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 and household businesses is still very limited. Micro 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 on 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 neighborhood? What are the key drivers 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 and barriers of micro-businesses' 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.

Author contribution: Javier Revilla Diez and Matthias Garschagen develop the conceptual framework, Roxana Leitold designed the experiments and carried them out with Van Tran. Javier Revilla Diez prepared the manuscript with contributions from all co-authors.

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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 who are shopkeepers, run cafes, restaurants, or repair shops, offer transport and warehouse or construction and maintenance services, often located in the middle of residential neighborhoods. According to the UN (2015) these businesses are a key engine of job creation and 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 are 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 on the impacts of climate change on small- and medium-sized firms (SMEs) and their adaptive behavior against climate change risks recently have received more attention (e.g., (Halkos and Skouloudis, 2019; Howe, 2011; Marks and Thomalla, 2017; Neise et al., 2019; Neise et al., 2018; Neise and Revilla Diez, 2019; Pathak and Ahmad, 2018; Pathak and Ahmad, 2016; Pauw and Chan, 2018), the focus on micro 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 underdeveloped capabilities in 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) exemplify that not all businesses have the same adaptive capacity, respond in the same way, and 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 exactly knowing how micro businesses are impacted and reacting to climate change, which adaptive capacities they possess and whether their adaptation behavior would change if for example incentives like financial support is 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 more future oriented, under which conditions are micro firms willing to invest jointly into proactive adaptation efforts in their neighborhood?

Our methodological approach is twofold. First, by 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 neigbourhood, or financial incentives provided by local authorities, or pure political pressure impacts 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 and interdependencies between adaptation scenario and micro business characteristics in order to the detect the key drivers and barriers for adaptation. The necessary data was generated during a household and micro business survey as part of a 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 1,240 observations were generated for data processing.

This article is organized as follows. Section 2 develops a conceptual framework on potential drivers and barriers of micro business adaptation. Section 3 introduces the study area and methodology. Section 4 presents the descriptive and analytical results of the study, while Section 5 discusses the implications of the results for addressing 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 IPCC Assessment Report (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; Linnenluecke et al., 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 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 on adaptation actions, adaptive capacities, and the overall role of smaller local businesses in climate adaptation. In comparison, small and micro businesses typically have lower profits, smaller cash reserves and seldom 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 and micro businesses are therefore bearing 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 the area of today's risk from 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 stocks and assets, as well as indirect impacts like postponed distribution and interruptions of business operations and supplies (Bahinipati et al., 2017; Marks and Thomalla, 2017; Neise et al., 2019; Verrest 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 since the beginning of the 21st century into flood-prone areas led to increased exposition. 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 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) show that micro businesses in the tourism and hospitality sector in Cambodia usually adopt temporary and reactive responses against floods and storms rather than long-term and proactive strategies. In the same vein, Neise and Revilla Diez (2019) emphasize that most of the small and micro manufacturing firms in their case study in Jakarta only cope during a flood event.

Relying on their established routines, they use floodwalls and sandbags to protect their production facility 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, benefits of adapting outweigh the financial costs), micro businesses face several barriers and structural deficits that limit their adaptive capacity and decision 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 and barriers of micro business adaptation

As micro businesses are a specific subset of small and medium-sized enterprises (SMEs), micro businesses have both similarities and differences with 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 Gheres 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 finance and other support mechanisms than larger small and medium-sized enterprises.

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

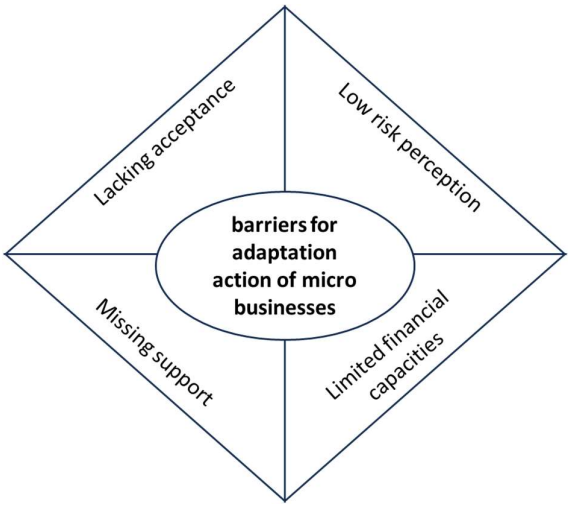


Figure 1: Key barriers for adaptation action of micro businesses

Key barrier 1: Acceptance of adaptation measures

A key barrier to addressing climate risks is lacking acceptance of adaptation options due to cultural attitudes, social barriers, and 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 by different actors (i.e., the community, firms in the neighborhood, local government gives incentives) could help to overcome biases, and support the implementation of different adaptation options. Understanding an adaptation measure, its tangible costs, and benefits can lower the social barriers to adopting new technologies and participating in flood adaptation (Chaudhury, 2018).

Key barrier 2: Risk perceptions at individual and household level

Since micro businesses are "owner-centered" (Gherhes et al., 2016), individual risk perceptions, skills and capabilities, and experience with, for example flood impacts, of decision-makers play an important role in micro business adaptation. Lawrence et al. (2014) reveal that flood experiences at the individual household level in New Zealand contribute 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 prepardeness of their managers. However, information on future climate impacts are 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 suffiently visible (Frei-Oldenburg et al., 2018).

Key barrier 3: Financial capacities

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 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, SMEs 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 into collective local adaptation measures. In the same vein, Pauw and Chan (2018) argue that smaller businesses could take active responsibilities in localized initiatives that connect different actors in the same neighborhood.

Key barrier 4: Influence of the institutional environment

Obviously, there are broader structural deficiencies in external support for microbusiness adaptation financing. In most recent literature that is developing around disaster risk reduction and adaptation barriers, access to and use of external finance such as loans and credits from banks or microcredit institutions and tailored insurances 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 underserved with respect to supportive policies and regulations (Revilla Diez, 2016; Trinh and Thanh, 2017). Therefore, local (business) associations have recently been considered as a promising information channel around 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 is already experiencing 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 with high tides and rainfall peaks, already resulting in compound flood events in many parts of the city (Downes and Storch, 2014; Scussolini et al., 2017). Located on the north-eastern edge of the Mekong Delta, at the mouth of the Dong Nai river basin, HCMC is characterized by topological conditions like many other delta regions in the world. More than half of the city is situated lower than 1.5 meter elevation above mean sea level (ADB, 2010). Lowlying 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 has already risen 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 water 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).

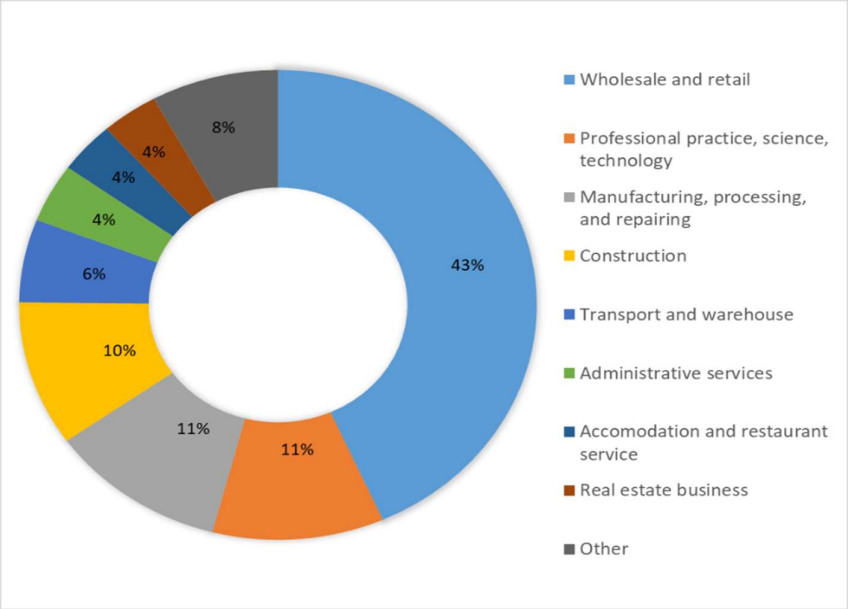


Figure 2: Main sectors of micro businesses in HCMC [percentage of businesses]
Source: GSO (2020)

Set in the 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 the Vietnam's largest city, HCMC is home to officially 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 VN Census in 2020 shows that micro and small businesses play an important role in Ho Chi Minh City. Alone, 86 % of the firms are micro-businesses. Small and medium sized businesses account for another 11 % meaning that micro businesses and SME represent 97% of the firms in HCMC. In respect to employment, micro businesses account for 19 % and SMEs for another 25% of the total employment, summing up to 1,3 Mio. Out of 2.9 Mio employees in HCMC. However, as in many fast-growing countries, official statistics about micro and small businesses in Vietnam in general and in Ho Chi Minh City specifically is limited and fragmented. This implies that the sector is might be still undervalued.

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, see Figure 2). Micro 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 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 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 damages in recent years. Businesses in the western part of the city (District 8 and Binh Tan) are mainly impacted by urban flash floods and pluvial flooding after heavy and prolonged rainfall. Binh Thanh district is located close to the Sai Gon river, making the area exposed to

flooding, which is exacerbated by the release of upstream water reservoirs (Duy et al., 2018). Nha Be district is located in the southern parts of the city and 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 a 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 flood vulnerability of micro businesses, their respective perceptions, and flood adaptation. 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 und local risk management systems. All respondents have been experienced with flooding (i.e., water entering the house/business premise) and suffered damages/losses due to floods since 2010. The questionnaires were field tested during a one-week pretest in 2019, and adjusted afterwards. Moreover, the survey was preceded by a one-day workshop for the enumerators during which they were trained how to conduct the survey and received feedback. In Vietnam, our partners of the Southern Institute of Social Sciences (SISS) organized and implemented the training and the main field campaign.

Second, we run scenario-based field experiments with about a quarter of 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 discrete public goods that are 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 of adaptation measures that differ in their design and 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 pre-tests 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 decision at each experiment (see Figure 3).

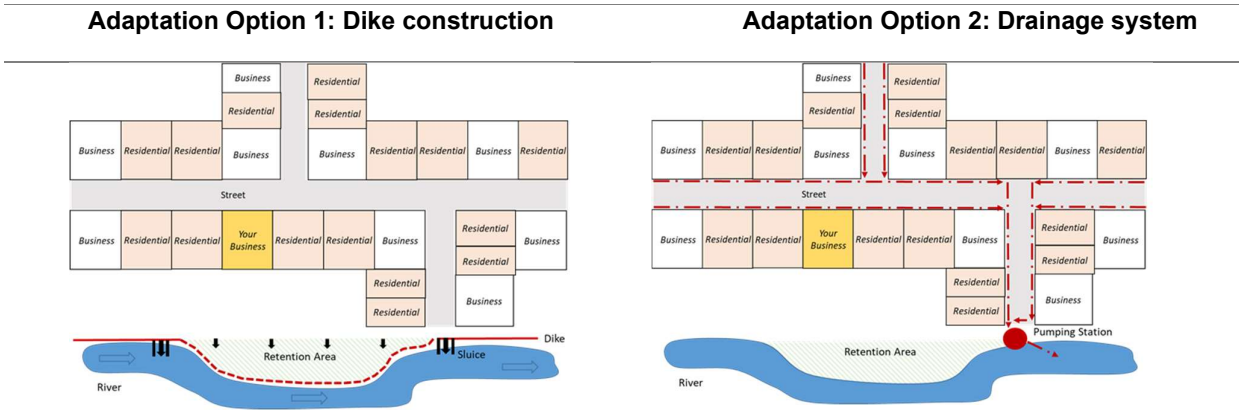
Figure 3: Data basis for the multilevel regression analysis

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 **Figure 4** for the overall experiment setting). We designed four adaptation cards, which were shown to the participants. In addition to the designs of adaptation measures, we built different financing options into the scenarios 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 have 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' was coded for micro business is willing to invest the necessary resources and '0' that a micro business was not willing 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 for *dike systems, drainage systems*, and *awareness programs* to assess the acceptance of different adaptation measures **(key barrier 1: lacking acceptance)**. To test preference 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*.



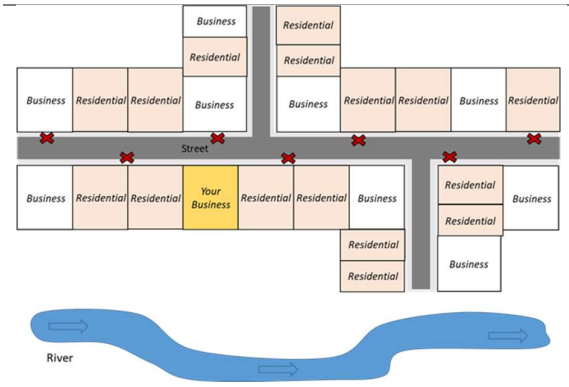
Measure:
Sophisticated dike system with two sluices in front of the river. Retention area in front of the riverside

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

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 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)

To test for the influence of risk perceptions at 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 describes that at least one person of 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 whether a micro-business was flooded more than five 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 positive relationships between the indicators for risk perception at individual level and the willingness to participate in collective adaptation.

In the business environment, we tested for financial capacities as factor influencing adaptation decisions **(key barrier 3: limited financial capabilities).** Following Chaudhury (2018) and Marks and Thomalla (2017), we developed indicators of *decline in business revenue* (when revenues have declined or fluctuated over the past five years) and *limited financial resources* (self-assessment of 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 raises 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.

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 dike system (high financial input, technological infrastructure)	-
	Drainage system	Scenarios with 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, equipments, products), high equals major and complete damage	+
	Flood experience	Business was flooded more than 5 times in the last 10 years	+
	Household education	At least one person of the household has a university degree or vocational training	+
	Expected flood increase	Expected flood incease in the next ten years	+
Business environment	Decline business revenue	Revenue decline/fluctuation in the last five years	-
	Limited financial resources	Low financial resources for preventing flood impacts (rating from 1-5, low equals 1 and 2)	-
	Local supplier	Suppliers located in the same district	+
Institutional environment	Member organization	Household members are part of an organization (e.g, Fatherland's Front, Women's Union, Youth Union, etc.)	+
	No repair after flood events	Government/Law doesn't allow to repair/rebuild after flood events (e.g. it is in a planning project area)	+
	Access to external capital	Business finances investments through loans from banks or microcredit institutions	+

We test the influence of the institutional environment using three explanatory variables **(key barrier 4: missing support).** It is expected that the willingness to participate in adaptation 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 party's own social organization could offer some patronage and special treatment when it comes to applying for support. To represent institutional barriers, we build 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, when micro businesses are located in a planning project area which is quite common in HCMC in recent years. Further, we test the influence of *access to external capital* in the form of loans from banks or microcredit institutions on willingness to participate. 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 1,240 observations for data processing. As each participant responded to 20 scenarios, scenario data are nested within business characteristics. Analyzing such hierarchically structured data with ordinary least squared 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 allows 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, houseware, electricity, or construction material. 10 businesses are operating in the service sector (16 %), and three in the production sector (5 %). 61 % of all businesses have been flooded more than five 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 own precautionary measures. We see that more than 50 % of the micro businesses already purchased water barriers for flood prevention and dry-proof 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.

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

	no damage	minor damages	moderate damages	major damages-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

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

In respect to the 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, micro businesses were willing to contribute to flood adaptation measures in their neighborhood. The results show substantial differences between participation in technical scenarios (dike system: 29 %, drainage system: 25 %, elevation: 26 %) and the less expensive flood awareness program, to which micro business owners were willing to contribute in 68 % of cases (see Figure 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 Figure 6). Also, the results for the 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 remain the same or even decrease. These results underline that owner of micro-businesses are well aware of the risks of future flooding.

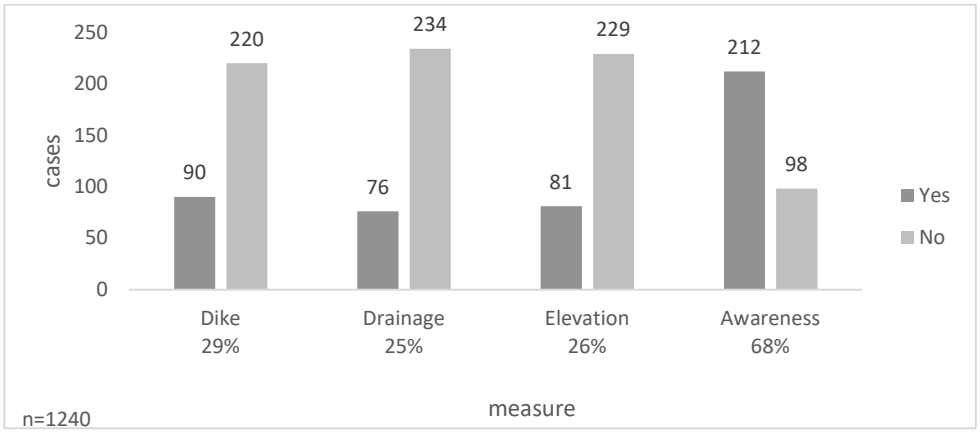


Figure 5: Preference of adaptation measure

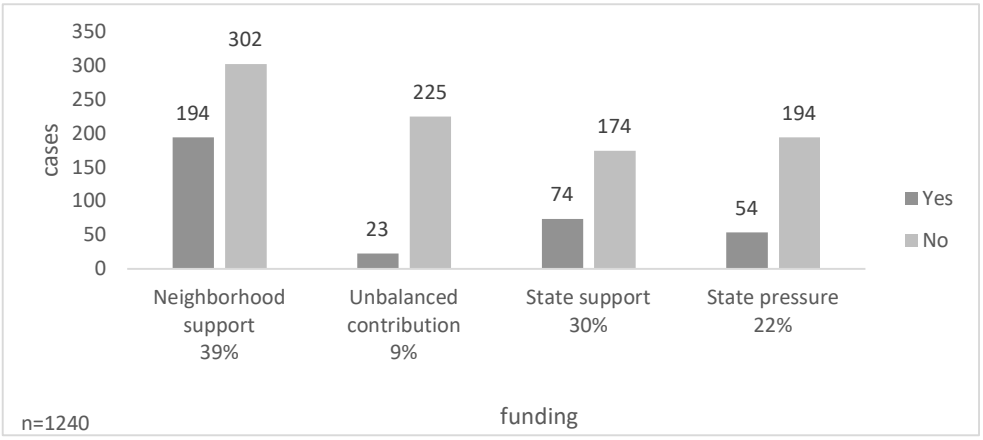


Figure 6: Preference of funding

In relation to the 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 % fluctuation in business revenues over the past five years. In addition to revenue, the financial resources available to prevent flood impacts are a key limiting adaptation factor to 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 and 2). Only 19 % of businesses surveyed have access to external capital, such as loans from banks or from microcredit institutions. 16 % receive loans from family members, relatives, or friends, while 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 and barriers for micro-business adaptations'` 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 or barriers to adaptation. 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 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 ten 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 revenues and limited financial resources for adaptation measures are reflecting 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 form of loans from banks or microcredit 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 highly significant positive influence on the willingness to invest in collective adaptation measures, together with other actors in the neighborhood.

The neighborhood of 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.

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

	Odds ratio (standard error)	Odds ratio (standard error)	Odds ratio (standard error)	Direction of effect
Fixed effects	m0	m1	m2	
Scenario characteristics				
Neighborhood support (shared funding)		4.721*** (1.207)	**4.712*** (1.208)**	**+**
Political support (shared funding)		2.222*** (0.638)	**2.231*** (0.643)**	**+**
Unbalanced contribution of businesses		0.133*** (0.055)	**0.121*** (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** (0.039)	**1.697** (0.426)**	+
Firm characteristics				
High individual damages			**3.207* (1.964)**	+
Flood experience			**5.596** (4.158)**	+
Expected flood increase			**7.496** (6.541)**	+
Household education			**1.322 (0.808)**	
Declining business revenue			**0.167** (0.121)**	-
Limited financial resources			**0.189** (0.126)**	-
Local supplier			**2.523 (1.759)**	
Member organization			**4.673* (4.184)**	+
No repair after flood events			**193.237*** (252.860)**	+
Access to external capital			**4.394* (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*** (0.000)**	
Random effects				
Firm var.(_cons)	4.364 (1.146)	6.938 (1.840)	**3.780 (1.020)**	
Model fit statistics				
Observations	1,240	1,240	**1,240**	
ICC firm	0.570	0.678	**0.535**	
Prob>chi2	0.000	0.000	**0.000**	

***Significant at 1% level (p<0.01); **Significant at 5% level (p<0.05); *Significant at 10% level (p<0.1). Source: Own calculation

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 drivers and barriers of micro business flood adaptation.

The 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 and suffering from damage to stocks 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 for 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 have limited expertise to predict and plan 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 of being "growth-adverse", and focusing more on non-economic aspects of business ownership. Growth intensions are often limited to a desired income which 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 kind of normality for small businesses, against which they do not plan to adapt 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 a "simply live with it" attitude. Business growth in terms of increasing headcount, diversification of products and services, and revenue growth is not aspired 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 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 for long-term adaptation. On this point, the institutional environment represents another critical barrier that can stimulate or inhibit adaptation. There is a lack of tailored external support mechanisms and adequate financing options that motivate micro businesses to initiate long-term business planning and thus also enables them to implement 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 amounts 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 manufacuturing SMEs (Leitold et al., 2020; Neise et al., 2019), the low uptake of technical adaptation measures can be explained by micro businesses' prerequisites like limited financial capabilities 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 noticeable to 39% if the costs could be shared with actors in their neighborhood and local authorities. Moreover, businesses that have access to external capital from banks or microcredit 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 horizon 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 into 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 support micro businesses that face institutional barriers for 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 needs also 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-businesses willingness to participate in adaptation is also subject to socio-economic constraints confronting individual decision makers and their lifestyle preferences (Lo et al 2019).

This understanding of micro-businesses, their lifestyle orientation 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 constraints and preferences of micro-businesses to better support them but also to integrate them better in adaptation schemes. As they are often located in densely populated neighborhoods where they also reside and form part of the social fabric, their role as multiplier for collective action could be used strategically in adaptation plans. However, our analysis is just a first step into 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, the 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 in collective action amidst major constraints is surprising. The conceptual framework presented in this paper helps us to understand the key drivers and barriers of micro-businesses willingness to participate in collective adaption activities. The most important key barriers of 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 are 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.

582 **Appendix:**

	Indicator	Description (min=0; max=1)	Obs.	Mean	Std. Dev.
Adaptation measures	Neighborhood support	Scenarios with shared funding	1,240	0.4	0.49
	Political support	Scenarios with shared funding	1,240	0.2	0.40
	Unbalanced contribution of businesses	Scenarios where micro businesses need to invest more than others in their neighborhood	1,240	0.2	0.40
	Dike system	Scenarios with dike system (high financial input, technological infrastructure)	1,240	0.25	0.43
	Drainage system	Scenarios with drainage system (medium financial input, technological infrastructure)	1,240	0.25	0.43
	Awareness program	Scenarios with awareness program (low financial input, soft measure)	1,240	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 equals major and complete damage	1,240	0.52	0.50
	Flood experience	Business was flooded more than 5 times in the last 10 years	1,240	0.61	0.49
	Household education	At least one person of the household has a university degree or vocational training	1,240	0.52	0.50
	Expected flood increase	Expected flood incease in the next ten years	1,240	0.77	0.42
Business environment	Decline business revenue	Revenue decline/ fluctuation over the past five years	1,240	0.51	0.50
	Limited financial resources	Low financial resources for preventing flood impacts (rating from 1-5, low equals 1 and 2)	1,240	0.58	0.49
	Local supplier	Suppliers located in the same district	1,240	0.60	0.49
Institutional environment	Member organization	Household members are part of an organization (e.g, Fatherland's Front, Women's Union, Youth Union, etc.)	1,240	0.15	0.35
	No repair after flood events	Government/Law doesn't allow to repair/rebuild after flood events (e.g. it is in a planning project area)	1,240	0.07	0.25
	Access to external capital	Business finances investments through loans from banks or microcredit institutions	1,240	0.18	0.38
Control variables	Spatial influence Nha Be	Business located in Nha Be	1,240	0.44	0.50
	Spatial influence District 8	Business located in District 8	1,240	0.32	0.47

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584 ## References

585 ADB, 2010. Ho Chi Minh City: Adaption to Climate Change, Mandaluyong City, Philippines.
586 Agrawala, S., Carraro, M., Kingsmill, N., Lanzi, E., 2011. Private sector engagement in adaptation to
587 climate change: approaches to managing climate risks. OECD Environment Working Papers.
588 https://doi.org/10.1787/5kg221jkf1g7-en.
589 Averchenkova, A., Crick, F., Kocornik-Mina, A., Leck, H., Surminski, S., 2016. Multinational and large
590 national corporations and climate adaptation: Are we asking the right questions? A review of
591 current knowledge and a new research perspective. Wiley Interdisciplinary Reviews: Climate
592 Change 7, 517–536. https://doi.org/10.1002/wcc.402.
593 Bahinipati, C.S., Rajasekar, U., Acharya, A., Patel, M., 2017. Flood-induced Loss and Damage to Textile
594 Industry in Surat City, India. Environment and Urbanization ASIA 8, 170–187.
595 https://doi.org/10.1177/0975425317714903.
596 Berkhout, F., Hertin, J., Gann, D.M., 2006. Learning to Adapt: Organisational Adaptation to Climate
597 Change Impacts. Climatic Change 78, 135–156. https://doi.org/10.1007/s10584-006-9089-3.
598 Challies, E., Newig, J., Thaler, T., Kochskämper, E., Levin-Keitel, M., 2016. Participatory and
599 collaborative governance for sustainable flood risk management: An emerging research agenda.
600 Environmental Science & Policy 55, 275–280.
601 Chaudhuri, A., 2011. Sustaining cooperation in laboratory public goods experiments: A selective
602 survey of the literature. Experimental Economics 14, 47–83. https://doi.org/10.1007/s10683-010-
603 9257-1.
604 Chaudhury, M., 2018. Conceptualizing micro, small and medium enterprise engagement in climate
605 change adaptation, in: Schaer, C., Kuruppu, N. (Ed.), Private-sector action in adaptation:
606 Perspectives on the role of micro, small and medium size enterprises. Copenhagen, pp. 29–37.
607 Chen, J., Chen, T.H.Y., Vertinsky, I., Yumagulova, L., Park, C., 2013. Public-Private Partnerships for the
608 Development of Disaster Resilient Communities. Journal of Contingencies and Crisis Management
609 21, 130–143. https://doi.org/10.1111/1468-5973.12021.
610 Chinh, D.T., Bubeck, P., Dung, N.V., Kreibich, H., 2016. The 2011 flood event in the Mekong Delta:
611 Preparedness, response, damage and recovery of private households and small businesses.
612 Disasters 40, 753–778. https://doi.org/10.1111/disa.12171.
613 Chirico, F., Salvato, C., 2008. Knowledge integration and dynamic organizational adaptation in family
614 firms. Family Business Review 21, 169–181.
615 Crick, F., Gannon, K.E., Diop, M., Sow, M., 2018. Enabling private sector adaptation to climate change
616 in sub-Saharan Africa. WIREs Clim Change 9, e505. https://doi.org/10.1002/wcc.505.
617 Daddi, T., Todaro, N.M., Giacomo, M.R. de, Frey, M., 2018. A Systematic Review of the Use of
618 Organization and Management Theories in Climate Change Studies. Business Strategy and the
619 Environment 27, 456–474. https://doi.org/10.1002/bse.2015.
620 Danielson, M.G., Scott, J.A., 2006. The capital budgeting decisions of small businesses. Journal of
621 Applied Finance 16.
622 Downes, N.K., Storch, H., 2014. Current Constraints and Future Directions for Risk Adapted Land-Use
623 Planning Practices in the High-Density Asian Setting of Ho Chi Minh City. Planning Practice &
624 Research 29, 220–237. https://doi.org/10.1080/02697459.2014.929835.
625 Duy, P.N., Chapman, L., Tight, M., Linh, P.N., Thuong, L.V., 2018. Increasing vulnerability to floods in
626 new development areas: evidence from Ho Chi Minh City. International Journal of Climate
627 Change Strategies and Management 10, 197–212. https://doi.org/10.1108/IJCCSM-12-2016-
628 0169.
629 Ehmke, M.D., Shogren, J.F., 2009. Experimental methods for environment and development
630 economics. Environment and Development Economics 14, 419–456.

631 Frei-Oldenburg, A., Wohlgemuth, J., Stieglitz, S.M. von, Stahr, C., Eisinger, F., 2018. Climate Expert: a
632 bottom-up approach to SME resilience to climate change, in: Schaer, C., Kuruppu, N. (Ed.),
633 Private-sector action in adaptation: Perspectives on the role of micro, small and medium size
634 enterprises. Copenhagen.
635 Geaves, L.H., Penning-Rowsell, E.C., 2016. Flood Risk Management as a public or a private good, and
636 the implications for stakeholder engagement. Environmental Science & Policy 55, 281–291.
637 https://doi.org/10.1016/j.envsci.2015.06.004.
638 Gherhes, C., Williams, N., Vorley, T., Vasconcelos, A.C., 2016. Distinguishing micro-businesses from
639 SMEs: a systematic review of growth constraints. Jrnl of Small Bus Ente Dev 23, 939–963.
640 https://doi.org/10.1108/JSBED-05-2016-0075.
641 Goldstein, A., Turner, W.R., Gladstone, J., Hole, D.G., 2019. The private sector's climate change risk
642 and adaptation blind spots. Nature Climate Change 9, 18–25. https://doi.org/10.1038/s41558-
643 018-0340-5.
644 GSO, 2017. Vietnam enterprise census 2017, Hanoi, Vietnam.
645 GSO, 2020. Completed Results of the 2019 Viet Nam Population and Housing Census.
646 https://www.gso.gov.vn/en/data-and-statistics/2020/11/completed-results-of-the-2019-viet-
647 nam-population-and-housing-census/ (accessed 28 May 2021).
648 Halkos, G., Skouloudis, A., 2019. Investigating resilience barriers of small and medium-sized
649 enterprises to flash floods: A quantile regression of determining factors. Climate and
650 Development 19, 1–10. https://doi.org/10.1080/17565529.2019.1596782.
651 Halkos, G., Skouloudis, A., Malesios, C., Evangelinos, K., 2018. Bouncing Back from Extreme Weather
652 Events: Some Preliminary Findings on Resilience Barriers Facing Small and Medium-Sized
653 Enterprises. Business Strategy and the Environment 27, 547–559.
654 https://doi.org/10.1002/bse.2019.
655 Haraguchi, M., Lall, U., 2015. Flood risks and impacts: A case study of Thailand's floods in 2011 and
656 research questions for supply chain decision making. International Journal of Disaster Risk
657 Reduction 14, 256–272. https://doi.org/10.1016/j.ijdrr.2014.09.005.
658 Howe, P.D., 2011. Hurricane preparedness as anticipatory adaptation: A case study of community
659 businesses. Global Environmental Change 21, 711–720.
660 https://doi.org/10.1016/j.gloenvcha.2011.02.001.
661 Hox, J.J., Moerbeek, M., van de Schoot, R., 2017. Multilevel analysis: Techniques and applications.
662 Routledge.
663 Kato, M., Charoenrat, T., 2018. Business continuity management of small and medium sized
664 enterprises: Evidence from Thailand. International Journal of Disaster Risk Reduction 27, 577–
665 587. https://doi.org/10.1016/j.ijdrr.2017.10.002.
666 Lawrence, J., Quade, D., Becker, J., 2014. Integrating the effects of flood experience on risk
667 perception with responses to changing climate risk. Nat Hazards 74, 1773–1794.
668 https://doi.org/10.1007/s11069-014-1288-z.
669 Leitold, R., Diez, J.R., van Tran, 2020. Are we expecting too much from the private sector in flood
670 adaptation? Scenario-based field experiments with small-and medium-sized firms in Ho Chi Minh
671 City, Vietnam. Climatic Change 163, 359–378. https://doi.org/10.1007/s10584-020-02888-y.
672 Leitold, R., Garschagen, M., van Tran, Revilla Diez, J., 2021. Flood Risk Reduction and Climate Change
673 Adaptation of Manufacturing Firms: Global Knowledge Gaps and Lessons from Ho Chi Minh City.
674 International Journal of Disaster Risk Reduction. https://doi.org/10.1016/j.ijdrr.2021.102351.
675 Linnenluecke, M.K., Griffiths, A., Winn, M.I., 2013. Firm and industry adaptation to climate change: A
676 review of climate adaptation studies in the business and management field. WIREs Clim Change
677 4, 397–416. https://doi.org/10.1002/wcc.214.

678 Linnenluecke, M.K., Stathakis, A., Griffiths, A., 2011. Firm relocation as adaptive response to climate
679 change and weather extremes. Global Environmental Change 21, 123–133.
680 https://doi.org/10.1016/j.gloenvcha.2010.09.010.
681 Lo, A.Y., Liu, S., Cheung, L.T.O., 2019. Socio-economic conditions and small business vulnerability to
682 climate change impacts in Hong Kong. Climate and Development 11, 930–942.
683 https://doi.org/10.1080/17565529.2019.1594665.
684 Marks, D., Thomalla, F., 2017. Responses to the 2011 floods in Central Thailand: Perpetuating the
685 vulnerability of small and medium enterprises? Natural Hazards 87, 1147–1165.
686 https://doi.org/10.1007/s11069-017-2813-7.
687 Marlowe, J., Neef, A., Tevaga, C.R., Tevaga, C., 2018. A new guiding framework for engaging diverse
688 populations in disaster risk reduction: Reach, relevance, receptiveness, and relationships. Int J
689 Disaster Risk Sci 9, 507–518.
690 MONRE, 2009. Climate change, sea level rise scenarios for Vietnam, Hanoi, Vietnam, 34 pp.
691 MONRE, World Bank Vietnam, DANIDA, 2006. Vietnam Environment Monitor 2006: Water Quality in
692 Viet Nam with a Focus on the Cau, Nhue-Day and Dong Nai River Basins; Technical Report, Hanoi,
693 Vietnam.
694 Neise, T., Revilla Diez, J., 2019. Adapt, move or surrender? Manufacturing firms' routines and
695 dynamic capabilities on flood risk reduction in coastal cities of Indonesia. International Journal of
696 Disaster Risk Reduction 33, 332–342. https://doi.org/10.1016/j.ijdrr.2018.10.018.
697 Neise, T., Revilla Diez, J., Garschagen, M., 2018. Firms as drivers of integrative adaptive regional
698 development in the context of environmental hazards in developing countries and emerging
699 economies – A conceptual framework. Environment and Planning C: Politics and Space 36, 1522–
700 1541. https://doi.org/10.1177/2399654418771079.
701 Neise, T., Sambodo, M.T., Revilla Diez, J., 2019. Are Micro-, Small- and Medium-Sized Enterprises
702 Willing to Contribute to Collective Flood Risk Reduction? Scenario-Based Field Experiments from
703 Jakarta and Semarang, Indonesia. Organization & Environment, 1-24.
704 https://doi.org/10.1177/1086026619875435.
705 Ngin, C., Chhom, C., Neef, A., 2020. Climate change impacts and disaster resilience among micro
706 businesses in the tourism and hospitality sector: The case of Kratie, Cambodia. Environmental
707 research 186, 109557. https://doi.org/10.1016/j.envres.2020.109557.
708 Ones, U., Putterman, L., 2007. The ecology of collective action: A public goods and sanctions
709 experiment with controlled group formation. Journal of Economic Behavior & Organization 62,
710 495–521. https://doi.org/10.1016/j.jebo.2005.04.018.
711 Pathak, S., Ahmad, M.M., 2016. Flood recovery capacities of the manufacturing SMEs from floods: A
712 case study in Pathumthani province, Thailand. International Journal of Disaster Risk Reduction 18,
713 197–205. https://doi.org/10.1016/j.ijdrr.2016.07.001.
714 Pathak, S., Ahmad, M.M., 2018. Role of government in flood disaster recovery for SMEs in
715 Pathumthani province, Thailand. Natural Hazards 93, 957–966.
716 Pauw, W.P., Chan, M., 2018. Multistakeholder partnerships for adaptation: the role of micro, small
717 and medium enterprises, in: Schaer, C., Kuruppu, N. (Ed.), Private-sector action in adaptation:
718 Perspectives on the role of micro, small and medium size enterprises. Copenhagen, pp. 99–109.
719 Pulver, S., Benney, T., 2013. Private-sector responses to climate change in the Global South. WIREs
720 Clim Change 4, 479–496. https://doi.org/10.1002/wcc.240.
721 Rabe-Hesketh, S., Skrondal, A., 2008. Multilevel and longitudinal modeling using Stata. STATA press.
722 Revilla Diez, J., 2016. Vietnam 30 years after Doi Moi: achievements and challenges. Zeitschrift für
723 Wirtschaftsgeographie 60, 121–133. https://doi.org/10.1515/zfw-2016-0035.
724 Schaer, C., 2018. Editorial: Private-sector action in adaptation: Perspectives on the role of micro,
725 small and medium size enterprises, in: Schaer, C., Kuruppu, N. (Ed.), Private-sector action in

adaptation: Perspectives on the role of micro, small and medium size enterprises. Copenhagen, pp. 7–17.
Schaer, C., Dale, T.W., Dorkenoo, K.E.J., 2019. Climate change adaptation and smaller businesses in the Global South: defining roles, limitations, and touch points for positive interventions for MSMEs situated indeveloping countrues. https://backend.orbit.dtu.dk/ws/portalfiles/portal/195281065/Climate_change_adaptation_and_smaller_businesses_in_the_Global_South_WEB.pdf (accessed 10 June 2020).
Scussolini, P., Tran, T.V.T., Koks, E., Diaz-Loaiza, A., Ho, P.L., Lasage, R., 2017. Adaptation to Sea Level Rise: A Multidisciplinary Analysis for Ho Chi Minh City, Vietnam. Water Resources Research 53, 10841–10857. https://doi.org/10.1002/2017WR021344.
Sohns, F., Revilla Diez, J., 2018. Explaining micro entrepreneurship in rural Vietnam—a multilevel analysis. Small Business Economics 50, 219–237. https://doi.org/10.1007/s11187-017-9886-2.
Surminski, S., Hankinson, J., 2018. MSMEs, climate change risks and insurance: reflections on the use of insurance for climate adaptation, in: Schaer, C., Kuruppu, N. (Ed.), Private-sector action in adaptation: Perspectives on the role of micro, small and medium size enterprises. Copenhagen, pp. 65–77.
Trinh, P.T.T., Thanh, N.D., 2017. Development Characteristics of SME Sector in Vietnam: Evidence from the Vietnam Enterprise Census 2006-2015. VEPR [Viet Nam Institute for Economic and Policy Research, supported by the Friedrich Naumann Foundation for Freedom], Working Paper WP-18, Hanoi, Vietnam, 50 pp.
UNDP, 2019. Landscape Assessment Report on Private Sector's Engagement in Disaster Management in Vietnam, 64 pp.
UNDRR, 2020. Reducing Risk & Building Resilience of SMEs to Disasters.
Verrest, H., Groennebaek, L., Ghiselli, A., Berganton, M., 2020. Keeping the business going: SMEs and urban floods in Asian megacities. International Development Planning Review 42, 241–261. https://doi.org/10.3828/idpr.2020.3.
Wedawatta, G., Ingirige, B., 2012. Resilience and adaptation of small and medium-sized enterprises to flood risk. Disaster Prevention and Management: An International Journal 21, 474–488. https://doi.org/10.1108/09653561211256170.
Wedawatta, G., Ingirige, B., Proverbs, D., 2014. Small businesses and flood impacts: The case of the 2009 flood event in Cockermouth. Journal of Flood Risk Management 7, 42–53. https://doi.org/10.1111/jfr3.12031.
World Bank, 2019. Vietnam: Towards a Safe, Clean, and Resilient Water System, Washington, DC, 190 pp.