distance	1.144***			0.838***
	(12.42)			(6.35)
Ln International trade	1.019***			2.383***
	(3.56)			(6.32)
Constant		−9.123***	−11.754***	−19.214***
		(-11.18)	(-12.85)	(-6.33)
N		2640	1575	1575
R-square adjusted		0.153	0.202	0.254

This table reports the determinants of the distance in temperature in our country pairs which is our main independent variable in the following tables. Note that column (1) indicates univariate results i.e. each parameter is estimated in a separate regression and so 12 regressions are estimated. T statistics are reported in parentheses. Appendix A offers the definitions of the variables and the sources used. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

perceive with little friction in the post-merger period or/and that they are subconsciously linked with. In line with equation (1), the dependent variable is the logarithm of the number of overseas mergers for each country pair, and the main independent variable is the absolute distance in the average capital temperature for the corresponding country pairs.

Column (1) of Table 3 reports the univariate results for all our variables under consideration i.e. when estimating 13 regressions. Once again, we only report the beta coefficient in these estimations for space consideration. We find that most parameter coefficients are in line with our expectations, with 10 of them being statistically significant. As theorized in this study we find that country pairs with short distances in their temperature exhibit more acquisitions. Most of the control variables have the expected sign. We find for example that country pairs that share borders and religion exhibit more cross-border acquisitions. Countries that share the same currency also exhibit more acquisitions. Country pairs with low distance in culture exhibit more acquisitions. The three control variables related to GDP are also significant.

More importantly, columns (2) and (3) report the multivariate results. First with the inclusion of all control variables other than the culture variable and then all together. With the inclusion of culture, we have 1065 missing observations. Still, due to the significance of culture on managerial decisions, we keep culture for most of the remaining tests in this study. There may be a high correlation among the control variables but we are mainly interested in the role of temperature after controlling for other variables that may influence managerial decisions. In line with our expectation, we find that the parameter coefficient on temperature is significantly negative indicating that country pairs that experience a small (large) distance in capital temperature experience more (less) cross-border acquisitions. The (log) number of mergers is expected to decrease by −0.011 units with an increase by a unit in the distance in temperature, holding all other variables in the model constant. The estimated incidence rate ratio decreases by a factor of 0.989 [which is the exponential value of −0.011]. A one-unit decrease in the difference of the temperature in a country pair is thus linked with an increase in the number of cross-border mergers by 1.09% [(0.989–1)*100]. The role of the distance in temperature is thus significant in economic terms.

We also find that most of the control variables hold in the multivariate regressions. Eight out of the twelve parameter coefficients are significant. Country pairs that share a border and those with low distances in their capital cities experience more acquisitions. Country pairs that share the same language and religion exhibit more acquisitions. Country pairs with low distance in culture exhibit more acquisitions. Large economies and those with relatively similar levels of GDP per capita experience more acquisitions.

Table 3
Temperature and the number of cross-border mergers.

	Ln Mergers		
	Univariate regressions	Multivariate regressions	
	(1)	(2)	(3)
Temperature distance	−0.024***	−0.013***	−0.011***
	(-10.46)	(-5.81)	(-3.69)
Shared border	0.422***	0.274***	0.342***
	(9.15)	(6.78)	(8.09)
Ln Capital distance	−0.135***	−0.077***	−0.054***
	(-9.53)	(-5.48)	(-3.50)
Shared language	0.017	0.034	0.123**
	(0.35)	(0.71)	(2.24)
Shared religion	0.066*	0.027	0.097***
	(1.87)	(0.73)	(2.59)
Shared legal origin	−0.03	0.036	0.028
	(-1.01)	(1.36)	(0.90)
Ln Culture distance	−0.057***		−0.025***
	(-5.02)		(-2.72)
Shared currency	0.422***	0.107***	0.005
	(8.47)	(2.78)	(0.12)
Ln Tax distance	−0.017	−0.022	−0.022
	(-0.94)	(-1.42)	(-1.28)
Ln GDP per capita	0.458***	0.823***	0.880***
	(20.20)	(29.10)	(20.53)
Ln GDP growth	−0.117***	0.300***	0.038
	(-3.52)	(8.37)	(0.59)
Ln GDP distance	−0.043***	−0.103***	−0.059***
	(-3.74)	(-10.14)	(-4.88)
Ln International trade	−0.120***	−0.549***	−0.503***
	(-3.16)	(-15.21)	(-11.74)
Constant		−2.812***	−4.780***
		(-9.51)	(-12.57)
N		2640	1575
Chi-square		1570.76	1351.169
Pseudo r-square		0.098	0.108

This table shows the main relation of this study regarding the absolute distance in the average temperature in capitals' country pairs and the corresponding number of cross-border mergers. We undertake Poisson estimations. The dependent variable is the logarithm of the number of cross-border mergers in country pairs and the main independent variable is the distance in temperature. Note that column (1) indicates univariate results i.e. each parameter is estimated in a separate regression and so 13 regressions are estimated. Z statistics are reported in parentheses. Appendix A offers the definitions of the variables and the sources used. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

4.3. Results for country pairs in the Northern versus the Southern hemisphere

We next explore whether decisions are influenced by the hot weather. Warm temperatures can influence our risk attitude. Several studies (e.g., Burke, Hsiang, & Miguel, 2015; Ranson, 2014) for example report that temperature can even influence the level of conflict in a country and as an example, it is more likely to experience violence on hot days since temperature influences our aggressiveness (Tiihonen et al., 1997). We expect that the relationship is most pronounced within the summer months.

We take advantage of a unique context in this field to test this. The summer in countries in the Northern hemisphere is between June and August, but in the Southern hemisphere between December and February. The winter in countries in the Northern hemisphere is instead between December and February but in the Southern hemisphere between June and August. Managers thus face different temperatures and climates during the same months of the year which offers an ideal context for direct comparisons that control for many unobserved characteristics. If the weather has an impact on decisions, managers should take very different decisions whether they live in the Northern or the Southern hemisphere during the same months.

We use the average temperatures of the capital cities in our sample separately for months from June to August and then from December to February. We control for the annual average temperature in each capital city to identify the incremental impact of weather on what managers may consider as 'normal' temperature. We test the main relation separately for country pairs that both countries are in the Northern and the Southern hemisphere.[6]

Table 4 reports the empirical results that offer strong support for our expectations. We find that the relevant parameter coefficient is significantly negative between June and August for country pairs in the Northern hemisphere (i.e. during summer). However, this parameter coefficient is insignificant for pairs in the Southern hemisphere (during winter). Also, the parameter coefficient is

[6] Country pairs that one country is on the Northern and the other in the Southern hemisphere or the reverse are excluded from this analysis. This data restriction explains the reduction in the number of observations available.

Table 4
Results for countries in the Northern versus the Southern hemisphere.

	Ln Mergers	
	Both countries in the Northern hemisphere (1)	Both countries in the Southern hemisphere (2)
Temperature distance	−0.015*	−0.010
	(-1.95)	(-0.34)
Temperature distance June–August	−0.012**	0.024
	(-2.19)	(1.10)
Temperature distance December–February	0.005	−0.049**
	(1.15)	(-2.07)
Previous controls	Yesˆ	Yesˆ
Constant	−3.444***	1.296
	(-9.97)	(0.76)
N	1959	89
Chi-square	1282.81	140.217
Pseudo r-square	0.104	0.138

This table shows the relation between the absolute distance in the average temperature in capitals' country pairs and the corresponding number of cross-border mergers between June–August and December–February. Summer months in the Northern hemisphere are between June and August. This is instead the period of winter for countries in the Southern hemisphere. Winter months in the Northern hemisphere are between December and February which is summer for countries in the Southern hemisphere. Z statistics are reported in parentheses. ˆ indicates that the culture distance variable is excluded from these estimations due to the very low number of observations that otherwise remained. Appendix A offers the definitions of the variables and the sources used. *, and ** indicate statistical significance at the 10, and 5% levels, respectively.

significantly negative between December and February for country pairs in the Southern hemisphere (during summer), but there is no relation for pairs in the counterpart Northern hemisphere (during winter). Our empirical results offer strong support for the significance of seasonality in the cross-border decision-making process. Previous cross-border determinants tend to ignore any seasonality in decisions.

4.4. Results per direction of cross-border mergers

Typical determinants are only available at a pair level and so temperature offers an advantage in the identification of the relationship considering that temperature can be estimated per side of cross-border mergers. We first estimate the main results with the use of both sides in each pair group into the same estimation. We explore for example the significance of the difference in temperature of London minus Washington DC in the number of mergers of US firms acquiring UK firms. Correspondingly, the difference in the temperature of Washington DC minus London is in association with the number of mergers of UK firms acquiring US firms.

In line with the main argument of this study, we expect that there are more cross-border mergers within countries with a close gap in their temperature for both directions. As shown in column (1) of Table 5, the empirical results indeed support our expectations. We find that the parameter coefficient on the distance temperature is significantly negative at the 1% level. Notice that the number of observations available doubled since for each country pair we include two data points rather than one used in the main analysis earlier. We use for example the number of mergers that took place from the UK to the US and then from the US to the UK rather than the number of total acquisitions in the country pair, UK/US.

More importantly, we explore the significance of relative heat on decisions. We reported earlier that the main association is driven by differences in temperature in summer months as a result that heat makes us more responsive (e.g., Burke, Hsiang, & Miguel, 2015; Ranson, 2014; Tiihonen et al., 1997). We explore in this section whether decisions are influenced by the relative heat of the counterpart country. We are keen on relatively warmer temperatures (e.g., Andrade et al., 2011), and it is thus expected more cross-border mergers towards relatively warmer countries. Due to global warming and the risks involved, we instead expect that managers may want to avoid countries with significantly warmer temperatures.

To test this, we generate first a dummy that takes one when the average difference in the temperature of two capitals is positive and zero otherwise. Correspondingly, we generate a dummy that takes one when the difference in the temperature is over 5, 10, 15, 20, 21, and 22 °C degrees. The dependent variable is the number of mergers per side of the cross-border flow. As shown in columns (2) to (8) our results offer some support of our expectations. The parameter coefficient of the dummy variable is significantly positive up to over 10 °C degree difference in the temperature between the capitals. This result indicates that managers are inclined to undertake acquisitions in countries with modestly warmer temperatures. Interestingly, the relation becomes insignificant with a positive sign in temperature differences over 15 and 20 °C degrees, and then insignificant and negative for over 21 and 22 °C degrees. Note that the p-value is (0.100) and thus only slightly insignificant at the 10% level when using over a 22 °C -degree difference in the temperatures showing that managers tend to avoid significantly warmer countries. It is not possible to undertake an estimation with over 23 °C degree differences in the temperature in country pairs due to the non-existence of enough ones in the dummy variable.

4.5. IV results

There may be no concern that there is reverse causality since the number of mergers cannot influence the temperature. Still, we undertake an IV test to mitigate any concern to the extent we have missed control variables that could have potentially impacted

Table 5
Results for both directions of cross-border flows.

	Ln Mergers							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Temperature distance	−0.012***							
	(-3.60)							
Dummy = 1 if the difference in temperature for targets >0 °C		0.137***						
		(5.10)						
Dummy = 1 if the difference in temperature for targets >5 °C			0.110***					
			(3.38)					
Dummy = 1 if the difference in temperature for targets >10 °C				0.173***				
				(3.78)				
Dummy = 1 if the difference in temperature for targets >15 °C					0.094			
					(1.34)			
Dummy = 1 if the difference in temperature for targets >20 °C						0.108		
						(0.90)		
Dummy = 1 if the difference in temperature for targets >21 °C							−0.145	
							(-0.71)	
Dummy = 1 if the difference in temperature for targets >22 °C								−0.474
								(-1.64)
Previous controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−7.261***	−7.226***	−7.167***	−7.086***	−7.115***	−7.151***	−7.167***	−7.163***
	(-16.57)	(-16.34)	(-16.12)	(-15.94)	(-16.01)	(-16.15)	(-16.21)	(-16.21)
N	3150	3150	3150	3150	3150	3150	3150	3150
Chi-square	1968.107	1884.51	1883.987	1895.757	1914.025	1914.063	1918.136	1922.348
Pseudo r-square	0.129	0.13	0.129	0.13	0.128	0.128	0.128	0.128

This table explores results when using both directions of cross-border flows by exploring managerial decisions regarding the location of overseas target firms in relation to the distance in their temperature. Z statistics are reported in parentheses. Appendix A offers the definitions of the variables and the sources used. *** indicates statistical significance at the 1% level.

significantly our results. We use two instruments; the absolute distance in the average alcohol consumption, and the average life expectancy. Studies have previously reported that temperature influences citizens' alcohol consumption, and life expectancy (e.g., Dell et al., 2014). We could not identify variables that influence the temperature that is not linked theoretically with mergers. Instead, we use instrument variables that are related to the temperature with little concern that these instruments may influence the number of cross-border mergers.

In the first stage, we regress each one of these instruments on temperature and estimate the predicted temperatures. In the second stage, we regress the predicted temperatures that arrive from the first stage of the number of acquisitions. Columns (1), and (3) of Table 6 report the first-stage results. As expected, we find that the relevant parameter coefficients are significantly positive showing that temperature matters in fields beyond business. More importantly, columns (2), and (4) report the second-stage results of the IV analysis. We find that the parameter coefficients on temperature remain significantly negative with the use of IV estimations. The relation is unlikely to be driven by endogeneity.

Table 6
Endogeneity.

	Instrument; Ln Alcohol distance		Instrument; Ln Life expectancy distance	
	Temperature	Ln Mergers	Temperature	Ln Mergers
	1st stage	2nd stage	1st stage	2nd stage
	(1)	(2)	(3)	(4)
Temperature distance		−0.103***		−0.209***
		(-4.32)		(-4.92)
Alcohol distance	2.010***			
	(10.95)			
Life Expectancy distance			0.912***	
			(6.83)	
Previous controls	Yes	Yes	Yes	Yes
Constant	−21.105***	−9.945***	−23.608***	−11.968***
	(-7.36)	(-10.89)	(-7.61)	(-9.06)
N	1575	1575	1575	1575
R-square adjusted	0.31	0.3114	0.278	0.0598

This table shows the IV results. We use as instruments; the absolute distance in the average alcohol consumption in country pairs as shown in columns (1) and (2), and the absolute distance in the average life expectancy in country pairs as shown in columns (3) and (4). T statistics are reported in brackets. Appendix A offers the definitions of the variables and the sources used. *** indicates statistical significance at the 1% level.

4.6. Invalidate alternate explanations

4.6.1. Controlling for environmental concerns

We invalidate in this section potential alternative explanations of the main relation. We first explore environmental concerns and so they may be closely related to our main independent variable (the distance in temperature), but such determinants are not commonly used in the cross-border merger literature and for this reason, they are controlled for only in this section as further support of our main findings. We explore whether managerial concerns regarding climate change may drive our relationship. In particular, we test whether managers avoid countries with high climate risk. To examine this, we estimate the absolute distance in the average climate risk index (CRI) score in country pairs as available from *Germanwatch* and re-estimate the Poisson regression with the addition of this extra control variable. CRI score indicates the total disruption that extreme weather has created in various countries such as through the number of fatalities per 100,000 citizens and the total damages per GDP between 1999 and 2018.

Column (1) of Table 7 reports the empirical results. We find that the parameter coefficient of climate risk is significantly negative showing that managers seem to be influenced by the potential risks as a result of climate change. Country pairs with relatively high distances in climate risk exhibit fewer cross-border mergers indicating that managers may avoid countries with relatively high climate risk. More importantly, the parameter coefficient of the distance in temperature remains significantly negative at the 1% level after controlling for climate risk. Our conclusions thus remain unchanged with the additional control of climate risk.

We also test whether the country's environmental performance influences managerial decisions and whether managers consider the level of environmental attitude at a country level when selecting overseas acquisitions. To test, this we download a relevant dataset as available in NASA and estimate the absolute distance in environmental performance in our country pairs. We also download from the Global Carbon Project, the total emissions per capita that we average for our country pairs during the sample period. We add these two variables and re-estimate the Poisson regression.

Column (2) shows some evidence that managers are keen on operating in highly polluted countries as shown by the positive parameter coefficient on emissions. The parameter coefficient on environmental performance may be insignificant but still negative showing some evidence that managers are keen on operating in overseas countries with relatively low levels of environmental pressure. More importantly for our study, the parameter coefficient of the distance in temperature remains significantly negative at the 1% level after relevant controls. Overall, our conclusions remain unchanged with the additional controls used in this section.

4.6.2. Controlling for firm availability to be a good match for an acquisition

We further explore whether the firm availability to be a good match for the acquisition is one of the factors that may explain the relation. We use one data observation per country considering that almost all our independent variables are constant over time. The alternative approach would have been to use each merger announcement as a separate data observation having hundreds of thousands of data to run our estimations. This latest approach would have only boosted the statistical significance level of our estimations

Table 7
Invalidate alternate explanations.

	Ln Mergers					
	(1)	(2)	(3)	(4)	(5)	(6)
Temperature distance	−0.009***	−0.009***	−0.011***	−0.011***	−0.011***	−0.007*
	(-3.12)	(-3.05)	(-4.45)	(-4.47)	(-4.45)	(-1.92)
Ln Climate risk	−0.048***					
	(-3.72)					
Ln Emissions		0.113***				
		(2.62)				
Ln Environmental performance		−0.021				
		(-1.26)				
Ln # of listed firms			0.198***	0.200***	0.198***	
			(15.42)	(15.18)	(15.42)	
Ln Market capitalization			0.233***	0.232***	0.233***	
			(8.38)	(8.25)	(8.38)	
Both countries high income				−0.026		0.145***
				(-0.70)		(2.89)
Both countries low income					0.000	
					(0.00)	
Temperature distance * Both countries high income						−0.014**
						(-2.34)
Previous controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−4.743***	−4.140***	−4.089***	−4.240***	−4.089***	−4.401***
	(-12.39)	(-8.46)	(-12.34)	(-10.95)	(-12.34)	(-9.88)
N	1565	1542	1191	1191	1191	1554
Chi-square	1462.458	1385.068	2570.13	2578.803	2570.13	1449.786
Pseudo r-square	0.111	0.110	0.158	0.158	0.158	0.109

This table explores potential alternate explanations of the main relation. We additionally control for climate risk, emissions, environmental performance, the number of listed firms, and the overall market capitalization. Z statistics are reported in parentheses. Appendix A offers the definitions of the variables and the sources used. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

potentially generating biased relations of the variables of focus. We still offer some reassurance with the below tests that it is not likely that the firm availability drives our relation.

We first control for the number of listed firms available and the market capitalization in these countries. As shown in column (3) of Table 7 these parameter coefficients are significantly positive showing that country pairs with developed financial markets exhibit more cross-border mergers. Importantly, the parameter coefficient on the distance in temperature remains significantly negative after relevant controls. After controlling for the number of available firms and the size of these firms, the role of the distance in temperature for cross-border mergers remains strong.

To offer further reassurance that it is not the level of development in a country that drives our main results, we further control for country pairs with high and low income as shown in columns (4) and (5). These are dummy variables that take one if they are both countries of high (or low) income otherwise zero. We find that these parameter coefficients are insignificant which is mainly due to the number of listed firms available and the market capitalization already used as control variables. In untabulated results, we find that the parameter coefficients are significant in the income group if the number of listed firms and the market capitalization variables are excluded from the analysis.

We further interact the countries with high income with the temperature distance. As shown in column (6), we find that the parameter coefficient on the interaction variable is significantly negative indicating that the main relation becomes most pronounced within countries with high income. It is thus not likely that the firm characteristics in a country drive our relation since lots of firms with various characteristics are available in developed economies.

4.7. *The significance of the temperature in other contexts*

This section intends to offer (i) further empirical support that the distance in temperature captures similarities among citizens in nations, and (ii) external validity of the distance in temperature in a different context other than cross-border mergers. We test the importance of temperature concerning the absolute distance in the average momentum profits, the average GDP per capita, and the average percentage of credit card users in country pairs. The definitions of these variables, and the sources used to develop them, are available in Appendix A. Briefly, momentum indicates the logarithm of the absolute distance in the average momentum profits in the countries as reported by Chui et al. (2010). The momentum effect is for example the most well-known stock market anomaly in the field of finance, with plenty of studies previously having debated its source (e.g., Jegadeesh and Titman, 1993).

Table 8
The significance of temperature distance in other settings.

	Ln Momentum distance	Ln GDP distance	Ln Credit card distance
Temperature distance	0.023***	0.032***	0.022***
	(2.72)	(6.39)	(4.62)
Shared border	−0.297	−0.277***	−0.162
	(-1.60)	(-2.86)	(-1.61)
Ln Capital distance	0.083	0.087***	−0.009
	(1.27)	(2.67)	(-0.29)
Shared language	−0.078	−0.096	−0.290**
	(-0.50)	(-0.79)	(-2.08)
Shared religion	0.039	−0.046	−0.038
	(0.34)	(-0.64)	(-0.54)
Shared legal origin	0.174*	0.109**	0.07
	(1.66)	(2.10)	(1.38)
Ln Culture distance	0.016	0.129***	0.072***
	(0.45)	(7.30)	(3.12)
Shared currency	−0.530***	−0.495***	−0.198**
	(-2.99)	(-5.33)	(-1.98)
Ln Tax distance	0.044	−0.048*	−0.005
	(0.78)	(-1.66)	(-0.15)
Ln GDP per capita	−0.028	0.833***	0.749***
	(-0.19)	(12.61)	(8.06)
Ln GDP growth	0.547**	0.347***	0.184
	(2.54)	(3.18)	(1.58)
Ln GDP distance	0.014		0.482***
	(0.26)		(13.54)
Ln International trade	−0.244**	0.201***	−0.644***
	(-1.98)	(3.13)	(-8.33)
Constant	0.606	0.237	−6.163***
	(0.50)	(0.37)	(-7.79)
N	578	1575	1528
R-square	0.1449	0.2591	0.389

This table shows whether the absolute distance in the average temperature in the capitals of the country pairs is related to several other contexts. We estimate the significance of temperature in three additional contexts; momentum returns, GDP per capita, and the percentage of citizens using a credit card. T statistics are reported in brackets. Appendix A offers the definitions of the variables and the sources used. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

Table 9
Robustness tests.

	Ln Mergers	Ln Mergers	Ln Mergers	Ln Value of mergers	Ln Mergers	Ln Mergers	Ln Mergers	Ln Mergers	Ln Mergers
	OLS regression	All country pairs including those with no mergers			The US is excluded from the analysis	Using New York rather than Washington DC	Results for country temperature	Results after controlling for average temperature	Results for High minus low temperature
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Temperature distance	−0.026***	−0.027***		−0.009**	−0.010***	−0.012***		−0.013***	
	(-3.92)	(-6.61)		(-2.51)	(-3.32)	(-3.85)		(-4.16)	
Ln Temperature distance			−0.082***						
			(-4.34)						
Country temperature distance							−0.008***		
							(-2.97)		
Average Temperature								0.011***	
								(2.58)	
High minus low temperature distance									−0.015*
									(-1.83)
Previous controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	−8.451***	−12.184***	−4.683***	−4.600***	−4.208***	−4.776***	−4.762***	−5.173***	−4.670***
	(-10.82)	(-20.53)	(-12.29)	(-8.72)	(-11.34)	(-12.58)	(-12.47)	(-12.34)	(-12.20)
N	1575	3246	1575	1575	1498	1575	1575	1575	1575
R-square adjusted	0.3669								
Wald Chi-square		2687.916	1378.841	622.015	1199.695	1359.636	1336.417	1365.672	1301.97
Pseudo r-square		0.304	0.108	0.108	0.096	0.108	0.107	0.109	0.106

This table shows the robustness tests on the main relation previously shown in Table 3. The main independent variable is the distance in temperature. Z and t statistics are reported in parenthesis. Appendix A offers the definitions of the variables and the sources used. *, **, and *** indicate statistical significance at the 10, 5, and 1% levels, respectively.

As shown in Table 8, we indeed find that the parameter coefficient on temperature is significantly positive across all three estimations. These results indicate that the differences in the average temperature influence people's decisions by making them behave more homogeneously. Temperature familiarity is a proxy that offers consistent results within alternate fields. The parameter coefficients in the control variables are instead inconsistent. These results report further the importance of including the distance in temperature in cross-country analysis within alternate fields.

4.8. Robustness tests

Finally, we undertake several robustness tests for the relation previously shown in Table 3. Column (1) of Table 9 reports results when undertaking an OLS estimation. We still find that the parameter coefficient on the distance in the temperature is significantly negative with the use of OLS estimation. Column (2) reports results when including all available country pairs, even those that experienced no merger deals during our sample period. Several countries in our sample are relatively small, with little (if any) overseas mergers. These country pairs were previously excluded from the analysis. We find that the parameter coefficient on temperature remains significantly negative with the use of the full sample of country pairs.

Column (3) reports results when using the logarithm of the distance in the temperature in our country pairs. In line with Camargo and Hsiang (2016, 2016), we previously did not follow a log transformation due to the difficulty to interpret physical phenomena. We report here that our conclusions are unchanged if we use the log of the distance in temperature. The relevant parameter coefficient remains significantly negative. Column (4) reports results when using the logarithm value of the deals (in $millions) for the country pairs rather than the total number of mergers. Once again, we find that the main parameter coefficient remains significantly negative.

Column (5) explores the significance of the United States of America in our empirical results. We exclude country pairs that have the United States of America and re-run the main Poisson estimation. We find that our results hold with the exclusion of the United States showing that our conclusions are not simply driven by one country. Note that we include only one data per country pair (rather than all merger announcements that took place separately), and so the impact of the United States of America in our results is minimal. Column (6) also reports results if using New York City rather than Washington DC used earlier. Once again, our conclusions remain unchanged.

Column (7) reports results when using the country temperature. We used earlier the temperature in the capitals since it is more likely that most significant companies are likely headquartered in the capital city of a country, and thus our measure is not influenced by temperatures in remote areas with potentially little economic activity. We re-download all temperature data now for the whole country and indeed find that the parameter coefficient of the distance in the temperature of the whole country remains significantly negative.

Column (8) reports results when we control for the average temperature for each country pair. This is to ensure that the distance in temperature and the average temperature capture two different stories. We find that the parameter coefficient on the average temperature is significantly positive showing that country pairs with relatively high temperatures exhibit more acquisitions. This result is in line with the previous findings in this study that the relation is most pronounced during summer months and towards modestly hotter countries as shown earlier. As we stated earlier, warm temperatures can influence our risk attitude and aggressiveness according to several studies (e.g., Burke, Hsiang, & Miguel, 2015; Ranson, 2014; Tiihonen et al., 1997). More importantly, the parameter coefficient on the distance in temperature remains significantly negative after controlling for the average level of temperature in our country pairs.

Finally, column (9) reports results when estimating the difference in high minus low average temperature for each capital. This test explores the significance of the volatility of the temperature over seasons. Once again, we find that the relevant parameter coefficient remains significantly negative.

5. Conclusion

We demonstrate in this study the significance of climate theory concerning managerial decisions. In particular, we propose a novel determinant of international decisions which is the temperature. Temperature influences who we are and how we behave. We indeed find that temperature captures similarities among citizens' behavior as shown by analyzing various fields such as the momentum returns available in international markets. We focus on the importance of temperature in the context of cross-border mergers. We indeed find that due to country familiarity, country pairs with little (large) distance in temperature tend to experience more (less) acquisitions. Our measurement is a continuous variable and data is available to any country around the world. It can also be easily estimated with freely available online data. We also find that decisions vary during the same months for firms headquartered in the Northern hemisphere versus firms headquartered in the Southern hemisphere. This result offers evidence of seasonality in decisions. The difference in the temperature can be estimated for each direction of cross-border flows which offers an advantage in understanding cross-border flows. We find that there are more overseas acquisitions towards countries with modestly warmer temperatures. Future studies that test cross-border phenomena could potentially use the temperature data available in the Online Appendix to explore international decisions.

A limitation of temperature is that it is not ideal for panel estimation. This is in line with most previously developed cross-border determinants such as whether two countries share a border or the distance in their capitals. Due to global warming, the average world temperature has increased in recent years. However, all countries have exhibited increases in temperatures, and there are only slight differences in yearly changes in temperature between our country pairs. We find that the maximum difference in temperature for a country pair is merely 1.15 °C, with a significant percentage of countries exhibiting tiny differences in yearly temperatures. Regardless,

and as discussed by Hsiang (2016), we are not the first study that demonstrates the significance of the long differences in temperature (e.g., Burke, Dykema, et al., 2015; Dell et al., 2012). Dell et al. (2014) actually suggest that more studies should undertake long-differences analysis considering that climate influences us mostly over the long term.

The number of cross-border mergers is, if any, expected to increase in the future due to the continuous increasing integration of the global economies. Factors that influence managerial decisions within an international setting will thus become increasingly important. We highlight in this study the role of the distance in temperature in managerial decisions that offers an interesting angle highlighting the role of climate finance that has received enormous attention in the last decade. Not all of our findings can be easily interpreted with strategic thinking by the managers, showing some evidence that biases can influence their decisions.

Data availability

Data will be made available on request.

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Appendix A

Variable definitions (in alphabetical order)

Variable	Source	Definition
Average temperature	Weatherbase	The average temperature of the capital cities in-country pairs (°C) over the sample period
Both countries high income	World Bank	A dummy variable that takes one of the countries in a pair that both belong to high income otherwise zero
Both countries low income	World Bank	A dummy variable that takes one of the countries in a pair that both belong to low income otherwise zero
Country temperature distance	Weatherbase	The absolute distance in the average temperature (°C) in-country pairs over the sample period
High minus low temperature	Weatherbase	The absolute distance in the average high minus low temperature in country pairs
Ln Alcohol distance	World Health Organization	The logarithm of the absolute distance in the average total alcohol consumption per capita in country pairs over the sample period
Ln Capital distance	Kristian Skrede Gleditsch	The logarithm of the absolute distance in the capital distance between country pairs (in kilometers)
Ln Climate risk	GermanWatch	The logarithm of one plus the absolute distance in the average Climate Risk Index (CRI) score in country pairs over the sample period
Ln Credit card distance	World Bank	The logarithm of the absolute distance in the average percentage of credit card users in country pairs over the sample period
Ln Culture distance	Hofstede	The logarithm of one plus the $\frac{\sum_{k=1}^{2}[(\mathbf{Country_i}-\mathbf{Country_j})^2/\mathbf{V_k}]}{2}$ where k is each dimension: long-term orientation, and indulgence and V is the variance of each of these two dimensions
Ln Emissions	Global Carbon Project	The logarithm of the average total emissions per capita in country pairs over the sample period
Ln Environmental performance	Socioeconomic Data and Applications Center	The logarithm of one plus the absolute distance in the average environmental regulations in country pairs over the sample period
Ln # of listed firms	World Bank	The logarithm of the average number of listed firms in country pairs over the sample period
Ln GDP distance	World Bank	The logarithm of the absolute distance in the average GDP ($) per capita in country pairs over the sample period
Ln GDP growth	World Bank	The logarithm of one plus the average growth in GDP ($) per capita in country pairs over the sample period
Ln GDP per capita	World Bank	The logarithm of the average GDP ($) per capita in country pairs over the sample period
Ln International trade	World Bank and OECD	The logarithm of the average percentage of trade as a share of GDP in country pairs over the sample period
Ln Life expectancy distance	United Nations Population Division	The logarithm of the absolute distance in the average life expectancy at birth (in years) in-country pairs over the sample period
Ln Market capitalization	World Bank	The logarithm of the average percentage of the market capitalization of listed domestic firms as a share of GDP in country pairs over the sample period
Ln Mergers	Thomson OneBanker	The logarithm in the total number of mergers between countries in each pair over the sample period
Ln Momentum distance	Chui et al. (2010)	The logarithm of the absolute distance in the average momentum returns in country pairs
Ln Tax distance	World Bank	The logarithm of one plus the absolute distance in the average tax rate per pair of countries (based on commercial profits) over the sample period
Ln Temperature distance	Weatherbase	The logarithm of the absolute distance in the average temperature of the capital cities in-country pairs (°C) over the sample period

(*continued on next page*)

(*continued*)

Variable	Source	Definition
Ln Value of mergers	Thomson OneBanker	The logarithm of the total value (in $ millions) of mergers between countries in each pair over the sample period
Shared border	Wikipedia	A dummy variable that takes one of the countries in a pair that share a border otherwise zero
Shared Currency	SIX	A dummy variable that takes one of the countries in a pair that share currency otherwise zero
Shared Language	CIA WorldFactbook	A dummy variable that takes one if citizens in country pairs share the same primary language otherwise zero
Shared Legal origin	La Porta et al. (2008)	A dummy variable that takes one if country pairs share the same legal origin (English, French, German, Scandinavian, Socialist) otherwise zero
Shared religion	NationMaster	A dummy variable that takes one if citizens in country pairs share the same primary religion otherwise zero
Temperature distance	Weatherbase	The absolute distance in the average temperature of the capital cities in-country pairs (°C) over the sample period

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