Climate risk and informal entrepreneurship in emerging economies: The moderating effects of entrepreneurs' socio-cognitions

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Abstract

This study investigates the impact of climate risk on informal entrepreneurship in emerging economies. Drawing on a sample of 6,317 new ventures operating in 38 emerging countries in the 2012-2013 period, we find that climate risk discourages informal entrepreneurship and this effect is stronger for entrepreneurs who fear failure but does not vary with their level of self-efficacy. Our study extends the consequences of climate risk to informal entrepreneurship and enriches our knowledge of the antecedents of informal entrepreneurship. Moreover, by contextualizing the implications of climate risk for informal entrepreneurship in emerging markets, we contribute to illuminating a more fine-grained analysis of the linkage between climate risk and entrepreneurship.

Keywords: climate risk; informal entrepreneurship; self-efficacy; fear of failure.

1. Introduction

What is the effect of climate risk on informal entrepreneurship in emerging markets? This question is important for three reasons. First, it extends the implications of climate risk for entrepreneurship. Climate risk, which refers to the extent to which countries have been affected by extreme weather events such as floods, temperature changes, storms, sea level rise, drought, rainfall, and landslides (Eckstein et al., 2021; Hussainzad & Gou, 2024), can influence entrepreneurship by either discouraging it through increased uncertainty or encouraging it by generating opportunities (Monllor & Murphy, 2017; Shepherd & Williams, 2014). However, existing studies focus mainly on how climate risk influences entrepreneurial *entry* (Boudreaux et al., 2019a, 2022, 2023), largely overlooking its effects on whether entrepreneurs register their businesses with the government—known as formal versus informal entrepreneurship (Dau & Cuervo-Cazurra, 2014). This gap is critical, as registration decisions significantly affect new ventures' adaptability and survival in climate risk environments[1] (Laing et al., 2022). Failing to account for the question leaves our knowledge of climate risk's effects on entrepreneurship incomplete, thereby limiting our ability to fully assess its implications. Thus, it is essential to examine the impacts of climate risk on entrepreneurs' choice between formal and informal entrepreneurship.

Second, the question above pertains to our understanding of the antecedents of informal entrepreneurship. Informal entrepreneurship, a common form of business activity globally (Bu & Cuervo-Cazurra, 2020), accounts for about 15% of GDP in developed economies and 40% in emerging markets (Medina & Schneider, 2018). Given its prevalence, a growing body of

[1] For example, climate risks actively shape entrepreneurial decisions in Bangladesh, where 75% of land lies below sea level and 44.5% of the population faces severe floods. Annual river erosion displaces 300,000–400,000 people, threatening key sectors like the garment industry (80% of exports). Entrepreneurs, vulnerable due to limited government flood mitigation, often rely on formal registration to access disaster loans.

literature has explored its sources from an institutional perspective and found that both formal institutions, such as governance quality and economic freedom, and informal institutions, such as national culture, shape entrepreneurs' pursuit of informal entrepreneurship (Autio & Fu, 2015; Dau & Cuervo-Cazurra, 2014; Thai & Turkina, 2014). However, entrepreneurs are embedded in a broader array of contextual factors (Hitt & Xu, 2019; Welter et al., 2019). Beyond institutional factors, other environmental elements, such as climate risk, also shape entrepreneurs' registration decisions. This is because heightened climate risk represents an inevitable source of uncertainty that may influence entrepreneurial decision-making (Ye et al., 2023). Therefore, the role of climate risk in informal entrepreneurship requires further investigation.

Third, the context of emerging markets is important. Scholars have recognized that the destructive influences of climate disasters are more severe in emerging countries. For example, the Global Climate Risk Index reports that eight of the top ten affected countries in extreme weather events in 2019 belong to low- and lower-middle income categories (Eckstein et al., 2021). Thus, inhabitants of emerging economies face inevitable climate risks that permeate nearly every aspect of life and influence various economic sectors such as agriculture, forestry, energy, transportation, and construction (He et al., 2023). In parallel, informal entrepreneurship is the dominant form of entrepreneurship in emerging markets (Bu & Cuervo-Cazurra, 2020; Salvi et al., 2023). For example, the informal economy's share of GDP in these countries is 2.5 times greater than in advanced economies (Medina & Schneider, 2018). In Sub-Saharan Africa and South Asia, 88% of the employed population works in informal employment (Dodman et al., 2023). Given the substantial economic influences of climate risk and the pivotal role that informal entrepreneurship plays in economic activity in emerging markets, it is vital to focus specifically on this context. However, prior studies have generally relied on cross-country

samples that combine advanced and emerging markets, leaving a key research gap.

To address the question, this study investigates the relationship between climate risk and informal entrepreneurship in emerging markets. Moreover, rather than assuming that climate risk influences all entrepreneurs uniformly, we draw on social cognitive theory to argue that entrepreneurs with different socio-cognitive traits have heterogeneous responses to external risks (Lent et al., 1994; Wood & Bandura, 1989). Social cognitive theory posits that while environmental factors play an important role in influencing human behavior, their effects vary with individual socio-cognitions, which shape how individuals perceive and respond to their surroundings (Wood & Bandura, 1989). Building on this theory, which positions self-efficacy and fear of failure as dual cognitive filters shaping entrepreneurs' risk perception (Boudreaux et al., 2019b; Wennberg et al., 2013; Ye et al., 2022), we further explore how these two key socio-cognitive traits moderate the relationship between climate risk and informal entrepreneurship. By doing so, we identify which mindsets make entrepreneurs more or less vulnerable to the effects of climate risk.

Drawing on a sample of 6,317 new ventures operating in 38 emerging countries in the 2012-2013 period, this study finds that climate risk discourages informal entrepreneurship and this effect is amplified by entrepreneurs' fear of failure but unaffected by their level of self-efficacy. Our study contributes to the literature in three ways. First, it enhances our understanding of the implications of climate risk for entrepreneurship, being among the first to examine its effects on a pivotal entrepreneurial decision—whether to formally register new ventures—and clarify how climate risk dissimilarly affects entrepreneurs with different socio-cognitive traits. Second, this study identifies a novel antecedent of informal entrepreneurship—climate risk. It goes beyond prior studies that focus on institutional factors (Autio & Fu, 2015; Mallon & Fainshmidt, 2022)

and shows that environmental elements are also important determinants of informal entrepreneurship. Lastly, by concentrating on emerging economies, where both climate risk and informal entrepreneurship are particularly prevalent, our study contrasts with prior research that has primarily used mixed cross-country samples combining advanced and emerging economies. This approach offers a more comprehensive understanding of how climate risk shapes entrepreneurial activity in the countries most affected.

2. Literature Review and Hypotheses

2.1. Climate risk and entrepreneurship

People worldwide are facing heightened climate risk, which often manifests in an increased frequency of extreme weather events. According to the Global Climate Risk Index, deaths attributed to extreme weather events rose from 11,953 in 2004 to 63,532 in 2022, while inflation-adjusted economic losses surged from $94.2billion to $220.9 billion during the same period. The Global Humanitarian Overview 2024 further underscores this intensification, reporting that climate-related disasters increased by 2.5 times in 2013-2022 compared to 1980-1989 baseline. This means that climate risk has emerged as an inevitable source of uncertainty that affects human life and economic performance, signaling the need for individuals to prepare for increasingly frequent and severe extreme weather events in the future (Eckstein et al., 2021). This urgency is particularly acute in emerging markets, where governments often lack the capacity to build effective governance frameworks to absorb, adapt to, and recover from extreme weather events (Conway & Schipper, 2011). For example, the Global Climate Risk Index reports that the countries most affected by extreme weather events between 2000 and 2019 were those emerging countries such as Puerto Rico and Myanmar. Scholars have examined the economic

outcomes of climate risk. For example, Hsiang and Narita (2012) find that extreme weather events can reduce economic growth rate, and Cavallo et al. (2013) report that catastrophic natural disasters negatively affect GDP per capita in both the short and the long runs.

Besides the direct economic outcomes, scholars have also linked climate-related factors with entrepreneurship and found that climate risk has mixed effects on entrepreneurship (Boudreaux et al., 2019a, 2022, 2023; Ye et al., 2023). On the one hand, climate risk increases the uncertainty associated with entrepreneurial activities (Monllor & Murphy, 2017). Extreme weather events involve damage to supply networks, infrastructure, and public services, which increases business operational costs (Boudreaux et al., 2022). Climate disasters also destroy fixed properties and equipment, which limit new ventures' production capacity utilization and decrease productivity (Huang et al., 2018). Several studies support these arguments. For example, Boudreaux et al. (2019a, 2022) find that natural disasters have a negative effect on the creation of firms in the short run (1-2 years) by analyzing cross-country panel data. He and colleagues further indicate that countries' well-functioning governance framework aids in alleviating the negative effect of disasters on entrepreneurship (Boudreaux et al., 2023).

On the other hand, climate risk generates market inefficiencies and spawns entrepreneurial opportunities (Boudreaux et al., 2022). Because such damage creates opportunities to replace outdated facilities and infrastructure with capital that incorporates modern technologies, the damages caused by climate disasters are viewed as Schumpeterian "creative destruction" (Crespo Cuaresma et al., 2008; Skidmore & Toya, 2002). Moreover, climate disasters reduce market entry barriers by lowering the "opportunity cost of capital if other business opportunities become unprofitable" (Boudreaux et al., 2022, p. 1845). Thus, climate risk might foster entrepreneurial activities. Several studies provide empirical support. For instance, Muñoz et al. (2019) find that

areas with greater climate risk impose ongoing threats to entrepreneurs that help them strengthen preparations and seek new opportunities. Wei et al. (2024) report that climate-related disasters generate opportunities for social entrepreneurship. Shepherd and Williams (2014) suggest that while natural disasters cause devastating effects on communities, individuals can rely on local and community resources to engage in entrepreneurship.

While these studies are insightful, two limitations exist. First, they generally analyze the role of climate risk in entrepreneurial entry, such as the creation of new ventures (Boudreaux et al., 2019a, 2022, 2023), but few have considered its implications for business registration decisions. This is a serious oversight as the choice that between formal and informal entrepreneurship strongly affects new ventures' adaptability and survival in climate risk environments (Laing et al., 2022). Unlike formal ventures, informal ventures, despite enjoying cost advantages and operational flexibility (Siqueira et al., 2016), generally face legitimacy challenges from key stakeholders, including governments, consumers, suppliers, and most critically, resource providers (Laing et al., 2022). These challenges may hinder informal entrepreneurial firms' access to resources and limit their survival in environments characterized by high climate risk. Therefore, to gain a deeper understanding of the influence of climate risk on entrepreneurship and to assess its broader economic implications, there is a need to uncover how climate risk affects entrepreneurs' business registration decisions.

Second, prior research mainly examines the influences of climate risk on entrepreneurship in both advanced and emerging markets. For example, Boudreaux et al. (2022) report that natural disasters negatively affect entrepreneurship drawing on data from both developed and emerging markets. Similarly, Ye et al. (2023) utilize mixed cross-country data to explore the role of climate risk in shaping entrepreneurial growth aspirations. However, the consequences of climate risk are

particularly severe in emerging markets. Boudreaux et al. (2023), for instance, show that weak governance, which is generally associated with emerging markets, can amplify the destructive effects of climate-related disasters. Thus, given that climate risk may significantly affect entrepreneurs' business registration decisions, and considering the importance of the emerging market context, it is important to investigate the relationship between climate risk and informal entrepreneurship within such a context.

2.2. Informal entrepreneurship and its antecedents

Informal entrepreneurship, a common form of entrepreneurship worldwide, particularly in emerging markets (Bu & Cuervo-Cazurra, 2020; Salvi et al., 2023), sustains the livelihoods of billions of people. For example, Dodman et al. (2023) indicate that approximately 61.2% of the global workforce is employed in informal sectors, and this figure rises to 88% in Sub-Saharan Africa and South Asia. Informal entrepreneurship includes a variety of activities, such as street vendors, small shops, online stores, and some medium-sized manufacturing and trade-oriented firms (Siqueira et al., 2016). Generally, at least three categories of entrepreneurs can be identified within the informal sector. The first category includes nascent entrepreneurs who seek to assess the feasibility of their business ideas before incurring sunk costs accompanied by registration (Bennett, 2010). The second category consists of entrepreneurs who opt to remain informal to avoid the burdens embedded in official registration (Sutter et al., 2013). Both of these groups of entrepreneurs are classified as opportunity-driven (Siqueira et al., 2016). Necessity entrepreneurs represent a third category; they engage in informal entrepreneurship due to an inability to find salaried employment and a lack of viable alternatives for desirable livelihoods (Perry et al., 2007).

Given the prevalence of informal entrepreneurship, it is important to identify its antecedents.

Many studies have examined this issue from an institutional perspective (Autio & Fu, 2015; Dau & Cuervo-Cazurra, 2014). The prevailing rationale behind entrepreneurs engaging in informal entrepreneurship is largely rooted in economic considerations (Webb et al., 2013), because informal entrepreneurial activities are often closely linked to burdensome regulations, corruption, and weak law enforcement (Mallon & Fainshmidt, 2022). For instance, scholars find that poor governance and state fragility significantly raise the costs of starting and operating formal ventures, encouraging entrepreneurs to avoid registering their businesses (Autio & Fu, 2015; Omri, 2020; Wei et al., 2023). Beyond formal institutions, research also underscores the role of informal institutions, such as performance-based culture and socially-supportive culture, in informal entrepreneurship (Thai & Turkina, 2014).

However, entrepreneurs operate in a broader set of contextual factors (Hitt & Xu, 2019; Welter et al., 2019). This suggests that the decision not to register can also be influenced by environmental factors besides just institutional elements. Scholars have begun to address this issue. For example, Siqueira et al. (2016) suggest that industry conditions in terms of dynamism, munificence, and concentration have profound effects on informal entrepreneurship. Moore et al. (2020, 2021) find that monetary aid and trade integration discourage informal entrepreneurship. Despite these promising insights, our understanding of how additional environmental factors influence informal entrepreneurship remains limited and deserves further exploration.

As indicated by the Global Humanitarian Overview 2024, climate-related disasters increased by 2.5 times in 2013-2022 compared to the 1980-1989 baseline, underscoring a dramatic escalation of climate risks over recent decades. This means that climate risk has become an unavoidable source of uncertainty in the future (Ye et al., 2023), particularly in emerging markets (Conway & Schipper, 2011), where it represents a crucial environmental factor

influencing economic activities (Eckstein et al., 2021). Therefore, given that informal entrepreneurship is a substantial part of economic activity in emerging markets (Medina & Schneider, 2018), exploring the role of climate risk in shaping informal entrepreneurship may advance our knowledge of the antecedents of informal entrepreneurship, providing a research opportunity for this study.

2.3. Climate risk and informal entrepreneurship

Climate risk has mixed effects on informal entrepreneurship. On the one hand, as climate risk heightens uncertainty in entrepreneurial activities, it may motivate entrepreneurs to choose informal entrepreneurship, which offers cost advantages and greater operational flexibility compared to formal ventures (Siqueira et al., 2016). Informal entrepreneurship, because of its unregistered status, not only allows entrepreneurs to bypass onerous registration procedures and related fees (Bu & Cuervo-Cazurra, 2020), but also enables them to avoid taxes, evade labor regulations, such as minimum wage standards and lower employee security expenditures, and skirt environmental requirements (Webb et al., 2013). These advantages are particularly pronounced in emerging economies, where pro-market institutions are often inadequately developed and entrepreneurs have to invest considerable effort in coping with institutional voids (Kistruck et al., 2015). Therefore, as climate risk intensifies, the increased risks and uncertainty may prompt entrepreneurs to choose informal entrepreneurship as a more adaptable and cost-efficient buffer against external threats. In this context, climate risk may encourage informal entrepreneurship.

On the other hand, climate risk may discourage entrepreneurs from pursuing informal entrepreneurship. Without registering with government authorities, informal ventures are often perceived as unreliable and risky by resource providers, customers, and suppliers (Laing et al.,

2022), which limits their access to essential resources and exacerbates legitimacy challenges (Kistruck et al., 2015; Larsen & Witte, 2022; Teyi et al., 2023). These legitimacy issues become even more pressing in the context of heightened climate risk, as government agencies may increasingly prioritize environmentally friendly practices and allocate resources to help firms withstand extreme weather events, while informal enterprises often evade environmental regulations and lack the qualifications needed to access these resources (Salvato et al., 2020; Webb et al., 2013). Therefore, given that climate risk can severely disrupt business operations and threaten the survival of new ventures (Boudreaux et al., 2022; Ye et al., 2023), as well as the reality of informal entrepreneurship faces extreme difficulties in obtaining resources and legitimacy needed to cope with such risks (Assenova & Sorenson, 2017), we argue that climate risk diminishes entrepreneurs' incentives to pursue informal entrepreneurship, favoring formal registration instead.

Although climate risk has both positive and negative effects on informal entrepreneurship, we posit that the negative effect outweighs the positive one. Specifically, despite operating businesses without legal registration can provide cost savings and greater operational flexibility (Siqueira et al., 2016), the "liability of newness" renders new ventures fragile and vulnerable (Shepherd et al., 2000), and lacks necessary resources to maneuver the amplified climate risk (Webb et al., 2013), even taking the cost advantages into account. Thus, as climate risk increases, engaging in informal entrepreneurship becomes a less appealing option. Conversely, enterprises that register with formal authorities have significant advantages in responding to heightened climate risk. For example, formal registration allows new ventures not only to increase their reliability in both suppliers and customers but also to acquire more sociopolitical legitimacy from the government and banks (Assenova & Sorenson, 2017; Laing et al., 2022). This enables

firms to build more stable supply and distribution networks and most importantly, acquire the resources needed to enhance resilience and overcome adversities posed by climate risk (Laing et al., 2022). Studies have provided support for this argument by showing that even governments within base-of-the-pyramid markets are capable of building effective financial institutions to support formally registered businesses' access to financial resources (Kistruck et al., 2015). Additionally, formal registration allows new ventures to access opportunities arising from climate-related disasters. This is because governments often allocate resources to update outdated facilities and infrastructure to better withstand extreme weather events (Salvato et al., 2020), and only formally registered firms qualify for these opportunities (Laing et al., 2022). This access strengthens the resilience and survival prospects of registered businesses in the face of amplified climate risk. Therefore, given that informal ventures exhibit weaker adaptability and survival capabilities compared to formal businesses in environments with high climate risk, we propose that:

> *Hypothesis 1: Climate risk will decrease entrepreneurs' likelihood of engaging in informal entrepreneurship.*

2.4. The moderating effects of entrepreneurs' socio-cognitions

Social cognitive theory suggests that although environmental factors influence human decision-making and behavior, their effects can be affected by personal socio-cognitions, which shape how individuals perceive and react to their external surroundings (Lent et al., 1994; Wood & Bandura, 1989). From this perspective, we assert that while climate risk discourages informal entrepreneurship, entrepreneurs with varying socio-cognitive traits have dissimilar perceptions of and responses to climate risk. This is consistent with the literature on strategic responses to external pressures (Mallon & Fainshmidt, 2022; Oliver, 1991; Xu et al., 2021), which suggests

that entrepreneurs with different traits exhibit varying levels of resistance to external pressures. We examine how entrepreneurs' self-efficacy and fear of failure moderate the relationship between climate risk and informal entrepreneurship. Both traits, highlighted by social cognitive theory, have been directly tied to individuals' risk perceptions (Boudreaux et al., 2019b; Wennberg et al., 2013; Ye et al., 2022). As such, they can affect entrepreneurs' perceptions of climate risk and subsequent responses, thereby altering the impact of climate risk on informal entrepreneurship. Thus, we adopt self-efficacy and fear of failure as key moderators.

Self-efficacy refers to whether entrepreneurs believe they have the abilities and skills that are important to accomplish desired goals, even in the face of adversities and risky environments (Boudreaux et al., 2019b). Self-efficacy frames individuals' beliefs in their skills and abilities to master their lives (Wilson et al., 2007). Compared with objective abilities, self-efficacy often has significant effects on individuals' affective states and behaviors (Markman et al., 2002) in that "we are motivated throughout our lives by perceived self-efficacy" (Wilson et al., 2007, p. 389). When entrepreneurs possess self-efficacy, they will be more resilient and persistent (Bullough et al., 2014). Due to the need to handle complex tasks and control over uncertain environments during entrepreneurial processes (Boudreaux et al., 2019b), scholars have highlighted the role of self-efficacy in entrepreneurial activities.

While we argue that climate risk discourages informal entrepreneurship, we further expect this relationship to be weaker for entrepreneurs who possess self-efficacy. Entrepreneurs who possess self-efficacy have greater self-confidence and believe that they can navigate risks (Wood & Bandura, 1989). To resist climate risks, such entrepreneurs can leverage their knowledge, skills, and social networks, instead of relying on external resources (Bullough et al., 2014). They are less concerned about whether they can obtain resources from government funding or banks,

which reduces the perceived benefits of formal registration and mitigates the inhibiting effect of climate risk on informal entrepreneurship. Conversely, entrepreneurs who lack self-efficacy tend to have lower self-confidence and a diminished belief in their capacity to overcome climate risks alone (Boudreaux et al., 2019b; Bullough et al., 2014). They have a greater demand for external support to survive new ventures in uncertain environments, making the option of formal registration more attractive. This strengthens the negative effect of climate risk on informal entrepreneurship. Overall, we propose that,

> *Hypothesis 2: The negative effect of climate risk on entrepreneurs' likelihood of engaging in informal entrepreneurship will be weaker for those who have higher self-efficacy.*

Fear of failure refers to the extent to which individuals tolerate risk and failure in achievement situations (Kollmann et al., 2017). Because failure is a common end in most entrepreneurial activities, i.e., more than 50% of entrepreneurs who start a new business face the reality of failure (Lee et al., 2021), fear of failure has been associated with less entrepreneurship (Boudreaux et al., 2019b; Wennberg et al., 2013). By triggering negative emotions including shame, guilt, and self-blame when encountering failure, fear of failure can discourage individuals from pursuing activities that involve risk (Shepherd, 2003). Accordingly, fear of failure is considered a strong deterrent to entrepreneurship (Morgan & Sisak, 2016; Wennberg et al., 2013).

We posit that fear of failure amplifies the negative association between climate risk and informal entrepreneurship. When entrepreneurs fear failure, they may view failure as the worst outcome and will attempt to avoid it (Boudreaux et al., 2019b; Shepherd, 2003). Thus, when confronted with the persistent threats from climate risk, rather than aiming at gaining cost advantages and operational flexibility by avoiding taxes and regulations and participating in informal entrepreneurship (Webb et al., 2014), they will take venture survival as the top priority.

This mindset drives them to choose a legal and legitimate entrepreneurial form, such as formal entrepreneurship, which enhances resource acquisition and survival in uncertain environments (Assenova & Sorenson, 2017; Webb et al., 2013). Therefore, the negative effect of climate risk on informal entrepreneurship intensifies. Conversely, entrepreneurs who do not fear failure are less sensitive to the increased uncertainty caused by climate risk (Boudreaux et al., 2019b; Ye et al., 2022). Their demand to acquire resources from external institutions is lower than those who perceive climate risk as a major threat. This diminishes the perceived gains of formal registration. Consequently, the role of climate risk in undermining the motivation to pursue informal entrepreneurship becomes less significant. Taken together, we propose:

> *Hypothesis 3: The negative effect of climate risk on entrepreneurs' likelihood of engaging in informal entrepreneurship will be stronger for those who fear failure.*

3. Methods

3.1. Sample

To test our hypotheses, we collected data from multiple sources. We began by gathering data on informal entrepreneurship from the Global Entrepreneurship Monitor (GEM). The GEM dataset surveys a representative sample of the population annually in dozens of countries to capture individuals' attributes and various entrepreneurial activities. It provides rich resources for entrepreneurship research and has been widely used (Dau & Cuervo-Cazurra, 2014; Mallon & Fainshmidt, 2022; Stenholm et al., 2013; Xavier-Oliveira et al., 2015). However, the GEM only includes informal entrepreneurship as a special topic in the 2012 and 2013 survey waves (Mallon & Fainshmidt, 2022). This limits the available data on informal entrepreneurship to these two years. We then collected country-level data from five sources: Germanwatch's Global Climate Risk Index (GCRI), World Bank Development Index (WDI), Worldwide Governance Indicators

(WGI), Global Competitiveness Index (GCI), and the Heritage's Economic Freedom Index (EFI). These datasets have also been used in entrepreneurship studies (Boudreaux et al., 2019b; Huang et al., 2018; Thai & Turkina, 2014; Ye et al., 2023). We matched the data and obtained a sample of 6,317 new ventures from 38 emerging markets in the 2012-2013 period. Table 1 reports the distribution of our sample by country.

[Insert Table 1 about here]

3.2. Measures

Dependent variable. To measure informal entrepreneurship, we used the question of whether the entrepreneur registered his or her new venture with the governmental authorities (Mallon & Fainshmidt, 2022). It is a binary variable coded 1 if the entrepreneur did not register his/her business and 0 otherwise. Because nascent businesses are in the formation phase and have not yet started, we only included newly established firms in our sample. This is consistent with studies on informal entrepreneurship (Autio & Fu, 2015; Dau & Cuervo-Cazurra, 2014).

Independent variable. Following Huang et al. (2018) and Ye et al. (2023), we measured climate risk using data from GCRI, which is compiled and published by Germanwatch every year. We selected the GCRI for two reasons. First, it provides a consistent and comprehensive methodology for quantifying climate risk, enabling cross-country comparisons that are essential for examining its effects on informal entrepreneurship across countries. Second, GCRI captures climate risk by utilizing two absolute indicators and two relative indicators: (1) number of deaths, (2) number of deaths per 100,000 inhabitants, (3) sum of losses in US$ at purchasing power parity (PPP), and (4) losses per unit of GDP. It calculates the climate risk score for each country as the average ranking across the four indicators, with the absolute indicators (1) and (3) each weighted at one-sixth, and the relative indicators (2) and (4) each weighted at one-third (Eckstein

et al., 2021). This approach ensures that the index captures both the magnitude and proportional impact of extreme weather events in each country. Because higher index scores represent lower climate risk, to facilitate interpretation, we reversed the index scores to ensure higher scores indicate higher climate risk. It is important to note that the GCRI indicators of the number of deaths and deaths per 100,000 inhabitants reflect deaths due to extreme weather events (Eckstein et al., 2021).

Moderators. We collected data on entrepreneurs' socio-cognitive traits from GEM. Self-efficacy is a binary variable coded 1 if the respondent believes that he or she has the knowledge, skills, and experience needed to start a new venture and 0 otherwise. Likewise, fear of failure is coded 1 if the entrepreneur responds that he or she is afraid of failure and 0 otherwise. Both indicators have been used in the literature (Boudreaux et al., 2019b; Wennberg et al., 2013; Ye et al., 2022).

Control variables. We included control variables both at the individual and country level to mitigate the concerns for omitted variable bias. At the individual level, we controlled for ten variables. GEM provides the data for these variables. First, we controlled for gender, age, and age square, because studies have suggested that female entrepreneurs and older entrepreneurs may be less likely to register their new ventures (Babbitt et al., 2015; Williams & Shahid, 2016). Gender was coded 1 for female and 0 for male. Age is a continuous variable. Because age may have a nonlinear relationship with entrepreneurship, we also included its square (Boudreaux & Nikolaev, 2019).

Second, research has indicated that financial capital, human capital, social capital, and access to resources from partners, along with entrepreneurial experience, are critical to entrepreneurs' resource endowments and play a role in circumventing registration-related costs

(Estrin et al., 2016; Jiménez et al., 2015; Mallon & Fainshmidt, 2022). Thus, we controlled for them. Specifically, because studies have suggested that household income is an important financial resource, we adopted entrepreneurs' household income as a proxy for financial capital (Boudreaux & Nikolaev, 2019). It is a binary variable coded 1 if the entrepreneur belongs to middle- or higher-income groups and 0 for the lowest-income group. For human capital, we defined it as a binary variable coded 1 if the entrepreneur has a college education and 0 otherwise (Boudreaux & Nikolaev, 2019). Social capital was operationalized as a binary variable coded 1 if the entrepreneur knows other entrepreneurs who have started businesses in the past two years and 0 otherwise (Sahasranamam & Nandakumar, 2020). To account for the resources that entrepreneurs acquire from partners, we controlled for non-solo founders. It was coded 1 if the entrepreneur started a business with at least one partner and 0 otherwise (Mallon & Fainshmidt, 2022; Ye et al., 2023). Finally, given that habitual entrepreneurs typically possess greater self-efficacy and entrepreneurial experience, their perceptions of starting businesses in the formal versus informal sectors may differ significantly. To account for this, we controlled for entrepreneurial experience. It is a binary variable coded 1 if the entrepreneur reports that (1) he/she has sold, shut down, discontinued, or quit a business in the past 12 months that he/she owned and managed, and (2) the firm continued to operate after the entrepreneur left; otherwise, it is coded as 0.

Third, to account for entrepreneurs' evaluation of opportunities that exist in informal sectors, we controlled for opportunity alertness. It is a binary variable coded 1 if the entrepreneur perceives there will be good opportunities to start a new venture in the next 6 months and 0 otherwise (Boudreaux et al., 2019b). Lastly, since entrepreneurs' perceptions of entrepreneurship and the related cultural values influence their decision to register new ventures, we controlled for

media attention and social status (Webb et al., 2013). Media attention denotes whether the entrepreneur often sees successful entrepreneurship stories in the public media, it is a binary variable coded 1 if yes and 0 otherwise. Social status reflects whether entrepreneurs agree with the statement that successful entrepreneurs have higher social status. This variable was coded 1 if yes and 0 otherwise (Mallon & Fainshmidt, 2022).

We also controlled for several country-level variables. We included GDP per capita and GDP growth because these two variables capture the level and trend of a country's economic conditions. Studies have found that higher GDP per capita and GDP growth encourage formal registration (Autio & Fu, 2015; Dau & Cuervo-Cazurra, 2014). Likewise, we controlled for the unemployment rate. A higher unemployment rate might encourage individuals who lack employment opportunities to use informal entrepreneurship (Siqueira et al., 2016). Additionally, as formal institutions are critical in affecting the time and costs spent on registration (Autio & Fu, 2015; Dau & Cuervo-Cazurra, 2014), we controlled the country's governance quality and economic freedom. We obtained the governance quality data from WGI, which is the average score of six sub-indicators: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption. We gathered data on economic freedom from Heritage's EFI. EFI is a multi-dimensional index that includes four areas: government size, rule of law, open markets, and regulative efficiency. Both measures have been widely used in prior studies (Autio & Fu, 2015; Dau & Cuervo-Cazurra, 2014; Thai & Turkina, 2014). In addition to formal institutions, scholars have also suggested that other contextual factors, such as organized crime can affect informal entrepreneurship (Mallon & Fainshmidt, 2022). Thus, we lastly controlled for organized crime, which measures to what extent organized crime imposes costs on businesses. Severe organized crime can exert significant

costs on formal businesses and motivate entrepreneurs to engage in informal sectors. The value of organized crime ranges from 1 to 7, we obtained this data from GCI.

3.3. Estimation methods

Because we combined both individual and country level data, we analyzed our data using a multilevel mixed-effects logistic regression (Bu & Cuervo-Cazurra, 2020). This method allows the models' intercept and standard errors to vary randomly across countries (Raudenbush, 1988). In this way, we not only account for the nonindependence of observations within the same country but also avoid the Type 1 error when employing standard estimation techniques (i.e., OLS) (Hofmann et al., 2000). To confirm the appropriateness of using a two-level model, we calculated the intraclass correlation coefficient (ICC), which yielded a value of 0.319. This suggests that 31.9% of the variance in informal entrepreneurship can be attributed to differences between countries, a figure significantly higher than the threshold for a large ICC value as suggested by Hox (2002). This supports the use of a two-level mixed-effects approach. Moreover, since these two GEM survey waves are based on different sets of entrepreneurs, we have a repeated cross-section. Consistent with prior literature on climate risk and entrepreneurship (Boudreaux et al., 2022; Huang et al., 2018), we lagged all country-level variables, including climate risk, by one year to test their effects on informal entrepreneurship in the following year. This helps mitigate reverse causality concerns (Dau & Cuervo-Cazurra, 2014).

4. Results

4.1. Findings

Table 2 reports the means, standard deviations, and correlations of all variables. To check for multicollinearity, we calculated the variance inflation factor (VIF) and found that the

maximum was 5.95 (average VIF = 1.85), suggesting multicollinearity was not a concern.

[Insert Table 2 about here]

Table 3 reports the multi-level regression results. Model 1 serves as the baseline model, which includes control variables and year and industry fixed effects. Model 2 augments the baseline model to include our focal variable—climate risk. We find that climate risk has a negative effect on informal entrepreneurship (β = –0.403, p = 0.001), providing support for Hypothesis 1. We calculate the marginal effect of climate risk on informal entrepreneurship. When climate risk increases by one standard deviation (SD = 37.22), an entrepreneur's probability of engaging in informal entrepreneurship decreases by 7.445%, on average[2]. Model 3 tests the moderating effect of self-efficacy. We find a positive but statistically insignificant interaction between climate risk and self-efficacy (β = 0.023, p = 0.443), which does not support Hypothesis 2. Model 4 includes the interaction of climate risk and fear of failure. We find a negative and statistically significant interaction term between climate risk and fear of failure (β = –0.076, p = 0.013), suggesting that the negative relationship between climate risk and informal entrepreneurship is stronger when entrepreneurs fear failure. This finding supports Hypothesis 3. Model 5 includes two interactions in the same model, and we obtain the same results.

[Insert Table 3 about here]

To facilitate interpretation, we plot the moderating effects that show the average predicted probability (with 95 percent confidence intervals) in Figures 1-2. Figure 1 plots the moderating effect of self-efficacy. The negligible difference in the slopes between the two lines supports the statistically insignificant coefficient of interaction between climate risk and self-efficacy. Figure 2 plots the interaction between climate risk and fear of failure. As climate risk increases from -50

[2] The average marginal effect (AME) calculated after the logistic regression is dy/dx = 0.002 and SD = 37.22. Therefore, SD x AME = 0.002*37.22*100%=7.445%.

to -10, the probability of engaging in informal entrepreneurship decreases by nine percent (from 0.64 to 0.55) for entrepreneurs who fear failure. However, when entrepreneurs do not fear failure, the probability only decreases by six percent (from 0.62 to 0.56). These results suggest that the marginal effect of climate risk on informal entrepreneurship is stronger among entrepreneurs who fear failure, which supports Hypothesis 3.

[Insert Figures 1-2 about here]

4.2. Robustness tests

To check the robustness of our findings, we conducted four additional checks.[3] First, we adopted coarsened exact matching (CEM) to adjust our model for self-selection into informal entrepreneurship. This helps ensure that entrepreneurs who register and do not register their businesses are comparable (Bu & Cuervo-Cazurra, 2020; Larsen & Witte, 2022). CEM coarsens the variables into strata and allocates weights to individuals based on their proximity to the treated group (Blackwell et al., 2009). We matched informal entrepreneurship based on several basic attributes including age, financial capital, self-efficacy, and fear of failure. We reported the $L1$ distance before and after treatment in Tables 4 and 5, respectively. The results show that the $L1$ distance decreases (0.2241 to 0.1285), which reflects a successful match. Accordingly, we include the CEM weights in our analysis to adjust for the self-selection concern (Nikolova et al., 2023). Table 6 reports the CEM results, and they are similar to our main results.

[Insert Tables 4-6 about here]

Second, as an alternative to the multilevel mixed-effects logistic method in the main analysis, we used logistic regression with country fixed-effects and clustered standard errors. This alternative approach helps to control unobserved heterogeneity across countries. Table S1 reports these results, and they are similar.

[3] Please see Tables S1-S3 in the Supplementary material.

Third, climate risk is a multi-dimensional variable that includes four sub-indicators. Following prior studies such as Boudreaux et al. (2019a, 2022), we used the number of deaths in disasters as an alternative measure of climate risk. We gathered the data from the Center for Research on the Epidemiology of Disasters. Table S2 reports these results, which are consistent with the results in the main analysis.

Lastly, we observed that Brazil accounts for a sizable portion of the total sample (30%). We therefore excluded Brazilian observations and re-analyzed the data (Autio et al., 2013; Bu & Cuervo-Cazurra, 2020). Table S3 presents these results, and they are similar. Overall, these additional checks suggest that our findings are robust.

5. Discussion

5.1. Contributions

Our study contributes to the literature in three ways. First, by examining how climate risk influences entrepreneurs' choice between formal and informal entrepreneurship, we extend the implications of climate risk for entrepreneurship. Prior literature has primarily focused on the effects of climate risk on entrepreneurial entry, such as the creation of new ventures (Boudreaux et al., 2019a, 2022, 2023). We shift the focus to its impact on entrepreneurs' registration decisions. We find that entrepreneurs' perception of intensified future climate risk discourages them from pursuing informal entrepreneurship, extending the significance of climate risk for entrepreneurship to business registration decisions. Thus, compared to studies that suggest climate risk prevents entrepreneurs from engaging in entrepreneurial activities or views entrepreneurs as passive recipients, our results suggest that entrepreneurs can proactively respond to climate risk by refusing to engage in informal entrepreneurship and choosing a form

of entrepreneurship that shows more adaption in uncertain environments, like formal entrepreneurship. In this regard, our study lays the foundation for future research to adopt a continuous perspective, exploring not only entrepreneurial entry but also how climate risk influences other decisions, such as new venture growth and exit strategies. Therefore, our study provides an integrated analysis of the relationship between climate risk and entrepreneurship.

Moreover, by examining the moderating effects of entrepreneurs' socio-cognitive traits, we contribute to a more nuanced understanding of the relationship between climate risk and entrepreneurship. Studies often assume that climate risk affects entrepreneurs equally (Boudreaux et al., 2019a; Muñoz et al., 2019). However, recent studies have indicated that entrepreneurs' attributes matter to the relationship between climate risk and entrepreneurship. For example, Ye et al., (2023) investigate how entrepreneurs' gender and partnerships shape the effect of climate risk on entrepreneurial growth aspirations. Our study advances this knowledge by examining how entrepreneurs' self-efficacy and fear of failure moderate the relationship between climate risk and informal entrepreneurship. We find that this relationship becomes weaker for entrepreneurs who do not fear failure. Our results suggest that entrepreneurs with diverse socio-cognitions make different decisions to respond to climate risk. Therefore, climate risk's influence on entrepreneurship can be more nuanced than studies have suggested.

Second, this study enhances our understanding of the antecedents of informal entrepreneurship. Given that informal entrepreneurship constitutes a significant portion of total economic activity, especially in emerging markets (Bu & Cuervo-Cazurra, 2020; Salvi et al., 2023), scholars have devoted considerable attention to identifying its drivers. However, prior research has primarily focused on the roles that formal and informal institutional factors played in informal entrepreneurship (Autio & Fu, 2015; Dau & Cuervo-Cazurra, 2014; Mallon &

Fainshmidt, 2022). While these insights are valuable, recent studies suggest that other contextual factors are also important in shaping informal entrepreneurship and call for further exploration of additional country-level motivators (Moore et al., 2020, 2021). We respond to this call directly by examining the role that climate risk plays in informal entrepreneurship in emerging markets and considering two critical socio-cognitive contingencies. We find that climate risk discourages informal entrepreneurship and this effect is enhanced by entrepreneurs' fear of failure. These findings indicate that climate risk is an important determinant of informal entrepreneurship in emerging markets and entrepreneurs' socio-cognitive traits are key boundaries. In this regard, our study extends findings reported by previous studies and underscores the importance of considering a broader set of contextual factors in understanding informal entrepreneurship, thereby enriching the literature on its complex antecedents.

Third, while studies have highlighted the role of climate risk in entrepreneurship, they often rely on mixed samples that include both advanced and emerging economies (Boudreaux et al., 2019a, 2022; Ye et al., 2023), potentially obscuring critical contextual differences. However, the implications of climate risk and the prevalence of informal entrepreneurship vary significantly between advanced and emerging markets. Relative to their counterparts in advanced countries, new ventures in emerging economies face more severe threats from climate risk because these countries often lack the capabilities and resources to offset climate risk's destructive consequences (Eckstein et al., 2021). Moreover, informal entrepreneurship is far more prevalent in emerging markets due to the underdeveloped nature of formal institutions and serves as a primary means of livelihood for billions of people (Bu & Cuervo-Cazurra, 2020; Salvi et al., 2023). Therefore, by contextualizing the impact of climate risk on informal entrepreneurship in emerging markets, this study provides a more nuanced understanding of how climate risk shapes

economic activity through entrepreneurship in regions where its impact is more acute and destructive.

5.2. Practical implications

This study offers suggestions for both entrepreneurs and policymakers. Our study indicates that climate risk discourages informal entrepreneurship in emerging markets. This requires entrepreneurs to delve into the climate context in which they operate to make informed decisions about business registration. However, their capacity to acquire relevant knowledge is often limited, which may hinder their understanding of how climate risk impacts their ventures and how it may evolve in the future. Therefore, engaging in training programs is essential for entrepreneurs to enhance their awareness of climate risk, empowering them to make better-informed decisions. Such training programs are increasingly accessible, even in emerging markets. For instance, the Climate Action and Support Transparency Training (CASTT), initiated by the United Nations, offers workshops that familiarize participants with climate-related issues, including current experiences, future expectations, and their implications for entrepreneurship across various sectors.[4] By participating in these programs, entrepreneurs can gain insights into effective adaptation strategies, such as choosing between formal and informal entrepreneurship in the face of climate risk.

Moreover, because informal entrepreneurship has harmful outcomes including tax losses, environmental pollution, employees safety and health hazards, and unfair competition towards formal businesses (Webb et al., 2014), to encourage formal entrepreneurship and reduce the size of informal entrepreneurship, governments in emerging markets could leverage our findings to design policies that encourage formal business registration, particularly during periods of heightened climate risk. Specifically, by recognizing that climate risk motivates entrepreneurs to

[4] https://www.adaptationcommunity.net/trainings/privaboo-summer-school-2024/

seek legitimacy and security, policymakers can offer incentives for formal respiration, such as tax breaks, streamlining registration processes, and creating special financial products, such as insurance or climate risk mitigation funds. For example, Peru, significantly affected by extreme El Niño events, has developed index-based insurance products aimed at mitigating the economic impacts of such extreme weather events on businesses. However, obtaining these insurance products often requires a business license, making registration a prerequisite for accessing crucial support. Thus, to reduce the effect of extreme weather events, entrepreneurs have to register their businesses, which in turn reduces the size of informal entrepreneurship.

5.3. Limitations and future directions

Our study has limitations that suggest avenues for future research. First, our study focuses on the relationship between climate risk and informal entrepreneurship. However, climate risk may also affect other types of entrepreneurial activities, such as necessity entrepreneurship and opportunity entrepreneurship. Notably, while research indicates a significant overlap between necessity entrepreneurship and informal entrepreneurship—where many necessity entrepreneurs engage in informal ventures (Perry et al., 2007)—the two concepts remain distinct. Necessity and opportunity entrepreneurship differ based on the motivations for entry, whereas formal and informal entrepreneurship are distinguished by their registration status. Moreover, not all informal entrepreneurship is driven by necessity. Some entrepreneurs, for example, may choose not to register their ventures immediately in order to test their business ideas, opting for formal registration only after a certain period of operation (Bennett, 2010). Similarly, some may delay formal registration to allocate their resources more effectively in the early stages of their ventures, rather than expending resources to navigate complex regulatory systems (Williams et al., 2017). This indicates that not all informal entrepreneurship arises from necessity or the

inability to find alternative employment. In supporting this, Ault and Spicer (2022) have demonstrated that informal entrepreneurship includes both survival-driven ventures and growth-oriented enterprises. Thus, informal entrepreneurship, while often associated with necessity entrepreneurship, is a distinct category that deserves further investigation.

Second, we adopted nonregistration as a measure of informal entrepreneurship. Although this measure has been used in the literature (Autio & Fu, 2015; Dau & Cuervo-Cazurra, 2014; Mallon & Fainshmidt, 2022), informal entrepreneurship includes several dimensions such as firm registration, tax payment, employee registration, and compliance with health, safety, and environmental regulations (Salvi et al., 2023). Future studies might consider using these measures of informal entrepreneurship. Additionally, due to data constraints, our analysis relied on 2012-2013 GEM datasets. Subsequent studies would benefit from leveraging emerging data sources to investigate temporal dynamics and strengthen causal claims.

Third, as entrepreneurs' socio-cognitive traits shape how they perceive and react to external surroundings, we examined how entrepreneurial self-efficacy and fear of failure moderate the relationship between climate risk and informal entrepreneurship. However, our exploration presupposes that entrepreneurs can fully aware climate risk as a decision-relevant threats—only when such awareness exists can climate risk systematically influence entrepreneurial decision-making. This fundamental premise warrants deeper theoretical unpacking. For instance, entrepreneurs' capacity to recognize climate risks is closely tied to two critical factors: climate literacy (e.g., understanding the severity of climate disasters and the ways these events affect human behavior and business practices) and their personal experiences (e.g., prior exposure to climate shocks). Future studies can either investigate how entrepreneurs' climate literacy and experiences interact with their socio-cognitive traits—in other words, how awareness of climate

risk influences their perceptions and reactions—or explore how these factors directly moderate the relationship between climate risk and informal entrepreneurship. These investigations would not only validate our foundational assumption but also enrich the theoretical understanding of how entrepreneurs' awareness capabilities shape their responses to risk.

Fourth, while our study focuses on climate risk as a critical environmental determinant of informal entrepreneurship, emerging evidence suggests that other contextual forces—such as geopolitical volatility (e.g., trade wars disrupting cross-border informal supply chains), unstable political conditions (e.g., policy shifts increase economic uncertainty faced by formal businesses), and technological turbulence (e.g., AI-driven automation displacing informal gig workers), which generate revenues for future studies.

Fifth, while our analysis is premised on the notion that informal entrepreneurs lack access to formal resources—a pattern observed in most contexts—exceptions exist in regions where informal economies underpin most livelihoods. For example, Kistruck et al. (2015) found that a small subset of Guatemalan banks offered loans to informal entrepreneurs at higher interest rates than those for formal loans, albeit at only 25% of the typical loan amount. This suggests that formal institutions may partially adapt to pervasive informality. Therefore, future studies should contextualize the influence of climate risk on entrepreneurial registration decisions in regions where informal economies dominate livelihoods.

Finally, while self-reported measures of self-efficacy and fear of failure from the GEM have been validated in prior work (Boudreaux et al., 2019b; Wennberg et al., 2013; Ye et al., 2022), we acknowledge potential response biases, such as overconfidence or social desirability effects. To address this limitation, future studies could undertake more fine-grained analyses to verify the validity of respondents' self-reported measures of self-efficacy and fear of failure.

6. Conclusion

Our study investigated the influence of climate risk on informal entrepreneurship and the moderating effects of entrepreneurs' self-efficacy and fear of failure. Using a sample of 6,317 new ventures across 38 emerging countries in 2012-2013, we found that climate risk discourages informal entrepreneurship. Moreover, this discouraging effect is amplified among entrepreneurs who fear failure, while it is not influenced by their level of self-efficacy. These findings not only extend the consequences of climate risk to informal entrepreneurship but also deepen our understanding of the antecedents of informal entrepreneurship. Additionally, by contextualizing the research within emerging economies, we provide a more nuanced analysis of the relationship between climate risk and entrepreneurship.

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Table 1 Distribution of observations along country

Country	N	Country	N	Country	N
Algeria	46	Ethiopia	173	Peru	69
Barbados	43	Ghana	244	Philippines	103
Bosnia and Herzegovina	32	Indonesia	716	Romania	34
Botswana	142	Iran	255	South Africa	98
Brazil	1883	Jamaica	81	South Korea	48
Chile	203	Latvia	31	Suriname	9
China	256	Libya	22	Thailand	405
Colombia	215	Lithuania	33	Trinidad and Tobago	97
Costa Rica	17	Malaysia	68	Tunisia	6
Ecuador	135	Mexico	68	Uruguay	22
Egypt	45	Namibia	113	Vietnam	16
El Salvador	43	Nigeria	428	Zambia	35
Estonia	36	Pakistan	47	**Total**	**6,317**

Table 2 Statistics and correlation matrix

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Nonregistration	0.692	0.462	1													
2. Climate risk	-59.47	37.22	-0.031	1												
3. Gender	0.497	0.500	0.150	0.023	1											
4. Age	36.46	11.34	-0.024	0.015	0.020	1										
5. Age square (*ln*)	7.097	0.623	0.024	0.004	-0.025	0.116	1									
6. Human capital	0.144	0.351	-0.235	0.044	-0.050	-0.011	-0.044	1								
7. Social capital	0.607	0.488	-0.076	-0.020	-0.070	-0.052	-0.035	0.084	1							
8. Opportunity alertness	0.630	0.483	0.022	0.022	0.006	-0.050	-0.004	-0.003	0.163	1						
9. Non-solo founder	0.228	0.420	-0.157	0.029	-0.080	-0.084	-0.004	0.114	0.038	0.004	1					
10. Media attention	0.791	0.407	0.042	0.046	0.035	0.013	-0.012	-0.049	-0.001	0.084	-0.012	1				
11. Social status	0.804	0.397	-0.002	-0.030	0.001	-0.003	0.007	-0.033	0.001	0.052	-0.017	0.192	1			
12. Financial capital	0.673	0.469	-0.185	0.036	-0.087	-0.040	-0.035	0.164	0.104	0.037	0.086	-0.004	0.002	1		
13.Entrepreneurial experience	0.067	0.249	-0.010	-0.015	0.008	0.002	-0.011	0.001	0.014	0.009	0.031	-0.023	0.017	-0.031	1	
14. Self-efficacy	0.779	0.415	-0.059	0.032	-0.060	-0.010	-0.027	0.041	0.215	0.207	0.032	0.054	0.036	0.141	0.020	1
15. Fear of failure	0.308	0.462	0.063	-0.049	0.048	-0.022	0.015	-0.018	-0.065	-0.098	-0.030	0.020	0.020	-0.071	0.004	-0.229
16. Governance quality	-0.163	0.557	-0.116	-0.163	0.026	0.100	-0.002	0.017	-0.096	0.013	0.033	0.018	0.014	-0.017	0.040	-0.031
17. Organized crime	-4.420	0.846	0.149	0.288	0.056	0.004	-0.018	-0.008	-0.031	0.001	-0.018	0.040	-0.032	-0.007	-0.079	-0.010
18. Economic freedom	58.85	7.218	-0.115	0.009	0.035	0.137	0.008	0.093	-0.019	0.090	0.030	-0.049	-0.077	0.017	0.032	0.019
19. GDP per capita (*ln*)	8.667	0.816	-0.138	-0.120	-0.012	0.090	0.009	0.076	-0.163	-0.093	0.083	0.001	-0.008	-0.006	-0.030	-0.125
20. GDP growth	4.622	3.531	0.096	0.181	0.041	-0.025	-0.042	-0.055	0.081	0.073	-0.060	0.0200	0.011	0.004	0.049	0.061
21. Unemployment rate	6.889	4.659	-0.116	-0.247	-0.058	-0.0220	-0.002	0.0120	-0.045	-0.025	0.111	-0.052	-0.005	0.007	0.082	0.038
	15	**16**	**17**	**18**	**19**	**20**	**21**									
15. Fear of failure	1															
16. Governance quality	-0.040	1														
17. Organized crime	-0.010	-0.254	1													
18. Economic freedom	-0.065	0.723	-0.147	1												
19. GDP per capita (*ln*)	0.007	0.614	0.172	0.294	1											
20. GDP growth	-0.017	-0.031	-0.214	0.021	-0.523	1										
21. Unemployment rate	-0.063	0.284	-0.128	0.062	0.281	-0.262	1									

Note: Correlations above |0.024| are statistically significant, $p < 0.05$

Table 3 The multilevel logistic regression results (*N*=6,317)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	1.203***	1.630***	1.636***	1.650***	1.651***
	(0.290)	(0.290)	(0.290)	(0.291)	(0.291)
Individual-level (level 1)					
Gender	0.246***	0.247***	0.248***	0.250***	0.250***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Age	-0.134***	-0.136***	-0.137***	-0.135***	-0.135***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Age square	0.077*	0.080*	0.080*	0.081*	0.081*
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
Human capital	-0.383***	-0.373***	-0.374***	-0.374***	-0.374***
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Social capital	-0.184***	-0.189***	-0.188***	-0.188***	-0.188***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Opportunity alertness	0.071*	0.076*	0.076*	0.079*	0.079*
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Non-solo founder	-0.207***	-0.201***	-0.201***	-0.201***	-0.201***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
Media attention	-0.039	-0.039	-0.039	-0.040	-0.040
	(0.038)	(0.039)	(0.039)	(0.039)	(0.039)
Social status	-0.031	-0.030	-0.029	-0.029	-0.029
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)
Financial capital	-0.297***	-0.311***	-0.312***	-0.316***	-0.316***
	(0.036)	(0.037)	(0.037)	(0.037)	(0.037)
Entrepreneurial experience	-0.042	-0.045	-0.045	-0.045	-0.045
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Self-efficacy	-0.101**	-0.097**	-0.099**	-0.095**	-0.096**
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Fear of failure	0.097**	0.091**	0.090*	0.094**	0.094**
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Country-level (level 2)					
Governance quality	-0.727+	0.403	0.405	0.424	0.424
	(0.421)	(0.438)	(0.438)	(0.439)	(0.439)
Organized crime	-0.031	0.370+	0.369+	0.368+	0.367+
	(0.194)	(0.194)	(0.194)	(0.194)	(0.194)
Economic freedom	0.328	-0.621+	-0.622+	-0.637+	-0.637+
	(0.316)	(0.329)	(0.329)	(0.330)	(0.330)
GDP per capita	-0.271	-0.470	-0.470	-0.476	-0.476
	(0.306)	(0.297)	(0.297)	(0.298)	(0.298)
GDP growth	0.230**	0.180*	0.177*	0.163+	0.163+
	(0.085)	(0.085)	(0.086)	(0.086)	(0.086)
Unemployment	0.110	-0.082	-0.083	-0.093	-0.093
	(0.238)	(0.228)	(0.228)	(0.229)	(0.229)
Main and moderating effects					
Climate risk		-0.403***	-0.402***	-0.405***	-0.405***
		(0.068)	(0.068)	(0.068)	(0.068)
Climate risk × Self-efficacy			0.023		0.005
			(0.030)		(0.031)

Climate risk × Fear of failure				-0.076* (0.030)	-0.074* (0.031)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes
Log likelihood	-2890.50	-2872.26	-2871.96	-2869.16	-2869.14
Wald Chi-square	529.44***	554.90***	554.62***	557.38***	557.26***
LR test vs. Linear regression	811.55***	847.55***	845.36***	845.95***	844.95***

Note: Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-tailed tests. DV = nonregistration.

Table 4 CEM imbalance measurement, univariate imbalance

Variable	L1	Mean	Min	25%	50%	75%	Max
Age	0.065	-0.585	0	-1	0	0	1
Financial capital	0.188	-0.188	0	-1	0	0	0
Self-efficacy	0.053	-0.053	0	0	0	0	0
Fear of failure	0.063	0.063	0	0	0	0	0
Multivariate L1 distance: 0.2241							

Table 5 CEM matching summary

Number of strata					Number of matched strata		
84					74		
	0				1		
All	1,944				4,373		
Matched	1,939				4,367		
Unmatched	5				6		
Variable	**L1**	**Mean**	**Min**	**25%**	**50%**	**75%**	**Max**
Age	0.054	-0.090	0	0	0	0	3
Financial capital	3.0E-15	3.2E-15	0	0	0	0	0
Self-efficacy	6.0E-16	0	0	0	0	0	0
Fear of failure	2.2E-15	1.7E-15	0	0	0	0	0
Multivariate L1 distance: 0.1285							

Table 6 The multilevel logistic regression results: Using the coarsened exact matching method (*N*=6,306)

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	1.137**	1.648***	1.651***	1.673***	1.671***
	(0.357)	(0.341)	(0.342)	(0.343)	(0.344)
Individual-level (level 1)					
Gender	0.234***	0.236***	0.236***	0.238***	0.238***
	(0.048)	(0.047)	(0.048)	(0.047)	(0.048)
Age	-0.073**	-0.077**	-0.077**	-0.075**	-0.075**
	(0.027)	(0.026)	(0.026)	(0.027)	(0.027)
Age square	0.050	0.053	0.053	0.054	0.054
	(0.034)	(0.034)	(0.034)	(0.033)	(0.034)
Human capital	-0.363***	-0.354***	-0.353***	-0.353***	-0.353***
	(0.046)	(0.045)	(0.045)	(0.046)	(0.046)
Social capital	-0.164**	-0.170**	-0.169**	-0.169**	-0.169**
	(0.053)	(0.053)	(0.053)	(0.053)	(0.053)
Opportunity alertness	0.079+	0.084+	0.083+	0.086+	0.086*
	(0.044)	(0.044)	(0.044)	(0.044)	(0.043)
Non-solo founder	-0.201***	-0.195***	-0.195***	-0.195***	-0.195***
	(0.050)	(0.051)	(0.050)	(0.050)	(0.050)
Media attention	-0.037	-0.038	-0.038	-0.039	-0.039
	(0.050)	(0.050)	(0.050)	(0.050)	(0.050)
Social status	-0.017	-0.016	-0.016	-0.015	-0.016
	(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
Financial capital	0.119+	0.102	0.102	0.096	0.096
	(0.070)	(0.063)	(0.063)	(0.062)	(0.062)
Entrepreneurial experience	-0.047	-0.047	-0.047	-0.048	-0.048
	(0.037)	(0.038)	(0.038)	(0.038)	(0.038)
Self-efficacy	-0.034	-0.026	-0.027	-0.025	-0.024
	(0.038)	(0.039)	(0.041)	(0.039)	(0.040)
Fear of failure	-0.012	-0.015	-0.015	-0.009	-0.009
	(0.052)	(0.050)	(0.050)	(0.041)	(0.040)
Country-level (level 2)					
Governance quality	-1.181	0.196	0.197	0.225	0.225
	(0.802)	(0.727)	(0.727)	(0.727)	(0.728)
Organized crime	-0.146	0.317	0.315	0.312	0.313
	(0.244)	(0.291)	(0.291)	(0.294)	(0.293)
Economic freedom	0.709	-0.472	-0.473	-0.495	-0.495
	(0.651)	(0.489)	(0.489)	(0.488)	(0.489)
GDP per capita	-0.182	-0.389	-0.389	-0.398	-0.397
	(0.438)	(0.453)	(0.452)	(0.455)	(0.455)
GDP growth	0.246*	0.182**	0.180**	0.161*	0.162*
	(0.119)	(0.070)	(0.069)	(0.072)	(0.071)
Unemployment	0.190	-0.068	-0.069	-0.080	-0.079
	(0.355)	(0.234)	(0.234)	(0.235)	(0.235)
Main and moderating effects					
Climate risk		-0.445*	-0.443*	-0.439*	-0.441*
		(0.193)	(0.191)	(0.193)	(0.191)

Climate risk × Self-efficacy			0.012 (0.029)		-0.010 (0.034)
Climate risk × Fear of failure				-0.078* (0.035)	-0.081* (0.041)
Year fixed effect	Yes	Yes	Yes	Yes	Yes
Industry fixed effect	Yes	Yes	Yes	Yes	Yes
Log likelihood	-2986.30	-2963.86	-2963.76	-2960.19	-2960.12
Wald Chi-square	1949.27***	4181.92***	7644.24***	7333.76***	9101.54***

Note: Standard errors in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, two-tailed tests. DV = nonregistration.

Figure 1 The moderating effect of self-efficacy

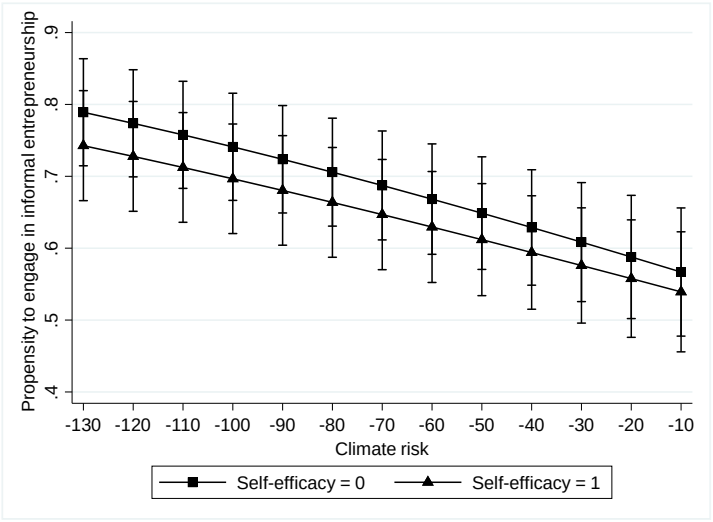

Figure 2 The moderating effect of fear of failure