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Socio-economic conditions and small business vulnerability to climate change impacts in Hong Kong

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Abstract

Small and micro businesses bear the brunt of climate change impacts in the climate-challenged economy. Vulnerability is embedded into the socio-economic trajectories of their primary decision-makers. Multiple vulnerabilities may arise if the decision-makers' socio-economic conditions are associated with climate-sensitive business characteristics. Previous research has provided little evidence on such linkages, thus losing insights into how different facets of vulnerability interact and evolve over time. This paper explores the interactions between elements of small business vulnerability and the socio-economic characteristics of their primary decision-makers. It draws on the results of a survey involving 116 owner-managers of small and micro businesses and in-depth interviews with a sub-sample. Study areas are three remote coastal communities in Hong Kong exposed to high floods. Results show that such interactions exist in multiple, non-linear ways. Socio-economic disadvantages (i.e. low education attainment, old age, low income, and female) are related to some aspects of small business vulnerability, while playing a role in mitigating or avoiding other aspects of it. The findings call for building frameworks that account for the multiple spheres in which vulnerabilities are engendered and their interactions, while allowing for complexities and feedback mechanisms.

Keywords: small business; vulnerability; climate change; flooding; adaptation; China

1. Introduction

Vulnerability is the propensity or disposition to be adversely affected. Various sources of vulnerability exist at individual and collective levels and interact with each other (Adger, 1999). The present study aims to examine one particular form of interactions, focusing on small and micro businesses and their owner-managers, which have received relatively less attention in climate change adaptation research, despite their economic and social importance (Schaer & Kuruppu, 2018).

Vulnerability can be defined in terms of a system's exposure, sensitivity and adaptive capacity (Burkett et al., 2014). Adger (2006) provides greater depth by describing vulnerability as the state of susceptibility to harmful impacts from exposure to stresses associated with a change and from the absence of capacity to adapt to that change. The scholarship has illuminated various pathways by which vulnerability arises from social and economic disadvantages, leading to normatively 'charged' concepts that explicitly recognise livelihood and entitlement conditions (Adger, 2006; Ford et al., 2006; Nelson et al., 2007; Pelling, 2011). O'Brien et al. (2007, p. 76) synthesise these perspectives and argue that vulnerability can be 'contextual' to the extent in which "climate variability and change are considered to occur in the context of political, institutional, economic and social structures and changes". Pre-existing conditions, such as power relations and social inequalities, are emphasised.

This contextual turn comes with a considerable emphasis on actors and their response to change (Miller et al., 2010). While mainstream analyses have accounted for the institutions and organisations on which people's livelihoods and entitlements depend (Adger, 2000; Adger et al., 2016; Agrawal & Perrin, 2009; Goulden et al., 2013; He et al., 2018; Lo et al., 2016a; Pelling & High, 2005), little work has been done to ascertain how pre-existing individual-level conditions are linked with vulnerabilities at another level, such as firm-level. The question at stake, therefore, is how the characteristics and capabilities of key decision-makers shape, or contextualise, the firm-level vulnerabilities.

Some recent studies have come close to addressing such a question (Biggs, 2011; Biggs et al., 2012; Graveline & Gremont, 2017; Howe, 2011; Marks & Thomalla, 2017; Marshall et al., 2015; Marshall, 2011; Marshall et al., 2012; Marshall et al., 2013). They focus on smaller businesses that are particularly vulnerable to climate change and extreme weather, due to their

high exposure to climate risks and limited capacities to cope and adapt. However, none of them has specifically investigated the linkages between business vulnerabilities and those of their primary decision-makers in the context of climate change and extreme weather.

Exploring such linkages could indicate the areas in which different facets of vulnerability interact and evolve over time, creating double or multiple vulnerabilities. As Marshall et al. (2015) have shown, for example, women-owned businesses were more likely to meet demise following Hurricane Katrina, due to their social roles as caregivers and their lack of mobility and access to capital as business owners. The shared roles compromised their social and economic resilience to extreme weather events. The vulnerability of individual operators of family or community business is often embedded into the wider social or cultural context that shapes the rules or norms of business operation in the local area, which might strengthen or reduce their capacity to adapt to climate change (Parsons et al., 2018).

The coupling of socio-economic and small business vulnerabilities can also be seen as a form of contextualisation. The structural conditions of one sub-system (e.g. community or family business) are likely to be associated with another one (e.g. household). The notion of coupling constitutes a conceptual lens through which we can see more clearly how wider contextual conditions and processes (e.g. globalisation, recessions) exacerbate (or mitigate) the vulnerabilities of individuals through the downstream economic activities and processes with which they engage. The interactions between different spheres in which vulnerabilities are engendered (Figure 1) could indicate where contextual vulnerabilities are more likely to arise, diffusing from one level to another. The present research aims to examine such interactions and in what directions they fare.

Small and micro businesses stand at the margins of the climate-challenged economy. Being small in size means they lack resources and capacities for preparing for, and coping with, the impacts of climate change (Biggs et al., 2012; Hall, 2006; Reynolds, 2013). As Howe (2011) suggests, more research is needed to understand how they become vulnerable and how they respond to these impacts. Marshall et al. (2015) and Graveline and Gremont (2017) have pointed out that previous studies have largely overlooked the importance of business owners' characteristics. The present study seeks to advance a nuanced perspective along this line that is articulated in terms of the socio-economic characteristics of individual owner-managers. The

objective is to explore the systematic relationships between business characteristics that have bearing for resilience and those of the individual decision-makers.

This paper presents an analysis of business vulnerability against the socio-economic characteristics of their owner-managers. The research is based on a survey of 116 community businesses located in three remote coastal communities in Hong Kong, China. The next section offers a review of literature on business vulnerability and adaptation to climate change, focusing on the smaller enterprises. We then introduce the study area and research methods. Results are presented and discussed in the following sections. In the concluding section, we reflect on the findings in relation to existing studies.

2. A review of literature

Businesses are the primary socio-economic units within which processes of climate change adaptation take place (Averchenkova et al., 2016; Crick et al., 2018b; Linnenluecke & Griffiths, 2015). They play an important role in community functioning by providing goods and services, employment opportunities, and taxes. However, business and economy were not featured in the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports prior to 2014. The Working Group II of the Fifth Assessment Report was the first one to create a chapter on 'Key Economic Sectors and Services' (Arent et al., 2014). Berkhout et al. (2006) were among the first ones to develop a framework for understanding business adaptation, followed by a series of studies by Linnenluecke et al. (2011, 2012, 2013). These studies put emphasis on the larger firms, such as ski resort operators, property developers, and utilities (Hales et al., 2016; Hopkins, 2014; Linnenluecke et al., 2011). The internal drivers of adaptation are usually articulated in terms of organizational characteristics, such as foreign ownership, expert orientation, and financial performance (Averchenkova et al., 2016).

However, smaller businesses bear the brunt of climate change impacts. Writing for industry clients and stakeholders, Reynolds (2013, p. 3) suggests that "lacking access to the capital and resources of large corporations, small businesses can suffer lasting economic damage as a result of a single extreme weather event". They typically have relatively lower profits and smaller cash reserves, and are less likely to have backup resources at alternative facilities or branch locations. They are more likely to be located in non-engineered buildings,

depend on neighbourhood customers, and lack the capacity to design and implement hazard management programmes (Zhang et al., 2009). These make small businesses more susceptible to mechanical breakdowns, absence of employees, interruptions of lifeline services and supplies, telecommunications failures, property damage, and rising insurance costs as a result of extreme weather events, such as floods, storm surge, cyclones or hurricanes, and wildfires (Crick et al., 2018b; Howe, 2011; Marks & Thomalla, 2017; Reynolds, 2013). Smaller businesses are driven to respond to climate change primarily due to their higher vulnerability to its impacts.

Attempts have recently been made to ascertain what contribute to the vulnerability of small businesses to climate-related hazards and their adaptation strategies. For example, Crick et al. (2018a) have found that sustainable adaptation responses are a function of general business support, access to information technology and adaptation assistance. Marks and Thomalla (2017) have argued that the vulnerability of these businesses is related to local socio-economic development. The notion of coupled vulnerability is embedded into the current scholarly debates, but not clearly elaborated. For instance, Howe (2011) surveyed 231 community businesses in Florida exposed to hurricane risks and explained their adaptive capacity in terms of a suite of business characteristics, such as business age and women ownership, among other factors. Yet, Howe (2011) did not go further by examining other socio-economic characteristics of small business owners or discussing their possible linkages with climate-sensitive business characteristics.

Graveline and Gremont (2017) develop a model for understanding the economic resilience of micro-businesses to natural disaster in French West Indies, which includes a basic typology of vulnerability. Their model portrays vulnerability as a function of physical exposure to risks, functional sensitivity, and socio-economic traits. The last one of these pertains to the intrinsic socio-economic characteristics and abilities of individuals who run the business, such as age and level of education (Graveline and Gremont, 2017, p. 528). Like Howe (2011), however, Graveline and Gremont's (2017) empirical analysis actually did not involve socio-economic traits. Whether or not such intrinsic individual characteristics reinforce or mitigate other facets of vulnerability remains unaddressed.

Drawing upon the 'Sustainable Family Business Model' (Danes et al., 2008; Stafford et al., 1999), Maria Marshall et al. (2015) stress that small business resilience to natural disaster depends on both business and family characteristics. Their regression models for predicting

business resilience to Hurricane Katrina included a much wider range of owners' characteristics, such as marriage status, education level, ethnicity, and household size. Households and businesses could exchange resources such as labour and finances, implying that business vulnerability can be a function of the size, composition, and financial capacity of the household. Despite highlighting the importance of household conditions, Marshall et al.'s (2015) empirical analysis failed to explicitly account for the interactions between owners' and business characteristics.

The implicit assumption that owners' and business characteristics are independent on each other is also evidenced in the studies of Biggs and others (Biggs, 2011; Biggs et al., 2012) and Nadine Marshall et al. (2012, 2013). Biggs solicited the stated responses of small enterprises in the coral reef industry in Australia and Thailand in the event of a systemic shock (Biggs, 2011; Biggs et al., 2012), whereas Marshall et al. (2012, 2013) focus on those from resource-dependent industries, including peanut producers and commercial fishers in Australia. Despite their different analytical strategies, these studies have included some household characteristics into analysis. Marshall et al. (2013), for instance, used respondent's age as an indicator of employability, which can also represent one's economic disadvantages if leaving the industry becomes the only option due to climate-induced changes. Biggs et al. (2012) put social capital attributes into their regression models, and found that informal businesses with more support from family, friends, and their community stated higher levels of resilience. Parsons et al. (2018) report a similar observation from a survey of tourism operators in Samoa.

There is a missing link in the methodological approaches adopted by these researchers. In the small business literature, vulnerability to climate-related hazards is considered to be intimately related to business approach and operational routines (Pathak & Ahmad, 2016; Wedawatta & Ingirige, 2012; Zhang et al., 2009). It is a common knowledge that the characteristics of individual decision-makers can influence the ways in which they run their businesses and, more specifically, respond to the actual or anticipated impacts of climate change and extreme weather. This implies that business vulnerability to these impacts is subject to the structural conditions and challenges experienced by individual decision-makers. Socio-economic characteristics do not only determine personal outcomes, but also those of the business they run and their employees, neighbourhood, and ultimately the local economy. Different sources of vulnerability might reinforce or mitigate each other. However, previous

studies provide little evidence on the relationship between these characteristics and the attributes of small business vulnerability.

A major flooding event could damage one's home as well as their business properties. Decision-makers of small businesses are exposed to multiple sources of miseries arising from climate change and extreme weather, and these multi-dimensional stressors may be interrelated. Evidence on their relationships could be an indication of under-estimation (or over-estimation) of the level of vulnerability. The study described below attempted to solicit such evidence.

3. Study area

The effects of climate change have already emerged in Hong Kong, with the frequency of extreme rainfall events and the threat of storm surges associated with tropical cyclones expected to increase (Environment Bureau, 2015). The present study was conducted in three rural coastal communities that will experience the greatest impacts, namely, Tai O, Cheung Chau, and Peng Chau.

Tai O is a traditional maritime village with a relatively small population (3,283 in 2016) (Census and Statistics Department, 2017a). Standing at the southwestern end of Hong Kong waters (Figure 2), it is far away from, and poorly connected with, urban centres. Mostly shouldering on hilly terrains, the main roads between Tai O and Tung Chung (regional town centre) are steep, winding and tight. Road conditions prohibit vehicular traffic in the event of extreme weather, such as rainstorms, which may cause landslides and reduce visibility. Ferries run on loose schedule, and they are suspended when higher typhoon signals come into effect.

Tourism is the main driver of the Tai O economy. The attraction of the village includes a variety of ecologically sensitive habitats, the fishing village ambience, the iconic stilt houses (Figure 3a), and a collection of vernacular architectures and graded historic buildings. Main streets are tight and full of shops selling traditional salted seafood, souvenir, and snack (Dryland & Syed, 2010) (Figure 3b and 3c). Many of them are located in proximity to the sea and the Tai O creek, which bring floodwaters when typhoons and high tides come at the same time.

Tai O is a low-lying area located on alluvium and marine deposits (Chan et al., 2013). Typhoons and intense rainfalls resulted in two extreme storm surge events in 2008 and 2017. Typhoon Hagupit swept the village on 23 September 2008. Residents witnessed a seawater overflow of more than 1.3m, which lasted from midnight to early morning. More than 200 premises were cut off electricity supply, and many residents recorded significant damage on properties (Environment Bureau, 2015). The remote location also made recovery a challenging task. Rising by 4.91 m above Mean Sea Level (MSL), the 2008 storm surge was believed to be a 1-in-50-year event (Woo & Wong, 2010). The second extreme weather event came with Typhoon Hato. On 23 August 2017, Hong Kong raised its tropical cyclone signal to the highest category. The profound tropical cyclone brought severe storm surge and record-high sea levels to the coast of Pearl River estuary, where the Tai O village is situated. The storm surge rose to 3.8m above MSL (Lai, 2017) (Figure 3d). More than 60 shops were severely affected by floods. Their inventories, fridges, and other properties and equipment essential to business operation were inundated, forcing them to shut down (Next Magazine, 2017).

Our research was also undertaken in two island communities sitting to the east of Lantau Island (Figure 2). Cheung Chau and Peng Chau are home to 20,956 and 5,480 people respectively (Census and Statistics Department, 2017a). Like Tai O, in recent decades the two outlying islands have turned themselves into major destinations for nature-based and cultural tourism. With a combination of sandy beaches, B&Bs, cultural heritage, shops, and seafood restaurants, Cheung Chau offers a greater variety of tourist attractions. Peng Chau is smaller in land area, but known for its natural landscape and vintage buildings dating back to mid-20th century.

The island communities are susceptible to tropical cyclones in the region. Regular ferry services, the only public transport option connecting the two islands with the rest of Hong Kong, are suspended during extreme weather. Also, the central part of Cheung Chau, where most houses, shops, and beaches are located, is a low strip of land along the coastline, exposing itself to storm surge. Huge waves induced by Typhoon Hagupit damaged an embankment in front of a row of houses in Cheung Chau, forcing more than 100 residents to evacuate. With a similar geography, the low-lying Peng Chau also experienced severe coastal flooding when Hagupit battered Hong Kong in 2008. Property damage and business disruption are expected to intensify as climatic changes accelerate.

These rural communities have a larger aged population than the rest of Hong Kong (Table 1). Particularly in Tai O, more than one quarter of its population is 70 or older, far exceeding the proportion of Hong Kong population in this age category (i.e. 10.5 per cent). There are slightly more people in these communities than the rest of Hong Kong with a monthly income below HK\$15,000 (approx. US\$1,900). A relatively high proportion of residents have received basic education only (primary or below), ranging from 28 percent in Peng Chau to 39.8 per cent in Tai O. Those in the 'No schooling/ Pre-primary' category (ranging from 10.3 per cent to 15.4 per cent) more than double that of Hong Kong (4.8 per cent).

We selected Tai O, Cheung Chau, and Peng Chau as study areas, because of their large proportion of tourism-oriented small businesses, remote locations, exposure to high risks of coastal flooding, and distinctive demographic profiles. Tai O warrants more attention than the other two sites. It is a major tourist spot to be expanded under the Sustainable Lantau Blueprint (Development Bureau, 2017), takes longer time to reach from urban centres (more isolated), a climate change 'hotspot' marked by the Environment Bureau (2015), and clearly stand out from the rest of Hong Kong demographically. The next sub-section describes the ways in which fieldwork was conducted.

4. Methods

4.1 Data collection

For this study we interviewed a number of individuals running a small or micro business in the three study areas. In Hong Kong, a non-manufacturing small and medium-sized enterprise (SME) is any business that employs fewer than 50 persons, whereas micro-enterprises are those that employ fewer than 10 persons (So, 2012). In 2017, there are 354,686 non-manufacturing SMEs in Hong Kong (98 per cent of total), of which 317,462 establishments employ less than 10 persons (88 per cent of total) (Census and Statistics Department, 2017b). All of those involved in the present study have less than 20 staff members.

A face-to-face survey was administered in the study areas during the second half of 2016. All respondents were owner-managers of local businesses serving tourists as well as local residents. There are approximately 130-140 small and micro businesses in Tai O. Given the small

size of business population, our research assistants attempted to reach out to all of them and invited those that were open for business to participate in a short interview based on a structured questionnaire. We visited 113 shops and managed to get 75 owner-managers to complete the questionnaire. There was a maximum of one interview per establishment, lasting for 20 minutes each on average. The same approach was used in Cheung Chau and Peng Chau. We made 70 requests and successfully collected 41 sets of response. The final sample size is 116.

More than half of the businesses surveyed offered food - dried seafood, snack, and meals (see details in Section 5). Some of them are very small and informal, involving only one or two people and not operating on regular hours. Many potential respondents had participated in our earlier study (Liu et al., 2017; Liu & Cheung, 2016)¹ and are well known by one of us, making access easier. Non-respondents included those who did not have time, were not interested in the research, or were not present on the day of visit.

The study also involved semi-structured interviews. Being a climate change 'hotspot' and a popular tourist site, Tai O has come under spotlight in recent years, thanks for the two major flooding events in 2008 and 2017, and the Government's controversial attempt to further develop Lantau Island. Given the importance of Tai O, we returned to the site in January and December 2017 to conduct further investigations. Through personal contacts, we identified twelve business owner-managers for the interviews during daytime. Selection was based on business type, respondents' demographics, their flooding experience, and opportunity. The goal was to achieve a sample of owner-managers at different life stages and with diverse experiences. Duration of interview ranged from 20 minutes to one hour. These interviews were guided by a list of open-ended questions, and nine of them were recorded and transcribed. Questions related to the actions taken in response to flooding were extracted for analysis.

4.2 Measurement

A structured questionnaire was used as the main instrument of research. Close-ended questions related to business vulnerability and socio-economic characteristics of respondents were

¹ The earlier study was about sustainable tourism development and sense of place, and did not involve anything about extreme weather and business vulnerability. The participants responded to a different questionnaire from the one upon which the present study is based.

extracted for analysis. In designing the questionnaire, we adopted Zhang et al.'s (2009) model of business vulnerability to environmental disasters.

According to Zhang et al. (2009), business vulnerability has four dimensions, namely, capital, labour, supplier, and customer. Capital vulnerability is articulated in terms of several key factors, such as capital mobility, capital ownership, and business size (as a proxy for capacity to cope and adapt). Labour vulnerability encompasses the ease of employee replacement and flexibility of labour organisation. Supplier vulnerability is represented by lifeline infrastructure dependence and inter-business dependence. Customer vulnerability consists of market diversification and reconstruction relevance (business type).

In our study, business vulnerability was measured in terms broadly consistent with Zhang et al.'s (2009) model. The information gathered included the proportion of goods and inventories that are immobile, number of full-time employees, access to substitute labour, operation duration without lifeline services and supplies, proportion of their customers being local residents, each representing a key factor in the four-dimension vulnerability model. Respondents were requested to assess these items based on their own experience or knowledge. For most of these items, a three- or four-point ordinal scale was used in analysis (Table 3). Other items are presented on a binary scale (see Appendix for the survey questions and response formats).

A few modifications were made to account for local situations and reduce complexity. Capital ownership could be very difficult to estimate due to its broad coverage, particularly for our older respondents. Instead, we focused on one important form of capital, i.e. business premise. We measured the proportion of operating income used for renting the current business premise. The use of this indicator is consistent with the rationale behind Zhang et al.'s (2009) attempt to measure capital ownership, i.e. leased capital (including buildings) bears interest and would create additional financial burdens to business owners during economically difficult times.

Indicators of reconstruction relevance were not included in our analysis. Reconstruction-relevant businesses, such as construction and building materials, are deemed to be less vulnerable as it can offer products or services that are needed for post-disaster reconstruction. However, there are only a handful of reconstruction-relevant businesses in the

study areas, rendering this indicator hard to operationalise. Instead of identifying which businesses would benefit, we identified those that are more likely to fall victim of major flooding events. Relatively more capital-intensive businesses, such as restaurants, bakery, repairing and maintenance, have more or larger mechanical or electrical equipment on site and are therefore more likely to suffer from functional breakdowns and record greater physical damage than others when floodwater flows in. We measured capital intensity in terms of business type. A dummy variable was created, which was coded '1' for capital-intensive businesses, and '0' for the otherwise.

An additional measure of market diversification was included to represent customer vulnerability. Businesses operating in multiple locations are less vulnerable to localised flooding. We assigned '1' to those respondents running branches or other businesses outside the study area (Tai O, Cheung Chau, or Peng Chau), and '0' to the others. The expected effects of these factors on vulnerability are shown in Table 3. Consistent with Zhang et al.'s (2009) interpretation, we consider factors such as low capital mobility, high capital intensity, and high proportion of local customers to be contributing to the vulnerability of small and micro businesses to extreme weather. Other factors are believed to be conducive to resilience.

To guide our analysis, we hypothesised a positive relationship between the magnitude of vulnerability and socio-economic disadvantages. This is based on a simple presumption that vulnerable factors often come with these disadvantages. Socio-economic disadvantages were measured in terms of four key personal characteristics, namely, age, sex, income, and education level. The information gathered was coded into four socio-economic variables that represent the hypothesised disadvantages. The age variable, for example, was coded as '1' for those aged 70 or older. In Hong Kong, the age of 70 makes local residents eligible for the Higher Old Age Allowance, a form of non-accountable welfare pension offered by the Hong Kong Government. The income variable was given a value of '1' if the respondent's monthly income from main employment falls below HK\$15,000. The cut-off level was determined by the estimate of median income across Hong Kong, which was HK\$15,500 in 2016 (Census and Statistics Department, 2017a). Regarding education, the highest qualification being primary or below was coded as '1'. It is considered as a source of disadvantage, because Hong Kong is a predominantly knowledge-based economy where the great majority of people (80 per cent) are educated to the secondary level or higher, whereas the rest are much less competitive, receiving a (median)

monthly income of HK\$10,000 or less (Census and Statistics Department, 2017a). Females are also coded as '1', as the traditional communities in Hong Kong, including Tai O, are characterised by gender inequality (Chan, 2008).

5. Findings

5.1 Descriptive statistics

Our sample consists of 116 owner-managers of small, community businesses in Tai O, Cheung Chau, and Peng Chau. Over 40 per cent of them are beyond or close to their retirement age (60 years old or older) (Table 2). About one-fifth (20.7 per cent) are 70 or above. A larger proportion of them (57.2 per cent) are females. Income levels are normally distributed, but skewed towards the lower ends. Over 60 per cent of respondents receive fewer than HK\$15,000 per month from main employment. More than 40 per cent of them have received basic education only (primary or lower), much higher the citywide estimate (as shown in Table 1 above).

Retailers dominate the three rural economies. More than half of respondents would identify themselves as a retailer, selling dried food or seafood (17.2 per cent), snacks (15.5 per cent), grocery (12.9 per cent), souvenirs (6.9 per cent), and others (Table 4). About one-fourth of the small businesses surveyed can be seen as relatively more capital intensive, such as the ordinary, mixed-style restaurants (10.3 per cent), those offering gas, repairing and engineering services (6 per cent), cafés (2.6 per cent), providers of tourist boats or water sports (1.7 per cent), traditional Chinese restaurant (1.7 per cent) and bakeries (1.7 per cent).

The vulnerability scale has shown some degree of variations. Survey results indicate that 37.9 per cent of respondents have more than 75 per cent of their business inventories and assets locked in space, i.e. low mobility, and therefore at risk of inundation during extreme weather events. The majority of them have no more than two full-time employees, and nearly half rely mainly on part-time workers, yielding an average value of 0.69. In most cases (94.3 per cent), rental expenses account for less than 50 per cent of operating income, because of the low levels of rent in these remote communities and full ownership of property. About 26.7 per cent fall into the capital intensive category.

To small and micro businesses, labour is a key limiting factor. Seventy-two per cent of respondents indicated that they have difficulties in replacing labour when needs arise. Operation is likely to be suspended if utilities (80.2 per cent) and supplies (58.6 per cent) are cut off during extreme weather events, reflecting the lack of back-up resources in store. The three rural communities are oriented to tourism. Thus, as much as 61.2 per cent of respondents indicated that fewer than 50 per cent of their customers are local residents, meaning that more than half come from outside. A small number of respondents (6 per cent) run a branch or other business in another location.

5.2 Probit regression

The main analysis was based on probit regression. Table 5 shows how age and sex are related to the vulnerability variables. Small businesses run by older residents have a higher proportion of customers being local residents (i.e. living in Tai O, Cheung Chau, or Peng Chau) and are less likely to be capital intensive. Female owner-managers have a lower proportion of customers being local residents and are less likely to operate other branches or businesses outside the study area.

Table 6 shows how education level and income are related to the vulnerability variables. Education has significant impacts on many of these variables. Small businesses run by less educated residents could operate longer if supplies are cut off. However, they have fewer full-time employees, have a higher proportion of customers being local residents and are less likely to operate if water and power are cut off. Income effects are limited to labour replacement. The worse-off business owner-managers have greater difficulties in finding replacement.

These results suggest that socio-economic characteristics interact with some elements of business vulnerability. The effects of age, sex, and income are limited to a few vulnerability variables. In general, businesses run by those who are disadvantaged in these terms are likely to be more vulnerable to extreme weather events. However, the older ones tend to avoid operating a business that requires more perishable supplies and investments, such as a restaurant or café. Moreover, females have a more diverse customer base, both conducive to resilience.

Representing human capital, education is found to be an important factor with mixed effects. The lower education level is linked with lower market diversity, suggesting such a disadvantage might contribute to customer vulnerability. It is also linked with small business size, i.e. most of the less educated residents run micro-businesses, which typically have reduced capacity to cope with extreme weather. Nevertheless, small scales could keep some vulnerability factors at bay. Many of the less educated, especially the older ones, own their business property (either by inheritance or purchase) and are driven by lifestyle motivations (Liu and Cheung, 2016). Their livelihoods do not depend on operating income, thus reducing financial risks arising from business interruption. Lower education attainment is also associated with longer operation hours during supply interruptions. Some of these contrasting findings are substantiated by our interviews with selected individuals from Tai O.

5.3 Semi-structured interviews

At the beginning of this paper, we argue that socio-economic disadvantages and some elements of business vulnerability follow each other. Our further investigation reveals more complexities than expected. There are some tendencies and mechanisms by which own-managers with certain socio-economic characteristics could reduce the risks to which they are exposed or the damage on their livelihoods.

Consistent with our main argument, we find that human capital is crucial for making a business more climate-resilient. Two of the younger interviewees had received tertiary education (Table 7). One of them (M05) runs a pharmacy practice. His goods and inventories were inundated during the 2008 flooding event. Since then, a strengthened sense of protection has been developed among. The owner-manager would actively seek updated information from the HKO whenever a typhoon approached the region, one thing that he learnt from the 2008 event. Three other younger and relatively more educated interviewees also expressed a strengthened sense of protection and have actually installed flood walls at the front gates (M02, F03, F04).

Many local restaurants and cafés were hit hard by Typhoon Hagupit. Our survey sample includes 17 individuals operating a restaurant or café, and 13 of them were educated to the secondary level or higher, i.e. higher proportion than the sample. One of them (M04) owns a

well-crafted café and experienced significant losses during the 2008 flooding event. A relatively more educated and well-travelled local resident in his 50s, he was aware of rapidly rising flood levels in the town when the powerful typhoon arrived and began to move inventories and cookware to higher positions in the mid-night – earlier than most other Tai O residents did. The prompt action was driven by his good knowledge in typhoons, flooding, and global climate change. The owner-manager has adopted functional adjustments to mitigate future flood risks, such as installing flood walls and actively seeking official weather information. Moreover, the café presented an image of sustainable lifestyle and targeted international tourists, indicating an external market orientation that could mitigate customer vulnerability.

Smaller shops had fewer hands to deal with high floods and the aftermath. A Tai O veteran in his early 90s, who runs a grocery store off the creek, described the 2008 flooding event as one of worst ones in his lifetime. He managed to save some of his inventories, but failed to keep key fixed assets from inundation. The same flooding event hit another small retailer, who was also in her 90s. The losses were limited to a small range of inventories, but she expressed a feeling of hopelessness during the worst hours of Typhoon Hagupit:

Two boxes of newly bought incense were inundated. All gone. One over another. All flooded. I was watching the floodwaters pouring in, but could do nothing. Hopeless.
(F01)

A similar sense of hopelessness was also expressed by another interviewee, who was in his 80s and operated a grocery store. Despite being shocked by the 2008 event, he did not express a concern about equally devastating events in the near future.

Nevertheless, smaller shops had fewer to lose. Many of their owner-managers were retirees who have limited skills and energy to manage a larger business, such as a restaurant. They tended to (or had to) keep their businesses small and flexible, and did not consider expansion or further investment. These shops had fewer machines and perishable inventories than their more capital-intensive counterparts. Debts and labour costs are kept at a minimum. Many of them were located away from the main streets, which typically attract higher rents and are more prone to flooding than inner areas. Moreover, we found that many older interviewees have strong social bonding with neighbours and other villagers, as they have been around for decades and are more sympathetic toward the traditional, collective social routines than the

younger ones. The networks on which their social life depends were crucial for coping with extreme weather. When asked if they helped each other in the event of high floods, an owner-manager at her retirement age said:

Yes, we called each other. As soon as we had our problems fixed, we came to help others. The neighbourly relationship here in Tai O is very good. We won't leave others alone. We always help those in need. (F02)

Despite their age and associated disadvantages, the older owner-managers were not financially fragile as their livelihoods did not depend on their business incomes, thus reducing their actual vulnerability. While this group of people were well prepared to live with floods, they held a rather loose attitude toward their businesses that threatens to reduce their motivation to think forward and prepare for the odds. As one of them indicated:

[the business] is inherited from my father. I keep it running but slow. I am getting old and don't need to fight for a living. Very casual It just gives me something to do, but I don't expect my children to take it over. (M02)

Tai O hosts a small community of lifestyle businesses run by those who seek a peace of mind from living in the rather isolated community and sharing their homemade products and aspirations with other like-minded tourists and residents. We interviewed the owner of one of these lifestyle businesses specializing in easy-to-make, traditional food products (F05), and found that there was no very strong concern about future floods in the community. The owner, who was in her mid-60s, sold a property to set up a snack shop five years ago, but makes no net profits from it, suggesting that it is not a subsistence business. Unlike these retiring decision-makers, the younger interviewees mentioned above and their employees have made greater efforts in enhancing resilience to floods in order to control the economic risks emanating from extreme weather.

Life stages affect the capacity and willingness of business decision makers to make efforts in coping and adapting to extreme weather. Socio-economic characteristics determine vulnerability in different ways, and they may demonstrate a non-linear relationship with each other. Although those owner-managers who have more energy, a broader skillset and better knowledge have higher capacity to cope and adapt, those who do not have these advantages tend to adopt a business approach or social practice that can reduce part of their vulnerability.

This is not suggesting that the latter are more climate-resilient - in fact, business resilience may be less important to them than we might assume.

6. Conclusions

This study aimed at exploring the interactions between elements of small business vulnerability and some of its internal drivers, such as the socio-economic characteristics of business decision-makers, which lack evidence from existing studies on disaster risk reduction and adaptation to climate change impacts by small or community businesses (Howe, 2011; Biggs et al., 2012; Graveline and Gremont 2017; Marshall et al., 2015; Marks and Thomalla, 2017). We surveyed a total of 116 owner-managers of small and micro businesses in three remote coastal communities in Hong Kong that are exposed to escalating flood risks and conducted in-depth interviews with a sub-sample.

Our findings contribute to knowledge by showing that such interactions exist in multiple, non-linear ways. Some elements of small business vulnerability, such as business size, capital intensity, and market diversity (customer base), warrant more consideration than others. There are systematic interactions between these elements and socio-economic disadvantages, such as lower educational attainment, older age, and being a female in a traditional community. Our study has provided some evidence supporting the general expectation that these disadvantages engender other vulnerabilities and could make certain aspects of small business operation susceptible to the impacts of climate change and extreme weather.

The younger and more educated business decision makers, for example, have a wider customer base, which is less prone to changes in local economic conditions. The less educated ones tend to run smaller businesses with fewer hands to cope with, and recover from, weather extremes. Pre-existing socio-economic conditions constitute a context in which vulnerabilities beyond the individual or household level accumulate (Adger, 1999; Lo & Cheung, 2015; Lo et al., 2016b; O'Brien et al., 2007; Schaer & Kuruppu, 2018). The evidence supports the views of Marshall et al. (2015) and Graveline and Gremont (2017) that business owners' characteristics are important for understanding micro-economic resilience. It also strengthens the case for examining the coupling of vulnerability to climate change impacts across multiple levels.

Nevertheless, a closer look at Tai O has shown negative feedback mechanisms at work. The older and less educated residents have a narrower set of business skills and their energy is declining, and therefore they tend to keep their family businesses small and flexible. The smaller businesses need fewer goods and assets to set up, and have fewer to lose during extreme weather events. As property owners and pensioners, these people could absorb a modest amount of losses arising from prolonged business interruptions, without incurring new financial burdens, and they do not primarily live on operating income. Biggs et al. (2012, p. 658) have offered similar explanations for the higher levels of expected resilience among informal businesses in Thailand, which benefited from their lower levels of capitalisation and lower requirements for a steady and continuous income flow relative to the formal ones. The lifestyle orientation and the flexibility of smaller, informal businesses are important considerations often overlooked in business adaptation research (Parsons et al., 2018).

In addition, the loose attitude toward their businesses also results in a sense of resilience to weather-driven shocks that prepares them to live with floods (Lo, 2013; Wong & Zhao, 2001). A caveat is that these characteristics can create mixed outcomes. For instance, smaller businesses have fewer hands to help in a crisis, and the lifestyle orientation could reduce motivation to take precautionary action. The latter finding echoes Parsons et al.'s (2018) view that lifestyles and worldviews underpin the adaptive capacity of small-scale tourism operators. Thus, we conclude that the interactions between the vulnerability of small businesses and the socio-economic characteristics of their primary decision-makers reveal more complexities than expected. Feedback effects occur in multiple directions. Socio-economic disadvantages are related to some aspects of small business vulnerability, while playing a role in mitigating or avoiding other aspects of it.

These findings call for dynamic perspectives on small business vulnerability and resilience to the impacts of climate change and extreme weather that account for the dual role of decision-makers in household and business. Many small and micro businesses in remote areas are managed by sole proprietors, who are also exposed to these impacts as ordinary residents. Apart from regulatory, economic, and organisational factors, small business vulnerability and resilience are subject to the socio-economic constraints confronting individual decision-makers and their lifestyle preferences. These constraints and preferences select the type of business and the ways in which it is operated, shaping the conditions for micro-

economic resilience as defined by Graveline and Gremont (2017). The overlapping of the personal and organisational spheres is often overlooked by the scholarship.

There is a need for building frameworks that account for the multiple spheres in which vulnerabilities are engendered and their interactions, while allowing for complexities and feedback mechanisms by which one source of vulnerability might contribute to mitigating another one. Moreover, there is a need for understanding more about service-based economies that are populated by small and micro businesses. Some of these businesses are found in a densely packed location exposed to the impacts of climate change and extreme weather that can create physical damage on property and cause business interruptions. They are typically less dependent on natural resources than those featured in widely discussed research reports (e.g. Marshall et al., 2012, 2013; Goulden et al., 2013; Lo and Cheung, 2016; Liu et al., 2018), and fewer efforts have been made to understand their vulnerability profile.

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