Empowering Organisations to Gain From Uncertainty: a Conceptualisation of Antifragility Through Leveraging Organisational Routines in Uncertain Environments

Albert Munoz[1], Mathew Todres[2] and Laura Rook[3]

Abstract

Economic shifts, disruptive innovations, and competitive rivalries continuously reshape the operating environment of organisations. Such uncertainty impacts organisations and raises significant challenges. While many organisations tend to respond to uncertainty by adopting loss minimisation strategies, others see uncertainty as an opportunity to achieve gains. The latter view is exemplified in Taleb's (2012) concept of 'antifragility', a property of systems that gain when exposed to uncertainty. For organisations, the challenge lies in the identification and execution of fundamental artefacts to accomplish work to achieve antifragile outcomes. One such artefact is the organisational routine; repeatable, regular patterns of behaviour and actions that influence performance. This paper conceptualises the intersection between antifragility, uncertainty management, and organisational routines literatures to identify four routine archetypes that can guide actions that contribute to organisational antifragility. Theoretically, this paper identifies how these archetypes arise from the interplay between temporal action (as tendencies towards proactive or reactive action) and risk mitigation strategies (as preference towards redundancies or flexibilities). Developed insights bring forth a foundation for predictive models of performance, and guidance for organisations aiming to thrive, rather than just survive, in uncertain environments. This paper concludes with the identification of further research avenues.

***JEL classification**:* M10

Keywords: Antifragility; Organisational Routines; Redundancy; Flexibility

[1] School of Business, University of Wollongong, Australia
[2] School of Business, University of Wollongong, Australia
[3] School of Business, University of Wollongong, Australia

1. Introduction

As recent COVID-19 related events continue to unfold, we are reminded that throughout history, significant events can bring about enormous uncertainty (Kirk & Rifkin 2020). For organisations facing such events and uncertainty, little is known about whether artefacts possessed by an organisation will help obtain favourable outcomes. Research acknowledges that markets are not given or deterministic, and proposals have been put forth that view markets as malleable, even in highly uncertain contexts (Nenonen & Storbacka 2020), and often present opportunities to leverage gains (Alvarez et al. 2018; Knight 1921). Although we understand the concept of gaining from uncertainty referred to as antifragility (Taleb 2012; Taleb & Douady 2013), and can observe some examples (Danchin et al. 2011; Markey-Towler 2018), there is little guidance as to how to design actions that help contribute to an organisation gaining from disorder. Organisations' actions during times of high uncertainty will have some influence over performance outcomes, as advocated by open system theories (Kast & Rosenzweig 1972). Thus, the decisions made by management prior to, and in reaction to events of great uncertainty that can decide whether or not an organisation will remain viable after an episode of great uncertainty.

Dealing with the challenge of emerging and future uncertainty, is underpinned by well-established forecasting, planning, and participatory approaches (Miles 2010), featured by applied methods, such as scenario planning (Derbyshire & Giovannetti 2017) and scenario forecasting (Crawford 2019), as well as models such as time series (Tseng et al. 2002) econometric (Garcia-Swartz et al. 2019), judgemental (Bolger et al. 2011) and Delphi models (Culot et al. 2020). Considering business organisations in the context of uncertainty specifically, recent contributions have drawn attention to the value of developing an 'antifragile' methodology to complement scenario planning (Derbyshire & Wright 2014), and building antifragile and resilient business ecosystems to cope with disruptive and unexpected events (Ramezani & Camarinha-Matos 2020).

In this paper, we propose that organisational routines are capable of leveraging gain from uncertainty, and thereby contributing to organisational antifragility. This can be achieved through employing organisational routines as the lever to exert influence on outcomes, with the desired outcome being organisational gain in times of great uncertainty. Underpinning this premise is that routines can have latent value, readily observable during times of great uncertainty, but hidden otherwise. The literature on latent functions describes the discovery of latent value as frequently being an unintended consequence (Merton 2016; Merton 1968) as original design efforts would be guided towards a different intended function. For example, the proper function of a hammer is to drive in nails, but a hammer can also be used as a paperweight. In doing so, the hammer would be used for a function that is vastly different to a hammer's intended purpose (Crilly 2010). This research posits that these functions, as they relate to routines, can be purposeful adoptions of organisations, and serve to elevate performance as a result of exposure to uncertainty. Furthermore, in developing a model identifying several possible variants of anti-fragile routines emergent from the contingent interplay between timing (proactive and reactive) and type of response to uncertainty (redundancy or flexibility), we view this model as a potential forecasting method for guiding decision-making for dealing with disruption. As such, our model contributes to the important notion of optionality available to decision-makers (Derbyshire & Wright 2014), by identifying possible routines through which to activate during times of uncertainty. At its core, we refer to these routines in our model, as the latent value of antifragile routines.

In conceptualising antifragile organisational routines, we begin with the foundational works in antifragility and open systems underpin these works with subsequent theoretical advancements in psychology. Organisational routines are repetitive, recognizable patterns of interdependent actions (Feldman & Pentland 2003) that are understood as the building blocks of organisational capability (Winter 1995). Given the ubiquity and potential range of organisational routines, it should therefore, be possible to leverage routines to 'gain from uncertainty' as described by Taleb (2012) . Current understanding of how antifragility is expressed points to the reconceptualization of uncertainty as potential for gain, similar to the uncertainty arguments that view chaos as opportunity to generate profit (Alvarez et al. 2018). A psychological interpretation of antifragility differs considerably from the recent research of Kirk and Rifkin (2020) on consumer behaviour. Where consumers follow a journey of reacting, coping, and eventual adaptation, antifragile personalities possess knowledge over others, an inherent flexibility, a desire to gain further knowledge, and a courage to try new things in uncertain situations (Markey-Towler 2018). Such a contribution sets the scene for reconceptualising characteristics of the anti-fragile personality into organisational routines. In doing so, organisations may facilitate purposeful use of routines which may not be beneficial in times of low uncertainty, but provide a gain in times of higher uncertainty. Translating this to an organisational context requires us to view organisations as sets of interacting routines, with the capacity to interchange routines given changes in environmental conditions. Such interactions are well placed in systems theories, specifically open systems. In order to effectively identify the manifestation of antifragility, the question we pose is what archetypes exist that can be operationalised as routines towards a 'gain from disorder'? Implicit in this question, is the suggestion that *variations* of anti-fragile routines may manifest themselves in different conditions of disorder and organisational contexts.

This research makes a contribution to the understanding of antifragility in business contexts by; (i) extend the literature on organisational routines to consider latent functionality of routines, (ii) present a new perspective of routines as vehicles of antifragility, and (iii) implement a diagnostic mechanism for the identification of archetypes by which routines can be identified as possible ways of purposeful implementation of antifragility in organisations.

2. Antifragility and Routines

Antifragility is the property of systems that allow a betterment as a result of exposure to stressors, shocks, volatility, noise, and uncertainty in general (Taleb & Douady 2013). The concept of gaining from uncertainty (Taleb 2012), referred to as antifragility, was popularised by Taleb (Taleb 2012). Systems that possess antifragility will seek to gain from disorder through a configuration of resources and capabilities (Derbyshire & Wright 2014). Taleb (2012) describes a system property contrary to fragility, namely antifragility, which benefits from shocks and stressors and essentially thrives when faced with uncertainty. To illustrate, consider how a muscle gains strength after being exposed to some stressors (e.g. exercise), or the Lernean Hydra, (a serpentine water monster in Greek and Roman mythology) with numerous heads, and when one head is cut off, two grow back in its place. In contrast to the hydra, organisations may need to actively seek out opportunities to gain from disorder, through purposeful engagement of resources towards gain.

A review of the literature was conducted to translate the desired goal of antifragility to organisational designs; with two themes emerging. The first is the concept that disruptions lead to failures that are repaired, but the repair is coupled with an improvement process leading to better performance (Aven 2015). For example, an individual that experiences a failure will often be

motivated to overcome its impact, explain the failure, and learn new knowledge to achieve success in the future (Shepherd 2004). This mechanism is present in other forms, such as the practical malleable characteristic of human beings that is capable of change when substantive stressors are experienced (Pierce et al. 1993). This capability to change, and change for the better is an exhibition of antifragility. The second theme is a reduction in the possible set of post-disruption outcomes through the adoption of a 'barbell strategy'. The barbell analogy refers to the distribution of capital investments, heavily weighted towards high and low risk extremes, with little in between (Taleb 2012), otherwise referred to as a 'bimodal investment strategy' (Taleb & Douady 2013). One mode of investment is apportioned to less-riskier actions while the other mode invests in riskier approaches. The aim of the strategy is to limit the potential loss by having some proportion of the investment portfolio dedicated towards safer assets, while designing some exposure to the potential upside of the riskier investments (Geman et al. 2015). In the context of organisations, the portfolio of routines can be distributed in a bi-modal investment manner by adopting routines that are able to generate value under low uncertainty situations as well as the capacity to exploit uncertainty.

Routines are considered to be the building blocks of organisations, form an integral part of the day-to-day operations of an organisation (Becker 2004), and help to explain both stability and change (Feldman & Pentland 2003). Routines, as with most artefacts, can be described as having an intended or manifest function, as well as the functions they can serve – so called latent functions (Crilly 2010). As such, the evaluation of a routines ability to produce gain from disorder may be difficult to appreciate without some means of uncovering value prior to the existence of high uncertainty. Moreover, an individual routine of contributing to organisational antifragility may lead to losses during times of low or no uncertainty. Similarly, even during times of high uncertainty – for example macro-economic contraction due to COVID-19 – routines possessing anti-fragile qualities may be restricted by wider organisational forces limiting potential gains from disorder. For example, misaligned and myopic strategy (Heracleous & Werres 2016), slow business model renewal (Doz & Kosonen 2010) and bureaucratic cultures (Aslam et al. 2018) will serve to dampen or prevent individual initiatives to adopt or develop antifragile routines. This highlights the importance not only of being able to identify anti-fragility amongst routines, but also to identify the value of access to antifragile organisational routines.

3. Uncertainty management as two dichotomies

Uncertainty is broadly recognised as the inability to determine the true state of affairs (Rowe 1994) and can arise from various sources (e.g., lack of information, market volatility and hyper competition) (Hattis & Burmaster 1994), creating significant challenges to the prediction of future events and their outcomes (Haimes 2015). Broadly, uncertainty is viewed as a source of risk to be managed from a loss minimisation perspective (Tversky & Kahneman 1986). Management decisions are either aimed at decreasing the sensitivity of a system to disruptions (i.e., robustness) or creating insensitivity to disruptions (i.e., fragility) (Aven 2015). Meanwhile, Taleb (2012) offers an alternative system property whereby the system benefits from shocks and stressors and thrives when faced with uncertainty. Research into risk management has made advancements about actions that enhance the ability to resist the impact or recover from downside uncertainty, (i.e., robustness and resilience, respectively). Out of this research, two dichotomies emerge to characterise the strategies based on actions taken, whether they focus on increasing redundancy or

enhancing flexibility, and whether the actions are proactive or reactive relative to a given uncertainty event. When combined, these two dichotomies formulate four variations of the antifragile archetype of organisational routines. We refer to these routines as archetypal as they exhibit a pattern of behaviour that is identifiable in many contexts in and outside of business settings.

The first dichotomy points to choices about redundancies or flexibilities as a means of mitigating risk and enacting contingencies where risks cannot be avoided (Sheffi 2005). The second dichotomy exists in the temporal space when managerial actions are enacted relative to some expected uncertainty, namely whether they are reactive or proactive (Craighead et al. 2007; Ivanov et al. 2017). From the perspective of the decision maker, these choices may be driven by either cognition or prior experience about the linkage between a choice and expectation (Gavetti & Levinthal 2000), as well as the framing of a particular outcome (Tversky & Kahneman 1992). Other contextual factors that influence the ability of individuals to effectively make decisions under uncertainty include perceptions of efficacy (Bandura 1977) and time pressure (Hu et al. 2015; Kahneman & Egan 2011). Academic studies (particularly in the supply chain management literature) discuss the relative value of redundancy over flexibility or vice versa (e.g. Dabhilkar et al. 2016; Pal et al. 2014; Sheffi 2005). Similarly, old adages propose that 'an ounce of prevention is worth a pound of cure' and 'prevention is better than cure' about the relative utility of proactive and reactive measures. However, it would be naïve to suggest that a 'one size fits all' solution exists, as the optimality of the solution may be contingent on the organisation, its operating environment or both.

3.1. When to address uncertainty: Proactive and Reactive Actions

Choices can be categorised in accordance with the temporal dimension in which they occur. Relative to the occurrence of some event that involves considerable uncertainty, choices can be made prior to, in anticipation of, or after an event, as a reaction to the event. *Proactivity* refers to actions taken prior to the disruption occurrence and involves planning to either reduce the probability of occurrence (Thun et al. 2011) or mitigate the severity of disruptions (Knemeyer et al. 2009; Mitroff & Alpaslan 2003). Proactive actions focus on identifying potential losses related to disruptions and operating sufficient countermeasures preceding disruption (Grötsch et al. 2013). Conversely, *reactivity* entails taking action after an event has occurred (Grötsch et al. 2013). Reactive behaviours are often associated with mitigation or the minimization of detrimental impacts (Sheffi 2005), often associated with unexpected events (Ivanov et al. 2017). Particular disruptions can be prevented through proactive actions that limit the probability of occurrence (Chopra & Sodhi 2004), while others can only be addressed by proactively preparing for their inevitable occurrence (Knemeyer et al. 2009) or reactive actions after the disruption is detected (Sheffi 2015).

Proactive mechanisms against uncertainty exist where particular types of risk through disruption are feared or believed to be inevitable - as just a matter of time. For example, the ramping up of production and distribution of products can be seen as an anticipatory mechanism established in light of predicted seasonal variations (e.g., toys for Christmas and chocolate for Valentine's Day). At the individual routine level, anticipatory mechanisms may be evaluated as wasteful and unnecessary as they would be contingent on the realisation of an anticipated catastrophe. An example in psychology of this mechanism is observed in survivalists, who exhibit anticipatory mechanisms for a range of expected catastrophes, such as human induced post-

apocalyptic nuclear warfare, economic collapse and terrorism through to 'force majeurs' (Williams 2008) characterised by events like tsunamis, hurricanes, volcanos eruptions and asteroid strikes. For survivalists, the occurrence of past economic crises (e.g., Wall Street Crash of 1929, Global Financial Crisis of 2008/2009) and environmental catastrophes (e.g., Haiti Earthquake of 2010, Japan Tsunami of 2011) serves as the rationale guiding preparation for further predicted disaster.

Proactive mechanisms have their theoretical foundations in the planned approach to strategic management. Checklist models such as the ADKAR (Hiatt 2006) and n-step stage models of change management; the three-step (Lewin 1947) and eight-step models for managing change (Kotter 2012) rest on the assumption that change management initiatives can be planned in advance and implemented to ensure positive outcomes at the routine level (Palmer et al. 2017). A further element associated with anticipatory mechanisms, includes scenario forecasting to identify possible future scenarios and associated solutions to be prepared for such eventualities (Arkin 2007; Verity 2003). However, caution should be exercised when engaging in proactive activities if the business environment is relatively stable, as perceptions of environmental stability may be limited and unable to consider extreme scenarios, such as hyper-competition (D'aveni 2010), or black swan events (Taleb 2007).

Arguably, the most germane concepts and models related to anticipatory mechanisms, is that of how flexibility and adaptability is built-in to 'organic' organisations (Burns & Stalker 1961). These organisations tend to celebrate and enjoy innovative entrepreneurial cultures (Kanter 1984, 1990). Moreover, these organisations tend to have 'built-to-change' characteristics, for example in companies like Capital One, where hiring and training of employees who embrace change is common, and who also eschew hierarchical for cross-functional structures (Worley & Lawler III 2006).

Reactive mechanisms against uncertainty by contrast, capture those behaviours that result in response to an unfolding uncertainty. Reactionary behaviours aim to adapt swiftly to the situation as it unfolds. Reactive mechanisms against uncertainty have their theoretical foundations in the emergent and processual schools of change management, based on the view that change is a non-linear, chaotic, and complex phenomenon (Alvesson & Sveningsson 2015). The implicit assumption with reactive mechanisms is that all aspects of uncertainty cannot be predicted and planned for in advance, but rather responded to as the changing circumstance unfolds with the organisation aligning and realigning itself to ever changing environmental conditions (Burnes 2017). One processual model (Dawson & Andriopoulos 2014) captures how complex internal and external forces such as political and temporal (comprising past, present and future) dynamics, result in situations that call for reactionary mechanisms to change. Having identified the dimension of behavioural dynamics of when to address uncertainty (anticipatory or reactionary), another crucial dimension helping to identify varying archetypal manifestations of antifragility, is the approach to decision-making on the basis of redundancy or flexibility.

3.2. How to address uncertainty: Redundancy and Flexibility

When facing uncertainty, business decisions have often focused on actions which can be broadly categorised as redundancies (Sheffi & Rice Jr 2005) and flexibilities (Stevenson & Spring 2007). Central to the notion of choices in redundancy is the idea of *doing more of the same* (Mackay et al. 2019). Redundancies in risk management aim to 'assume the functions of failed components without adversely affecting the performance of the system itself' (Haimes 1998), or more

succinctly, holding additional resources in reserve to deal with disruptions (Sheffi & Rice Jr 2005). Redundancies often act to assume the role of failed components after a disruption (Haimes 1998), or as a 'buffer' against uncertainty (Sheffi & Rice Jr 2005). For example, redundancy within the supply chain literature (Kamalahmadi & Parast 2016), often constitute actions such as increased resource pooling (Azadeh et al. 2014), and a shift from reliance on single to multiple suppliers (Tang 2006). Another view of redundancy is in engineering systems where there is a duplication of critical components to ensure reliable service. An example is the use of multiple sources of power generation in an electrical grid, if one electricity source fails, the others are able to maintain electrical services. More broadly, the operations management literature has pointed to redundancies such as inventory stockpiling (Christopher & Peck 2004). If a threat to the supply of goods is perceived, individuals will commonly engage in hoarding behaviours, accumulating large inventories in response to (or in anticipation of) uncertainty (Hurd 2019). An example of this was seen in the recent COVID-19 pandemic, with the recent panic buying of food and toilet tissue for fear of a supply shortage spreading throughout the market (Sim et al. 2020). This example highlights a largely irrational response to a threat, as there was no real indication of an upcoming scarcity. Strategically, it may be sensible to engage in stockpiling behaviours when it is rational to do so (Sterman & Dogan 2015). As such, the actions of acquiring and accumulating large inventories may be seen as a strategic response to expectations or perceptions of increases in uncertainty. Examples of strategic acquisition of large inventories exist in many business applications, and research about buffer inventory. To cope with variations in demand, many businesses opt for holding additional inventory to cushion against unpredictable fluctuations (Hill & Hill 2012). Holding additional inventory comes at a cost, and the benefits of buffer inventory are only realised when uncertainty is manifested (e.g., demand variations). In acknowledging the value potential of strategic acquisition of redundancies, organisations may proactively prepare for or react to scarcity in an efficient manner.

Flexibility represents the ability to restructure existing capabilities and assumes a different position or configuration towards mitigating the negative influences of uncertainty (Carvalho et al. 2012; Lee 2004; Tang & Tomlin 2008), in other words, *being able to do things differently* (Mackay et al. 2019). Flexibility can exist as a capability to reconfigure operations (Beamon 1999), or as a change in business configurations towards adaptation (Ma et al. 2009; Srinivasan & Swink 2018; Swafford et al. 2008). Although numerous flexibility-centric actions have been proposed to proactively deal with uncertainty, such as inbuilt capabilities to differentiate products off a single manufacturing configuration (Tang & Tomlin 2008), others equate flexibility to the ecological concept of adaptability (Smit & Wandel 2006) and plasticity in biological systems (Levis et al. 2018; Price et al. 2003). In doing so, these contributions point to adaptation being a reactive phenomenon, in response to some change in the working environment. Simple examples of flexibilities include the rerouting function in many modern route planning software applications as a means of adapting the route taken to suit changes in traffic circumstances. In many cases, various strategies (such as relying on multiple suppliers), can be viewed as both a redundancy and a flexibility initiative, depending on the contextual lens.

4. The Emergence of Four Anti-Fragile Routine Archetypes

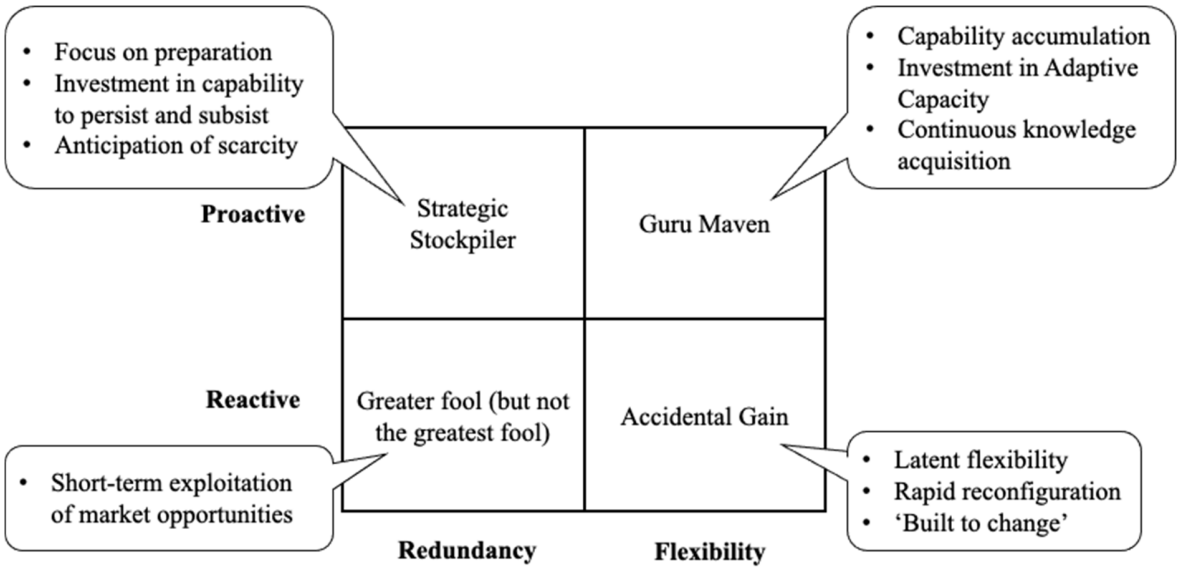

Figure 1- Antifragile routine matrix

The strategic stockpiler

We refer to the first quadrant as a 'strategic stockpiler' routine, and there are affinities with this from the literature on psychological tendencies of 'preppers'. The 'stockpiler' is synonymous with a survivalist and is commonly defined as an individual that proactively prepares for emergencies. These emergencies may include disruptions to order that threaten the previous mode of operation. The key character traits have been explored in the psychology literature (Fetterman et al. 2018) describing these individuals as inherently anxious. Their anxiety is mainly directed at future uncertainty and events that threaten the status quo which can trigger a protectionist mechanism. The stockpiler values their current situation and will acquire additional resources to protect it, as there is an expectation of future uncertainty. Overall, strategic stockpilers have a tendency to proactively gather redundancies prior to a disruptive event occurring. The intention of stockpiling proactively avoids the panic stockpiling (such as that observed in retail during the COVID-19 pandemic noted in Pantano et al. 2020). One example is the holding of cash reserves to help cope with unexpected adversity (Kuan et al. 2011). Antifragility research would argue that such stockpiles can help to drive gains from uncertainty, as these redundancies have a latent functionality and realise value due to the increase in uncertainty.

The 'guru maven'

It is common to cope with uncertainty by seeking out new information (Becker 2004). We refer to the second quadrant as the guru maven routine, as this mechanism places a premium on continuous acquisition of skills and knowledge, regardless of whether these acquisitions offer immediate utility. From the psychology literature antifragile personalities are acknowledged to possess knowledge over others, an inherent flexibility, a desire to gain further knowledge, and a courage

to try new things in uncertain situations (Markey-Towler 2018). The cultural trope related to the learning routine is that of the 'maven' – a Yiddish term denoting 'one who understands' and one who has access to extensive information about a subject, or multiple subjects (Feick & Price 1987). The maven is regarded as a subject specialist, and continuously aims to learn. Organisations that embody this continuous search for information enrich their knowledge pool and can help identify and exploit opportunities for gain (Ren et al. 2015).

The greater fool (but not the greatest fool) - high frequency trading routine.

We refer to the third quadrant as 'the greater fool'. The 'greater fool' routine operates reactively to a situation as it unfolds, by enacting behaviours that aim to exploit markets. These behaviours, are redundancies in that they proliferate further actions that are 'more of the same' as exploitation of the mania of buyers and sellers in a market exposed to uncertainty. Consider the example of a panic buyer, who vigorously seeks to exploit uncertainty and scarcity by bulk buying, with intentions to sell at a profit, or trade at a surplus. Examples include high frequency trading and arbitraging efforts (Seddon & Currie 2017), where the intention is to gain in the short term by engaging in large volumes of exchanges without retention of resources.

Historically, examples of the trading routines can be extracted from speculation trades prior to economic crashes. Consider the example of tulip mania in 17th Century Holland (Dash 2011). Introduced to Holland from the Ottoman Empire, tulips quickly became a coveted luxury item, ultimately resulting in speculative tulip futures trading, with investors irrationally assuming that prices would ceaselessly and exponentially increase. At its peak from 1637-1638, tulip bulbs sold between 3,000 and 4,200 guilders – equivalent to the yearly income of a skilled craftsmen (Nusteling 1985). Individual speculators may have known the irrationality that they displayed in buying bulbs exceeding yearly incomes, but they nevertheless engaged in such investments based on the assumptions that short-term wins could be selfishly gained at the expense of others. More contemporary examples of the speculative panic buyer or greater fool include day traders, sub-prime mortgage speculators and enthusiastic participants of ponzi schemes – a recent example being that of the fake crypto-currency 'OneCoin' (Suberg 2015). Arbitrage presents another example, where resources are procured from undervaluing sellers and sold to overvaluing customers (Ehret 2014). In times of great uncertainty, the value differential of goods may be vast between sellers and buyers, and sales time-sensitive. Thus, high frequency trading and arbitrage mechanisms can provide significant gain resulting from uncertainty. Ultimately, the success of speculating depends on ensuring that it is at the expense of others – to ensure that it is someone else ('the greatest fool') who is ultimately the last person left with the bag of tulips once prices have crashed.

The unexpected gain organisation

The fourth quadrant is characterised by latent functionality; when sudden changes occur in the operating environment some routines could be enacted that execute dramatically different activities. This quadrant we refer to as 'the unexpected gain' where an organisation would react to uncertainty by being flexible in their operations through considering alternatives. These acts of flexibility are purely reactionary, yet have the potential to yield elevated performance. In many cases, the capability to reactively be flexible was already existent, usable and executable, but valueless and dormant. However, when the organisation faces considerable uncertainty, the routine

is activated and executed to great benefit. One example is that of automakers Ford and General Motors, in response to the COVID-19 induced demand for ventilators in hospitals, spent considerable effort to reconfigure existing plants. As demand for ventilators in hospitals began to exceed capacity, automobile manufacturing capacity was diverted towards the production of ventilators and spare parts for nearby hospitals (Perkins 2020). In doing so, automobile manufacturers diverted resources and reconfigured the supply chain and exploited the latent functionality of production assets. Meeting the needs of nearby hospitals created value as greater hospital capacity and less loss of life. This action exemplifies how reconfiguration can serve to create greater value in times of pandemic, where hospitals were under threat of failure, similar to their counterparts in Italy and Spain. Having identified the above four archetypes emerging as a result of the intersecting dimensions of when (proactively or reactively) and how to address uncertainty (as a redundancy cs. flexibility); we progress to consider how these archetypes can be practically realised through particular organisational routines.

5. The Organisational Management Challenge – embedding routines

Extremely surprising and unpredictable 'black swan' events (Taleb 2007) result largely in uncertainty and irrational behaviour. For some, however, these events present opportunities to thrive and gain from the ensuing disorder. For organisations in these settings, there is potential for substantive gain in executing one or more of the four antifragile routines. As a consequence of environmental uncertainty increasing for many organisations and industries, it will be critical for organisations to consider routines collectively as an antifragile capability that can influence performance outcomes. Central here is the need to identify and nurture behaviours associated with the anti-fragile personality (Markey-Towler 2018), converted into routines executable in organisations during times of high uncertainty. Such routines may be dormant in times of low uncertainty, and have value that can only be appreciated as a latent functionality. As such, a lack of appreciation for the latent value may make them difficult to identify during times of relatively low levels of uncertainty. Organisations are recognized as needing to have adaptive cultures to cope with rapidly shifting business conditions. Routines are recognised as generating not only organisational stability, but also helping to realise change (Feldman & Pentland 2003). There are however a plethora of choices and routines available to managers, which may cause confusion, especially when one considers that only a few routines will leverage a gain from uncertainty. For organisations operating in uncertain environments, the capability to leverage uncertainty into a gain presents an intuitively valuable proposition. However, identifying the right routines may be difficult, as the range of possible routines is vast relative to the antifragile routines.

The strategic stockpiler characteristically and proactively prepares for possible emergencies. The proactive nature of the stockpiler means engaging in a routine of resource acquisition or resource adaptation to prepare for a future scenario which may or may not occur. The strategic stockpiling routine, therefore, would gather additional resources in anticipation of a sudden increase in uncertainty. These resources may be exemplified as cash reserves, fuel and other consumables. For the organisation capable of stockpiling, complementary anticipatory routines may include extensive scenario planning and forecasting (Bradfield et al. 2005), as well as strategic information acquisition (Wakolbinger & Cruz 2011). An example of this which occurred in the recent crisis situation of COVID-19 was that of the micro–brewery which was able to pivot their business to producing hand sanitiser as a result of having an oversupply of 'ethanol' a key ingredient used in both alcohol processing and hand sanitiser (Butler 2020a). When uncertainty increases and resources become scarce, businesses that have engaged in routine

acquisition will leverage associated resources to continue in times of shortage and adversity. The gathering of additional resources exhibits antifragility in a less-than-straightforward fashion. Referring to their ability to 'gain from disorder', having these additional resources will preserve an operational status quo in times of high uncertainty by consuming previously acquired resources. In doing so, an organisation that is executing a stockpiling routine will experience higher performance relative to others with increasing uncertainty, even if their pre- and post-disruption performance appear to be equal or lower.

The guru maven proactively acquires skills and knowledge regardless of whether these acquisitions will offer them immediate reward. The guru maven engages in a continuous quest for personal growth and finds joy in stretching their mental and/or physical capabilities. While the stockpiling routine directs energies to preparing for an anticipated disruption, the guru maven directs energies to self-improvement irrespective of whether the outcomes generate value at scale. The positive outcomes associated with routinised learning for example, include mastery of new technology or subject. While this routine is proactive in seeking out information, and operates to foster knowledge sharing and creation, there is less of an emphasis on scale and efficiency. As such, the routine expresses antifragility by expending more resources in information seeking activities. Such information, if held over others, ties together the antifragile psychology narrative by Markey-Towler (2018) with the ability to gather more flexibility options (Nonaka 1994), resulting in a greater probability of discovering an antifragile set of actions.

Applying the guru maven routine can enable organisational learning. Organisational learning, and the employment of information and knowledge gathering are central themes to a proactive routine centred on flexibility. Organisational learning encompasses identification of opportunities, reframing, and understanding how to employ assets in different ways (Tranfield & Smith 1998). Organisational learning also has a strong emphasis on the seeking out of new information through experimentation and search (Berkhout et al. 2006). Moreover, routines that enable organisational learning focus on measuring and understanding the current situation (Tranfield et al. 2000). Organisational learning routines are also enabled by visualising what could be new ways of operating (Tranfield et al. 2000). The flexibility of the routine is the result of a creative process involving search for experience and knowledge that can be applied and recombined to generate a variety of options about how to operate differently (Nonaka & Takeuchi 2011).

The greater fool archetype reactively responds to the situation by exploiting the market. For example, this organisation may see an opportunity in buying goods in bulk (e.g., face masks and hand sanitiser), with the intention of personal use or for selling at a later date for profit. The organisation will react quickly and often faster than other actors in a market. Their attitude may reflect confidence, even arrogance, and some level of self-interest. This organisation in times of high uncertainty is quick thinking, achieving reactive exploitation of a market, even if it is at the expense of other actors. The ability of the organisation to quickly pivot by executing a greater number of actions in a short period of time will increase its competitive advantage. The trading routine operates with a similar presumption to that of the stockpiling routine – both are mindful of redundancy – for the former it is one of market demand far outstripping supply. Contrasting redundancy-focused routines, prepping may have anticipated scarcity of supply, while the trading routine would rush to buy and sell before substantive currency devaluation or depletion of available stocks and supplies. The speculative element of this behaviour is encapsulated in the 'greater fool theory' which stipulates that the price of an object is determined not by any intrinsic value, but rather by the buyer who justifies that another is willing to pay an even higher price. The

high frequency trading routine exhibits antifragility by exploiting reactivity and responsiveness – for example, in buying and selling of shares before price crashes, as well as trading in commodities which may experience price fluctuations in light of environmental issues like droughts. However, it should be noted that some caution must be exerted in engaging the panic buying routine, as recent events have noted, ethical and legal issues may arise from panic buying and render profit making inviable (Hodge 2020). Consider the example of arbitraging household items (e.g. cleaning products, hand sanitiser) during the Covid-19 pandemic which were removed from popular online auction and retail sites (Butler 2020b; Smithers 2020), potentially leaving the arbitrager as the greatest fool.

One way in which the unexpected gain organisation is operationalised is through becoming an accidental gainer. This means that they may characteristically display a sense of purpose and meaning, and seek opportunities in which to create social good. Such an organisation reacts to social problems through bringing together groups of people in the community to solve social issues, thus gaining from disorder through addressing the suffering of others. Sudden events of great uncertainty uncover latent social entrepreneurship capabilities. In seeking to embed unexpected gain routines into the organisation, one example is the process of seeking out philanthropic opportunities with other organisations as partnerships for public good.

Another way in which the unexpected gain organisation is operationalised, involves the reconfiguration of the routines. This involves an appreciation of resources possessed and considering adjacent possible as ways of doing things. Complexity theory indicates organisations be open to trying different strategies and exploring their space of possibilities in order to be sustainable entities (Mitleton-Kelly 2003). These organisations need to be open to several possibilities and try different strategies, it is not possible to explore all possibilities (Mitleton-Kelly 2003). Kauffman (1996) alternatively suggests to consider the 'adjacent possible'. In other words, use the readily available resources and put them together in a different way. This opens up a newer way of viewing things and the cycle continues creating "…ever expanding possibilities of the adjacent possible" (Mitleton-Kelly 2003, p. 232).

6. Conclusion and further considerations

Organisations operating in uncertain environments risk having performance outcomes be influenced by a multiplicity of intersecting factors, with possessing limited understanding about how managerial decisions' express agency. In many cases, uncertainty itself is an undeniable influencer upon outcomes, while at other times, an organisation's choices drive results. This phenomenon is dealt with mainly as a loss mitigation exercise, where management see uncertainty as resulting in an imminent loss, and choices can only serve to minimize the loss. However, organizations need not view uncertainty as a threat, but rather as a potential from which to generate favourable outcomes.

Concepts observed in the antifragility literature contend that uncertainty can be leveraged for gain (Taleb 2012). In other words, organizational routines can be seen as tools that can be activated when organizations face uncertainty. As they do this, there is an acceptance of uncertainty as a potential, to be convertible towards favourable outcomes. In observing occurrences of antifragility, scholars cite various examples in nature (e.g. phenotypic plasticity) (Price et al. 2003) and mythology (e.g. hydra) (Taleb & Douady 2013) as models for development in real world settings. Amalgamating the concepts of antifragility, risk and routine literatures in uncertain environments points to prescription of careful adoption of practices that can leverage

uncertainty towards a gain. With this in mind, this paper conceptualised the intersection between antifragility, uncertainty management, and organisational routines literatures to identify four routine archetypes. In so doing, organisations can be guided towards achieving organisational antifragility. Theoretically, this paper has identified how these archetypes arise from the interplay between temporal action (as tendencies towards proactive or reactive action) and risk mitigation strategies (operationalised as redundancies or flexibilities). Such conceptualisations should encourage organizations to embrace the contingent selection and application of the antifragile archetypes expressed as routines to suit environmental conditions. In doing so, the routines can empower organizations to control the dispersion of outcomes. In essence, these routines limit the influence of uncertainty on performance outcomes.

In light of the four routine archetypes developed above, several research avenues arise. In considering prolonged periods of adversity (such as the COVID-19 pandemic), future research could investigate the relative utilities of the routine archetypes. One avenue for investigation could query the antecedents predisposing organizations to favourable selection and application of specific archetypal routines. A potentially fruitful avenue of research would investigate the antecedent factors contributing to the activation of archetypal routines. For example, we would hypothesise that particular conditions such as proximity to business failure and willingness to reconfigure, would be important prerequisites to activating archetypal routine(s). We would also anticipate that where organizational cultures of high trust and mutual support exist, that such features would again encourage firms to activate archetypal routines and different times.

While we have charted four anti-fragile routine archetypes manifested at the intersection between proactive and reactive temporal dimension, and redundancy and flexibility risk mitigation behaviours, a qualification is necessary. In reference to Figure 1 above, we note that boundaries between routines are not absolute, and that a 'zone of intermediacy' exists between routines. Furthermore, the routines may exhibit complementarity and substitutability interactions, where the interaction between two or more routines itself may influence antifragility (as per Porter & Siggelkow 2008). These notions present some exciting prospects for future research and highlight some limitations of the conceptualisations presented herein. Furthermore, the nature of latent functionality has potential implications for routine value in times of low or no uncertainty. In many instances these latent capabilities that enable antifragility can limit the value a routine can produce in other times, leading managers to fail to see the value of such resources in uncertain times.

References

Alvarez, S, Afuah, A & Gibson, C 2018, 'Editors' comments: should management theories take uncertainty seriously?', *Academy of Management Review*, vol. 43, no. 2, pp. 169-72. https://doi//10.5465/amr.2018.0050

Alvesson, M & Sveningsson, S 2015, *Changing organizational culture: Cultural change work in progress*, Routledge.

Arkin, A 2007, 'The generation game', *People Management*, vol. 13, no. 24, pp. 24-7.

Aslam, U, Muqadas, F, Imran, MK & Rahman, UU 2018, 'Investigating the antecedents of work disengagement in the workplace', *Journal of Management Development*.

Aven, T 2015, 'The concept of antifragility and its implications for the practice of risk analysis', *Risk analysis*, vol. 35, no. 3, pp. 476-83. https://doi.org/10.1111/risa.12279

Azadeh, A, Atrchin, N, Salehi, V & Shojaei, H 2014, 'Modelling and improvement of supply chain with imprecise transportation delays and resilience factors', *International Journal of Logistics Research and Applications*, vol. 17, no. 4, pp. 269-82. https://doi.org/10.1080/13675567.2013.846308

Bandura, A 1977, 'Self-efficacy: toward a unifying theory of behavioral change', *Psychological review*, vol. 84, no. 2, p. 191. https://doi.org/10.1016/0146-6402(78)90002-4

Beamon, BM 1999, 'Measuring supply chain performance', *International Journal of Operations & Production Management*, vol. 19, no. 3, pp. 275-92. https://doi.org/10.1108/01443579910249714

Becker, MC 2004, 'Organizational routines: a review of the literature', *Industrial and corporate change*, vol. 13, no. 4, pp. 643-78. https://doi.org/10.1093/icc/dth026

Berkhout, F, Hertin, J & Gann, DM 2006, 'Learning to adapt: organisational adaptation to climate change impacts', *Climatic Change*, vol. 78, no. 1, pp. 135-56. https://doi.org/10.1007/s10584-006-9089-3

Bolger, F, Stranieri, A, Wright, G & Yearwood, J 2011, 'Does the Delphi process lead to increased accuracy in group-based judgmental forecasts or does it simply induce consensus amongst judgmental forecasters?', *Technological Forecasting and Social Change*, vol. 78, no. 9, pp. 1671-80. https://doi.org/10.1016/j.techfore.2011.06.002

Bradfield, R, Wright, G, Burt, G, Cairns, G & Van Der Heijden, K 2005, 'The origins and evolution of scenario techniques in long range business planning', *Futures*, vol. 37, no. 8, pp. 795-812. https://doi.org/10.1016/j.futures.2005.01.003

Burnes, B 2017, *Managing change*, 7th Edition edn, Pearson Education, Sydney.

Burns, T & Stalker, GM 1961, *The management of innovation*, Tavistock, London.

Butler, S 2020a, 'BrewDog begins making hand sanitiser amid shortages in UK ', *The Guardian*, viewed June 26, 2020, https://www.theguardian.com/business/2020/mar/18/brewdog-begins-making-hand-sanitiser-shortages-uk.

—— 2020b, 'New UK taskforce to crack down on coronavirus profiteers ', *The Guardian*, viewed June 21, 2020, https://www.theguardian.com/business/2020/mar/20/new-uk-taskforce-to-crack-down-on-coronavirus-profiteers.

Carvalho, H, Barroso, AP, Machado, VH, Azevedo, S & Cruz-Machado, V 2012, 'Supply chain redesign for resilience using simulation', *Computers & Industrial Engineering*, vol. 62, no. 1, pp. 329-41. https://doi.org/10.1016/j.cie.2011.10.003

Chopra, S & Sodhi, MS 2004, 'Managing risk to avoid supply-chain breakdown', *MIT Sloan Management Review*, vol. 46, no. 1, p. 53.

Christopher, M & Peck, H 2004, 'Building the resilient supply chain', *The International Journal of Logistics Management*, vol. 15, no. 2, pp. 1-14. https://doi.org/10.1108/09574090410700275

Craighead, CW, Blackhurst, J, Rungtusanatham, MJ & Handfield, RB 2007, 'The severity of supply chain disruptions: Design characteristics and mitigation capabilities', *Decision Sciences*, vol. 38, no. 1, pp. 131-56. https://doi.org/10.1111/j.1540-5915.2007.00151.x

Crawford, MM 2019, 'A comprehensive scenario intervention typology', *Technological Forecasting and Social Change*, vol. 149, p. 119748. https://doi.org/10.1016/j.techfore.2019.119748

Crilly, N 2010, 'The roles that artefacts play: technical, social and aesthetic functions', *Design Studies*, vol. 31, no. 4, pp. 311-44.

Culot, G, Nassimbeni, G, Orzes, G & Sartor, M 2020, 'The future of manufacturing: a Delphi-based scenario analysis on Industry 4.0', *Technological Forecasting and Social Change*, p. 120092.

D'aveni, RA 2010, *Hypercompetition*, Simon and Schuster.

Dabhilkar, M, Birkie, SE & Kaulio, M 2016, 'Supply-side resilience as practice bundles: a critical incident study', *International Journal of Operations & Production Management*, vol. 36, no. 8, pp. 948-70. https://doi.org/10.1108/IJOPM-12-2014-0614

Danchin, A, Binder, PM & Noria, S 2011, 'Antifragility and Tinkering in Biology (and in Business) Flexibility Provides an Efficient Epigenetic Way to Manage Risk', *Genes*, vol. 2, no. 4, pp. 998-1016. https://doi/10.3390/genes2040998

Dash, M 2011, *Tulipomania: The story of the world's most coveted flower and the extraordinary passions it aroused*, Hachette UK.

Dawson, P & Andriopoulos, C 2014, *Managing change, creativity and innovation*, Sage.

Derbyshire, J & Giovannetti, E 2017, 'Understanding the failure to understand New Product Development failures: Mitigating the uncertainty associated with innovating new products by combining scenario planning and forecasting', *Technological Forecasting and Social Change*, vol. 125, pp. 334-44.

Derbyshire, J & Wright, G 2014, 'Preparing for the future: development of an 'antifragile'methodology that complements scenario planning by omitting causation', *Technological Forecasting and Social Change*, vol. 82, pp. 215-25. https://doi.org/10.1016/j.techfore.2017.02.007

Doz, YL & Kosonen, M 2010, 'Embedding strategic agility: A leadership agenda for accelerating business model renewal', *Long range planning*, vol. 43, no. 2-3, pp. 370-82. https://doi.org/10.1016/j.lrp.2009.07.006

Ehret, M 2014, 'Financial socialism: The role of financial economics in economic disorganization', *Journal of Business Research*, vol. 67, no. 1, pp. 2686-92. https://doi.org/10.1016/j.jbusres.2013.03.017

Feick, LF & Price, LL 1987, 'The market maven: A diffuser of marketplace information', *Journal of marketing*, vol. 51, no. 1, pp. 83-97. https://doi.org/10.1177%2F002224298705100107

Feldman, MS & Pentland, BT 2003, 'Reconceptualizing organizational routines as a source of flexibility and change', *Administrative Science Quarterly*, vol. 48, no. 1, pp. 94-118. https://doi.org/10.2307/3556620

Fetterman, AK, Rutjens, BT, Landkammer, F & Wilkowski, BM 2018, 'On Post-apocalyptic and Doomsday Prepping Beliefs: A New Measure, its Correlates, and the Motivation to Prep', *European Journal of Personality*.

Garcia-Swartz, DD, Muhamedagić, M & Saenz, D 2019, 'The role of prices and network effects in the growth of the iPhone platform', *Technological Forecasting and Social Change*, vol. 147, pp. 110-22. https://doi.org/10.1016/j.techfore.2019.06.020

Gavetti, G & Levinthal, D 2000, 'Looking forward and looking backward: Cognitive and experiential search', *Administrative Science Quarterly*, vol. 45, no. 1, pp. 113-37. https://doi/pdf/10.2307/2666981

Geman, D, Geman, H & Taleb, N 2015, 'Tail risk constraints and maximum entropy', *Entropy*, vol. 17, no. 6, pp. 3724-37. https://doi:10.3390/e17063724

Grötsch, VM, Blome, C & Schleper, MC 2013, 'Antecedents of proactive supply chain risk management–a contingency theory perspective', *International journal of production research*, vol. 51, no. 10, pp. 2842-67.

Haimes, Y 2015, *Risk modeling, assessment, and management*, John Wiley & Sons.

Haimes, YY 1998, 'Reducing Vulnerability of Water Supply Systems to Attack', *Journal of Infrastructure Systems*, vol. 4, no. 4, pp. 164-77. https://doi:10.1061/(ASCE)1076-0342(1998)4:4(164)

Hattis, D & Burmaster, DE 1994, 'Assessment of variability and uncertainty distributions for practical risk analyses', *Risk analysis*, vol. 14, no. 5, pp. 713-30. https://doi:

10.1111/j.1539-6924.1994.tb00282.x

Heracleous, L & Werres, K 2016, 'On the road to disaster: Strategic misalignments and corporate failure', *Long range planning*, vol. 49, no. 4, pp. 491-506. https://doi.org/10.1016/j.lrp.2015.08.006

Hiatt, J 2006, *ADKAR: a model for change in business, government, and our community*, Prosci.

Hill, A & Hill, T 2012, *Operations management*, Palgrave Macmillan, 0230362907.

Hodge, J 2020, 'The odd heroism of doing nothing', *Eureka Street*, vol. 30, no. 6, p. 29.

Hu, Y, Wang, D, Pang, K, Xu, G & Guo, J 2015, 'The effect of emotion and time pressure on risk decision-making', *Journal of Risk Research*, vol. 18, no. 5, pp. 637-50. https://doi.org/10.1080/13669877.2014.910688

Hurd, M 2019, *Hoarding*, Salem Press, http://ezproxy.uow.edu.au/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=ers&AN=94415437&site=eds-live.

Ivanov, D, Dolgui, A, Sokolov, B & Ivanova, M 2017, 'Literature review on disruption recovery in the supply chain', *International journal of production research*, vol. 55, no. 20, pp. 6158-74. https://doi.org/10.1080/00207543.2017.1330572

Kahneman, D & Egan, P 2011, *Thinking, fast and slow*, vol. 1, Farrar, Straus and Giroux New York.

Kamalahmadi, M & Parast, MM 2016, 'A review of the literature on the principles of enterprise and supply chain resilience: Major findings and directions for future research', *International Journal of Production Economics*, vol. 171, pp. 116-33. https://doi.org/10.1016/j.ijpe.2015.10.023

Kanter, RM 1984, *Change masters*, Simon and Schuster.

—— 1990, *When giants learn to dance*, Simon and Schuster.

Kast, FE & Rosenzweig, JE 1972, 'General systems theory: Applications for organization and management', *Academy of Management Journal (pre-1986)*, vol. 15, no. 4, p. 447. https://doi.org/10.5465/255141

Kauffman, SA 1996, *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity*, Oxford University Press.

Kirk, CP & Rifkin, LS 2020, 'I'll trade you diamonds for toilet paper: Consumer reacting, coping and adapting behaviors in the COVID-19 pandemic', *Journal of Business Research*, vol. 117, pp. 124-31. https://doi.org/10.1016/j.jbusres.2020.05.028

Knemeyer, AM, Zinn, W & Eroglu, C 2009, 'Proactive planning for catastrophic events in supply chains', *Journal of Operations Management*, vol. 27, no. 2, pp. 141-53. https://doi.org/10.1016/j.jom.2008.06.002

Knight, FH 1921, *Risk, uncertainty and profit*, vol. 31, Houghton Mifflin.

Kotter, JP 2012, *Leading change*, Harvard business press.

Kuan, T-H, Li, C-S & Chu, S-H 2011, 'Cash holdings and corporate governance in family-controlled firms', *Journal of Business Research*, vol. 64, no. 7, pp. 757-64. https://doi.org/10.1016/j.jbusres.2010.07.004

Lee, HL 2004, 'The Triple-A Supply Chain', *Harvard Business Review*, vol. 82, no. 10, pp. 102-12.

Levis, NA, Isdaner, AJ & Pfennig, DW 2018, 'Morphological novelty emerges from pre-existing phenotypic plasticity', *Nature ecology & evolution*, vol. 2, no. 8, p. 1289. https://doi:10.1038/s41559-018-0601-8

Lewin, K 1947, 'Frontiers in group dynamics: II. Channels of group life; social planning and action research', *Human relations*, vol. 1, no. 2, pp. 143-53. https://doi:10.1177/001872674700100201

Ma, X, Yao, X & Xi, Y 2009, 'How do interorganizational and interpersonal networks affect a firm's strategic adaptive capability in a transition economy?', *Journal of Business Research*, vol. 62, no. 11, pp. 1087-95. http://dx.doi.org/10.1016/j.jbusres.2008.09.008

Mackay, J, Munoz, A & Pepper, M 2019, 'Conceptualising redundancy and flexibility towards supply chain robustness and resilience', *Journal of Risk Research*, pp. 1-21. https://doi:10.1080/13669877.2019.1694964

Markey-Towler, B 2018, 'Antifragility, the Black Swan and psychology', *Evolutionary and Institutional Economics Review*, vol. 15, no. 2, pp. 367-84. https://doi:10.1007/s40844-018-0097-6

Merton, R 2016, 'Manifest and latent functions', *Social theory re-wired: new connections to classical and contemporary perspectives (2nd edition). New York: Routledge*, pp. 68-84.

Merton, RK 1968, *Social theory and social structure*, MacMillan Pubishing Co., New York.

Miles, I 2010, 'The development of technology foresight: A review', *Technological Forecasting and Social Change*, vol. 77, no. 9, pp. 1448-56. https://doi.org/10.1016/j.techfore.2010.07.016

Mitleton-Kelly, E 2003, 'Ten principles of complexity and enabling infrastructures', *Complex systems and evolutionary perspectives on organisations: The application of complexity theory to organisations*, vol. 1, pp. 23-50.

Mitroff, II & Alpaslan, MC 2003, 'Preparing for evil', *Harvard Business Review*, vol. 81, no. 4, pp. 109-15.

Nenonen, S & Storbacka, K 2020, 'Don't adapt, shape! Use the crisis to shape your minimum viable system – And the wider market', *Industrial Marketing Management*, vol. 88, pp. 265-71. https://doi.org/10.1016/j.indmarman.2020.05.022

Nonaka, I 1994, 'A dynamic theory of organizational knowledge creation', *Organization science*, vol. 5, no. 1, pp. 14-37. https://doi.org/10.1287/orsc.5.1.14

Nonaka, I & Takeuchi, H 2011, 'The wise leader', *Harvard Business Review*, vol. 89, no. 5, pp. 58-67, 146.

Nusteling, HPH 1985, *Welvaart en werkgelegenheid in Amsterdam, 1540-1860: een relaas over demografie, economie en sociale politiek van een wereldstad*, Bataafsche Leeuw.

Pal, R, Torstensson, H & Mattila, H 2014, 'Antecedents of organizational resilience in economic crises—an empirical study of Swedish textile and clothing SMEs', *International Journal of Production Economics*, vol. 147, pp. 410-28. https://doi.org/10.1016/j.ijpe.2013.02.031

Palmer, I, Dunford, R & Akin, G 2017, *Managing organizational change*, 3rd Edition edn, McGraw-Hill New York, NY.

Pantano, E, Pizzi, G, Scarpi, D & Dennis, C 2020, 'Competing during a pandemic? Retailers' ups and downs during the COVID-19 outbreak', *Journal of Business Research*, vol. 116, pp. 209-13. https://doi.org/10.1016/j.jbusres.2020.05.036

Perkins, T 2020, 'Can Detroit's automakers solve America's ventilator crisis?', *The Guardian*, viewed June 24, 2020, https://www.theguardian.com/world/2020/apr/05/automakers-gm-ford-ventilators-coronavirus-detroit.

Pierce, JL, Gardner, DG, Dunham, RB & Cummings, LL 1993, 'Moderation by organization-based self-esteem of role condition-employee response relationships', *Academy of Management Journal*, vol. 36, no. 2, pp. 271-88. https://doi.org/10.5465/256523

Porter, M & Siggelkow, N 2008, 'Contextuality within activity systems and sustainability of competitive advantage', *Academy of Management Perspectives*, vol. 22, no. 2, pp. 34-56. https://doi.org/10.5465/amp.2008.32739758

Price, TD, Qvarnström, A & Irwin, DE 2003, 'The role of phenotypic plasticity in driving genetic evolution', *Proceedings of the Royal Society of London. Series B: Biological Sciences*, vol. 270, no. 1523, pp. 1433-40. https://doi.org/10.1098/rspb.2003.2372

Ramezani, J & Camarinha-Matos, LM 2020, 'Approaches for resilience and antifragility in collaborative business ecosystems', *Technological Forecasting and Social Change*, vol. 151, p. 119846. https://doi.org/10.1016/j.techfore.2019.119846

Ren, S, Eisingerich, AB & Tsai, H-t 2015, 'Search scope and innovation performance of emerging-market firms', *Journal of Business Research*, vol. 68, no. 1, pp. 102-8. https://doi.org/10.1016/j.jbusres.2014.04.011

Rowe, WD 1994, 'Understanding uncertainty', *Risk analysis*, vol. 14, no. 5, pp. 743-50. https://doi.org/10.1111/j.1539-6924.1994.tb00284.x

Seddon, JJJM & Currie, WL 2017, 'A model for unpacking big data analytics in high-frequency trading', *Journal of Business Research*, vol. 70, pp. 300-7. https://doi.org/10.1016/j.jbusres.2016.08.003

Sheffi, Y 2005, *The resilient enterprise: overcoming vulnerability for competitive advantage*, MIT Press, USA.

—— 2015, 'Preparing for Disruptions Through Early Detection', *MIT Sloan Management Review*, vol. 57, no. 1, pp. 31-42.

Sheffi, Y & Rice Jr, JB 2005, 'A Supply Chain View of the Resilient Entreprise', *MIT Sloan Management Review*, vol. 47, no. 1, pp. 41-8.

Shepherd, DA 2004, 'Educating entrepreneurship students about emotion and learning from failure', *Academy of Management Learning & Education*, vol. 3, no. 3, pp. 274-87.
Sim, K, Chua, HC, Vieta, E & Fernandez, G 2020, 'The anatomy of panic buying related to the current COVID-19 pandemic', *Psychiatry Research*, vol. 288, p. 113015. https://doi.org/10.1016/j.psychres.2020.113015
Smit, B & Wandel, J 2006, 'Adaptation, adaptive capacity and vulnerability', *Global Environmental Change*, vol. 16, no. 3, pp. 282-92.
Smithers, R 2020, 'Amazon and eBay failing to stop Covid-19 profiteers, says Which? ', *The Guardian*, viewed June 21, 2020, https://www.theguardian.com/business/2020/mar/25/amazon-and-ebay-failing-to-stop-covid-19-profiteers-says-which.
Srinivasan, R & Swink, M 2018, 'An investigation of visibility and flexibility as complements to supply chain analytics: An organizational information processing theory perspective', *Production and Operations Management*, vol. 27, no. 10, pp. 1849-67. https://doi.org/10.1111/poms.12746
Sterman, JD & Dogan, G 2015, '"I'm not hoarding, i'm just stocking up before the hoarders get here.": Behavioral causes of phantom ordering in supply chains', *Journal of Operations Management*, vol. 39, pp. 6-22. https://doi.org/10.1016/j.jom.2015.07.002
Stevenson, M & Spring, M 2007, 'Flexibility from a supply chain perspective: definition and review', *International Journal of Operations & Production Management*, vol. 27, no. 7, pp. 685-713. https://doi.org/10.1108/01443570710756956
Suberg, W 2015, 'One Coin, Much Scam: OneCoin Exposed as Global MLM Ponzi Scheme', *Coin Telegraph*.
Swafford, PM, Ghosh, S & Murthy, N 2008, 'Achieving supply chain agility through IT integration and flexibility', *International Journal of Production Economics*, vol. 116, no. 2, pp. 288-97. https://doi.org/10.1016/j.ijpe.2008.09.002
Taleb, NN 2007, *The black swan: The impact of the highly improbable*, vol. 2, Random house.
—— 2012, *Antifragile: how to live in a world we don't understand*, vol. 3, Allen Lane London.
Taleb, NN & Douady, R 2013, 'Mathematical definition, mapping, and detection of (anti) fragility', *Quantitative Finance*, vol. 13, no. 11, pp. 1677-89.
Tang, C & Tomlin, B 2008, 'The power of flexibility for mitigating supply chain risks', *International Journal of Production Economics*, vol. 116, no. 1, pp. 12-27. https://doi.org/10.1016/j.ijpe.2008.07.008
Tang, CS 2006, 'Robust strategies for mitigating supply chain disruptions', *International Journal of Logistics Research and Applications*, vol. 9, no. 1, pp. 33-45. https://doi.org/10.1080/13675560500405584
Thun, J-H, Drüke, M & Hoenig, D 2011, 'Managing uncertainty–an empirical analysis of supply chain risk management in small and medium-sized enterprises', *International journal of production research*, vol. 49, no. 18, pp. 5511-25. https://doi.org/10.1080/00207543.2011.563901
Tranfield, D, Duberley, J, Smith, S, Musson, G & Stokes, P 2000, 'Organisational learning–it's just routine', *Management Decision*. https://doi.org/10.1108/00251740010326315
Tranfield, D & Smith, S 1998, 'The strategic regeneration of manufacturing by changing routines', *International Journal of Operations & Production Management*. https://doi.org/10.1108/01443579810193267

Tseng, F-M, Yu, H-C & Tzeng, G-H 2002, 'Combining neural network model with seasonal time series ARIMA model', *Technological Forecasting and Social Change*, vol. 69, no. 1, pp. 71-87. https://doi.org/10.1016/S0040-1625(00)00113-X

Tversky, A & Kahneman, D 1986, *Judgment under uncertainty: Heuristics and biases*, Judgment and decision making: An interdisciplinary reader.

—— 1992, 'Advances in prospect theory: Cumulative representation of uncertainty', *Journal of Risk and Uncertainty*, vol. 5, no. 4, pp. 297-323.

Verity, J 2003, 'Scenario planning as a strategy', *European Business Journal*, vol. 5, no. 4, pp. 185-95.

Wakolbinger, T & Cruz, JM 2011, 'Supply chain disruption risk management through strategic information acquisition and sharing and risk-sharing contracts', *International journal of production research*, vol. 49, no. 13, pp. 4063-84. https://doi.org/10.1080/00207543.2010.501550

Williams, A 2008, *Duck and Cover: It's the New Survivalism*, https://www.nytimes.com/2008/04/06/fashion/06survival.html, The New York Times.

Winter, SG 1995, 'Four Rs of profitability: rents, resources, routines, and replication', in *Resource-based and evolutionary theories of the firm: Towards a synthesis*, Springer, pp. 147-78.

Worley, CG & Lawler III, EE 2006, 'Designing organizations that are built to change', *MIT Sloan Management Review*, vol. 48, no. 1, pp. 19-23.