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ABSTRACT

In line with the fallacy of riskification of uncertainty by which decision makers believe that the effects of unpredictable phenomena can be captured accurately by probability distributions, organizational scholars commonly treat the organizational inefficiency in dealing with uncertainty shocks—exogenous hazards whose welfare effects spread across industries and markets, such as natural disasters, terrorist attacks, and financial crises—as a problem of risk management. This is problematic because the consequences of uncertainty shocks outstrip the predictability capacity for the average manager and entail a greater complexity of internal and external factors. Moreover, their uniqueness makes translating experience into learning far more difficult. We seek to address this inadequate approach with a theoretical framework that captures the multidimensional complexity of organizations preparing for, coping with, and recovering from exogenous uncertain disruption. We bring together the literatures on cognitive psychology that suggest that biases and heuristics drive behavior under uncertainty, a Neo-Carnegie perspective that indicates that organizational structure and strategy regulate these behavioral factors, and institutional theory that points to stakeholder and institutional dynamics affecting economic incentives to invest in prevention and business continuity. Taken together, this article offers the foundation for a behaviorally plausible, decision-centered perspective on organizational decision-making under uncertainty.

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In the last 20 years, terrorist attacks, natural disasters, technological accidents, financial crises and political coups have become the principal determinants of volatility affecting firm performance and a major cause of firm insolvency or bankruptcy (Baker & Bloom, 2013; Ballesteros, Wry, & Useem, 2018; Consultants, 2018). The Federal Emergency Management Agency estimates that 40% of businesses in the United States do not reopen after being hit by a natural disaster and 90% fail within a year if they have not resumed operations in less than a week (FEMA, 2015). The disruption is pervasive even among the largest and oldest firms that have been enduring uncertainty shocks for decades. There is evidence, for instance, that the 9/11 terrorist attacks reduced 5.6% of the overall value of the largest 100 companies worldwide and some firms have not recovered the loss value six years after the attacks (Suder, Chailan, & Suder, 2008).

The growing scholarship studying the consequences of these shocks on organizations has traditionally approached the problem as one of risk management. Scholars refer to these phenomena as "discontinuous risk" (Oetzel & Oh, 2014), and argue that catastrophes such as 9/11, Hurricane Katrina, the 2011 Tōhoku earthquake and tsunami in Japan, the 2007-09 financial crisis and the 2017 trifecta (Hurricanes Harvey, Irma and Maria) have solidified the public discourse of the *risk society*: a world concerned with identifying and managing risks (Beck, 2006). This is in line with the fallacy of *riskification* of uncertainty by which decision makers believe that probability distributions can capture unpredictability (Hardy & Maguire, 2016).

This approach, however, entails an important functional inaccuracy: the consequences of these shocks outstrip the dimension of predictability for the average manager. To illustrate this point, most firms in the Houston area were not aware that urban planning and policymaking would fuel flooding that led to a 1-in-1000-years economic destruction (Ballesteros & Gatignon, n.d.). Prior to the Tōhoku disaster, scientists calculated a close-to-zero probability that the

Fukushima Daiichi plant could be affected by a hundred-foot wave tsunami (Ferris & Solis, 2013). When Katrina hit New Orleans and became the worst natural disaster in U.S. history, the magnitude of the storm refuted experts' accounts that the city's levees would contain the water surge (Cutter, 2006). Similarly, the widespread 2007-09 economic meltdown surprised analysts and regulators regarding the resilience of international financial markets (Jin, Kanagaretnam, & Lobo, 2011).

The dynamic nature of these shocks is rarely captured by the static measurements, such as the gross domestic product (GDP), used to calculate disaster vulnerability, design emergency preparedness plans, and allocate relief (Ballesteros, Useem, & Wry, 2017; Bloom, 2009) After Japan experienced a 9.0-magnitude earthquake in 2011, many firms with operations in the country believed that the third largest economy worldwide would be barely affected and that the potential market disruption would be minimal (Cavallo, Cavallo, & Rigobon, 2013). At the time, public debt was twice Japan's s GDP so the government had limited liquid resources to quickly mobilize for relief. The economic impact of the earthquake would become the costliest disaster in history (Ballesteros & Useem, 2015).

The decision-making processes associated with uncertain shocks are far more complex than when the firm deals with more predictable risks. In fact, several of the actions implemented by managers when coping with the consequences of these disruptions s are ad-hoc and deviate from well-established routines. (Kunreuther & Useem, 2018). Given the uniqueness of each disaster, organizational change, such as employee turnover (Knyazeva, Knyazeva, & Stiglitz, 2013), and environmental change, such as urbanization (Kousky, 2013), experience rarely makes impacts predictable and responses generalizable (Kunreuther & Useem, 2018; Lampel, Shamsie, & Shapira, 2009).

With this article, we seek to address the inadequate approach in the study of how firms deal with what we call uncertainty shocks: exogenous and unpredictable disruptions whose welfare

effects spread across geographies, industries, and markets. We offer a theoretical synthesis of organizational decision making that captures the multidimensional complexity of preparing for, coping with, and recovering from uncertain disruption. We illustrate cases of how individual-, firm-, and context-specific factors determine the functioning of the organization before, during, and after disruption.

More generally, we aim to redress the lack of systematic attention to the role of uncertainty shocks in organizational performance. Arguably, this neglect is due, in part, to the tendency to treat rare shocks as outliers in organizational life, "accidental manifestations of underlying organizational processes" (Lampel et al., 2009: 835). Management and organizational scholars have concentrated their attention on individual or idiosyncratic risks affecting a single firm—such as the risk of technological obsolescence (Tripsas, 2009), the risk of bad relationships with key stakeholders (Bitektine, 2011), the risk of imitative competition (Lieberman & Montgomery, 2013), and the risk associated with foreign expansion (Zaheer, 1995).

Extrapolating from what we know about how firms deal with individual risks to uncertain shocks is inappropriate because dealing with these broad-based, correlated, or systemic phenomena entail different mechanisms and levels of organizational resources (Altay & Ramirez, 2010; Baker & Bloom, 2013; Kunreuther, 1996; Teece & Leih, 2016). For instance, when a corporation suffers an individual shock like a factory fire, it can draw resources from other subsidiaries and mitigate its impact. In some cases, the temporary changes in performance associated with individual shocks are fully concentrated at the corporate level. In the context of uncertainty shocks, the efficiency of pooling disappears because financial losses are often larger than the available firm resources.

More importantly, the decision-making process for dealing with uncertainty shocks is far more complex than for idiosyncratic risks because it involves a diversity of employees at distinct levels in the organization whose choices are affected by three dimensions. First, individuals

combine intuitive with deliberative thinking when making decisions under uncertainty (Meyer & Kunreuther, 2017). Intuitive thinking operates automatically and quickly guided by emotions and rules of thumb acquired by personal experience. Deliberative thinking allocates attention to effortful and intentional mental activities where individuals undertake trade-offs, recognize relevant interdependencies and the need for coordination (Kahneman, 2011). This *micro* dimension thus focuses on how managers and other employees attend to external phenomena, perceive them as threats, communicate those perceptions, and follow actions and coordinate with others to address them (Lampel et al., 2009).

Second, a *meso* dimension builds on the tradition of the Carnegie School literature by illuminating how organizational structures and strategies are impacted by intuitive and deliberative thinking via authority, communication, and incentive systems (Gavetti, 2012; Gavetti, Levinthal, & Ocasio, 2007). More specifically, the way information plays a role in choosing a course of action during disruption depends not only on how the C-suite level transforms and disseminates information, but also on how other levels of the organization interpret and value this information (Gavetti, Greve, Kaplan, Nadkarni, & Rerup, 2017; Hoffman & Ocasio, 2001; March & Shapira, 1992). In turn, the effectiveness of organizational procedures to implement courses of action by teams across the organization will impact the ability to avoid major performance losses (Beck & Plowman, 2009; Starbuck, 2009; Zollo, 2009).

Finally, a *macro* dimension draws upon institutional theory to analyze the external determinants of exposure to, management of, and learning from uncertainty shocks. Local norms, rules, and customs and stakeholder dynamics influence a firm's decisions on preparing for a disaster (Aghion, Bloom, & Lucking, 2016; Bloom & Reenen, 2007; Bloom, Sadun, & Reenen, 2012). For instance, public subsidies and post-disaster aid may foster commercial expansion into disaster-prone areas (Cummins & Mahul, 2009; Wenzel & Wolf, 2013). In turn, the firm's investment in preventive infrastructure may affect how much nearby organizations will be

investing in prevention regardless of their own level of hazard exposure (Kunreuther, Meyer, & Michel-Kerjan, 2013).

These three dimensions have not been integrated into a theoretical argumentation in the literature on organizational decision making. Scholars have noted that a micro focus centering on routines, or a macro focus focusing on the social context in which firms operate, has supplanted an organizational component (Gavetti et al., 2007). Studies on the microfoundations of organizational behavior often do not integrate communication, incentives, and authority structures that influence how employees behave (Bingham & Eisenhardt, 2014; Gavetti, 2012; Helfat & Peteraf, 2015). Analyses of the institutional factors affecting organizational choices have oversimplified behavioral processes that impact decision making within the firm (Felin, Foss, & Ployhart, 2015; Lampel et al., 2009; Teece, 2007). This is hard to reconcile with the consensus among management and organizational scholars that firms are not monolithic entities and there is no such thing as *organizational preferences* (Argote & Greve, 2007; March & Olsen, 1975). As a result, the literature lacks a single theory covering the causal path characterizing how organizations manage and learn from uncertainty shocks.

To tackle this gap, we propose a theoretical framework in which a firm's capability to manage uncertainty shocks is a dynamic system where organizational strategy and structure interact with institutional and stakeholder forces in ways that determine how biases and heuristics affect incentives to prevent rare disruptions and deal with their impacts should they occur. We build on interviews with managers with over 100 firms in the Standards & Poor's 500 Index to connect insights from the cognitive psychology, Neo-Carnegie, and institutional literatures.[1] Caselets, quotes and anecdotes from this qualitative study illustrate the complexity

[1] Over a five-year period, a research team from the Wharton Risk Management and Decision Processes Center and Wharton Leadership Center at the University of Pennsylvania conducted interviews with chief financial officers, risk managers, and other employees on their teams, units, and firms' actions before, during, and after severe adverse events. The firms differ by industry sector and size, with annual revenues ranging from $1 billion to over $400 billion (median revenue: $12 billion average revenue: $29 billion). Their work forces range from a few thousand

of achieving collective action when the firm faces environmental unpredictability and causal ambiguity. Our theoretical framework thus presents a behaviorally plausible perspective on organizational processes under uncertainty and responds to calls for refocusing attention to organizational decision-making (Gavetti et al., 2007).

In what follows, we characterize the implications of uncertainty shocks for managerial practice and then develop the three dimensions of our theoretical framework. We hope that future empirical studies will refine our model to generate a more nuanced understanding of the mechanisms and conditions under which organizations avoid major performance disruptions and learn appropriately from external shocks. We discuss these potential avenues of research in the concluding section.

MANAGING IN THE ERA OF UNCERTAINTY SHOCKS

A well accepted idea among management and organizational scholars is that uncertainty is the essence of entrepreneurship and firm performance (Alvarez & Barney, 2005; Baker & Nelson, 2005; Kaplan, 2008; March & Shapira, 1987; Milliken, 1987; Sarasvathy, 2001; Teece & Leih, 2016). Remarkably, this consensus has rarely translated into an explicit and systematic study of organizational decision making under exogenous uncertainty (Teece & Leih, 2016). This is puzzling because the relationship between environmental turbulence and organizational operation and performance volatility are central tenets in strategy and management (Aghion et al., 2016; Ahuja & Yayavaram, 2011; Gaba & Terlaak, 2013; Maitland & Sammartino, 2014; Ryall, 2009). When studied, the literature treat natural disasters, financial crises, terrorist attacks and other uncertainty shocks as risks (Oetzel & Oh, 2014) and the pervasive failure of organizations to deal with them as a "failure to effectively manage risks" (Hardy & Maguire, 2016: 80).

employees to over two million (median number of employees: 20,000; average number of employees: 70,000). For more details see Kunreuther and Useem (2018).

On the other hand, managerial attention to uncertainty shocks has grown considerably. Once thought of as a technical subject for specialist attention, uncertainty is now far more central in organizational decision making today. Publicly-listed firms, for instance, discuss the topic of uncertainty shocks at most board meetings as they relate to adverse shocks that they and other firms experienced (Kunreuther & Useem, 2018). For instance, a 2017 report shows that interviewed managers considered natural disasters 1.89, 3.5, and 4.4 times more disruptive than the individual-risk incidents of cyber, product-quality, and internal supply-chain disruption, respectively (Allianz Global Corporate & Speciality, 2017).

This trend in practitioner attention reflects the rise in the associated financial toll on business performance. Every year, uncertainty shocks disrupt supply chains (Boehm, 2014; Cavallo et al., 2013), trigger temporal or permanent institutional changes such as more stringent building codes or liquidity limits for market operation (Klinenberg, 2003; Useem, Kunreuther, & Michel-Kerjan, 2015) inflict direct damages on the firm, such as injuring employees or destroying plants (Whiteman, Muller, & Voort, 2005). Consider the cases associated with the 2010 floods in Thailand. This disaster caused a major setback to Apple in its production of computers, a quarterly loss and production drop for months to Western Digital (the world's largest maker of hard-disk drives), and suspension of automobile production for Toyota and Ford. The 2011 Tōhoku disaster affected massive conglomerates such as Sony which had to shut down operations in six plants, and Panasonic, which closed its two biggest plants in Japan, reported a quarterly revenue loss of 11% associated with the disaster, and eventually had to sell part of its appliance business (Ballesteros, 2017). In summary, the average firm in 2016 was estimated to be 25 times more likely to face disaster losses than a similar organization 20 years before and the disruption is widespread across firm sizes (Ballesteros, 2017; SwissRe, 2018).

The Riskification of Uncertainty Shocks

Historically, and in line with the predominant discourse on risk, the pervasive inefficiency in dealing with uncertainty shocks has been approached empirically and theoretically as a risk-management problem (Hardy & Maguire, 2016; Lampel et al., 2009). Popular and expert media thus identifies firms failing to deal after these phenomena as those that tried but did not have adequate hedging mechanisms or those that could have hedged their risk, for instance by buying insurance, but opted not to.

This narrative creates several fallacies. The first one is the *riskification* of uncertainty: the idea that, at some point, decision makers will transform exogenous uncertainty into risk by generating probability distributions of its threats (Hardy & Maguire, 2016). However, despite progress in measuring the consequences of catastrophes, reliable information on their effects takes months or years to be produced and released (Kousky, 2013). Firms are rarely provided with a description of the damage to infrastructure and other public goods, the resources and time needed for recovery. Hence, organizations often utilize data that are not associated with the disaster in making emergency decisions. For example, when allocating resources to rebuilding economic infrastructure, firms often use the expenditures following significantly different past disasters (Ballesteros et al., 2018). Additionally, the *riskification* of uncertainty leads to the delusion that increasing formal insurance take-up is a sufficient mechanism to reduce vulnerability against uncertainty shocks. This fails to consider that sophisticated risk transfer instruments, such as parametric insurance, weather derivatives, and catastrophe bonds have been available for firms for over 25 years (Ballesteros, 2010), while the average economic loss has skyrocketed. Moreover, because a cost-benefit assessment is often infeasible, biases and heuristics play a preponderant part in hedging choices not only among naïve decision-makers but also among users of logic and probability (Kunreuther, Meyer, et al., 2013).

More problematic is the fallacy that learning from high-consequence shocks is a temporal, finite process (Rerup, 2009). Managers focus their attention on shocks that were particularly

consequential for the organization and repeat or avoid choices that proved successful or unsuccessful in dealing with these disruptions. They believe that experiencing the consequences of shocks have prepared the organization for dealing with future disruption without considering the uniqueness of these shocks, which leads to a false sense of control. For example, a large retailer reacted to the H5N1 (avian flu) outbreak by preparing for an H5 type virus. But when the next influenza outbreak hit a couple of years later, it took the form of the H1 strain, and thus the plan was not applicable. A manager of this company told us that "*A lesson coming out of disasters is that, number one, you can spend a lot of time building out intricate plans for different scenarios, but the odds are what you're actually going to face is not going to be exact. So, you're planning …to have generic strategies… that are often hard to adapt."*

Another fallacy is that firms will be better off by centralizing the functions of analyzing and managing shocks in specialized risk-management units to formalize routines for business continuity and recovery (Dong & Tomlin, 2012). In practice, after major recent disasters such as the 9/11 terrorist attacks, the 2004 Asian tsunami, and the 2007-09 financial crisis, firms have made systematic efforts to formalize and increase risk assessment and management. For instance, more than 75% of the firms interviewed noted the existence of routines for threat identification and prioritization. Most of these firms have standardized manuals to deal with major disruptions with a few using ad-hoc strategies. Therefore, the rise in the costs of uncertainty shocks have occurred despite an exponential growth in human capital devoted to overseeing firm-wide risk management with the creation of new functions, such as chief risk officers and enterprise risk-management teams (Kunreuther & Useem, 2018).

Although standardization and centralization are important when dealing with uncertainty shocks, as we discuss below, their prominence often negatively affects sensemaking (i.e., the interpretation of information) and sensegiving (i.e., the influence on how others interpret information). When the firms faces pervasive uncertainty, flexibility and delegation are valuable

assets because they facilitate employees across the organization becoming information nodes for identifying threats whose signals are ambiguous or novel (Beck & Plowman, 2009).

Our interactions with S&P 500 firms suggest that formalization and centralization do exist. However, rather than emphasizing rigid top-down routines that yield a false sense of control, firms focus on strategies to prepare for dealing with abnormal conditions with the participation of employees across the organization. Such firms often have annual training programs with the goal of mitigating the role that behavioral biases play when faced with causal ambiguity. An executive of a computer technology organization provided the following insights regarding his firm's navigation of the disruption caused by the 2011 disaster in Japan: "*We had made some conscious decisions with parts of our business to have multiple points of failure for business operations. When the earthquake and tsunami happened, the units impacted were businesses that we knew would be at risk. We had prepared crisis management processes so representatives of different areas would be in communication and would be working together to deal with its impact on our employees, to our facilities and then to ongoing business operations.*"

In addition, we found that these companies take a preemptive approach to the potential role of the public sector in dealing with large catastrophes. Instead of looking to government agencies for disaster relief, these firms strive to reduce their dependency on external sources of funding by investing in their own resources to reduce the impact of disruptions on their operations. As a manager of a technology company indicated: "*In the macro sense of shock management…learning with each disaster has also been talking to the government to help us decide where to invest going forward.*"

We now elaborate on these individual-level, firm-level, and environmental forces affecting organizational decision making under uncertainty shocks by linking empirical research in cognitive psychology, a Neo-Carnegie perspective of organizational behavior, and institutional

theory. We draw upon the primary-data collection with S&P 500 firms to bridge these three dimensions that comprise our theoretical framework.

A FRAMEWORK OF ORGANIZATIONAL DECISION MAKING UNDER UNCERTAINTY SHOCKS

More than 70 years ago, Herbert Simon contended that organizational decision making *must be derived from the logic and psychology of human choice* (Simon, 1947: xlvi). Employees, managers, board members and shareholders vary in their ability to anticipate external threats, interpret and communicate them, respond with coping mechanisms, and transform experience into resilience (Christianson, Farkas, Sutcliffe, & Weick, 2009; March & Shapira, 1987; Nikolaeva, 2014; Starbuck, 2009). Given the correlated nature and duration of the consequences of uncertainty shocks, the choices that the organization makes may be highly consequential for its performance and long-term sustainability.

Our framework, represented in Figure 1, outlines the microfoundations (biases and heuristics or simplified decision rules), the organizational determinants (structure and strategy), and the macro determinants (external stakeholders and institutional dynamics) that determine organizational decision making under uncertainty shocks.

----------Insert Figure 1 about here----------

Micro Dimension

We have learned from cognitive psychology that individuals make decisions under uncertainty by using a combination of intuition and deliberative thinking (Kahneman, 2011). When faced with unpredicted disruption, System 1 (intuitive thinking) triggers the rapid reactions by a production-line employee in escalating data on potential external threats, of supervisors in reallocating the responsibilities of their personnel and assigning them new tasks, and of the CEO

in issuing emergency protocols. System 2 (deliberative thinking) guides the choice of coping and recovery strategies. It drives employees to share relevant information with the appropriate personnel, leads the supervisor to assess what activities to prioritize and assign them to the most suitable team, and spurs the CEO to implement a cost-effective emergency plan.

The combination of System 1 and 2 generally results in reasonably good choices when decision makers have considerable experience as a basis for their actions (Kahneman, 2011). A chemical company, for instance, applied deliberative thinking to specific events in post-mortems or after-action reviews, which enhanced its capability to respond intuitively to subsequent storms. An executive describes these actions: "*We did a postmortem after Katrina and talked about what worked and what we should have done beforehand. When we see hurricanes coming now we proactively stage equipment within proximity but not in the strike zone, so that we can get generators, water and other supplies and equipment much more quickly. We work with local authorities to be able to get these trucks through any police barricades or roadblocks that have been set up in the natural-disaster zone.*"

Another case in point is Morgan Stanley's evacuation of nearly 3,000 employees from one of the World Trade Center (WTC) towers during the 9/11 attacks. Morgan Stanley's Director of Security, Richard Rescorla had little information about what had just happened, but he had lived through the 1993 Al Qaeda bombing of the WTC. Appreciating how many people might have perished if that assault had succeeded in collapsing the towers, Rescorla had instituted quarterly evacuation drills ever since, making sure new employees were trained and veteran workers did not become complacent. Eight years later, Rescorla's experience with a previous shock proved critical. In determining whether to order the evacuation, Rescorla had no time to perform a cost-benefit analysis. He relied on his gut feeling (intuition) and on institutional evacuation training conducted in previous years (deliberation). Both were essential.

However, experience is often unavailable or even misleading given the uniqueness and ambiguity of uncertainty shocks. Managers and other employees often exhibit the following behavioral biases and heuristics in their decision-making processes:

Availability. There is a tendency to estimate the likelihood of an uncertain event by the ease with which instances of its occurrence can be brought to mind, leading to an underestimation of the likelihood of a shock prior to an adverse event, and overestimation following its occurrence (Tversky & Kahneman, 1973). We found in our investigation that many major preventive strategies were adopted only after experiencing a severe disaster. For instance, several interviewed managers reported that they had not considered how devastating an earthquake would be to their operations worldwide until the 2011 Tohoku disaster in Japan. However, when managers succumb to the availability bias following an adverse event by overestimating its likelihood, they may decide to invest in protective measures that would not be justified if they had undertaken a systematic analysis via a deliberative process.

Misestimation. Attributing positive outcomes to one's ability rather than luck often leads individuals to assume that a shock has a drastically different probability of occurrence than it actually has. As an example of the *riskification* of uncertainty, this misestimation is generally coupled with the inaccurate perception of the expected return of investments in prevention and mitigation. Managers' underestimation of the hardship of the 2007-09 financial crisis highlights this point as illustrated by the following comment by the CEO of a chemical company: "*We saw some signs as early as June that there was a real storm coming economically. We got together all of our leaders in July and we had them work through our traditional scenario evalution on what they would do if volumes fell 5%, 10%, 20%,… Now, when it hit, it turned out to be a lot worse than the 20% for some of our businesses.*"

Overconfidence. The tendency for decision makers to focus only on readily available data can lead to overconfidence in one's choices because relevant factors are not considered. This

bias was highlighted by the chief risk officer of a bank. He noted that his organization learned the hard way because he was overconfident about the firm's retrospective risk models, which led him to neglect the chance of inaccurate predictions due to lack of relevant data. The director of risk management of an information technology company described that dealing effectively with a series of negative individual disruptions early in their company's history impacted the organizational culture when dealing with shocks noting that: "*After surviving fairly well different events, I get the sense we were confident that we could handle it again and deal with events like that in the future. Probably overconfidence to a certain degree…When we dealt with a risk that we were not expecting, we again followed our risk model, but barely survived*."

Short time horizons. Employees are susceptible to different types of myopia or short-sightedness when deciding not to invest in prevention and mitigation. There is a tendency by managers to discount the future very sharply so there is a reluctance to incur high upfront costs of investments unless the payoffs from them can be accrued over the next few years. For instance, British Petroleum suffered a string of accidents from 2005 to 2010 culminating in the massive oil spill in the Gulf of Mexico in 2010. An independent panel that had reviewed an earlier BP refinery explosion that resulted in the loss of fifteen lives concluded that short-term management incentives had been a key contributor to the company's underinvestment in process safety: "*The performance system has a decidedly short-term emphasis, with performance contracts typically focused on short-term goals [. . .] Decisions and events impacting process safety or human capability may not have a discernible impact for many years. For example, a decision to reduce spending on inspections, testing, or maintenance may have no apparent negative impact on process safety performance for a lengthy period.*" (Baker et al., 2007: 90–91). This tendency to prioritize the short-term is not exclusive to BP. Many companies similarly underprepare for rare events because they focus on the next period (e.g., quarter or year) when determining the likelihood of the event occurring (Garicano & Rayo, 2016).

Thresholds. Managers often ignore extreme events because they perceive the likelihood of their occurrence (p) to be below their threshold level of concern (p*). Suppose that p* is defined as a one percent chance that the adverse event will occur next year. If the firm believes that p is lower than p*, it will ignore the potential consequences of the event occurring (Slovic, Fischhoff, & Lichtenstein, 1977; Slovic, Fischoff, & Lichtenstein, 1982). An enterprise risk manager from an oil company highlighted the role that threshold rules play in justifying taking action: "*We've done a rough job, I'll say, of trying to define certain thresholds at which risks are elevated for review. So for example, a $100 million loss event is one that typically is elevated to regional leadership. Anything that could, we believe, plausibly result in a fatality has to be explicitly elevated to the overall leadership team."*

Survival points. Firms are concerned with determining when their surplus liquidity would not be able to cover the costs of an accident or disaster. They often construct scenarios depicting extreme events where the losses exceed their current surplus and assign likelihoods of each of these scenarios occurring. The decision as to which of these scenarios to consider depends on the managers' attitude toward risk or their risk appetite—i.e., how much risk they deem acceptable (March & Shapira, 1987). If the firm has not suffered severe losses in recent years, then the key decision makers may determine that these scenarios are below the firm's threshold level of concern. Only after suffering a significant reduction in their surplus are they likely to change their behavior.

Following the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, another integrated oil company made a decision to get out of deep water drilling. The director of risk management indicated that the company felt that it would not have the liquidity to withstand an event similar to the BP accident: *"Although that oil spill didn't impact us directly it probably has had the single largest impact on the industry I've seen in ten years. We quickly came to the conclusion that we really wouldn't survive an event of that magnitude. It is our view that there is always the*

potential for something to happen like that. So we spent a lot of time asking, 'Is that the type of a business we'd like to be in?'"

Status quo. This heuristic is based on the relevant reference point that distinguishes outcomes perceived as losses from those perceived as gains. The potential negative consequences of moving away from the current state of affairs are weighted much more heavily than the potential gains, often leading the decision maker not to take action (Kahneman & Tversky, 1979). This behavior is reinforced because movements away from the current plan are viewed as performance failures**.** Employees who have a vested interest in the current state of affairs may use their power to block change. Hence, it often takes a severe adverse event for the organization to consider challenging the status quo (Samuelson & Zeckhauser, 1988).

After the Tōhoku disaster in 2011, a publishing firm in East Japan began thinking about what could happen to the nearby nuclear power plant if an earthquake occurred. The director of business continuity recognized that the probability of having an earthquake at this location was less than 1-in-10,000, but felt it was something that could happen and indicated that "*After any catastrophe the firm needs to take a look and ask itself, am I okay with the status quo? I know what's happening with this. What do I need to look at differently?"*

A medical technology firm behaved in a similar fashion even though they had not suffered any damage. The director of corporate risk management noted: "*There were some people who asked, 'Could this happen some place else and result in exactly the same sort of exposure to another part of the company?' And we said this was an earthquake event, which had a tsunami associated with it, which doused the nuclear plant that went into meltdown. Extraordinary set of circumstances. Where else could this possibly happen to our company?"*

Meso Dimension

A cornerstone of Simon's (1947) seminal *Administrative Behavior* is that the influence of firm-level factors is necessary to understand the choice process of employees. Drawing upon this argument, we now characterize how the organizational structure deals with biases and heuristics that influence employees' decision processes. An organization, as a system of collective action among individuals and teams with different preferences and information (March & Simon, 1993) that operates under institutional contexts (March & Simon, 1958), faces comparatively high behavioral complexity when managing and learning from uncertainty shocks.

The organizational and management literatures have overemphasized the role of top managers in the performance of organizations in the context of adversity or emergency (Eggers & Kaplan, 2009; Helfat & Peteraf, 2015). In practice, employees at different levels of the organization are key actors in discovering threats, transmitting tacit information, and designing and implementing continuity and recovery plans. Transforming past experience into more resilient organizations by learning from earlier disasters and disruptive events normally entails diverse and often conflicting cognitive factors (Lampel et al., 2009). Strategy—the organizational goals and initiatives—and structure—the formal mechanisms of communication and authority—trigger or control biases and heuristics, thus affecting collective action when dealing with disruption (Oliver & Marwell, 1988). We review these determinants in the following subsections.

Strategy

A recurrent question emanating from Simon (1947) is what defines the limits of rationality among business decision makers and how they relate to intuitive (System 1) and deliberative (System 2) thinking under uncertainty. With respect to organizational strategy, the answer relates

to how the goals and initiatives of the firm shape the biases and heuristics utilized by managers and other employees in their decision-making process.

We found that the goals of the unit and/or company tend to connect strongly with managers' threshold heuristics. For instance, firms with a long-term orientation that prioritized survival were much more likely to invest in disaster preparation than firms with a short-term focus on profitability because the latter were more likely to be affected by myopia and the status quo bias. Some managers use their risk appetite as a guideline for their unit's or firm's strategic planning. When they conclude that no exogenous disruptions are likely to affect their performance targets, they tend to be overly conservative in their market behavior. When they feel there is a reasonable chance of disruptive events that will lead the firm to not meet its performance target, managers will often engage in risk taking in the hope of still meeting their goals and targets (Bowman, 1982).

We observed that the firms that were best able to deal with uncertainty shocks were those whose strategy facilitated adaptation of functions and reconfiguration of resources. A flexible strategy not only helped control the individual biases of key decision makers, but also avoided the fallacy of *riskification* of uncertainty. That is, managers of these firms were generally aware that actions taken in response to one disaster may not enable the firm to deal with a catastrophe that takes a different form.

Conversely, firms suffering significant losses from exogenous crises tended to have well-established routines that allowed little consideration to abnormal situations. For instance, only after their building in downtown Bangkok was burnt to the ground in the context of political unrest in Thailand, did a service industry invest heavily in a business-continuity procedure by

which employees could use IT systems installed in their own homes. A manager of this corporation narrated his visceral memories of the 2011 Thailand floods that rendered their procedure inoperable because they did not have access to their office and their workers' homes were underwater.

Structure

There are three elements behind organizational structure that are critical for firms to manage and learn from uncertainty shocks: hierarchy and authority, economic incentives and communication systems.

Hierarchy and authority. The organizational chart that defines the functional and geographical location of employees and their role as informational nodes will determine their ability and incentives to attend to and communicate threats and to facilitate business continuity during disruptions (Cyert & March, 1963; Gavetti et al., 2017; March & Simon, 1958; Simon, 1947). The structure of work affects what biases and heuristics will be more likely to arise. For instance, employees working in teams often underestimate signals of rare threats when several team members are overconfident about the functioning of the operation (Rerup, 2009).

The characteristics of authority will influence how individuals implement choices whose outcomes are difficult to predict. For instance, the marketing department may undervalue disruption when entering a politically turbulent, but commercially attractive market (Maitland & Sammartino, 2014). Conversely, the risk-management department of an insurer may overemphasize the probability of hazards in the aftermath of a catastrophe and order their underwriters to cease providing insurance (Kunreuther & Useem, 2018).

Leading and following orders or recommendations during turbulence are critical tasks in managerial practice (Gavetti et al., 2007; Simon, 1947). When uncertainty is pervasive, leadership at all levels is essential for interpreting ambiguous information and then collectively responding to unpredictable phenomena. During disruption, managers must hastily respond to new information and often deviate from established protocols. While dealing with their own biases, leaders will be a strong influence for how much other employees will be using intuition or deliberation.

Moving from individual actions to team decisions and tiered leadership brings an additional complexity to uncertainty management that is addressed in diverse ways by organizations. In some firms, executives in the C-suite rely on their middle managers to identify external threats and then both groups work together to prioritize threats. In other firms, tiered decision making is viewed as introducing conflicts that could result in disastrous outcomes. A vice president of an IT firm noted "*I could not imagine more than two teams from different areas planning what to do. That would be a very lengthy and conflictual process.*"

Economic incentives. Studies in the risk-management literature suggest that myopia often dominates willingness to invest in preparation and mitigation unless there are short-term economic incentives that encourage firms to think long-term (Dong & Tomlin, 2012; Kunreuther, 1996; Kunreuther, Pauly, & McMorrow, 2013). For example, a CEO may avoid costly mitigation investments if the assessed benefits do not materialize during her expected tenure in the organization (Levinthal & March, 1993). Recent disasters have affected how managers perceive the value of such investments as illustrated by the comments of an executive of an IT firm: "*Production lines going down in an earthquake was unbelievable so (we) didn't plan for what actually happened---all seven production lines in the plant not functioning. After*

the Japanese earthquake/tsunami, the firm invested $400 million in specialized equipment in their manufacturing plants in Japan and did structural design work so that the plants could withstand higher shocks."

Given the short-memory for shocks, the formalization of economic incentives into procedures and plans in the aftermath of disasters varies as a function of the *long-term orientation* of the compensation scheme in the organization (Flammer & Bansal, 2017). Firms that tend to reward employees based on immediate goals (e.g., annual income) are likely to view them as more preoccupied with day-to-day operations and less interested in assessing sources of disruption and investing in improving business-continuity procedures. When managers in these firms face uncertainty, they often compensate their units' operation to maximize expected short-term profits. Hence, these organizations tend to discount significantly the long-run survival of the enterprise and underestimate the relevance of low-probability phenomena. Conversely, managers whose compensation schemes have a longer-term orientation (e.g., a portion of income is linked to share prices) have an additional reminder of the economic value of investments that can last for many years (Kunreuther & Useem, 2018).

The relationship between managing uncertainty and economic incentives involves a paradox on the use of deliberation vis-à-vis intuition. On the one hand, recognizing the value of preparing against uncertainty shocks implies a greater influence of deliberative over intuitive thinking. Not incurring the upfront costs now are likely to undercut the long-term returns of the firm (Meyer & Kunreuther, 2017). The Global Head of operational risk of an investment bank mentioned that, after seeing so many companies going out of business after the 9/11 attacks, the "*firm became more deliberative in tackling black swan events*."

On the other hand, when employees see a substantial amount of their income attached to short-run organizational outcomes, through bonuses or job security, they neglect less proximate and ambiguous goals. For instance, a piece-meal worker is likely to be unclear about the benefits of stopping production to retrofitting the factory against hurricanes because the financial cost of such interruption is immediate for such a worker. Behind this inclination, there is also deliberation and rational choice as in the case of a manager investing in prevention.

Given these considerations, compensation schemes may affect the performance of the organization during disasters. A consideration to the role of biases such as myopia, underestimation and overconfidence is necessary when organizations design economic incentives across the organization.

Communication systems. The choice of action depends not only on goals formulated at the C-suite level but on how these are communicated and interpreted at lower levels of the organization and vice versa. In fact, the literature offers several cases of organizations failing to avoid disruption due to decision makers at the top of hierarchy disregarding warnings raised by employees associated with the firm's operations (Lampel et al., 2009; Rerup, 2009). For instance, in the months running up to the financial disasters that struck AIG and Lehman in September 2008, many of their front-line employees had feared that the rapid growth of sub-prime mortgages that they held could prove catastrophic, but top-line managers did not absorb or act on that upward provided information to avert disaster (Kunreuther & Useem, 2018).

The effectiveness of communication is instrumental to navigate the complexity that arises during disruption. As a senior risk manager of a large bank reported: *"Communication is of critical importance following a disaster. We don't need more information, but pertinent data.*

One of the unfortunate things during a crisis is somebody presses a button somewhere, and suddenly you're presented with 10,000 pages of information you must wallow through to find something critical. So, there must be some filtering so that critical information is presented to the board, to the leadership, and to the managers on the ground. That's not a science; it's an art, an evolving art."

As a general lesson from the study with S&P 500 firms, we found that organizations with multi-tiered structures in which different levels play a role during shocks were comparatively successful in having a more comprehensive understanding of the threat. This form of specialized decision-making structures fostered reconciliation and integration of divergent perceptions and were relatively able to reach cooperation during abnormal times. Most effective companies used this architecture in harmony with an organizational culture that brings those distributed leadership layers together to control biases and heuristics toward collective action.

Macro Dimension

In 2007, Gavetti et al., suggested that "the most important developments in organizational theory in the last two decades…are the increasing understanding…about the environment and broader social context under which organizations operate" (Gavetti et al., 2007: 524). As this pattern in the literature has arguably continued for the past decade, scholars studying how organizations deal with exogenous disruption have strived to generate statistical regularities across firms by focusing on institutional and stakeholder dynamics (Ballesteros & Gatignon, n.d.; Ballesteros et al., 2017; Luo, Zhang, & Marquis, 2016; Madsen & Rodgers, 2014; Muller & Kräussl, 2011; Oetzel & Oh, 2014; Oh & Oetzel, 2016). The tradeoff of this focus has been a neglect of the firm's cognitive richness and idiosyncrasies whereby the organization is a "relatively vacuous"

entity embedded in social structures and aligning to institutional referents (Gavetti et al., 2007: 524; Powell & Colyvas, 2008).

Most work has assumed that organizational decision-making under uncertainty follows well-known institutional logics, stable regulatory mechanisms, and clear stakeholder dynamics (Pahnke, Katila, & Eisenhardt, 2015; Powell & Colyvas, 2008; Zhang & Luo, 2013). Consequently, this literature has not considered the environmental instability that natural disasters, political coups, terrorist attacks and similar phenomena often create (Alvarez & Barney, 2005; Tilcsik & Marquis, 2013).

Uncertainty shocks often change the macro status quo (Aghion et al., 2016; Cavallo et al., 2013; Cavallo & Noy, 2011). They may lead to temporary or permanent institutional arrangements, such as government agencies (Ballesteros & Gatignon, n.d.; Useem et al., 2015) or bring prominence to societal dynamics that remain subtle or inconsequential in stable conditions (Alessi, 1975; Douty, 1972). In this last dimension of our theoretical framework, we aim to refocus on this turbulence by integrating the internal and external factors affecting how organizations deal with unpredictability and ambiguity.

Institutions

As suggested above, the traditional approach of the literature studying the context-based determinants of organizational behavior is to consider the institutional environment to be stable (Kaplan, 2008; Powell & Colyvas, 2008; Tracey, Philips, & Jarvis, 2010). In practice, uncertainty shocks often swiftly reshape norms, values, and rules, which otherwise change incrementally (Bloom, 2009; North, 1990). They provide unique opportunities for rapid market changes due to novel public policy or changes to the competitive landscape (Aghion et al., 2016; Baker & Bloom, 2013; Cavallo et al., 2013; Kousky, 2013).

For instance, construction of factories and infrastructure must adhere to a host of new regulations issued or reformed in the aftermath of disasters. This is illustrated by the enforcement of construction codes after the 1999 earthquake in Turkey that changed the commercial landscape in the Marmara region (Anbarci, Escaleras, & Register, 2005). Firms sometimes have to adjust their geographical markets after human resettlement and gentrification that often follow large disasters such as Hurricane Katrina in New Orleans (Cutter, 2006).

Therefore, managers face not only the underlying uncertainty of the hazard, but also the causal ambiguity resulting from institutional change. Under these conditions, the biases and heuristics that managers traditionally use when coping with emergencies may become highly inefficient when uncertainty shocks trigger substantial institutional change.

In this sense, local governments often play an important part in shaping how managers use existing organizational resources to deal with emergencies. Public policy is essential for mitigating extreme shocks or recovering from catastrophic events but finding the balance between uncertainty hedging and post-disaster economic dynamism is not trivial. In the U.S., for instance, the federal government has responded to crises by adding new regulations to reduce company risk, and while well intentioned, *overregulation* and the uncertainty of future regulation have themselves become a concern for many firms (Kunreuther & Useem, 2018).

At the same time, tax credits or subsidies for real estate development sometimes increases risk taking by managers because they perceive a lower financial cost at stake (Wenzel & Wolf, 2013). This has led to construction of production facilities in disaster-prone areas, such as San Francisco Bay, the coast of Florida, and the seismic zones of Mexico City and the Italian Abruzzo region (Ballesteros & Useem, 2015). In this regard, the short-sightedness of policymakers, allowing urban sprawl in disaster areas, combined with the overoptimism of business managers, who underestimate the possibility of a large shock, creates problems for firms in the future should a serious disaster occur.

The regulation and policy instruments that countries use to deal with future large-scale disasters may moderate the role that cognitive biases and heuristics play with respect to the organization's vulnerability to external disruption. As a case in point, a financial institution recognized the importance of focusing on their survival point after being rescued by a stimulus package by the U.S. government during the financial crisis of 2007-2009. Only then did they take into account a set of low probability events that were not previously on their radar screen. The firm's director of risk management noted, *"I think the amount of capital that we take, the modeling that we use to anticipate these black swans and the resulting capital that we have to set aside for these anticipated risks are taken far more seriously than they were before because of the bailout."* Conversely, public financial assistance following a catastrophic event distorts managerial incentives to prepare against disasters (Platt, 2012). This is a moral hazard associated with public aid in the sense that firms perceive that there will always be a funding source in case of calamity, and thus they underinvest in mitigation mechanisms.

The role of institutional factors causing hardship to firms from uncertainty shocks is exacerbated by economic interdependencies. As shown by disasters such as 9/11 and Hurricanes Katrina and Sandy, the failure of infrastructure in one economic sector or industry can quickly translate into a systematic disruption. And the internationalization of the supply chain has diminished the role of geographical location as a condition for suffering the consequences of shocks. For instance, U.S. auto-makers, for instance, had losses following the 2011 Tōhoku disaster that were equivalent to the losses suffered by their supplier companies located in Japan (Berlemann & Wenzel, 2018; Boehm, 2014). Economic interdependencies have thus increased the complexity of preparing against uncertainty shocks.

Stakeholders

In an integrated economy, the magnitude of the hardship faced by firms depends not only on its own managers' decisions but also on those of others external to the organization, such as

customers, competitors, and regulators. For instance, organizations often look to firms in the same industry to obtain guidance for their own choices and to help determine their vulnerability to correlated shocks (Ballesteros et al., 2018). Imitation helps managers legitimize measures whose efficiency is ambiguous (DiMaggio & Powell, 1983; Mizruchi & Fein, 1999). This type of social learning is widespread when organizations deal with uncertainty (Madsen, 2009) and influences the diffusion of practices across firms (Gaba & Terlaak, 2013; Levitt & March, 1988).

More specifically, the economic incentive of organizations to invest in preventive measures against disasters often depends on how competitors behave. In the study with S&P 500 firms, managers reported that they frequently consider what their counterparts in rival firms were doing to protect themselves against catastrophic losses. For example, some firms revealed that the decision by a division's manager on whether to incur in costly investments to retrofit factories would often follow the investment behavior of nearby competitors. Additionally, the biases and heuristics of input suppliers are also a crucial factor when firms navigate uncertainty. When managers in energy companies misestimate the likelihood of hurricanes and underinvest in the resilience of power grids, these firms fail to allocate resources to prepare the grids against disasters, such as trimming vegetation near distribution lines. In California they are then held responsible for wildfires that are caused by sparks emanating from their power lines (Peloso & Miller, 2018).

Similarly, optimism, myopia, and other biases in financial sector firms may affect the ability and incentives of managers in customer organizations to hedge against disasters. After Hurricane Katrina, for instance, the demand for property insurance exceeded its supply since some insurers ceased underwriting policies in the area due to fear that their portfolio risk would exceed the company's surplus. When many insurers resumed activity a year or more after the disaster, insurance penetration did not reach pre-disaster levels (Zanetti, Schwarz, & Lindemuth, 2007). Another example is the case of banks in California not requiring earthquake insurance as a

condition for a mortgage because they believe that it will hamper their competitiveness given that borrowing would become more expensive for the property owner. As a result, many California-based companies are underinsured against earthquakes (Kunreuther & Useem, 2018).

Insurers' behavior with respect to pricing terrorism coverage illustrates another heuristic used by firms: threshold-like behavior. Prior to 9/11 insurers did not explicitly consider the likelihood and potential costs of an terrrorist attack despite the 1993 World Trade Center bombing, the Oklahoma City terrorist truck bombing attack in 1995 and other attacks around the world. The decision by insurance firms not to charge a penny for losses due to terrorism before 9/11 could be explained by the fact that they had never considered terrorism as a meaningful threat in determining premiums for residential and commercial properties. Their claim payments from the 1993 World Trade Center disaster and the 1995 Oklahoma City bombing did not make a dent in their balance sheets so they felt it was not necessary to consider terrorism in their premium calculations. After 9/11 most insurers refused to offer terrorism coverage even though firms were willing to pay extremely high premia, leading to the passage of the Terrorism Risk Insurance Act in 2002, a public-private partnership (Kunreuther, Michel-Kerjan, Lewis, Muir-Wood, & Woo, 2014).

A final consideration regarding on how external actors affect managers' decision-making processes when dealing with uncertainty shocks is the role of mass media. Often, organizations design their emergency plans around the specific feautures of shocks that have attracted significant media coverage and, therefore, are likely to be enacted in the organizational discourse on *likely* calamities (Eisensee & Strömberg, 2007; Hoffman & Ocasio, 2001; Lampel et al., 2009). However, as discussed above, the unpredictability in the characteristics of disasters often surprises managers, as it rarely resembles the disruption that the firm envisioned. This is illustrated by the following comment from the vice president of risk management of a pharmaceutical company: "*Everything we read was about the bird flue in Asia. And we*

implemented pandemic planning in with all of the models indicating bird flu. When we had the swine flu outbreak in Mexico […] A lot of things that were planned for around that bird flu and the expected high level of acuity were inappropriate."

Often disasters magnify the influence of intermediaries in the value chain. In the aftermath of Cyclone Enawo in Madagascar in 2017, firms that stood between farmers and food companies took advantage of the high demand of vanilla to increase its scarcity, which propelled prices that have lasted until today and affected the profit forecasts of the several food companies worldwide. The vice president of supply chain of the Dunkin' Brands Group that was impacted by the price increase said that the firm was "Monitoring the situation with vanilla extract prices very closely, and (is) working hard to mitigate the impact on our costs." Other firms have changed their structures to create special units dedicated to mitigating the role of intermediaries during disasters and have engaged in negotiations with customers "to counter much of the headwinds posed by certain rising ingredient costs, including vanilla extract" (Pavlova, 2018).

DISCUSSION

"High dwellings are the peace and harmony of our descendants. Remember the calamity of the great tsunamis. Do not build any homes below this point." This is the inscription on one of the many stone monuments abounding the city of Miyako in East Japan. Officials built them to motivate preparation for events that are unpredictable. They were aware that undermanaging uncertainty is part of the human condition (Meyer & Kunreuther, 2017). Despite numerous disasters hitting the area over the years, each time its residents have rebuilt as if those calamities never happened. The 2011 Tōhoku disaster killed 420 residents and destroyed over 4,000 buildings in Miyako.

Unfortunately, similar behavior before, during, and after disasters are pervasive across the organizations we interviewed. In fact, the statistics suggest that most firms fail in efficiently

managing and learning from uncertainty shocks—i.e., exogenous and unpredictable disruptions, whose welfare effects spread across geographies, industries, and markets (FEMA, 2015; SwissRe, 2018). We have argued that a critical reason behind this failure is the *riskification* of uncertainty: the fallacies that unpredictability is controllable, and experience is the same as learning. When managers believe that the next disaster will be similar to the previous one, they are likely to be ill-prepared for the next shock (Kunreuther & Useem, 2018).

Confounding uncertainty with risk is inadequate because hard data suggest that the consequences of correlated shocks are difficult to translate into probability functions and most firms approach managing these shocks as an unstructured activity that rarely is integrated into annual financial projections. The mechanisms through which organizations learn from extreme phenomena differ from learning from individual, more frequent accidents (Madsen, 2009).

More generally, approaching the organizational inefficiency in dealing with uncertainty shocks as a problem of risk management underestimates the institutional and stakeholder complexity that decision makers face. Across societies, these phenomena can be a source of creative destruction: the status quo is disrupted (Barro, 2007; Bloom, 2009), competition is altered (Cavallo et al., 2013), technological, social, and economic change is frequent (Dong & Tomlin, 2012; Kunreuther et al., 2002), and opportunities for rents are generated (Ballesteros et al., 2018; Muller & Kräussl, 2011). Uncertainty shocks challenge established incumbents and open opportunities for business creation and radical innovation (Seo, 2017). This is observed, for instance, in the aftermath of the 9/11 attacks (Aggarwal & Wu, 2014; Paruchuri & Ingram, 2012; Seo, 2017), the earthquakes and tsunamis in Chile in 2010 (Useem et al., 2015) and in Japan in 2011 (Layne, 2011). On the flip side, uncertainty shocks are also associated with significant business mortality. Hence, how managers choose to prepare for, cope with, and recover from uncertainty shocks are, highly consequential decisions for firm performance and sustainability.

We believe that a large portion of the literature follows the erroneous approach of treating uncertainty as risk (Hardy & Maguire, 2016). We suggest that one way to start correcting this approach is by understanding the individual-, firm-, and context-specific factors that differentiate firms that navigate sudden disruption more successfully from those do not. We believe that a few lessons are suitable of generalization. First, scholars should consider that organizational structure and strategy plays a critical role in mediating and moderating behavioral factors. Attention to external threats by investing in protective measures and implementing business continuity and recovery plans depends on the organizational architecture of communication that guides the flow of data as an integral part of uncertainty management (Gavetti et al., 2007; Kunreuther & Useem, 2018).

Second, in line with earlier research on organizational decision-making (Beck & Plowman, 2009; Rerup, 2009), dealing with uncertainty is not an exclusive task of the top management but a collective-action problem. Everybody is responsible, which is often not the case when dealing with individual risks (Kunreuther & Useem, 2018). For instance, the interviews with risk managers revealed they were often more acutely aware of emerging hazards than those in the C-suite who often were reluctant to make investments in loss reduction measures a priority. Organizational procedures that ensure the engagement and alignment of different hierarchical levels hasten the mobilization and deployment of resources during abnormal times. The benefits of leadership at each level is likely to be strongest if it is shaped by guidance and collaboration from the levels below and above. The value of tiered leadership increases as the degree of ambiguity in the risk is higher and there is greater urgency in dealing with the disruption created by the crisis or adverse event. In turn, authority and centralization affect the combination of intuition and deliberation by determining the formal capacity of individuals to steer the organization during disruption.

Third, incentive structures are a strong regulator of the behavioral factors affecting organizational decision-making under uncertainty. The degree of long-run orientation of economic-incentive schemes will affect the willingness of employees to invest in prevention and mitigation. Our investigation suggests that most firms are not aware of this relationship. In this respect, a promising avenue of study is the effect of different compensation schemes (e.g., piece-meal versus fixed-wage) on the impact of disasters on financial performance.

A final lesson is that learning from uncertainty shocks is an on-going process. Across the life of the organization, managers will vary in their ability to prepare for, cope with, and recover from crises. Firms should embrace this idea; the costliest losses frequently came after organizations felt they had a sense of control, that they had *riskified* uncertainty and could predict the consequences of shocks. It is at that stage that organizational learning stalled because managers thought that they had enough information to deal with exogenous disasters. The director of corporate risk management at a medical technology company summarized this nicely: "*How can I tell you what we don't know, because we don't know it? So I am looking at other ways just to continually keep people thinking about events outside the organization that are at least plausible and that we should take a look at*." In the context of organizational decision making under uncertainty shocks, data are always incomplete and rationality is never full (Kunreuther & Useem, 2018).

CONCLUSION

The last two decades have witnessed a substantial rise in the managerial and organizational attention to uncertainty shocks (Ballesteros et al., 2018). The World Economic Forum, which has annually gathered business and government elites in Davos for 45 years to discuss global challenges, provides a proxy in this regard. In 1997, only 5% of the sessions at the annual meeting focused on uncertainty shocks; by the mid-2000s, about 35% of the sessions were

devoted to this topic. In recent years, the discussion in Davos has moved from understanding shocks to better managing them and building resilience (Kunreuther & Useem, 2018).

The academic literature does not reflect this trend in managerial practice and continues to treat the organizational complexity of dealing with uncertainty shocks as a problem in risk management. Scholars that explicitly have studied organizational decision making under conditions of causal ambiguity and environmental uncertainty have focused on well-defined individual risks and explored short-run outcomes such as sales, market entry, or non-market behavior (Ballesteros & Gatignon, n.d.; Hardy & Maguire, 2016; Oh & Oetzel, 2016). Uncertain shocks need to be considered in a different light from these individual risks as they trigger systematic biases and heuristics by decision makers that are modulated by firm-specific variables.

The framework proposed in this article offers opportunities for systematic analysis that promise to increase our understanding of the relationship between uncertainty and organizational performance, particularly when organizations seek to manage and learn from catastrophes. A focus on the short run restricts the ability of firms to develop cost-effective strategies for dealing with future crises and disruptions that requires the organization to behave in a more deliberative manner. Given the relevance of uncertainty shocks on firm performance and sustainability worldwide, future research on this relationship is likely to have significant managerial and public-policy implications.

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TABLES AND FIGURES

Figure 1. The three dimensions of organizational decision making under uncertainty shocks