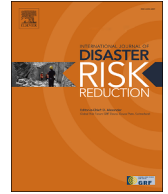


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## Business recovery from disasters: Lessons from natural hazards and the COVID-19 pandemic

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### ABSTRACT

This paper compares economic recovery in the COVID-19 pandemic with other types of disasters, at the scale of businesses. As countries around the world struggle to emerge from the pandemic, studies of business impact and recovery have proliferated; however, pandemic research is often undertaken without the benefit of insights from long-standing research on past large-scale disruptive events, such as floods, storms, and earthquakes. This paper builds synergies between established knowledge on business recovery in disasters and emerging insights from the COVID-19 pandemic. It first proposes a disaster event taxonomy that allows the pandemic to be compared with natural hazard events from the perspective of economic disruption. The paper then identifies five key lessons on business recovery from disasters and compares them to empirical findings from the COVID-19 pandemic. For synthesis, a conceptual framework on business recovery is developed to support policy-makers to anticipate business recovery needs in economically disruptive events, including disasters.

Findings from the pandemic largely resonate with those from disasters. Recovery tends to be more difficult for small businesses, those vulnerable to supply chain problems, those facing disrupted markets, and locally-oriented businesses in heavily impacted neighborhoods. Disaster assistance that is fast and less restrictive provides more effective support for business recovery. Some differences emerge, however: substantial business disruption in the pandemic derived from changes in demand due to regulatory measures as well as consumer behaviour; businesses in

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high-income neighborhoods and central business districts were especially affected; and traditional forms of financial assistance may need to be reconsidered.

## 1. Introduction

The COVID-19 pandemic has affected economies around the world. By some estimates, global economic activity in 2020 shrank by 3.2%, global trade fell by 5.3%, and U.S. gross domestic product (GDP) in 2020 declined by 3.4% compared with the previous year [1]. If both economic and human losses are assessed jointly using population health metrics such as disability-adjusted life years (DALYs), the impact of COVID-19 in 2020 alone far exceeds that of all epidemics and disasters from natural hazard events over the last 20 years [2].

As in floods, earthquakes, and other disasters, economic impacts and recovery in the pandemic have been decidedly uneven. Across the globe, some sectors, such as tourism, have been devastated, while others have largely managed to persist with minor adaptations. Some countries, sub-national regions, and cities have been economically shuttered for periods of time while others have avoided lengthy lockdowns. At the scale of businesses, some have failed, others remain in precarious situations, and some have felt little impact or even fared well during the pandemic.

Research on previous disasters has established that such unevenness derives not only from characteristics of the hazard itself, but also from underlying vulnerability conditions of the affected businesses. The impact and recovery experienced by a business derives from factors such as its ability to continue operating, the survival of its suppliers and customers, its pre-disaster financial health, and its ability to adapt to a changing environment – regardless of whether the initial shock was a flood, earthquake, or pandemic.

This paper argues that concepts and findings from prior research on business recovery in disasters can help to clarify impacts of the COVID-19 pandemic and support policy-making. (Note that in this paper, the term “disasters” is used rather than “natural disasters” in order to acknowledge that while the triggering event may be natural, the resulting disaster derives importantly from societal vulnerabilities and responses; further, the term “natural hazard” is used here to refer to geophysical, hydrometeorological, and similar events rather than pandemics, even though the latter have biological origins.) Many themes arising during the pandemic have been explored extensively in the disasters literature, but might not be well known outside the field. Lessons from prior disasters can help policy-makers appreciate hidden impacts, anticipate upcoming trends, and avoid repeating past mistakes. Conversely, studies of the pandemic can be utilized to re-examine, confirm, refine, and advance knowledge from the disasters literature. Yet, such empirical comparison between the pandemic and disasters arising from natural hazard events is hindered by the lack of comprehensive conceptual frameworks on how disruptive events affect business recovery.

This paper makes three key contributions toward this comparative objective. First, it proposes a taxonomy of events that cause economic disruption, clarifying the ways in which the pandemic resembles natural hazard events – and the ways in which it differs – in terms of implications for business impacts and recovery (Section 2). In contrast to typical natural hazard event classifications that emphasize physical event properties, this taxonomy focuses on relevance for economic disruption and business recovery. Second, the paper identifies a series of salient lessons from the literature on business recovery in disasters and re-examines them in light of studies on the COVID-19 pandemic (Section 3). The findings highlight similarities and differences between disasters and the pandemic, informing the development of a synthesis framework that comprehensively outlines factors influencing business recovery (Section 4). The paper concludes with recommendations for further research (Section 5).

This paper focuses on businesses as the unit of analysis, rather than entire sectors or economies, and examines published evidence on business recovery available in approximately the first two years of the pandemic. It further focuses on findings from high-income countries and draws on the empirical disasters literature from these economic settings. Economies around the world were affected, many especially severely in the global South; however, taking into consideration the important disparities in social, economic, and policy contexts was beyond the scope of this paper.

## 2. A taxonomy of economically disruptive events

### 2.1. Characterizing disasters as economically disruptive events

In order to consider the ways in which business recovery lessons from disasters may be relevant to the COVID-19 pandemic, it is useful to consider how the health crisis resembles and differs from natural hazard events, as well as from the national and global financial crises to which it has also been compared (e.g., Ref. [3,4]). Table 1 proposes a taxonomy of economically disruptive events from the perspective of business recovery. “Economically disruptive event” is defined broadly here to encompass any shock or stressor event that causes substantial economic impact, including for example hurricanes, pandemics, and financial crises. These events are described along two broad dimensions, their spatio-temporal profile and economic shock profile, each of which includes several characteristics. Table 1 outlines each characteristic in terms of possible types, illustrative examples, and relevance for business recovery. The latter may pertain to opportunities for business preparation prior to the disruption, to implications for business response and adaptations in the event, and/or to effects on the broader context in which businesses operate (e.g., government policy response or consumer demand).

In terms of spatio-temporal profile, onset speed is a standard characterization in the disasters literature, which distinguishes between sudden-onset events, such as earthquakes and slow-onset events that progressively increase in intensity over time, such as droughts (e.g., Refs. [5,6]). Sudden-onset events are sometimes associated with some advance warning. From the perspective of business recovery, these characteristics are relevant in their implications for the ability of businesses to prepare for the event, and the

**Table 1**  
Taxonomy of Disasters and Other Economically Disruptive Events (source: authors).

Characteristic	Type (examples)	Implication for business recovery
<b>SPATIO-TEMPORAL PROFILE</b>		
Onset speed	<ul style="list-style-type: none"> <li>• Sudden and rapid onset (earthquake, tsunami)</li> <li>• Sudden onset with advance warning (hurricane)</li> <li>• Gradual or slow onset (drought, fluvial flood)</li> </ul>	Quality of preparedness; availability of rapid assistance
Duration	<ul style="list-style-type: none"> <li>• Short (flash flood)</li> <li>• Medium (fluvial flood)</li> <li>• Long (multi-year drought)</li> </ul>	Business and government responses; ability to adapt
Recurrence	<ul style="list-style-type: none"> <li>• One-time event (hurricane)</li> <li>• Repeated events over a fairly well-defined period (earthquake with aftershocks)</li> <li>• A prolonged repetitive event (storm surges associated with sea level rise)</li> </ul>	Preparedness for event
Predictability of impacts	<ul style="list-style-type: none"> <li>• Plausible intensities known, impacts less so (earthquakes)</li> <li>• Impacts largely known, timing and intensity not (hurricanes, pandemics, wildfire)</li> <li>• Neither likely impacts nor timing/intensity known (solar storms)</li> </ul>	Preparedness for consequences
Spatial extent	<ul style="list-style-type: none"> <li>• Localized (fluvial flood)</li> <li>• Widespread (drought)</li> <li>• Global (pandemic, climate-modifying volcanic eruption)</li> </ul>	Ease of mobilizing resources and substituting activities; cascading impacts; governance and management challenges
<b>ECONOMIC SHOCK PROFILE</b>		
Inputs	<ul style="list-style-type: none"> <li>• Damage to physical capital and infrastructure (earthquake, flood)</li> <li>• Damage to labour and human capital (pandemic)</li> <li>• Damage to financial capital (financial crisis)</li> </ul>	Quantity and quality of production
Supply chain	<ul style="list-style-type: none"> <li>• Damage to transportation networks (volcanic eruption, earthquake, storm, wildfire)</li> <li>• Damage to crucial inputs in supply chain (a disaster hitting monopolistic locations)</li> <li>• Damage to financial links (financial crisis)</li> </ul>	Changes in inputs that are substitutes and complements; indirect impacts on related supply chains
Demand	<ul style="list-style-type: none"> <li>• Sectoral demand shifts (natural hazard)</li> <li>• Behavioural change (pandemic, financial crisis)</li> <li>• Government mandates (pandemic)</li> </ul>	Affects businesses selling these products and services

availability of rapid assistance in the aftermath. Similarly, the duration of the disaster, including the emergency response and recovery phases, affects government responses as well as businesses' abilities to sustain operations and adapt.

Whether or not the institutions and practices necessary to prepare for the shock are established and function well also depends on the frequency of a hazard's recurrence and the predictability of its impacts. A more frequent event type, such as hurricanes in a storm-prone region, is much more likely to be expected and therefore prepared for than one that seldom happens. Related to this uncertainty is whether the disaster is clearly perceived to be a singular event, or is instead perceived to remain a threat throughout an ill-defined period of heightened risk [128]. As an example of the latter category, the aftershocks experienced following some earthquakes, such as the 2010–2012 Canterbury earthquake sequence, provide a useful comparator to the pandemic's ebb and flow (see Ref. [7]). The uncertainty associated with an ambiguous ending of a heightened risk period has been observed to be detrimental to successful business recovery.

The spatial extent of the area directly impacted by the disaster relates to the severity of the disaster, affecting the demand for response and recovery resources, the ease with which they can be mobilized, the complexities of cascading impacts, and associated governance and management challenges.

Table 1 further characterizes event types and their associated economic shock profiles. Disasters, in general, change the economic contexts in which businesses operate by affecting their ability to produce or by changing the demand for their products and services. The supply of goods and services is affected in primarily two ways: destruction of inputs to production such as labour, physical assets, or financial capital; and disruptions in the supply chain. Demand can be affected by the shock itself, by behavioural responses to it, and through government interventions. Following a disaster, the spending priorities of governments, businesses, and households change as a consequence of the shock. An especially well-documented distinction that applies in most disasters is between sectors for which demand decreases (e.g., luxury goods, tourism), and ones for which demand increases (e.g., construction).

## 2.2. The pandemic as an economically disruptive event

In considering business recovery, some authors have compared the consequences of the COVID-19 pandemic to those of financial crises, as well as disasters from natural hazard events [8–10]. We argue that it is important to consider both similarities and differences along the dimensions detailed in Table 1, above. Like sudden-onset disasters, the direct impacts of the pandemic on businesses occurred suddenly as snap lockdowns and mass layoffs took effect in the space of weeks. Yet, the COVID-19 pandemic also differs in terms of other temporal characteristics: Its duration continuously surprised commentators with the emergence of new variants and

new infection waves; indeed, two years after the pandemic's onset, we are not yet sure when, or indeed if, it will end (i.e., become endemic). In terms of predictability of impacts, while the recurrence of pandemics had been predicted, there was little that allowed businesses and policy-makers to anticipate the impacts of COVID-19, as even the 1918–1920 influenza pandemic did not generate such strong policy reactions (e.g., border closures and lockdowns) and considering structural economic changes in the ensuing century [11,12]. Moreover, the global reach of the COVID-19 pandemic vastly exceeded the spatial extent of disaster damage caused by any single natural hazard event.

One shock that might be more akin to the COVID-19 crisis in terms of spatio-temporal profile is a global financial crisis (such as the Great Recession in 2008), since most financial crises are sudden-onset events with indeterminate duration. Furthermore, they have the potential to re-occur and repeat (especially when some of the financial fragilities that caused them have not been addressed), and a financial crisis can also be global. Unlike a financial crisis, however, the core driver of business impacts in the pandemic was not structural imbalances in the economy.

Rather, the COVID-19 pandemic caused severe economic disruptions to production inputs, supply chains, and demand-side factors. While the pandemic did not inflict direct physical damage to assets, it caused massive disruption to labour availability and supply chains that impeded businesses' ability to operate. Substantial demand shifts were also experienced, largely driven by consumers' behavioural changes and government restrictions and mandates. The pandemic thus resembles disaster events in some key dimensions, while differing in others.

### 3. Approach

The approach employed to produce this synthesis paper consisted of an integrative literature review [13] conducted in three stages. The first two stages focused on the disasters literature, while the third integrated findings with a review of COVID-19 pandemic studies. The research team started with taking stock of the theoretical and empirical knowledge on business recovery in the disasters literature. The objective was to identify key themes or “lessons” about business recovery from disasters that could serve as an informative starting point for developing expectations about business recovery in the COVID-19 pandemic.

The first stage of the process focused on published review papers that surveyed the literature on economics of disasters (e.g., Refs. [14–17]). These papers identified and discussed the evidence for several empirical findings on business recovery in previous disasters, including earthquakes, tsunamis, floods, hurricanes, wildfires, and tornadoes, among other hazard events. These findings reflect a variety of disaster contexts, research foci, and methodological approaches. Some findings were reported only occasionally or inconsistently across hazard events; others were commonly cited. The research team focused on the most robust findings – those that were consistently supported by empirical evidence from multiple studies of varied types of disasters – and characterized them as a series of five lessons on business recovery, discussed in detail in Section 4 below. This first phase involved development of a research agenda-setting paper [99] and an annotated bibliography with some 45 references [19]; subsequent phases added several dozen sources to the review. The second stage involved in-depth examination of the five lessons to gather further evidence, particularly from studies of recent and international disasters. Each lesson was thus re-examined, confirmed, and refined in light of an updated and broader literature base.

The third stage entailed examining the five lessons in relation to business recovery from the COVID-19 pandemic. Keyword searches of standard databases (in particular, Web of Science and Google Scholar) were used to identify relevant studies available as of December 2021, nearly two years after the onset of the pandemic in most regions of the world. The pandemic studies were examined to determine the ways in which their findings were similar to or different from the disaster experience for each of the five lessons, taking into consideration the disaster taxonomy in Table 1 above. The insights gained from these comparisons enabled the research team to develop a more generalized conceptual understanding of business recovery from all shocks and disasters, summarized in Section 5 below.

Across all three stages, the research focused primarily on peer-reviewed journal articles published in the English language, although COVID-related reports from key multilateral organizations such as the OECD were not excluded. While both quantitative and qualitative studies were examined, most of the evidence base is quantitative, typically deriving from business surveys and/or administrative data. The scope was limited to empirical studies focusing on business recovery in high-income countries.

### 4. Examining lessons from disasters in light of the pandemic

Research on business recovery from disasters in high-income countries has established that most businesses recover [14,15,20,21]. For example, Dahlhamer and Tierney [22] found that approximately 16 months after the 1994 Northridge (Los Angeles) earthquake, 75% of firms had recovered. Corey and Deitch [23] observed some six to eight months after Hurricane Katrina in the U.S., two-thirds of businesses had either fully recovered to pre-disaster business performance or grown; for those doing worse, a substantial proportion were nonetheless still in operation. Some 26 months after the disaster, according to Lam et al. [105] 12% of businesses remained closed. In the 2010–11 Canterbury earthquakes in New Zealand, Stevenson et al. [24] found that approximately 66% of organizations self-reported that they were about the same or better off following the earthquakes and 61% considered themselves fully recovered.

These statistics reflect how, as the knowledge base has developed, the definition of business recovery has become more nuanced. As a starting point, business recovery might be understood to indicate that at some point in time following a disaster, a firm has recommenced operations and returned to pre-disaster operating conditions. The disasters literature expands this on two fronts. Firstly, Chang and Rose [16] define economic recovery as “the process by which businesses and local economies return to conditions of stability following a disaster.” Note that this definition focuses on a return to stability, rather than a return to economic conditions

as they were before the disaster. Businesses may still be considered recovered even if their conditions have changed to a “new normal.”

The second important nuance pertains to how business recovery can be assessed. Many authors, for both conceptual and practical reasons, have defined recovery in a dichotomous way: either recovered/reopened or demised/closed. LeSage et al. [25] and Lam et al. [105] both considered a firm to be recovered if it had reopened or never closed. Dahlhamer and Tierney [22] classified businesses that were better off or about the same as before the event as being “recovered”, and those that were worse off as “not recovered”. Corey and Deitch [23] analyzed data on the percentage change in business performance. In contrast, Marshall and Shrank [26] posit that business recovery is not a dichotomy of “recovered” or “demised”; instead, they propose a framework based on the argument that business recovery is an ongoing process over time. Illustrating this argument, Stevenson et al. [24] analyzed business recovery following the 2010 Canterbury earthquake using different metrics. When looking at whether the business is operating or not (dichotomous view), they find that nearly 90% of respondent businesses reopened and only 1% reported closing permanently. Yet subjective self-assessment of those same firms found that only 66% reported being about the same or better off. This shows that objective measures, such as whether a business is operating or not, can obscure challenges the business is experiencing.

The disasters literature identifies many explanatory variables that influence business recovery. In addition to direct damage from the disaster, other factors include: business size and sector; infrastructure or lifeline disruption; disaster impacts on employees, customers and competitors; market access; product substitutability or complementarity; and the business' pre-disaster financial condition (e.g., Refs. [14–16,27,28]). Tierney [15] argues that when a disaster results in a business failing, it is usually because pre-existing vulnerabilities were exacerbated by the disaster event. Indeed, the variables identified in the literature as being most influential on a business' likelihood of failure following a disaster are the same as those that influence failure in normal times. Notably, even businesses that do not experience direct damage can be profoundly impacted by disaster events via impacts on supply chains, consumer impacts and behavior, economy-wide impacts, etc.

This paper focuses on five findings that are robust across multiple studies and that, as a set, cover a range of factors influencing business recovery in disasters: (1) small businesses have more difficulty recovering than large ones; (2) businesses vulnerable to supply chain disruptions have more difficulty recovering; (3) businesses facing disrupted markets have more difficulty recovering; (4) businesses in severely impacted neighborhoods have more difficulty recovering; and (5) faster, less restrictive funding facilitates business recovery. In discussing each of these below, and in comparing findings from disasters with the pandemic, the analysis seeks to draw insights about underlying recovery processes in order to inform a generalized conceptual understanding of business recovery from shocks and stressors.

#### 4.1. *Small businesses have more difficulty recovering than large ones*

Following most disasters, small businesses have been found to experience more difficulty recovering than larger establishments [15,16,27–30]. These post-disaster outcomes are consistent with evidence that smaller firms are more sensitive in general to economic downturns in the normal business cycle [31]. The greater vulnerability of small and medium-sized enterprises (SMEs) in disasters involves both directly relevant characteristics (e.g., lack of formal disaster planning) and indirect factors (e.g., smaller size and less experience); moreover, these characteristics are often correlated. While there is considerable heterogeneity across individual businesses, overall, small businesses tend to be more vulnerable to disasters and have greater difficulty recovering.

Many of the mechanisms behind SMEs' greater vulnerability relate to their financial circumstances and access to resources. Smaller businesses are often not in a financial position to actively take on what may be viewed as elective risk mitigation measures, such as purchasing insurance for property damage and business interruption [32]. Generally, small businesses operate under conditions of relatively higher financial fragility and smaller cash buffers; for example, in the U.S., half of SMEs operate with less than 27 days of cash reserves [106]. Challenges to small businesses in post-disaster recovery include disruption of cash flow, access to capital, and problems related to disaster assistance programs [33].

Small businesses are also more likely to be run by business owners who belong to disadvantaged groups. In the U.S., minority- and woman-owned businesses largely consist of sole proprietorships rather than partnerships or corporations, and represent a large share of businesses in states and cities at risk of natural hazards [15]. Minority-owned businesses face numerous disadvantages, including barriers to capital access [34]. Such businesses have long faced socioeconomic and cultural barriers to business formation [35]. For example, there tends to be greater prevalence of sole ownership, non-employee firms, and higher rates of home-based operations for black-owned businesses compared to white-owned businesses in the U.S. [36,107].

Furthermore, small businesses tend to be over-represented in economic sectors that are more vulnerable to disaster impacts, such as retail and services catering to local customers. For example, Chang and Falit-Baiamonte [37] found that in the 2001 Nisqually earthquake, businesses in the retail sector that relied on foot traffic experienced more significant losses than the businesses in manufacturing.

These findings from the disasters literature largely resonate with business recovery in the COVID-19 pandemic. Small businesses experienced substantial losses in the pandemic, notwithstanding variations related in part to differences in underlying vulnerabilities and public health measures [38,107–110]. Studies have found the recovery of small businesses in the pandemic to be influenced by their relatively higher financial fragility and smaller cash buffers, along with greater difficulty accessing different sources of finance [38,39,110,111]. Smaller businesses were found to be more likely to be closed than the larger counterparts [38]. Some evidence indicates that microenterprises struggled with funding general support of employees, such as employee health insurance and paid time off amid extremely tightened financial margins, especially among those businesses with seasonal functions [112]. Among SMEs, minority and female business owners were disproportionately impacted in the pandemic due to small financial buffers and limited access to various financial sources [40,107].

SMEs also tended to be overrepresented in economic sectors most affected by the COVID-19 pandemic, including the associated public health restrictions. For example, businesses such as tourism and restaurants are among those most heavily impacted by the pandemic [38]. On average across OECD countries, SMEs account for 75% of employment in sectors most affected by the pandemic, as compared with 60% in the economies as a whole [40].

Interestingly, some observations from the COVID-19 pandemic indicate potential differences from many disasters in relation to business recovery. Following the initial 9–12 months of the pandemic, there was a surge in new small businesses, a phenomenon that has received scant attention in the peer-reviewed disasters literature to date. In the U.S., for example, new business applications rose dramatically from June 2020 to May 2021, with 2.8 million more microbusinesses opening in 2020 than in 2019 [42]. Some other countries experienced a similar increase in new business applications in the third quarter of 2020, including Turkey, Chile, Australia, and the United Kingdom; one hypothesis is that consumer preferences during the pandemic, such as for online shopping, created opportunities for entrepreneurship [113]. In Japan, new store openings in some cities in mid-2021 exceeded rates in the 19 years prior to the pandemic, anecdotally reflecting increased demand for stores providing home delivery services [43]. Among existing businesses, studies ranging from Israel to Brazil have found that SMEs increased use of digital technologies as an adaptation strategy to the pandemic disruption [39,44,108].

#### 4.2. *Businesses vulnerable to supply chain disruptions have more difficulty recovering*

Supply disruptions frequently pose challenges to businesses recovering from disasters, and can derive from several different causes. Typically, physical damage to production facilities leads to reduced production of goods and services that are required as inputs by other businesses, which may be located in the disaster-affected region or in distant locations. Production shortages in one sector or even a single critical business in the disaster region can propagate to other businesses, sectors, and regions through the complex inter-industry connections. For example, in the 2011 Great East Japan (GEJ) earthquake, damage-related shortages of intermediate goods caused sharp drops in automobile production with varying time lags; production decreases were experienced in Guangdong province, China, one month after the earthquake and in Thailand in the next month [45]. In this disaster, power shortages in the damaged regions exacerbated long-term impacts on businesses [46].

Supply-side disruptions in disaster recovery can also be caused by other factors. Capacity loss in the transportation and logistics sector can ripple throughout global supply chains. In the 2010 earthquake in Chile, the closure of ports caused construction companies in Chicago to face shortages of lumber [47]. Similar disruptions have been seen from government responses to other events, notably after the September 11, 2001, terrorist attacks, when closing of U.S. borders induced global-scale supply chain disruptions in automotive industries [48]. Labor shortages can also impede post-disaster recovery; for example, in the 2011 GEJ earthquake, the supply-demand mismatch of employment in construction and the professional and engineering occupations delayed reconstruction activities [49].

Beyond production capacity reductions, situations of demand exceeding supply (i.e., excess demand) during reconstruction and recovery can also cause shortages. In particular, in many large-scale disasters, extensive property damage leads to substantial increases in household spending on durable goods, as has been documented for example following the 1995 Kobe Earthquake [50], 2005 Hurricane Katrina, and other disasters [51].

Certain sectors have been found to be particularly vulnerable to supply-chain disruptions in disasters. The 1999 Taiwan earthquake led to large-scale supply-chain impacts due to the shortage of semiconductors [52]. The automobile industry and electronics (in particular, hard disk drive) supply chains were severely impacted by the 2011 flooding of the Chao Phraya River in Thailand [53]. High-tech industries have been especially vulnerable to supply-chain disruptions because they rely upon a system of complex international specialization for production inputs.

While the COVID-19 pandemic did not entail physical damage to production facilities, it did lead to supply disruptions through other mechanisms. In the initial stages, large-scale disruptions of supply chains were not observed except in the case of medical devices, where pandemic-induced demand exceeded supply, and for fast-moving consumer goods due to consumer behavioral changes such as hoarding and bulk buying [114]. Early in the pandemic, many businesses implemented layoffs and reduced their production capacity. However, rapid economic recovery has revealed capacity issues such as in the maritime logistics sector. Reduction of inventories also accelerated shortages of key materials in many sectors. In the U.S. Census Small Business survey, held from May 31 to June 6, 2021, more than 50% of small businesses in manufacturing, construction, retail trade sectors faced domestic supplier delays [54]. Demand driven shortage was also seen in construction materials. For example, significant price increase (more than 300%) has been observed in the U.S. lumber markets due to the boom in domestic real estate and home improvements in addition to labour shortages [55].

Mismatches of supply and demand in the labor market have been observed during the pandemic. Data on job openings and hires in the U.S. in August 2021 [56] show significant mismatches in several sectors, including leisure and hospitality, transportation, warehouse and utilities, and manufacturing. As Krumeel et al. [115] finds, a decrease in required skills and salary possibly led to individuals being unwilling to re-enter the labor market.

Sectors typically vulnerable to supply-chain disruptions in disaster events were also disrupted in the COVID-19 pandemic. A shortage of semiconductors, leading to the disruption of supply chains in the automobile manufacturing sector, was induced by the rapid economic recovery. Notably, however, the cause of the shortage in the COVID-19 pandemic differed from that of natural hazard events: Semiconductor makers, which serve different goods markets and constitute a complex production system, shifted their final products to meet a surging demand for semiconductors used to enable remote healthcare, work-at-home, and virtual learning during the second quarter of 2020 [57]. However, the makers underestimated the recovery of automobile demand, and semiconductor shortages lasted for a long period (continuing as of this writing in July 2022).

Thus, while the pandemic resembles disasters in the overall processes by which supply disruptions can occur, it differs in the relative importance of these mechanisms as well as in how they were instigated. Further, the duration of supply chain disruptions in the COVID-19 case is significantly longer than in many disasters, and occurred simultaneously in many regions around the world.

#### 4.3. *Businesses facing disrupted markets have more difficulty recovering*

Prior studies have also frequently found that businesses whose markets and/or demand for goods and services have been disrupted by a disaster have more difficulty recovering [7,15,16,23,27,28,32,58,59,116–118]. Demand disruption in a natural hazard context is mostly driven by population relocation [23,33], inaccessibility due to physical damage [118], and changes in consumer preferences and needs [28,32,125]. Demand disruption is particularly impactful to locally oriented sectors such as retail and hospitality. Some sectors, however, can experience market growth; most commonly, the construction sector as a result of reconstruction activities. While demand impacts on business recovery have featured in the disasters literature, they are often dwarfed by the focus on supply impacts, such as direct disruption to physical infrastructure, staff, and financial capital, and the associated consequences to production inputs [118].

In the COVID-19 pandemic, by contrast, business impact and early recovery have been dominated by demand impacts. Negative consequences in the pandemic include reduced demand for air travel [119], tourism, and retail activities [120]. On the other hand, positive impacts have been observed, related for example to increased demand for medical supplies, post and warehousing services, and internet/technology [114,120]. Surveys of small businesses in the U.S. in early- to mid-2020 indicated that initially in the pandemic, demand disruptions were more impactful for businesses than supply chain or staffing disruptions [38]. Expectations of demand fluctuations were also a key driver in business decisions to reopen, including the presence of stimulus packages to boost consumer spending [121].

The pandemic caused changes in consumer behavior as people stopped, reduced, or replaced consumption of some items as a result of regulatory measures (e.g., lockdown orders), self-imposed isolation, unemployment [122], or changes in needs and wants [127]. The widespread use of regulatory measures to halt the spread of the disease, such as lockdowns, gathering limits, and physical distancing, significantly impacted demand for many goods and services, particularly those relying on face-to-face service delivery modes. One example is fresh produce early in the pandemic, whose demand experienced a sharp decline following the closure of restaurants, food courts, and university campuses. This demand was replaced by canned and other non-perishable food [127].

Beyond mandatory measures, consumers also exhibited behavior changes to limit their own exposure to the virus. This included increased demand for domestic rather than international goods [119], in-home services, technology services, and medical supplies, and avoidance of discretionary face-to-face activities [120]. Some consumers also re-prioritised discretionary spending; for example, home renovations in some regions accelerated as alternative spending outlets such as travel and hospitality were unavailable [60]. In short, data have shown that the COVID-19 crisis had the effect of skewing consumer demand towards fewer discretionary services but more discretionary goods (see, e.g., [126]).

While research into impacts on businesses are still emerging, demand changes, regardless of the cause, are likely to have a lesser impact on businesses that 1) had or have created a diverse market, 2) could pivot during the pandemic to find new markets (e.g., distilleries making hand sanitizer), or 3) could switch to alternative modes of delivery, for example, changing from out-of-home to in-home service delivery models [61,123]. With the lengthy duration of the pandemic, the impact of demand changes on business recovery will likely change over time, and temporal patterns may look different from a natural hazard.

#### 4.4. *Businesses in severely impacted neighborhoods have more difficulty recovering*

Studies of previous disasters have found that businesses located in more severely disrupted areas have more difficulty recovering, even if the businesses themselves suffered little direct damage or loss in the event [14,16]. Location in heavily damaged areas has been found to negatively influence business recovery after controlling for other explanatory factors, in disasters including the 1994 Northridge earthquake [27] and 2005 Hurricane Katrina [62]. This neighborhood effect – above and beyond a particular business' own impacts – is especially pronounced in heavily damaged business districts and for retail and service businesses that are dependent on foot traffic. More generally, business recovery is affected not just by conditions of the business itself, but also by the context of the surrounding neighborhood.

One reason is that businesses in heavily damaged neighborhoods may be at a competitive disadvantage, losing customers to businesses in less damaged neighborhoods [37,59,62]. Neighborhood damage and repairs may entail street and sidewalk closures, loss of parking space, or other impediments to physical access. Furthermore, the neighborhood's image may have suffered, as portrayed for example in media reports, thus discouraging customers and driving them to shop elsewhere. These effects tend to disproportionately affect service and retail sector businesses, particularly small establishments reliant on foot traffic and operating from a single location.

A second reason is that locally-oriented businesses in a heavily damaged neighborhood face disruption to their customer base [15,59]. Many residents and businesses may have evacuated or been displaced, and there may not be a critical mass of them returning. Those that remain may be suffering substantial losses, diverting resources to making repairs or otherwise reducing or altering spending. Business recovery has been found to be influenced by local area household recovery [63]. As noted following Hurricane Katrina, “Individual businesses depend critically on robust local business ecologies... without a critical mass of consumers, workers, and other enterprises that are back in operation, business recovery outcomes will likely be very poor” (Ref. [15] p. 287).

These interactions between business and neighborhood recovery remained important in the COVID-19 pandemic. While the pandemic did not cause concentrations of property damage, some neighborhoods were particularly severely affected; notably, central business districts (CBDs) in major cities emptied out when office workers shifted to working from home [64]. Locally-oriented businesses in CBDs have been heavily impacted [65]. In downtown Washington, DC, for example, daytime population had dropped 82%

and office space was only 9% occupied a year after the pandemic's start [66]. In the region's business districts, weekday farmer's markets suffered debilitating effects, with some closing for the entire year; in contrast, weekend markets serving residential neighborhoods fared comparatively well [67].

But the pandemic also led to some new and different neighborhood impacts. In contrast to natural hazard events, locally-oriented businesses in high-income neighborhoods were more impacted than those in low-income areas. Residents in higher-income areas were not only better able to comply with stay-at-home orders, but they also had greater propensity to flee cities [68–71]. During the lockdown in Spain, the rich were much more able to stay home than the poor, and wealthier neighborhoods exhibited a sharper decline in spending [72]. In the initial two months of the pandemic, New York City experienced a loss of some 5% of its residents, disproportionately from the wealthiest neighborhoods, where the residential population dropped by 40% or more [73]. One US study found that early in the pandemic, revenues for small businesses fell by over 65% in the highest income areas, compared with 30% in the lowest income neighborhoods; relatedly, small businesses closed at a much higher rate in affluent areas, particularly restaurants and other businesses requiring physical interaction [74].

#### 4.5. *Faster, less restrictive funding is better for affected businesses*

Finally, the disasters literature suggests that assistance programs for individual businesses vary in their effectiveness due to differences in their characteristics and funding mechanisms. Assessing the effectiveness of recovery programs is difficult due to the issue of confounding factors and selection bias, where businesses that are more damaged are also more likely to apply for assistance [27,75,76]. However, studies have suggested that funding type, speed, and requirements are critical considerations when designing recovery programs [28,77–79].

With respect to funding type, findings are mixed for loan-based assistance, despite its use in several countries [80–82]. Research has found loans to have both positive impacts and negative impacts on recovery after disasters [27,83,84]. Negative findings have been hypothesized to be a result of the additional debt placed on already heavily indebted businesses [27]. Disaster-induced demand changes, physical losses, and operational disruptions can lead to precarious financial positions prior to taking on loans, particularly for small businesses [28,32]. Grants or forgivable loans, therefore, will be more desirable for businesses, but more expensive to implement. Insurance provides a more market-based alternative, but many small businesses are not covered [85–87], and the claims process can be complex and difficult to navigate, even for those with coverage [88].

Rather than offering a large pot of funding, assistance programs can alternatively leverage speed of fund delivery. Even small amounts of faster funding can help businesses re-open more quickly and reduce their interruption losses [89,100]. This can serve two purposes: first, it allows businesses to re-capture their demand share and market position given that there is high volatility in customer behavior [90], particularly for reconstruction-related businesses who need to capitalize quickly on increased demand immediately after the event [28]. Secondly, this funding can serve as gap financing while businesses pursue larger, and perhaps loan-based, assistance [91,92] or use the time to assess and plan a different way forward [79]. Having restored sources of revenue and repayment ability, the debt burden of consequent loans may have less of an adverse impact.

Having this type of “gap” or “bridge” financing is also important due to criticism that business disaster assistance has received for the paperwork burden, in terms of both time and effort, faced by applicants [33,77]. For loan-based assistance, this paperwork establishes credit worthiness; however, most types of funding involve paperwork to reduce fraud and determine eligibility. This process can be challenging for smaller businesses already dealing with recovery demands and fewer staff, and documentation can be lost during a disaster. Some businesses may also have little awareness of disaster recovery program requirements and procedures [86]. This combined with the aforementioned debt risk can lead to low rates of businesses actually receiving funds, and funding going to less damaged, larger businesses, and corporate businesses [93,94]. Funding requirements have also faced criticism for tying businesses to their previous location [78], given that populations and markets can change after a disaster event and that moving outside the disaster area has been shown to be positively associated with survival [76]. Wage subsidies were successful after the Canterbury Earthquakes [79] because they tied funding to the labor needs of the business [63], allowing a business to relocate, and could be justified as assisting both households and businesses.

During the COVID-19 pandemic, these assistance challenges were present, but new considerations emerged as a result of differences in the spatio-temporal and economic shock profiles of the crisis. For businesses, grants were still more likely to be preferable to loans, perhaps more so given that interruption duration is longer and more uncertain during the pandemic [38,39,95]. Many sectors, such as those in entertainment, were completely shut down and would be unable to repay loans until government restrictions lifted and demand returned, with no guarantee the business would be able to resume its previous level of operations. However, this longer pandemic timeframe also meant that the amount of public funding required for assistance programs has increased. This has highlighted duration as a different time dimension to consider, namely how much assistance businesses can receive and for how long it will be provided.

The pandemic has led to renewed discussion on the issue of requirements for disaster assistance, namely which types of businesses should benefit from pandemic aid. Early reports have suggested that the assistance winners and losers seen after previous disasters are similar during the pandemic, where larger businesses and corporations benefited [96,124]. Programs targeting subsets of businesses have emerged based on sector, size, and ownership characteristics such as race and gender. For some, this has moved the discussion of the effectiveness of disaster assistance to include equity rather than purely performance-based or need-based criteria [97]. This opens up many future research streams on how new forms of assistance emerging from the pandemic have performed and how they might translate to future events.



### 5. Synthesis

Findings from approximately the first two years of the COVID-19 pandemic have not only reinforced many lessons from the disasters literature, but also enhanced and enriched understanding of how businesses recover from disruptive events. Reflecting this expanded knowledge base, Fig. 1 provides a synthesis of the factors, moderators, and mechanisms that influence business recovery outcomes following disruptive events. Factors refer to characteristics of the business itself (e.g., size and sector) that may influence its vulnerability, as well as to attributes of the hazard event (e.g., duration and spatial extent) that indicate the severity of the event itself. While these factors influence business impacts and recovery, they can be moderated by actions on the part of the business (e.g., obtaining insurance) and government policies such as financial assistance or lockdowns, which can either impede or facilitate recovery. Mechanisms refer to the processes by which a business' operations are impacted and recover, and relate to the business' production capacity and market context. Some mechanisms are internal to the business, such as damage to its physical capital or managerial decision-making, or its capacity to adapt to changing conditions; others, such as supply chain disruptions and consumption pattern changes on the part of households, are external to the business. All of these influence business recovery outcomes, which are nuanced and ongoing.

This framework provides a comprehensive structure by which to consider how the pandemic resembles and differs from natural hazard events, from the perspective of business recovery. In the pandemic, as in natural hazard events, some types of businesses tend to experience more difficulty in recovery. Characteristics such as small business size and woman- or minority ownership are often associated with disadvantages through mechanisms such as limited access to finance that pose challenges in recovery. Compared to all businesses, SMEs are typically over-represented in sectors that are most affected, whether locally-oriented retail and services in a disaster region or, in the case of the pandemic, sectors such as tourism and restaurants that were especially affected by public health restrictions.

Shortages that impede business production and hence recovery can occur for similar reasons in pandemics and other disaster types, even as the mechanisms behind the bottlenecks may vary. Sectors such as automobile and electronics manufacturing, which rely on specialized international suppliers for critical components, are particularly prone to supply chain disruptions. Shortages can be caused by conditions whereby demand greatly exceeds supply, whether this be for construction materials following a destructive natural hazard event or for medical devices in a pandemic.

Similarly, disruptions to a business' market context influence recovery, even though the mechanisms behind the demand disruptions may differ between disasters and the pandemic. In a natural hazard event, businesses can be affected if their customer base is local and thus also impacted by the disaster. In the pandemic, substantial shifts in demand for many goods and services were observed in response to regulatory measures and voluntary changes in consumer behavior.

Based on the disasters literature, it is likely that government assistance programs providing faster, less restrictive funding will be more effective in supporting business recovery. Factors such as debt burden, paperwork burden, and facilitating adaptation are likely to be as applicable in the pandemic as in disasters.

The factors, moderators, and mechanisms outlined in Fig. 1 are general and applicable to a range of economically disruptive events (see Table 1 above). For example, the framework can be applied to better empirically research and theorize business recovery, to help identify business sectors that may be particularly challenged in a given type of hazard event, and to develop flexible policies to support business recovery across a range of disruption possibilities.

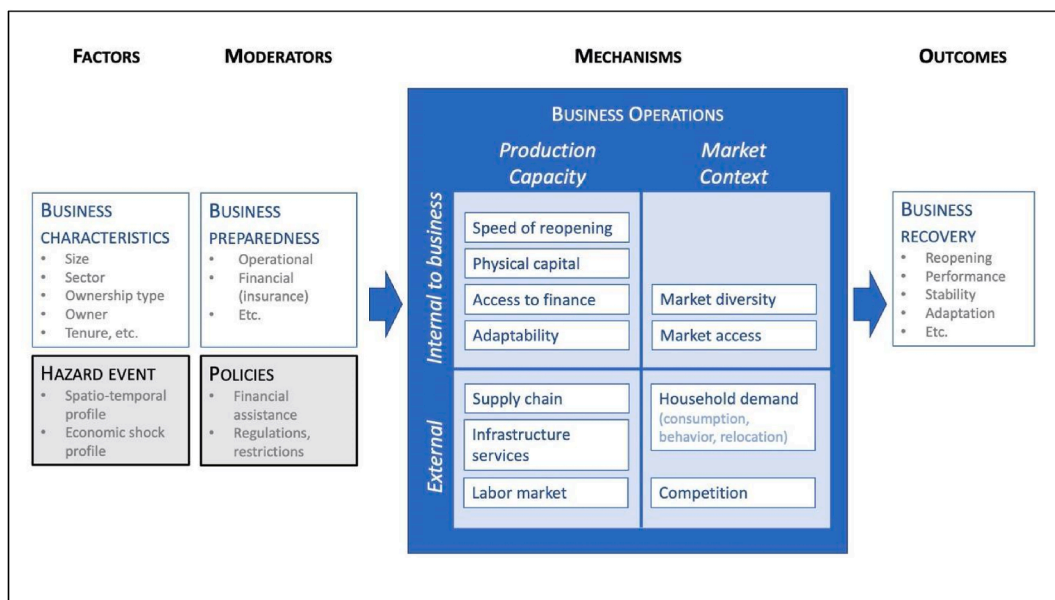


Fig. 1. Conceptual Framework of Business Recovery (source: authors).

## 6. Conclusion

This paper has examined the extent to which long-established findings about business recovery, deriving from studies of disasters triggered by natural hazards, hold for the COVID-19 pandemic. It found that the factors, moderators, and mechanisms of business recovery in the pandemic broadly resonated with those of natural hazard events. Some contrasts were observed, however, that largely relate to distinctive features of the pandemic as an economically disruptive event – perhaps most notably, in terms of the long duration and associated uncertainties, the unfamiliarity of pandemics and lack of preparedness for them, the prominence of demand-side disruptions caused by unprecedented government restrictions and massive behavioral shifts, and new forms of adaptation such as shifting to online work or e-commerce.

The length of the disruption from the pandemic has resulted in significant impacts and change. Some of these shifts in business, consumer and household behavior seem likely to remain as permanent changes, such as more online shopping and management and working from home, while other changes such as reduced international travel seem likely to return only slowly. Given that the pandemic continues to unfold, findings about disaster recovery are tentative.

The findings presented in this paper are subject to a number of limitations. An overarching consideration is that the COVID-19 pandemic and its impacts continue as of this writing, and uncertainty remains regarding potential future waves and variants of the virus. Statements about the impacts of COVID-19 and recovery from them are subject to the significant caveat that relevant data and analyses are still underway and may produce results that challenge or modify what is set out here. Furthermore, this paper has relied on available published reports, which not only vary in their methodology and data sources but are also skewed geographically and linguistically. The analysis has largely overlooked the specific local contexts in which the COVID-19 pandemic has occurred, including local differences in aspects ranging from disease severity and government restrictions to extreme weather and other natural hazard events that occurred concurrently with the pandemic.

Further research on business recovery in the COVID-19 pandemic should address these limitations to the extent possible, while capitalizing on the lessons of prior disasters to help policy-makers appreciate less visible impacts and avoid repeating past mistakes. Considering the distinctive aspects of the pandemic, three research needs emerge as particularly valuable to investigate:

- Adaptation to the lengthy duration of the COVID-19 pandemic, waves of disease, shifting public policy, and ongoing uncertainty, is critical to survival and recovery. How have businesses sought to adapt in difficult circumstances of uncertainty and constant change, and what strategies are most effective? How can SMEs and in particular, minority- and female-owned businesses, which have been historically underrepresented in research and policy, improve their capacity to adapt to future economically disruptive events? What public policies best support such adaptation?
- The global scale of the pandemic, affecting every country and part of the world more or less simultaneously, is unique. There have been calls to reduce dependency on international flows of people, goods and services as these have been restricted during the pandemic. In contrast, there have also been calls for more cooperation and exchange for health and related measures to contain the pandemic. These issues need attention from researchers.
- Given the long duration of the pandemic, it is unclear what kinds of financial assistance are most effective. This opens up many future research streams on how new forms of assistance emerging from the pandemic have performed and how they might translate to future events. Related to this issue is the tremendous variation in government policy response between and within countries, and shifts in these responses over time as the pandemic progressed. This provides opportunities for valuable comparative research to assess the effectiveness of different approaches.

Such research can not only support government policies for business recovery in this pandemic, but also inform understanding of business recovery challenges and needs in future disasters, where the hazards will continue to evolve and to surprise in the context of a changing climate.

## Data availability

No data was used for the research described in the article.

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