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Micro-business participation in collective flood adaptation: lessons from scenario-based analysis in Ho Chi Minh City, Vietnam

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Abstract. Although research on the impacts of climate change on small- and medium-sized enterprises (SMEs) and their adaptation to climate change risks has recently received more attention, the focus on micro-businesses and household businesses is still very limited. Micro-businesses and household businesses are adversely affected by compound flooding events – a situation that will become more acute in the future – but there is little attention in the scientific literature to their adaptation options and actual implementation. Against this background, the paper analyzes the following research questions. How are micro-businesses already responding to flooding? Are micro-businesses willing to collectively invest in future proactive adaptation efforts in their neighborhoods? What are the key drivers of and barriers to adaptation? Based on scenario-based field experiments in Ho Chi Minh City, our results show that micro-businesses could play a much larger role in collective adaptation. Often overlooked in adaptation research, their willingness to engage in collective action under severe constraints is surprising. The conceptual framework presented in this paper helps us to understand the key drivers of and barriers to micro-business willingness to participate in collective adaptation activities. The most important key barriers for micro-businesses are limited financial capacity and lack of support from local authorities. However, micro-businesses are willing to contribute depending on the concrete adaptation measure and financing options. If no financial contribution is expected, almost 70 % are willing to participate in awareness-raising campaigns. And although their financial capacity is very limited, 39 % of micro-businesses would contribute financially if the costs were shared with other businesses in their neighborhood and with local authorities. In this context, micro-businesses should be much more involved in adaptation plans and measures. Through their local embeddedness, they can be important multipliers in strengthening adaptive capacity at the local level.

1 Introduction

In many countries of the Global South micro-businesses, together with small- and medium-sized businesses, build up the "economic and social fabric" (Chaudhury 2018). In an urban context, they include individuals or households that are shopkeepers; run cafes, restaurants, or repair shops; offer transport and warehouse or construction and maintenance services; and are often located in the middle of residential neighborhoods. According to the UN (2015), these businesses are a key engine of job creation and are responsible for more than 50 % of total employment. However, these micro-, small-, and medium-sized businesses are facing tremendous challenges with respect to climate change. A very illustrative example is Ho Chi Minh City (HCMC). HCMC is already facing manifold challenges due to regular flooding, which is projected to be aggravated by future climate change (Downes et al., 2016; Downes and Storch, 2014; Duy et al., 2018; Nicholls et al., 2007).

Although research regarding the impacts of climate change on small- and medium-sized firms (SMEs) and their adaptive behavior versus climate change risks recently has received more attention (e.g., Halkos and Skouloudis, 2019; Howe, 2011; Marks and Thomalla, 2017; Neise et al., 2019,

2018; Neise and Revilla Diez, 2019; Pathak and Ahmad, 2018, 2016; Pauw and Chan, 2018), the focus on micro-businesses and household businesses is still very limited.

Micro-businesses typically have limited financial resources to invest in both short- and long-term adaptation measures (Leitold et al., 2021; Ngin et al., 2020) and have underdeveloped capabilities for business planning (Gherhes et al., 2016). However, because they bear the brunt of climate-related impacts, generate high shares of employment, and are thus closely linked to peoples' livelihoods, the discussion of the significance and prospects of micro-businesses in responding to climate impacts has received attention in adaptation research (Chaudhury, 2018; Schaer et al., 2019). Crick et al. (2018) and Pulver and Benney (2013) show that not all businesses have the same adaptive capacity, respond in the same way, or consider climate change as part of their business operations. What Daddi et al. (2018) and Linnenluecke et al. (2013) already illustrated for SMEs is especially true for micro-businesses: their decision-making for or against adaptation action is still underexplored and remains a black box (Crick et al., 2018; Pauw and Chan, 2018). Recently, multi-stakeholder initiatives involving small- and medium-sized businesses have been discussed as door openers for private-sector engagement in adaptation efforts (Challies et al., 2016; Chen et al., 2013; Leitold et al., 2020; Neise et al., 2019). But, how successful can these initiatives be without knowing exactly how micro-businesses are impacted by and reacting to climate change, which adaptive capacities they possess, and whether their adaptation behavior would change if, for example, incentives like financial support were provided.

Against this backdrop, this paper explores the potential role of micro-businesses in collaborative-adaptation initiatives. We will focus on the following research questions. How do micro-firms already respond to flooding? And a more future-oriented question, under which conditions are micro-firms willing to invest jointly in proactive adaptation efforts in their neighborhoods?

Our methodological approach is two-fold. First, using scenario-based field experiments we examine the willingness of micro-businesses to invest in collective adaptation options depending on different financing options. We analyze how the distribution of costs among other micro-businesses and the neighborhood, financial incentives provided by local authorities, or pure political pressure impact the willingness of micro-businesses to contribute financially to different adaptation scenarios like the implementation of a dike system, a drainage system, or awareness programs. Second, we applied a two-level binary logistic regression that allows us to consider the differences in and interdependencies between adaptation scenarios and micro-business characteristics in order to the detect the key drivers of and barriers to adaptation. The necessary data were generated during a household and micro-business survey as part of the collaborative research project "DECIDER" (Decisions for the Design of Adaptation Pathways and the Integrative Development, Evaluation, and Governance of Flood Risk Reduction Strategies in Changing Urban–Rural Systems). A total of 252 micro-businesses were surveyed in HCMC between September and November, 2020. In addition, we were able to conduct the scenario-based experiments with 62 out of the 252 micro-businesses. As each participant responded to 20 scenarios, 1240 observations were generated for data processing.

This article is organized as follows. Section 2 develops a conceptual framework for potential drivers of and barriers to micro-business adaptation. Section 3 introduces the study area and methodology. Section 4 presents the descriptive and analytical results of the study, while Sect. 5 discusses the implications of the results for addressing the micro-business perspective in collective flood adaptation. Section 6 provides a conclusion.

2 Conceptual considerations

2.1 What do we know from adaptation literature?

Businesses play important roles in economic and social development worldwide by providing employment, goods, value-added services, and taxes (Halkos et al., 2018; Leitold et al., 2020; Lo et al., 2019). However, the fifth Intergovernmental Panel on Climate Change (IPCC) Assessment Report (IPCC, 2014) revealed a striking gap in existing scientific literature on private-sector adaptation to floods (e.g., Berkhout et al., 2006; Linnenluecke et al., 2013, 2011). Since then, a body of literature has emerged that focuses on large and multinational enterprises that are understood to be important entities for financing adaptation projects, developing technologies, and producing innovative adaptation solutions (Averchenkova et al., 2016; Haraguchi and Lall, 2015; Neise et al., 2018). However, this focus on large international enterprises provides only limited knowledge of adaptation actions, adaptive capacities, and the overall role of smaller local businesses in climate adaptation. In comparison, small businesses and micro-businesses typically have lower profits, smaller cash reserves, and seldom have backup resources so that a single extreme-weather event can led to long-lasting negative impacts. Clearly, smaller businesses lack the capacity to design and implement adaptation measures (Zhang et al., 2009). Small businesses and micro-businesses therefore bear the brunt of climate-related impacts – a burden that is expected to intensify over the next decades (e.g., Lo et al., 2019; Ngin et al., 2020). In areas with current risk of flooding, storm surges, and heavy rainfall, several studies illustrate that smaller businesses with local operations in particular experience both direct impacts like property damage, mechanical breakdowns, and the destruction of stock and assets and indirect impacts like postponed distribution and interruptions of business operations and supplies (Bahinipati et al., 2017; Marks and Thomalla, 2017; Neise et al., 2019; Ver-

rest et al., 2020; Wedawatta et al., 2014; Wedawatta and Ingirige, 2012). In addition, they are often situated in a multi-risk environment, usually unprotected by public flood protection. This is especially true in HCMC where uncontrolled urban expansion into flood-prone areas since the beginning of the 21st century has led to increased exposure. Poorly established and connected infrastructure has exacerbated flooding risks, leading to a reduction in water regulation capacity, drainage capacity, water permeability, and land subsidence (Storch and Downes, 2011; The World Bank, 2019). As a result, small businesses and micro-businesses are forced to respond to climate risks independently due to their higher vulnerabilities (Lo et al., 2019).

Recent research has sought to determine whether and to what extent micro-businesses are responding to acute climate risks such as flooding and what options they have to prepare for the intensification of future impacts. Ngin et al. (2020) showed that micro-businesses in the tourism and hospitality sector in Cambodia usually adopt temporary and reactive responses to floods and storms rather than long-term and proactive strategies. In the same vein, Neise and Revilla Diez (2019) emphasized that most of the small- and micro-sized manufacturing firms in their case study in Jakarta only cope during a flood event. Relying on their established routines, they use flood walls and sandbags to protect their production facilities from water, place their products in higher places, and use small pumping systems to drain the water. While Chaudhury (2018) makes some arguments for motivating businesses to take proactive adaptation measures (e.g., greater risk awareness and the benefits of adapting outweigh the financial costs), micro-businesses face several barriers and structural deficits that limit their adaptive capacity and decisions to invest in individual adaptation measures. Unlike their larger counterparts whose adaptation actions are usually driven by organizational characteristics such as financial liquidity, business performance, foreign ownership and knowledge spillovers, micro-businesses are facing different barriers (Leitold et al., 2021; Lo et al., 2019).

2.2 Drivers of and barriers to micro-business adaptation

As micro-businesses are a specific subset of small- and medium-sized enterprises (SMEs), micro-businesses have both similarities to and differences from larger small- and medium-sized enterprises. Both micro-businesses and SMEs are characterized by their relatively smaller size compared to larger firms; are typically privately owned and operated by entrepreneurs or a small group of individuals; and have a local or regional focus, serving a specific market or community. However, the literature suggests that micro-businesses, by definition, are even smaller in terms of the number of employees, have lower sales and profits, and have limited assets. A systematic literature review by Gherhes et al. (2016) shows that micro-businesses often lack growth ambitions because owners tend to be growth averse and are constrained by underdeveloped skills in key business areas such as networking, marketing, business planning, and human resources. Due to time constraints, micro-businesses are locked into day-to-day operations rather than investing time in long-term strategic business management. In addition, institutional bottlenecks place an additional burden on micro-enterprises. As a result, they have limited access to higher-skilled labor, face a "closed" business environment as a result of negative external perceptions stemming from the stigmatization of their location, and find it more difficult to access financing and other support mechanisms than larger small- and medium-sized enterprises do.

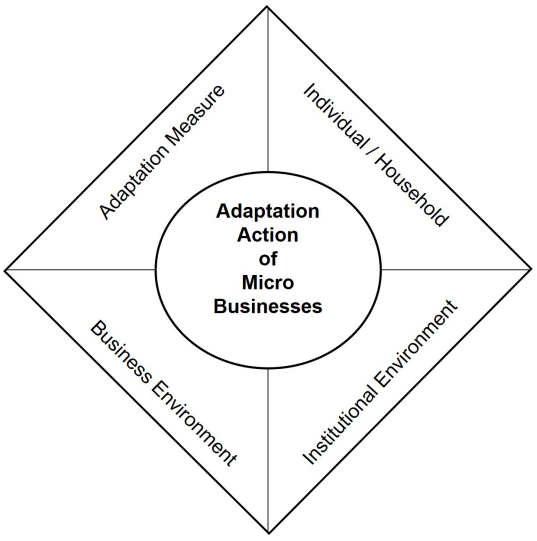


Figure 1. Key barriers to adaptation action for micro-businesses.

Based on these specifics, we present a conceptual framework to help understand drivers of and barriers to adaptation action of micro-businesses. Many micro-businesses find it challenging to develop adaptation strategies because of four key barriers (see Fig. 1).

2.2.1 Key barrier 1: acceptance of adaptation measures

A key barrier to addressing climate risks is a lack of acceptance of adaptation options due to cultural attitudes, social barriers, or a lack of understanding. A study by Geaves and Penning-Rowsell (2016) shows that large-scale protection measures fail to attract long-term participation from private actors due to a lack of local bonding. By contrast, a recent study by Leitold et al. (2020) reveals that small-scale adaptation measures initiated in a smaller neighborhood, like flood protection awareness programs, can promote the willingness of resident SMEs to adapt. In particular, collaborative approaches with shared funding from different actors (i.e., the community, firms in the neighborhood, or local government incentives) could help to overcome biases and support the implementation of different adaptation options. Understand-

ing an adaptation measure and its tangible costs and benefits can lower the social barriers to adopting new technologies and participating in flood adaptation (Chaudhury, 2018).

2.2.2 Key barrier 2: risk perceptions at the individual and household level

Since micro-businesses are "owner-centered" (Gherhes et al., 2016), individual risk perceptions; skills and capabilities; and experience of decision-makers with, for example, flood impacts play an important role in micro-business adaptation. Lawrence et al. (2014) reveal that flood experience at the individual household level in New Zealand contributes to increased risk perception and readiness to adapt. For the manufacturing sector, Neise et al. (2019) also show that SME adaptation to flood impacts in Indonesia is closely related to the risk preparedness of their managers. However, information on future climate impacts is often inaccessible for micro-businesses or even completely absent at the local level, leading businesses to make decisions based on subjective perceptions (Chaudhury, 2018; Danielson and Scott, 2006). In addition, there is general agreement that individual and household education levels can influence how businesses are organized and managed and how they respond to current and future climate risks (Chirico and Salvato, 2008; Crick et al., 2018; Lo et al., 2019). Yet the link between business viability and the need to adapt to future climate change impacts is not sufficiently visible (Frei-Oldenburg et al., 2018).

2.2.3 Key barrier 3: financial capacity

It is common knowledge that business characteristics are critical factors that shape adaptive action (Agrawala et al., 2011; Halkos et al., 2018; Pulver and Benney, 2013). In particular, limited financial resources and business performance have been proven to be barriers to the implementation of adaptation measures in small businesses and micro-businesses. They tend to have lower business capital and cash reserves and are less likely to have financial reserve funds (Gherhes et al., 2016). A study by Marks and Thomalla (2017) shows that after severe flooding in Thailand in 2011, SME recovery was particularly hampered by financial constraints. Chaudhury (2018) further argues that even after conducting robust risk assessments and identifying cost-effective adaptation options, limited financial capacity hinders the actual implementation of planned measures. In addition, the direct business neighborhood could shape collective business adaptation, as micro-businesses are highly dependent on their local customers and suppliers. Leitold et al. (2020) illustrate that interaction with neighboring firms is a driving factor for SMEs to invest in collective local adaptation measures. In the same vein, Pauw and Chan (2018) argue that smaller businesses could take active responsibility in localized initiatives that connect different actors in the same neighborhood.

2.2.4 Key barrier 4: influence of the institutional environment

Obviously, there are broader structural deficiencies in external support for micro-business adaptation financing. In the most recent literature around disaster risk reduction and adaptation barriers, access to and use of external financing such as loans and credit from banks or micro-credit institutions and tailored insurance is argued to be the major bottleneck for adaptation (Chaudhury, 2018; Chinh et al., 2016; Crick et al., 2018; Surminski and Hankinson, 2018; UNDP, 2019; UNDRR, 2020). As many micro-businesses are part of the informal economy, social protection and external-financing mechanisms are often not accessible at the business level (UNDRR, 2020). Therefore, it is not surprising that Halkos et al. (2018), Neise et al. (2019), and Leitold et al. (2020) found that institutional support and external guidance have a direct impact on the engagement of smaller firms in implementing adaptation measures against recent and future extreme events like floods and storms. In some economies like Vietnam, private businesses are under-served with respect to supportive policies and regulations (Revilla Diez, 2016; Trinh and Thanh, 2017). Therefore, local (business) associations have recently been considered a promising information channel regarding climate change impacts and ultimately for stimulating adaptation action of private businesses.

3 Material and methods

3.1 Study area: flooding in HCMC and the impact on micro-businesses

HCMC in Vietnam already experiences frequent flooding, which is expected to intensify in the coming years and decades due to the impacts of climate change. Seasonal extreme rainfall, storm surges, and discharge from upstream reservoirs often come at the same time as high tides and rainfall peaks, resulting in compound flood events in many parts of the city (Downes and Storch, 2014; Scussolini et al., 2017). Located on the northeastern edge of the Mekong Delta, at the mouth of the Dong Nai River basin, HCMC is characterized by topological conditions similar to many other delta regions in the world. More than half of the city is situated below 1.5 m elevation above mean sea level (ADB, 2010). Low-lying lands, proximity to the sea, and an interconnected system of small rivers and channels result in a high overall exposure to future sea level rise. According to national studies, the sea level already rose by 20 cm off the coast of Vietnam in the last 50 years before 2009 (MONRE, 2009), and the trend is upward (Scussolini et al., 2017). In addition, uncontrolled urban expansion and poorly connected infrastructure act as flood risk multipliers, leading to land subsidence and a reduction in drainage capacity and wa-

ter permeability. This is particularly problematic during the rainy season (May to October), which already provides 85 % of the total rainfall per year (MONRE et al., 2006; World Bank, 2019).

After being set in motion by the liberalization policies in 1986 and the subsequent transition to a market-oriented economy, HCMC has been steadily growing in population and private businesses. As Vietnam's largest city, HCMC is officially home to 8.9 million people (GSO, 2020). Although the private economic sector plays a decisive role in HCMC's remarkable economic development, many of the SMEs and micro-businesses are at the forefront of flood-related losses and damage. The Vietnam census in 2020 shows that micro-businesses and small businesses play an important role in Ho Chi Minh City. By themselves, 86 % of the firms are micro-businesses. Small- and medium-sized businesses account for another 11 %, meaning that micro-businesses and SMEs represent 97 % of the firms in HCMC. With respect to employment, micro-businesses account for 19 % and SMEs for another 25 % of the total employment, adding up to 1.3 million out of 2.9 million employees in HCMC. However, as in many fast-growing countries, official statistics about micro-businesses and small businesses in Vietnam in general and in Ho Chi Minh City specifically are limited and fragmented. This implies that the sector might be still undervalued.

As shown in Fig. 2, 43 % of the approximately 200 000 officially registered micro-businesses (1–9 employees) in 2020 belong to wholesale and retail; 11 % to manufacturing, processing, and repairing; and 10 % to the construction sector (GSO, 2020). Micro-businesses and family businesses in these sectors in particular are highly exposed to recent and future flood impacts. Manufacturing businesses are sensitive to compound flooding sources due to their location-specific production, hard-to-change infrastructure, and heavy machinery. While many medium and large firms operating in international value chains are often located in industrial parks with sufficient infrastructural flood protection, small businesses and micro-businesses have to put up with business interruptions during flood events several times a year (Leitold et al., 2021). Wholesale and retail businesses are highly dependent on regional and local value chains, which are particularly disrupted by heavy rainfall during the rainy season and by tide-induced flooding. In addition, direct flooding in stores damages flood-sensitive goods such as flowers, food, and paper products.

This study was carried out in four case study areas in HCMC where households and micro-businesses have already suffered some flood damage in recent years. Businesses in the western part of the city (district 8 and Bình Tân district) are mainly impacted by urban flash floods and pluvial flooding after heavy and prolonged rainfall. The Bình Thạnh district is located close to the Saigon River, making the area exposed to flooding, which is exacerbated by the release of upstream water reservoirs (Duy et al., 2018). The Nhà Bè district is located in the southern parts of the city and is characterized by a peri-urban morphology. According to the projections, Nha Be is one of the districts in HCMC that will be most affected by future sea level rise (Scussolini et al., 2017).

3.2 Household-survey- and scenario-based field experiments

The empirical analyses in this paper are based on two combined datasets.

First, we used a household survey in HCMC conducted as part of the collaborative research project DECIDER (Decisions for the Design of Adaptation Pathways and the Integrative Development, Evaluation, and Governance of Flood Risk Reduction Strategies in Changing Urban–Rural Systems) to understand the flood vulnerability of micro-businesses, their respective perceptions, and flood adaptations. The standardized household survey was conducted in two different wards of the four case study districts (district 8, Binh Tan, Binh Thanh, and Nha Be) in HCMC. In addition to 748 households, a total of 252 micro-businesses were surveyed in HCMC between September and November 2020. We developed a questionnaire on general characteristics and the economic situation of micro-businesses, investment decisions, flood impacts, adaptation strategies, and perceptions of future risk and local risk management systems. All respondents have experience with flooding (i.e., water entering the house/business premises) and had suffered damage/losses due to floods since 2010. The questionnaires were field tested during a 1 week pretest in 2019 and adjusted afterwards. Moreover, the survey was preceded by a 1 d workshop for the enumerators during which they were trained on how to conduct the survey and received feedback. In Vietnam, our partners at the Southern Institute of Social Sciences (SISS) organized and implemented the training and the main field campaign.

Second, we ran scenario-based field experiments with about a quarter of the micro-businesses owners from the main survey. The goal of the experiments was to examine the willingness of businesses to invest in collective adaptation options to protect themselves from future flood impacts. The scenario-based field experiments consist of a public good game design with different adaptation scenarios in a field experiment environment (Leitold et al., 2020; Neise et al., 2019). Public good games are rooted in behavioral economics. They aim to explain why collective actions succeed or fail and decipher participants' contributions to a public good (Ones and Putterman, 2007). In our experiments, flood adaptation measures are defined as a discrete public good that is only provided when multiple actors make individual financial contributions. Implementing public good games in real field environments rather than in a laboratory provides a deep understanding of explanatory factors for participants' decision making in collective adaptation actions (Ehmke and Shogren, 2009). The experiments used vignette designs that present carefully constructed but hypothetical descriptions

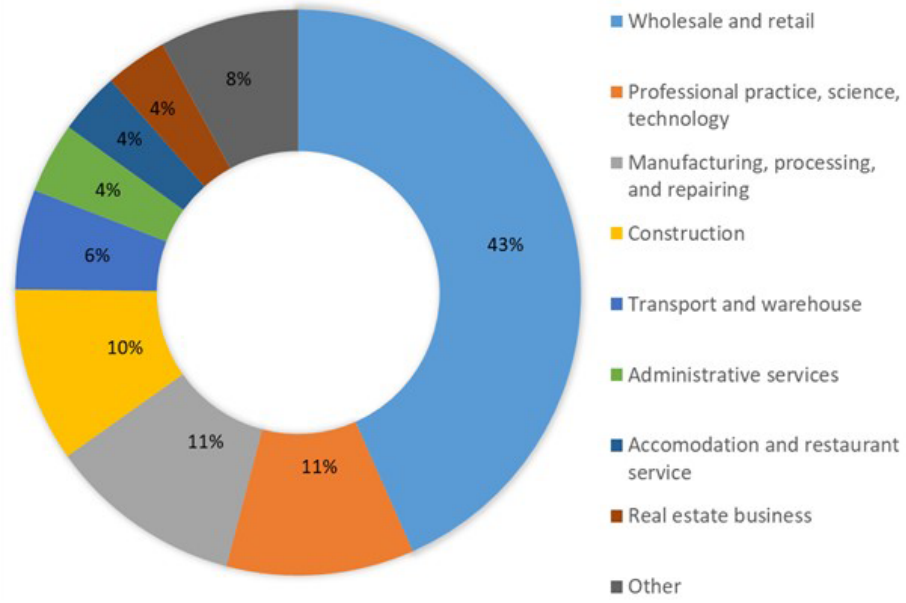


Figure 2. Main sectors of micro-businesses in HCMC by percentage. Source – own design; data – GSO (2020).

Figure 3. The data basis for the multilevel regression analysis.

of adaptation measures that differ in their design and in the financial contributions for their implementation (Atzmüller and Steiner, 2010).

In total, our Vietnamese project partners from the University of Economics and Law, Vietnam National University, conducted experiments with 62 out of the 252 micro-businesses from the main survey. The methodology and the different scenarios were explained in detail to the enumerators in a training workshop and during supervised pretests prior to the experiments. Then, we linked the micro-business survey data to our experiment data using the survey identification to combine information on household and business characteristics and perceptions with the investment decisions from each experiment (see Fig. 3).

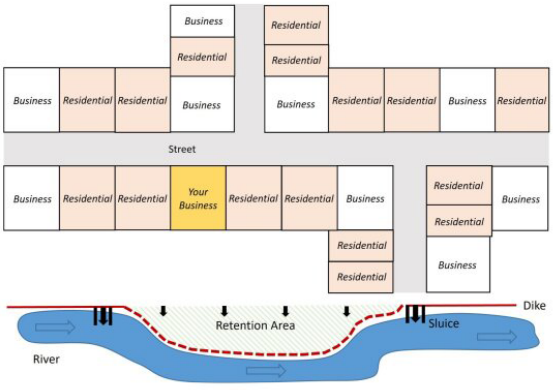
3.3 Experiment design, measurement, and data analysis

Four realistic adaptation measures were developed for the experiments. The conceptualization of these measures is based on our previous study of manufacturing SMEs in HCMC (2018–2019; see Leitold et al., 2020) but was adapted to the local realities of micro-businesses in collaboration with our local project partners in order to minimize hypothetical bias.

To analyze the influence of respective adaptation measures and financing options on the willingness of micro-businesses to participate in collective adaptation, we used the same locational setting representing typical flood-prone areas in HCMC for all adaptation options (see Fig. 4 for the overall experiment setting). We designed four adaptation cards that were shown to the participants. In addition to the designs of adaptation measures, we built different financing options into the scenario cards. In the first two options, either the residents in the neighborhood or the other micro-businesses contribute to the same amount and share the costs of adaptation measures (neighborhood support). In the third option, local authorities provide financial incentives and support the implementation of adaptation measures (political support). By contrast, in the fourth option, local authorities demand the participation of businesses or impose fines for non-compliance (political pressure). In the fifth option, other businesses contribute less than the necessary amount, and the micro-business must invest more than others in their direct neighborhood (unbalanced contribution). In total, the respondents had to go through 20 scenarios (4 adaptation scenarios multiplied by 5 financing options).

For data analysis, we created a dichotomous dependent variable "willingness to participate in collective flood adaptation", where 1 represented a micro-business' willingness to invest the necessary resources and 0 represented a micro-business' unwillingness to contribute sufficiently. In general, our indicators are presented on a binary scale (see Table 1 for the explanation of indicators). Following Leitold et al. (2020), we tested dike systems, drainage systems, and awareness programs to assess the acceptance of different adaptation measures (key barrier 1: lacking acceptance). To test

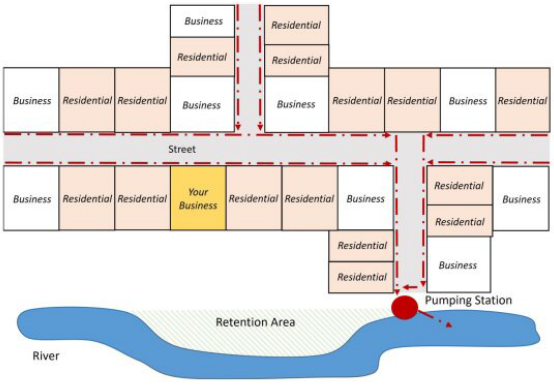
Adaptation Option 1: Dike construction



Measure:
Sophisticated dike system with two sluices in front of the river. Retention area in front of the riverside

Strategy:
Safeguard riparian zones and canal areas. Reduce inundation level

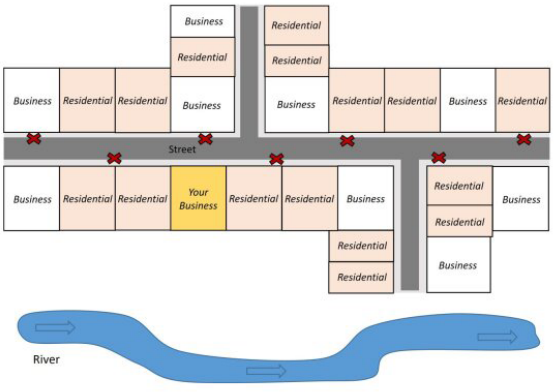
Adaptation Option 2: Drainage system



Measure:
Clean and upgrade drainage system within the community

Strategy:
Increase drainage capacity. Reduce inundation level

Adaptation Option 3: Road elevation



Measure:
Elevation of the main roads in the neighborhood

Strategy:
Reduce inundation level due to heavy rain.

Adaptation Option 4: Awareness program

Measure:
Funding of an awareness raising program
Develop district adaptation pathways

Strategy:
Strengthen flood risk management. Increase local awareness on flooding (and waste disposal etc.)

Figure 4. Overall experiment setting and adaptation options (source – the design is based on Neise et al., 2019; and Leitold et al., 2020).

Table 1. Key indicators of collective flood adaptation.

	Indicators	Descriptions (no = 0; yes = 1)	Expected impacts
Adaptation measure	Neighborhood support	Scenarios with shared funding	+
	Political support	Scenarios with shared funding	+
	Unbalanced contribution of businesses	Scenarios where micro-businesses need to invest more than others in their neighborhood	–
	Dike system	Scenarios with a dike system (high financial input, technological infrastructure)	–
	Drainage system	Scenarios with a drainage system (medium financial input, technological infrastructure)	+
	Awareness program	Scenarios with awareness program (low financial input, soft measure)	+
Individual household	High individual damages	High damage of business components (e.g., furniture, electronics, equipment, products); "high" means major or complete damage	+
	Flood experience	Business was flooded more than 5 times in the last 10 years	+
	Household education	At least one person in the household has a university degree or vocational training	+
	Expected flood increase	Expected flood increase in the next 10 years	+
Business environment	Decline in business revenue	Revenue decline/fluctuation in the last 5 years	–
	Limited financial resources	Low financial resources for preventing flood impacts (rating from 1–5, 1 and 2 are considered "low")	–
	Local supplier	Suppliers located in the same district	+
Institutional environment	Member organization	Household members are part of an organization (Fatherland's Front, Women's Union, Youth Union, etc.)	+
	No repair after flood events	Government/law does not allow repair/rebuilding after flood events (e.g., the business is in a planned project area)	+
	Access to external capital	Business finances investments through loans from banks or micro-credit institutions	+

preferences for different funding options, we used neighborhood support as a proxy for the preference for shared funding of measures and political support as a proxy for desired support from public stakeholders. We also controlled for unbalanced contributions of businesses.

To test the influence of risk perceptions at the individual and household level (key barrier 2: low risk perception), we generated the indicators expected flood increase and household education (Crick et al., 2018). The latter means that at least one person in the household has a university degree or vocational training. Consistent with Neise et al. (2019) and based on the assumptions of Lawrence et al. (2014), flood experience was measured as whether a micro-business was flooded more than 5 times in the last 10 years. Based on the answers from the micro-business survey, an additional measure of future flood perception was included to represent high individual damages that occurred during the most serious flood since 2010. We hypothesized that there would be positive relationships between the indicators for risk perception at the individual level and the willingness to participate in collective adaptation.

In the business environment, we tested for financial capacities as the factor influencing adaptation decisions (key barrier 3: limited financial capabilities). Following Chaudhury (2018) and Marks and Thomalla (2017), we developed the indicators decline in business revenue (when revenue has declined or fluctuated over the past 5 years) and limited financial resources (self-assessment by micro-businesses of their financial resources for flood adaptation). We expect both indicators to be barriers to collective adaptation. We also tested dependence on local customers and suppliers, as relations with neighboring firms raise the probability for co-funding by other firms, although this indicator is difficult to operationalize. However, we coded local supplier as 1 for businesses that report that their suppliers are located in the same flood-exposed neighborhood.

We test the influence of the institutional environment using three explanatory variables (key barrier 4: missing support). It is expected that willingness to participate in adapta-

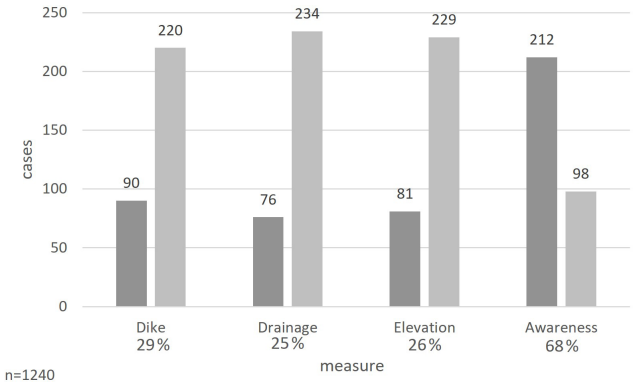


Figure 5. Preferences for adaptation measures.

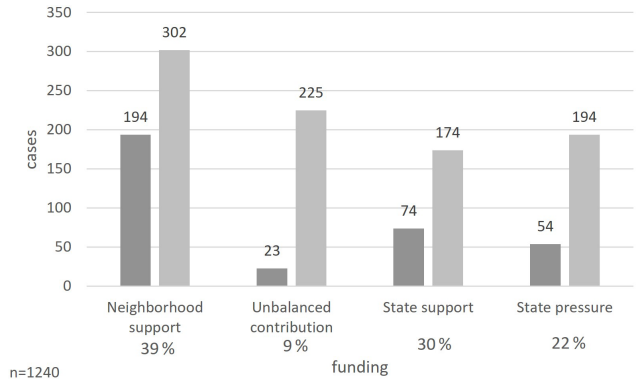


Figure 6. Preferences for funding.

tion increases if a household member is part of an organization (i.e., Fatherland's Front, Women's Union, Youth Union; Leitold et al., 2020). Especially in Vietnam, being a member of the Communist Party's own social organization could offer some patronage and special treatment when it comes to applying for support. To represent institutional barriers, we built an indicator for the situation where public policies or public laws do not allow private buildings to be repaired or rebuilt after floods. For example, micro-businesses may be located in a planned project area, a situation which has become quite common in HCMC in recent years. Further, we test the influence of access to external capital on willingness to participate, in the form of loans from banks or micro-credit institutions. We expect negative correlations for both indicators and adaptation willingness. Finally, we controlled for the influence of location within our four case study areas.

The scenario-based field experiments generated 1240 observations for data processing. As each participant responded to 20 scenarios, scenario data are nested within business characteristics. Analyzing such hierarchically structured data using an ordinary least-squares regression would lead to spatial autocorrelation and a violation of the independence assumption for scenario observations (Hox et al., 2017; Sohns and Revilla Diez, 2018). Therefore, we applied a two-level binary logistic regression that allowed us to consider the differences and interdependencies between scenario and micro-business characteristics (Rabe-Hesketh and Skrondal, 2008). Multicollinearity (average variance inflation factor for the independent variables = 1.6) can be rejected.

4 Findings

4.1 Descriptive findings

Our sample consists of 62 micro-businesses: 46 businesses are stores or retailers (74 %) for food and beverages, clothing, housewares, electricity, or construction material; 10 businesses are operating in the services sector (16 %); and 3 are in the production sector (5 %). Out of these businesses, 61 % have been flooded more than 5 times per year in the last 10 years and 44 % even more than 10 times a year. It is evident that as soon as damage is reported, it is mostly classified as major damage requiring repair. In particular, the level of damage to products is relatively high (see Table 2). Complete damage has not been reported. As a consequence, the micro-businesses do undertake their own precautionary measures. We see that more than 50 % of the micro-businesses have already purchased water barriers for flood prevention and dry-proofed their valuables, goods, and products during severe flood events. In addition, 84 % of micro-businesses have already elevated their ground floor or foundation to prevent flooding into their premises. In terms of acute flooding events, which are already clearly noticeable today, the micro-businesses are therefore (most reactively) already doing something.

The descriptive analysis of the key barriers partly confirms but also opposes the findings from the literature.

In respect to key barrier 1 (lacking acceptance), the complete rejection of adaptation measures cannot be confirmed as stated in the conceptual section. However, in only 28 % of all scenarios were micro-businesses willing to contribute to flood adaptation measures in their neighborhoods. The results show substantial differences between participation in technical scenarios (dike system – 29 %; drainage system – 25 %; and elevation – 26 %) and the less expensive flood awareness program, to which micro-business owners were willing to contribute in 68 % of cases (see Fig. 5). In terms of financing adaptation measures, decision makers were willing to contribute financially in 39 % of the scenarios if other actors in the neighborhood (i.e., the community – 30 % and other businesses – 48 %) were also involved. For all other options – financial support from local authorities or when businesses have to pay a fine for not investing in collective protection measures – willingness to participate was below average (see Fig. 6). Also, the results for key barrier 2 (low risk perception) are different than expected. The survey results indicate that 77 % of the businesses expect flooding to increase in the next 10 years, while 16 % expect flooding to

Table 2. Individual damage of micro-businesses from the most severe flood since 2010.

	No damage	Minor damage	Moderate damage	Major damage – needs repair	Complete damage – needs replacement	No answer
Furniture	39	8	1	14	0	0
Electronics	37	3	4	16	0	2
Business-specific equipment	39	6	8	9	0	0
Products	28	4	6	22	0	2

remain the same or even decrease. These results underline that owners of micro-businesses are well-aware of the risks of future flooding.

In relation to key barriers 3 (limited financial capabilities) and 4 (missing support), the results are in line with the findings in the literature. About 37 % of businesses report a decline and 15 % a fluctuation in business revenues over the past 5 years. In addition to revenue, the financial resources available to prevent flood impacts are a key limiting adaptation factor for micro-businesses. On a scale from 1 (very poor) to 5 (very good), more than half of the businesses rate their financial resources as limited (58 % rate 1 or 2). Only 19 % of businesses surveyed have access to external capital such as loans from banks or from micro-credit institutions; 16 % receive loans from family members, relatives, or friends; and the majority finance their business investments through personal funds or savings. Support by state agencies is hardly mentioned.

4.2 Multilevel regression findings

In order to detect the key drivers of and barriers to micro-business adaptation strategies, the main statistical analysis was based on the two-level regression. Table 3 shows which indicators influence the willingness of micro-businesses to invest in collective flood adaptation measures and whether they act as either drivers for or barriers to adaptation (for descriptions, see Table A1). The scenario-level results underscore the findings of the descriptive analysis. Micro-businesses significantly prefer to invest in the awareness program, while their willingness to invest is not influenced by hard technical measures like, for example, the dike system or the drainage system. What is particularly clear is that shared funding opportunities between micro-businesses and local authorities, as well as from the community and other businesses in their neighborhood, significantly increase the investment in collective flood adaptation. Accordingly, an unbalanced contribution of businesses in their neighborhood reduces the investment and thus acts as a barrier.

In addition, further variables also influence the willingness to participate in adaptation measures. Businesses that already suffered high individual damages during the most serious flood since 2010, businesses that have high flood experience, and those that expect a high increase in floods in the next 10 years are significantly more willing to invest in collective flood adaptation measures. In the overall picture, all three indicators of risk perception and experience act as drivers for collective adaptation. Interestingly, the investment decisions of micro-businesses were not influenced by household education.

As expected, financial constraints and decreasing business performance indicators act as barriers for collective adaptation. A general decline in business revenue and limited financial resources for adaptation measures reflect the situation of the majority of businesses in the sample. Both indicators significantly decrease participation in the scenarios. Regarding the dependence on local suppliers, the analysis did not yield any significant results.

The results further reveal that external guidance and institutional support play a major role in micro-business decision making for collective adaptation. When a household member is part of an organization, the willingness to invest in collective adaptation increases slightly significantly. Similarly, access to external capital in the form of loans from banks or micro-credit institutions increases the willingness to participate. Since some urban-development policies act as barriers to individual risk reduction and hinder the repair or reconstruction of private buildings after flood events, it is not surprising that such situations have a highly significant positive influence on the willingness to invest in collective adaptation measures together with other actors in the neighborhood.

The impact of the neighborhood of the micro-businesses on decision-making in the experiments for which we controlled does not yield significant results. Thus, micro-businesses in the case study areas make decisions based on scenario and individual-level characteristics, regardless of their place of operation.

5 Future role of micro-businesses in collective flood adaptation

The empirical results of this analysis add important insights from the particular case of HCMC toward a broader understanding of the drivers of and barriers to micro-business flood adaptation.

Acceptance of and participation in adaptation measures are clearly related to the risk perceptions and awareness at the individual and household level. In this case study, high future risk perception, often based on past experience with flooding

Table 3. Multilevel regression results for willingness to participate in collective flood adaptation.

Fixed effects	Odds ratio (standard error) m0	Odds ratio (standard error) m1	Odds ratio (standard error) m2	Direction of effect
Scenario characteristics				
Neighborhood support (shared funding)		4.721[a] (1.207)	4.712[a] (1.208)	+
Political support (shared funding)		2.222[a] (0.638)	2.231[a] (0.643)	+
Unbalanced contribution of businesses		0.133[a] (0.055)	0.121[a] (0.052)	−
Dike system		1.333 (0.338)	1.334 (0.338)	
Drainage system		0.845 (0.220)	0.844 (0.220)	
Awareness program		1.697[b] (0.039)	1.697[b] (0.426)	+
Firm characteristics				
High individual damages			3.207[c] (1.964)	+
Flood experience			5.596[b] (4.158)	+
Expected flood increase			7.496[b] (6.541)	+
Household education			1.322 (0.808)	
Declining business revenue			0.167[b] (0.121)	−
Limited financial resources			0.189[b] (0.126)	−
Local supplier			2.523 (1.759)	
Member organization			4.673[c] (4.184)	+
No repair after flood events			193.237[a] (252.860)	+
Access to external capital			4.394[c] (3.624)	+
Control variables				
Nha Be (location)			3.136 (2.750)	
District 8 (location)			2.239 (1.930)	
Constant	−1.489 (0.281)	0.894 (0.386)	0.000[a] (0.000)	
Random effects				
Firm var.(_cons)	4.364 (1.146)	6.938 (1.840)	3.780 (1.020)	
Model fit statistics				
Observations	1240	1240	1240	
ICC firm	0.570	0.678	0.535	
Prob_chi2	0.000	0.000	0.000	

[a] Significant at 1 % level ($p < 0.01$); [b] significant at 5 % level ($p < 0.05$); [c] significant at 10 % level ($p < 0.1$). Source – own calculation.

and suffering damage to stock and assets, was clearly identified as a driver for investment in collaborative flood adaptation. Conversely, a lack of risk perception and assessment, particularly with an eye towards upcoming flood risks, acts as a barrier to long-term adaptation. Although 77 % of the businesses in our survey expect flooding to increase – suggesting that the awareness is quite high – the direct (or indirect) impact on business operations is often unclear and may explain the overall restraint in the experiments. Schaer (2018) argues that either businesses do not perceive future impacts to be a risk factor for their business operations or they have limited expertise to predict and plan for the risks accurately. The link between business benefits and adaptation is not clear to decision makers. It is added that micro-businesses differ from larger SMEs by being owner-centered, having a tendency to be "growth-adverse", and by focusing more on non-economic aspects of business ownership. Growth intensions are often limited to a desired income that is sufficient for making a living (Gherhes et al., 2016). Neise and Revilla Diez (2019) and Leitold et al. (2021) already point out that frequent but smaller floods are the norm for small businesses, which they do not plan to adapt to in the future. They often lack long-term business plans or any risk assessments, either for climate risks or for other business risks, and follow an attitude of "simply live with it". Business growth in terms of increasing head count, diversification of products and services, and revenue growth is not an aspiration anyway. Thus, the impact of flooding is only relevant if it threatens the profitability of the micro-business for household income.

Following this vein, we clearly see an overlap of the different key barriers developed in our conceptual framework (Lo et al., 2019). It can be argued that the general development constraints of micro-businesses are also responsible for barriers to adaptation. In particular, financial limitations in

the business environment act as additional barriers to long-term adaptation. On this point, the institutional environment represents another critical factor that can stimulate or inhibit adaptation. There is a lack of tailored external support mechanisms and adequate financing options to motivate micro-businesses to initiate long-term business planning and thus it also keeps them from implementing adaptation measures (Berkhout et al., 2006; Schaer, 2018).

In general, the willingness to participate financially in our scenario exercise stood at 28 % and was lower than what we had expected. Average results in such public good games typically amount to 40 %–60 % of personal endowment (Chaudhuri, 2011). The results of the experiments show no substantial differences between the contribution to different technical adaptation measures and the influence on decision making to participate in adaptation measures. Although the preference for low-cost and soft measures over cost-extensive and technological measures is generally comparable to experiments with manufacturing SMEs (Leitold et al., 2020; Neise et al., 2019), the low uptake of technical adaptation measures can be explained by micro-business prerequisites like limited financial capacity and low risk perception for entrepreneurial decision making.

However, depending on the adaptation measure and financing option, micro-businesses could play a larger role in flood adaptation. Overall, almost 70 % of the micro-businesses are willing to participate in collective awareness programs. In general, the willingness to participate financially increases noticeably, to 39 %, if the costs could be shared with actors in their neighborhood and with local authorities. Moreover, businesses that have access to external capital from banks or micro-credit institutions are more willing to participate in collective adaptation in general. In most cases, and in contrast to larger firms, micro-businesses have a local life and business horizons and are closely embedded in local (business) networks (Halkos and Skouloudis, 2019; Kato and Charoenrat, 2018). Therefore, local adaptation solutions, support mechanisms, and incentives must also be created in the direct business environment. Building local business associations outside of industry-specific associations and engaging decision makers could be one important starting point to involve micro-businesses in larger adaptation initiatives and motivate them to participate. Additionally, community organizations and neighborhood unions should place future risk trends and flood hazards on their agendas to promote micro-business awareness of flooding but also to support micro-businesses that face institutional barriers to flood adaptation.

It is argued here and supported by Chaudhury (2018) that information about future climate-related risks and uncertainties, while relevant for decision-making processes, is often still unavailable for micro-businesses. Therefore, additional initiatives like awareness-raising programs are easy to implement and do not reach technological capacity limits but can help to promote future risk assessments and weighting of adaptation options and possibilities. Building effective adaptation infrastructure consists not only of physical infrastructure such as elevation, drainage systems, or dike systems but also needs to include "informational infrastructure" (Marlowe et al., 2018; Ngin et al., 2020) in the form of channels for communicating disaster risks and raising awareness. But apparently as our results clearly show, micro-business willingness to participate in adaptation is also subject to socioeconomic constraints confronting individual decision makers and their lifestyle preferences (Lo et al., 2019).

This understanding of micro-businesses, their lifestyle orientations, and their flexibility is often overlooked in adaptation research and in adaptation policies (Parsons et al., 2018). There is a need to understand more about the constraints and preferences of micro-businesses to better support them but also to integrate them better into adaptation schemes. As they are often located in densely populated neighborhoods where the owners also reside and form a part of the social fabric, their role as multipliers for collective action could be used strategically in adaptation plans. However, our analysis is just a first step in this direction. Our multilevel analysis is based on hypothetical and simplified designs of adaptation scenarios. Therefore, external validity should be improved by conducting similar experiments in different field contexts. Moreover, research design based on "yes or no" responses is not able to capture the intensity of contextual influences on micro-business willingness to participate in respective adaptation options. Another relevant future research avenue is to quantitatively investigate the causal relationships of various drivers and barriers that influence micro-business decision-making for flood adaptation based on a higher number of experiments.

6 Conclusion

Micro-businesses could play a much larger role in collective adaptation. Often overlooked in adaptation research, their willingness to contribute to collective action despite major constraints is surprising. The conceptual framework presented in this paper helps us understand the key drivers of and barriers to micro-businesses willingness to participate in collective adaptation activities. The most important key barriers for micro-businesses are limited financial capabilities and missing support from local authorities. However, micro-businesses are willing to contribute depending on the concrete adaptation measure and funding options. If no financial contribution is expected, almost 70 % are willing to assist in awareness-raising campaigns. And although their financial capabilities are very limited, 39 % of the micro-businesses would contribute financially if the costs were shared with other firms in their neighborhood and with local authorities. Against this background, micro-businesses should be much more involved in adaptation plans and measures. Through

their local embedding, they can be important multipliers in strengthening adaptive capacity at the local level.

Appendix A

Table A1. Descriptive statistics of micro-business adaptations' strategies.

	Indicator	Description (min = 0; max = 1)	Obs.	Mean	SD
Adaptation measures	Neighborhood support	Scenarios with shared funding	1240	0.4	0.49
	Political support	Scenarios with shared funding	1240	0.2	0.40
	Unbalanced contribution of businesses	Scenarios where micro-businesses need to invest more than others in their neighborhood	1240	0.2	0.40
	Dike system	Scenarios with a dike system (high financial input, technological infrastructure)	1240	0.25	0.43
	Drainage system	Scenarios with a drainage system (medium financial input, technological infrastructure)	1240	0.25	0.43
	Awareness program	Scenarios with an awareness program (low financial input, soft measure)	1240	0.25	0.43
Individual risk knowledge, risk assessment and flood experience	High individual damages	High damage of business components (e.g., furniture, electronics, equipments, products); "high" means major or complete damage	1240	0.52	0.50
	Flood experience	Business was flooded more than 5 times in the last 10 years	1240	0.61	0.49
	Household education	At least one person in the household has a university degree or vocational training	1240	0.52	0.50
	Expected flood increase	Expected flood increase in the next 10 years	1240	0.77	0.42
Business environment	Decline in business revenue	Revenue decline/fluctuation over the past 5 years	1240	0.51	0.50
	Limited financial resources	Low financial resources for preventing flood impacts (rating from 1–5, 1 and 2 are considered "low")	1240	0.58	0.49
	Local supplier	Suppliers located in the same district	1240	0.60	0.49
Institutional environment	Member organization	Household members are part of an organization (Fatherland's Front, Women's Union, Youth Union, etc.)	1240	0.15	0.35
	No repair after flood events	Government/law does not allow repair/rebuilding after flood events (e.g., the business is in a planned project area)	1240	0.07	0.25
	Access to external capital	Business finances investments through loans from banks or micro-credit institutions	1240	0.18	0.38
Control variables	Spatial influence Nha Be	Business located in Nha Be	1240	0.44	0.50
	Spatial influence district 8	Business located in district 8	1240	0.32	0.47

Code availability. The STATA code can be provided upon request to the corresponding author.

Data availability. Due to privacy issues, the questionnaire data are not publicly accessible, but they can be provided upon request to the corresponding author.

Author contributions. RL, JRD, and MG developed the conceptual framework; RL designed the experiments and carried them out with VT; and JRD and RL prepared the manuscript with contributions from all co-authors.

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