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On the Mitigability of Uncertainty and the Choice between Predictive and Non-Predictive Strategy

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ABSTRACT

Managers face a critical issue in deciding when to employ a predictive planning approach versus a more adaptive and flexible strategic approach. We suggest that determining which approach is ideal for a given context hangs on the extent to which uncertainty is, or might be, mitigable within that context. To date, however, the mitigability of uncertainty has not been adequately distilled. Here we take on this issue, distinguishing mitigable ignorance of pertinent but knowable information (i.e. epistemic uncertainty) from immitigable indeterminacy (i.e. aleatory uncertainty). We review the current state of the debate on the existence of free will because the acceptance or rejection of conscious agents as a true first cause has fundamental implications. A critical examination of the arguments for and against the free will hypothesis land us on the side of voluntarism, which implies immitigable indeterminacy (but not complete unpredictability) wherever conscious actors are involved. Accepting the existence of immitigable or aleatory uncertainty, then, we revisit the determination of strategic logics and produce important theoretical nuance and key boundary conditions in the normative choice between predictive and non-predictive strategies.

Keywords: Strategic decision-making; free will; aleatory uncertainty; epistemic uncertainty; effectuation

INTRODUCTION

"Natural science does not render the future predictable. It makes it possible to foretell the results to be obtained by definite actions. But it leaves impredictable two spheres: that of insufficiently known natural phenomena and that of human acts of choice" (Mises, 1998: 105).

When should managers and entrepreneurs forecast and plan, and when should they adopt a more dynamic, adaptive strategy? So far, there has been a "disturbing inconclusiveness of the empirical research on the relationship between planning and market performance" (Chwolka & Raith, 2012: 387). Present sentiment holds that planning and adaptation ought to be integrative and/or concomitant, and that the extent of planning versus dynamic adaptation ought to depend on the amount of uncertainty surrounding the firm or venture (Brinckmann, Grichnik, & Kapsa, 2010; Chwolka & Raith, 2012; Reymen et al., 2015). The meta-theoretic assumptions underlying this view suppose uncertainty to be mitigable, and that information gathering efforts can reduce uncertainty sufficiently to facilitate prediction and planning. The boundary between prediction/planning and non-prediction/adaptation, then, concerns the magnitude or extent of uncertainty—when uncertainty is sufficiently strong such that the costs of necessary information gathering outweigh the benefits of its alleviation, a non-predictive or effectual approach may be preferable (Wiltbank, Dew, Read, & Sarasvathy, 2006).

However, uncertainty theorists have yet to carefully examine the nature of, and possible differences in, uncertainty's mitigability. It is not altogether clear that all uncertainty is, or may be, mitigable, and some uncertainties may be more mitigable than others. For example, Alvarez and Barney (2005) imply that Knightian risk is mitigable, whereas Knightian uncertainty is not (cf. Wiltbank et al., 2006), a topic on which Knight himself was somewhat unclear. Most, however, apparently presume that all uncertainty is mitigable *in principle*, and that firms with the most and best information and, thus, least uncertainty in aggregate possess the advantage (see Townsend, Hunt, McMullen, & Sarasvathy, 2018 for a review). Uncertainty, then, is commonly understood to exist on a continuum, from weak to strong, with no apparent fundamental delineation regarding the nature of the underlying uncertainties that epitomize the ‘strength’ or ‘degree’ (or mitigability) of the presently instantiated uncertainty (Dequech, 2011). As a result, arguments advocating a turn toward more dynamic or non-predictive decision logics (e.g. Packard, Clark, & Klein, 2017; Perry, Chandler, & Markova, 2012; Sarasvathy, 2001) so far remain theoretically incomplete as they lack sufficient boundary conditions to delineate under what uncertainty conditions such strategies would be preferable over more traditional strategic planning approaches (Arend, Sarooghi, & Burkemper, 2015; but see Gupta, Chiles, & McMullen, 2016; Read, Sarasvathy, Dew, & Wiltbank, 2016). For example, when does uncertainty become too strong to effectively manage via information management and analysis, thereby compelling a dynamic uncertainty navigation approach? When is uncertainty able to be sufficiently assuaged so as to facilitate effective management through prediction, or when is it so strong as to practically disallow such prediction and, therefore, require more adaptive strategic management? Or when do the costs of uncertainty’s mitigation surpass the strategic benefits of a predictive strategy compared to an adaptive one? The roots of this issue are not only in *what* and *how much* is uncertain, but also in the *nature* of that uncertainty and the extent to which it is, or may be, mitigable.

In this article we examine the theoretical and philosophical roots and sources of *mitigable* versus *immitigable* uncertainty and elaborate on the strategic importance of mitigability within the context of managerial decision-making (e.g. when non-predictive strategies would be normatively preferable over predictive strategies). We find theoretical grounding for this project in probability theory, which has distinguished uncertainty derived from ignorance of knowable information (i.e. *epistemic* uncertainty) from that derived from inherently stochastic events (i.e. *aleatory* uncertainty) (Der Kiureghian & Ditlevsen, 2009; Fox & Ülkümen, 2011; Hacking, 1975; Perlman & McCann, 1996; Tannenbaum, Fox, & Ülkümen, 2017). The difference between these epistemic and aleatory uncertainty concepts, however, is not altogether clear, and hangs in large part on larger questions and assumptions. Specifically, does *true* stochasticity exist, or is perceived randomness simply ignorance (i.e. epistemic uncertainty) of the underlying causal inputs to an outcome? Ultimately, this drives us to important philosophical questions concerning mental causation and the existence and nature of free will. We carefully explore the current state of science regarding these questions and conclude that we cannot yet and, thus, should not reject the free will hypothesis. Adopting this position here, the effective actions of conscious actors are, to us, inherently and immitigably uncertain (though not always or entirely unpredictable). As a result, in the vast majority of relevant cases, decision makers are confronted with situations comprised of both mitigable (epistemic) and immitigable (aleatory) uncertainty types.

The implications of this delineation for management are profound, touching virtually all areas of management interest, from entrepreneurship and strategic management to organizational behavior and human resource management. In particular, we show how the (im)mitigability of uncertainty provides a critical boundary condition for strategic decision-making (cf. Tsoukas, 1996), and argue that the perceived nature of the various uncertainties one faces will (and ought to) dictate which type of strategic logic one pursues (cf. Wiltbank et al., 2006). A strategy of concomitant predictive and non-predictive logics is not enough; the strategist must also understand which uncertainties require which logics and when a shift in logics is in order. We also offer, in conclusion, a cursory look at some additional implications of a truly immitigable uncertainty concept, corresponding to the notions of free will and indeterminism, for management research while leaving the bulk of such implications to future research.

ON THE (IM)MITIGABILITY OF UNCERTAINTY

One of the primary goals of strategic management and entrepreneurship, and the strategic tools that have been developed therein, is to facilitate more successful management of the uncertainty that managers and entrepreneurs face with regard to future demand (Anupindi & Jiang, 2008; Goyal & Netessine, 2007), competition and competitive action (Grimm, Lee, Smith, & Smith, 2006; Milliken, 1987), institutional and regulatory change (Bylund & McCaffrey, 2017; Smith & Grimm, 1987), factor markets (Walker & Weber, 1987; Williamson, 1975), and so on. However, there are two dominant strategies that pertain to uncertainty management. The first seeks competitive advantage through uncertainty mitigation and planning-based strategic management. The second pursues success and sustainability through adaptability and agility.

Uncertainty management through mitigation has been the prevailing paradigm for several decades. It has roots in Taylor's (1914) scientific management. It was prevalent in Thompson's (1967) classic work, and is a foundational tenet of resource dependence theory (Pfeffer & Salancik, 1978), which argues that firms can manage uncertain environments via control over key resources and through the formation of interorganizational relationships (Hillman, Withers, & Collins, 2009). According to the resource-based view, information and/or knowledge are key resources that bestow advantages in strategically dealing with uncertainty (Barney, 1991; Wernerfelt, 1984), which is also the basis of a knowledge-based view (Felin & Hesterly, 2007; Grant, 1996; Spender, 2003). Uncertainty mitigation is one of the foundational motivations for the organizational learning and absorptive capacity literatures (Argyris & Schön, 1978; Cohen &

Levinthal, 1990; Kraatz, 1998; March, 1991; Siegenthaler, 1997; Sinkula, 1994), which see knowledge advantages as bestowing predictive superiority and, thus, greater strategic and innovative success. In short, this perspective sees information as the remedy to uncertainty, and so strategic advantage via uncertainty mitigation is conferred upon those who are most adept at finding, absorbing, controlling, and utilizing information (Klir, 2006).

The second uncertainty management strategy involves coping with and, perhaps, capitalizing on uncertainty rather than attempting to mitigate it. This alternative view was highlighted in Burns and Stalker's (1961) early contingency theoretic work, which argued that organizations in contexts of high uncertainty may better manage that uncertainty through organic structural organization rather than mechanistic designs (cf. Ouchi, 1977, 1979; Ouchi, 1980). It was developed in Ackoff and Emery's (Ackoff, 1983; Ackoff & Emery, 1972) 'systems thinking' approach to management. The importance of adaptability within uncertain environments was prominent in Mintzberg's (1973, 1978; Mintzberg & McHugh, 1985; Mintzberg, Raisinghani, & Theoret, 1976) theorizing on strategy formation. It is also a central theme of the dynamic capabilities literature (Schilke, 2014; Teece, Pisano, & Shuen, 1997), real options (McGrath, Ferrier, & Mendelow, 2004), and strategic effectuation (Wiltbank et al., 2006). In short, this view holds that uncertainty is, often, best addressed through its effective navigation rather than its mitigation, e.g., strategically organizing for rapid informational processing and response rather than superior knowledge acquisition and exploitation.

The tension between these literatures is often overlooked, perhaps because they are seen as addressing the same issue. Certainly, it need not be the case that firms focus exclusively on uncertainty mitigation *or* its navigation. Whereas the ideal organizational form and function for uncertainty mitigation is understood to be much different from that of an adaptive approach, some have advocated more fluid structures that are able to toggle between both strategic approaches (Brinckmann et al., 2010; Chwolka & Raith, 2012; O'Reilly & Tushman, 2013; Reymen et al., 2015). However, such strategic dualism can be costly, difficult, and often ineffective under more radical types of uncertainty (Tushman & O'Reilly, 1996). Such ineffectiveness is, likely, due to ambiguities in determining if and when one or another approach is preferable (a gap we seek to address). It behooves us, then, to more thoroughly distil the boundary conditions by which a particular strategic decision approach is, or ought to be, determined. To answer this, we must better understand the distinct natures of the uncertainty that they seek to address.

Wiltbank and colleagues (2006), in line with the work of Shackle (1949, 1979, 2009) and others (e.g. Buchanan & Vanberg, 1991; Lachmann, 1977, 1986), distinguish two types of uncertainty: the *unknown* and the *unknowable*—or, in our terminology, the *mitigable* and the *immitigable*. Their treatment of these, however, is brief and inadequate to establishing a well-formed boundary. We therefore expound on these two types in the following.

Epistemic (Mitigable) Uncertainty

Epistemic uncertainty originates from ignorance of knowable information (Der Kiureghian & Ditlevsen, 2009; Perlman & McCann, 1996; Tannenbaum et al., 2017). In a Newtonian sense, all outcomes are presumed to be knowable *ex ante* so long as all causal factors and their effects are known *a priori*. Probabilities are merely shorthand for ignorance of certain underlying criteria needed to perfectly predict an outcome. For example, a coin flip would become perfectly predictable if all the variables by which it is flipped (angle, velocity, spin rate, air friction, angle and hardness of the landing surface, etc.) could be fully accounted for and their effects fully understood. Thus, epistemic uncertainty concerns various “knowledge problems”

(Townsend et al., 2018: 659), including causal ignorance and ambiguity, equivocality, probabilistic risk (Knight, 1921), as well as what Dosi and Egidi (1991: 148) dub *weak substantive uncertainty*, which derives from a "lack of information about the occurrence of a particular event within a known list of events, in principle representable as a random drawing by 'nature', with a certain known (or at least knowable) probability distribution."

Epistemic uncertainty also reflects Dosi and Egidi's (1991: 146) notion of *procedural* uncertainty, which derives from "a competence gap in problem-solving," or a computational incapacity to fully process available information into a known, consequential outcome. Perlman and McCann (1996: 17) depict epistemic uncertainty in this way, defining it as "uncertainty existing because the mind… cannot apprehend more than a limited sphere."

Here we define epistemic uncertainty in terms of its mitigability—that is, uncertainty is, for us, *epistemic* if it results from ignorance of knowledge that is knowable *in principle*. This includes those uncertainties for which the information or computational capacity needed to mitigate them may not yet be available. That we cannot, as of yet, always and precisely predict changes in weather and climate does not mean that they are wholly unpredictable—prediction should, in fact, become possible if and once we have determined and can precisely measure all relevant factors, their weights, and interactions.

The sources of epistemic uncertainty

Following early pioneers of the environmental uncertainty construct, we observe three primary sources of epistemic uncertainty: complexity, dynamism, and stochasticity (Child, 1972; Dess & Beard, 1984; Duncan, 1972; North, 2005). *Complexity* reflects the total amount of data or "the level of complex knowledge that understanding the environment requires" (Sharfman & Dean, 1991: 683). *Dynamism* refers to the rate at which such causal factors within an environment change. *Stochasticity* (or *non-ergodicity*) refers to the non-repetitiveness or randomness of change in an environment such that a pattern cannot be detected and, thus, next-states predicted (Davidson, 1991). Individually and conjointly, these factors inhibit predictability inasmuch as the actor and/or the computational system tasked with information processing cannot sufficiently observe or manage the amount of observable data required to predict next-state outcomes.

Once the capacity or speed limits of procedural rationality—the total computational power that one possesses or has access to in order to assess and analyze observational data—are surpassed, a decision maker cannot calculate certainly the next-state outcome (Simon, 1979). Partial ignorance of the complete immediate state of possibly relevant factors, or a procedural incapacity to calculate their effects, forces the mind to deal with consequential ambiguity. Within such ambiguity, one must instead imagine expected outcomes through mental play-outs of possibilities (Johnson-Laird, 1983; Johnson-Laird & Byrne, 1991; Shackle, 1949, 1969). Inasmuch as the decision maker recognizes these computational limitations and admits alternative outcome possibilities, s/he experiences epistemic uncertainty.

In conclusion, the delineation between Knightian risk and uncertainty and the corresponding planning versus strategic adaptation decision logics (e.g. Alvarez & Barney, 2005) is incomplete. While risk is, inherently, mitigable, much of Knightian uncertainty (or what is often described as such) is also. Thus, planning scenarios may be preferable within certain uncertainty conditions, if those conditions can be sufficiently and easily mitigated.

Aleatory (Immitigable) Uncertainty

While much of uncertainty is *epistemic* and, thus, mitigable, it is not clear whether *all* of it is, or may be, or whether some of what is uncertain is absolutely beyond knowability, even in principle, such that it is altogether immitigable. In this section we explore the possibility of causal indeterminacy and the *aleatory* uncertainty that would result.

The term ‘aleatory’ derives from the Latin *alea*, meaning the rolling of dice. It has been employed in probability theory to model uncertain contexts in which intrinsic randomness is observed (Der Kiureghian & Ditlevsen, 2009; Hacking, 1975). More recently, the term ‘aleatory uncertainty’ has been used to describe decisions in which indeterminate and unknowable factors produce a situation that is perceived to be stochastic (Fox & Ülkümen, 2011; Perlman & McCann, 1996). It is, according to Perlman and McCann (1996: 17), “a factual uncertainty,” ontologically real where, in a Newtonian sense, at least one underlying causal factor is utterly unknowable, even in principle (cf. Dequech, 2004). This relates to Dosi and Egidi’s (1991: 148) notion of *strong substantive uncertainty*, which involves “the impossibility, even in principle, of defining the probability distribution of the events themselves.” Whether an outcome is truly random in a probabilistic sense, or if its determination is utterly unknowable, may be pertinent to the decision making process, although standard decision theories generally treat the two scenarios as equivalent (e.g. Kahneman & Tversky, 1979; Savage, 1954). In the former case, the possible outcomes are known, but their likelihoods cannot be. In the latter, the outcomes themselves are unknown and unknowable, the set of outcomes unbounded or indeterminate (Packard et al., 2017). Both cases, however, are *aleatoric* or result in *aleatory uncertainty*.

For us, aleatory uncertainty is characterized by its immitigability. It is uncertainty not characterized by ignorance of knowable information, but by immitigable ignorance. It is a knowledge problem produced by some inherent, *a priori* causal indeterminism that cannot be mitigated, even in principle.

Is there any such ignorance and, thus, uncertainty that is, altogether, immitigable? If so, what information is unknowable? This is a philosophic question, and one on which scholars disagree. Here we briefly review the debate in order to assess whether aleatory uncertainty ought to be understood as objectively real, or whether its effects are only meaningful through its subjective perception (as in Tannenbaum et al., 2017).

The free will debate

A primary possible source of indeterminism is human choice. To what extent are human actors predictable, or to what extent could they be? Certainly, we often feel like we can predict people, especially those we know well. In a general or aggregate sense, we are often right in our predictions of behavior. However, it seems possible for a person, even one we know very well, to act in a way that is wholly unpredictable *a priori*. For example, while a parent might be so familiar with their child's goals and preferences and have well-formed beliefs regarding the child's future behaviors, and although such beliefs often turn out to be quite accurate, parents will attest to their children's continued abilities to surprise them.

While there is general agreement that humans are at least difficult, if not impossible to predict (Popper & Eccles, 1977; Scriven, 1965), there is less clarity amongst opinions of why this is the case. Are human actors a source of mitigable (epistemic) uncertainty that can become fully predictable once all the pertinent data can be observed and processed? Or, is the exercise of human agency a source of immitigable (aleatory) uncertainty, incapable of being fully predicted?

The theoretical possibility of perfectly predicting human action—i.e. of fully mitigating behavioral uncertainty—rests on our assumptions concerning free will. By *free will* we mean "the thesis that we are sometimes in the following position with respect to a contemplated future act: we simultaneously have both the following abilities: the ability to perform that act and the ability to refrain from performing that act" (van Inwagen, 2008: 329). The question of free will concerns “whether there is anything left over by these conditions of our existence such that our free actions can be said to be (i*) *our products* (i.e. caused by us) and such that (ii*) their occurring rather than not occurring here and now, or vice versa, *has as its ultimate or final explanation the fact that they are caused by us*” (Kane, 1989: 224, emphasis in original). This question adopts a ‘counterfactual’ account of causality (Lukka, 2014), which holds that “[a]n event Y depends causally on a distinct event X if and only if both X and Y occur, and if X had not occurred, then Y would not have occurred either” (Lewis, 1973: 9). That is, the free will question asks if intentional action cannot happen except with, through, and/or because of the conscious will. This is not to say that human *reflex* cannot happen without the will, but instinctive or reflexive behaviors are of a different category than conscious or intentional behaviors (Mises, 1998).

The concept of free will has been of central concern within philosophy, its implications quite strong with regard to how we understand and study people. Yet, little real progress has been made in understanding mental causation. This is not to say that important work has not been done on the topic—on the contrary, modern arguments for and against the existence of free will have become advanced and refined (e.g. Baer, Kaufman, & Baumeister, 2008; Crescioni, Baumeister, Ainsworth, Ent, & Lambert, 2016; Nahmias, 2014; Nichols, 2011; Searle, 2015). However, despite this progress, we remain in the same state as we did centuries ago—*we do not know*. Some believe that the question of free and conscious will, which has roots in the mind-body problem (i.e. the question of where consciousness and mental causation comes from), may be unsolvable (see Chalmers, 1996; McGinn, 1989).

On the one hand, many hold that behavior is fully *caused*, and that improvements in observation, measurement, and data processing will improve the prediction of human behavior up to and, at least in principle, including to the point where perfect data would yield perfect prediction. This *determinist* position on the question of free will is, succinctly, that it does not exist, and that the sense that one experiences of the ability to choose is, in fact, illusory (Wegner, 2003). This view has been buoyed by experiments in neuroscience and psychology. For example, Libet and coauthors (1983) found that preparatory cognitive activity *precedes* one's awareness of any intention to act, which has been taken by determinists as evidence that intentions to act are an epiphenomenon, outside of the causal chain of action (see Figure 1). Langer (1975) found that, in circumstances of pure chance, individuals often feel as if they have some control over the outcome. This illusion of control is, for determinism, an aspect of the illusion of free will, an illusion that is important to one's self-concept and psychological well-being (Taylor & Brown, 1988). Researchers have also observed a "blindsight" phenomenon (Becker, Cropanzano, & Sanfey, 2011; Humphrey, 1974), where participants react to stimuli that they had no apparent conscious awareness of (e.g. Leh, Johansen-Berg, & Ptito, 2006). Wegner (2003; 2004: 649) concludes that "the *experience* of consciously willing an action and the *causation* of the action by the person's conscious mind… are entirely distinct, and the tendency to confuse them is the source of the illusion of conscious will." This perception of free will may have evolved within us to ensure cooperative and ethical behavior (see Baumeister, Masicampo, & DeWall, 2009; Clark et al., 2014; Krueger, Hoffman, Walter, & Grafman, 2013; Monroe, Dillon, & Malle, 2014; Pereboom, 2001; Stillman, Baumeister, & Mele, 2011; Vohs & Schooler, 2008).

Insert Figure 1 about here

On the other hand, *voluntarism* holds that free will is a real phenomenon and a true causal originator—an “uncaused cause” (Shackle, 1983). For voluntarism, behavior cannot be reduced to purely circumstantial causes. There is a factor of conscious intentionality or agency—of free will—in human action (Mises, 1998). Like determinism, voluntarism accepts the trans-temporality thesis that the state of the world at one time is causally related to the state of the world at another time, otherwise we would not act (Finch, 2013; Mises, 1962). It rejects, however, the Kantian dictum that *everything has a cause*, supposing there to be an Aristotelian ‘first cause’ in the conscious mind, that free will cannot be reduced to purely physical causes such that what we might call the ‘self’ can be removed from predictive models of behavior (see Figure 2). In other words, it rejects determinism’s conclusion that the state of the world at one time *fully* determines the next state of the world, given the immutable laws of nature.

There is some debate and, sometimes, misunderstanding with regard to the extent of mental causation. For example, if an instructor asks a question and a student raises her hand to answer, we might say that the question ‘caused’ her to raise her hand—i.e., the question indicated that a response was desired, prompting the student to mentally derive an answer to the question, which was then judged with respect to the worthiness of the answer, the worthiness itself inducing the student to choose to share it, which, in turn, elicited the raising of the hand. To what extent was her will a factor in this process? The answer is, in short, we do not know. The voluntarist position is, in contrast to the determinists’, that it is more than nothing.

Insert Figure 2 about here

A third camp, the *compatibilist* view, contends that free will exists, but is *caused* (Hume, 2003). Just as it is acceptable and, even, correct to say a wing causes flight, even though a ‘wing’ is just a concept representing the matter arranged in a particular configuration that makes it up, the will is caused by underlying factors (Nahmias, 2014)—a *caused* cause. For example, Searle (1980, 2015) proposed that consciousness and free will emerge from the complex organization of the brain. While compatibilism is attractive, its viability rests on redefining fundamental terms in such a way as to allow compatibility. As per the so-called Consequence Argument (van Inwagen 1983), the concept of 'free will' as meant by determinists and voluntarists cannot allow reconciliation between the two positions—either free will is a true first cause, or choices are *fully* attributable to causal factors other than free will (Finch, 2013; van Inwagen, 2008).

Ever-increasing empirical evidence of behavioral determinants can be interpreted as suggestive that, eventually, human behavior will become predictable and, thus, an epistemic uncertainty problem (Harris, 2012; Wegner, 2003). However, Nahmias (2014) points out that determinism's epiphenomenalist conclusion that the neural correlates of intentionality are bypassed in the causal sequence of events, thereby producing a merely illusory experience of free will, rests on three assumptions, none of which are currently supported by the evidence.

First, it assumes that we can identify the nonconscious neural activity that precedes conscious awareness as the true source of intentionality. Neuroscientific research continues to be unable to ascertain the origins of neural activity and so cannot place its origins within nonconscious sources. It is certainly plausible, for example, that willful intentions initiate a neurological sequence of customary or pre-planned behaviors—*scripts*, in the language of structuration theory (Giddens, 1984)—that are, then, monitored by the will as events and behaviors unfold to ensure that desired outcomes result or, if not, recalibrate and modify the course of action toward the intended end or, otherwise, revise the intentions sought. Such an alternative explanation allows for brain processes to be caused by the will while also preceding what has so far been described as conscious awareness, which awareness may quite possibly be mere *urges* rather than irrevocable *intentions* or *decisions* to act (Mele, 2009). Or, alternatively, Schurger and colleagues (2012) propose that the observed neuronal activity widely understood as 'readiness potential' that precedes conscious willing to act (Libet et al., 1983) may instead be a separate judgment to determine when to make an action judgment (e.g. when there is enough information, or when the actor is ready). In other words, what scientists previously thought determined conscious action *before* one's recognition of having made the decision to act may actually be one's decision *to make a decision* and, thus, correspond appropriately with one's temporal perception of willing.

Second, it assumes that such intentionality in fact causally *bypasses* the will rather than operating *through* it. Additional experiments performed by Libet (1999) and colleagues suggest that the observed mental preparation to act—the urge to act in a particular way—can be consciously 'vetoed,' preventing the action, which would suggest that the process operates *through* the conscious will and not around it.

Finally, it assumes that we can accurately identify participants' reports of conscious awareness of the *urge* to act at a certain time with the actual *decision* to act at that time. However, neuroscientific research suggests that the temporal perception of conscious awareness is not straightforward. For example, in one experiment participants perceived *voluntary* actions as occurring later, and their sensory outcomes earlier, than they actually were, whereas for perceived *involuntary* actions the effect was the opposite (Haggard, Clark, & Kalogeras, 2002). Evidence suggesting that the *experience* of free will occurs after intentions to act are already instigated is not at all surprising or contradictory to the voluntarist position, as "[t]he sensation of will isn't the will itself any more than the sensation of hunger is the same thing as being devoid of nutrients, or the sensation of warmth is heat itself, or the smell of a rose is the rose itself" (Hardcastle, 2004: 662; Heyman, 2004; Jack & Robbins, 2004).

We are far from being in a position, as a science, to simply dismiss free will as a causal factor of behavior. In this state, then, we conclude that the appropriate, pragmatic assumption must be voluntarism.

> "We may or may not believe that the natural sciences will succeed one day in explaining the production of definite ideas, judgments of value, and actions in the same way in which they explain the production of a chemical compound as the necessary and unavoidable outcome of a certain combination of elements. In the meantime we are bound to acquiesce in a methodological dualism.
>
> Human action is one of the agencies bringing about change…. As—at least under present conditions—it cannot be traced back to its causes, it must be considered as an ultimate given and must be studied as such" (Mises, 1998: 18).

Voluntarism is the more defensible 'default' position for management science for several reasons. First, while the source of mental causation (i.e. conscious will) remains unobservable, its unobservability is insufficient to justify assuming non-existence (Godfrey & Hill, 1995; Hayek, 1989). Second, social and human sciences generally deal with large amounts of unexplained variance. Dismissing this variance as noise is less tenable, we think, than attributing some, if not much, of it to free will (see Howard & Conway, 1986; Miller & Atencio, 2008). Finally, research strongly suggests that promotion of free will is ethically preferable to an advocacy of determinism. Because a belief in determinism facilitates counterproductive and unethical behavior (Baumeister et al., 2009; Krueger et al., 2013; Vohs & Schooler, 2008), we are ethically obliged to avoid jumping to such conclusions absent incontrovertible evidence.

Human action is, as far as science has so far allowed us to determine, an originator of causation, a creator, an uncaused or first cause (Joas, 1996; Shackle, 1979). Thus, the practical course is to treat human action as inherently uncertain, which uncertainty cannot be mitigated to the extent that free will has causal influence over outcomes. As more conscious actors come to have potential influence over any particular outcome of interest, that outcome becomes increasingly and immitigably uncertain.

Other sources of aleatory uncertainty

Even if we were to determine free will to be an illusion, however, there may be other possible sources of aleatory uncertainty that might render human action and other causal factors altogether unknowable. We briefly acknowledge two. First is the unknowability of *what is it like* to have conscious experience. This "what is it like" problem of subjective experience has been put forward by philosophers as a critical boundary of epistemology (Jackson, 1982, 1986). For example, Nagel (1974) famously observed that some knowledge is altogether beyond science's reach, such as the experience of being a bat. We may know *about* bats, their blindness, echo location, their biology, and so forth; but we can never know what it is like to *be* one. At best, we can only imagine or mimic the experience from our own viewpoint, i.e. "what it would be like for *me* to behave as a bat behaves;" we cannot know "what it is like for a *bat* to be a bat" (Nagel, 1974: 439). Thus 'qualia,' the conscious experience of what something *feels like* from the first-person perspective, involves more than what a purely physical observation or explanation can produce.

The unknowability of qualia presents an irresolvable hurdle that also leads to aleatory uncertainty. For example, if the outcome of interest is, specifically, another's experience, such an outcome would be, to some extent, beyond knowability. While others' experiences are not typically of direct interest to the decision maker, who is generally more concerned about the others' behaviors and the ability to predict them, direct, first-hand experience—the qualia of such experience—contains the interpretive lens through which learning occurs. Thus, individual knowledge and understanding, which are (or may be) scientifically unknowable, is employed directly in determining behavior. Thus, the 'what it's like' problem itself creates aleatory uncertainty regarding human behavior, even in the absence of free will.

Secondly, physicists have run into significant knowability problems at the quantum level. For example, whereas quantum particles (e.g. electrons) normally exhibit a waveform pattern, the mere observance of some particle collapses its wavefunction and produces a single-stream pattern instead. Attempts to explain such results have led to a variety of interpretations. The popular "Copenhagen interpretation" posits quantum *indeterminism*, suggesting that the quantum world is merely probabilistic and, therefore, only semi-predictable (Bell, 1964; Einstein, Podolsky, & Rosen, 1935; Gröblacher et al., 2007). Heisenberg's uncertainty or indeterminacy principle posits that the position and the velocity of a quantum object cannot both be measured simultaneously *and* exactly, even in theory. Quantum theory, which has strong support of experimental evidence, suggests that there may be aspects of aleatory and immitigable uncertainty even within the physical realm. While the relevance of such physical indeterminism to the realm of management science, for now, appears to be limited, it illustrates that aleatory uncertainty is, or may be, real and relevant far beyond what has hitherto been recognized.

Insert Figure 3 about here

The Boundaries of Uncertainty's Mitigability

The total uncertainty of an environment or outcome is comprised of all indeterminacy or unknowability (i.e. *aleatory* uncertainty) as well as all observational and procedural limits to prediction (i.e. *epistemic* uncertainty), as illustrated in Figure 3. Epistemic uncertainty, as we have defined it, is mitigable, whereas aleatory uncertainty is not. Thus, total uncertainty is mitigable to the extent that the epistemic component can be eliminated through increases in information and in cognitive awareness and capacity—e.g., through technological advancements by which cognitive awareness and computational capabilities may be supplemented. This uncertainty mitigation is bounded, however at the upper limit of aleatory *indeterminism*—where aleatory uncertainty exists, it bounds uncertainty's mitigation to some real and significant limit.

Of note, the acceptance of aleatory uncertainty within a system implies that *causal closure* is impossible. Causal closure refers to the bounding of causal influence to a limited number of known factors, whereas an open system can be influenced by unknown 'outside' factors. *Physical causal closure* refers to a state in which all outcomes have only physical, and thus knowable, causes (Papineau, 2009). Free will disallows physical causal closure, as it must always be 'outside' of the known causal factors within a system.

Proposition 1: Outcomes within a system characterized by physical causal closure and, thus, epistemic uncertainty are, in principle, fully predictable.

Proposition 2a: There can be no causal closure where human actors are involved. Behavioral uncertainty is, at most, only partially mitigable. There will always be some aspect of human choice that is immitigably uncertain.

Proposition 2b: The level of aleatory (immitigable) uncertainty increases correspondingly to the extent that free will is a causal factor of an outcome. The more influence an actor has on an outcome, and the more actors that have an influence on an *outcome, the more immitigably uncertain that outcome will be.*

THE BOUNDARIES OF (NON-)PREDICTIVE STRATEGY

Having laid out the arguments for a delineation between mitigable epistemic uncertainty and immitigable aleatory uncertainty, how does this distinction causally influence decision-making and successful strategy? Is one decision process superior to another within epistemic versus aleatory uncertainty? Specifically, we are interested in whether and when predictive and planning strategies are preferable to non-predictive approaches. For simplicity, we focus our attention on effectuation theory as it has already cleanly delineated predictive (i.e. causal) and non-predictive (i.e. effectual) logics, and because there is a highly relevant and ongoing conversation about appropriateness of its boundary conditions and their ties to uncertainty concepts (Arend, Sarooghi, & Burkemper, 2016; Gupta et al., 2016; Read et al., 2016). However, these implications are, or ought to be, equally relevant for other strategic judgment approaches such as real options (McGrath, 2001; McGrath et al., 2004) and heuristics-based management (Bingham & Eisenhardt, 2011; Maitland & Sammartino, 2015).

Before determining the boundary conditions that normatively delineate a predictive versus non-predictive strategy, we must first lay out the primary differences in these strategies, including and especially their distinct costs and benefits. By non-predictive strategy we do not mean that there is no prediction or judgment whatsoever, for all action requires such—we would not act if there were no expectation of some preferred outcome as a result of that action (Mises, 1998). The delineation between predictive and non-predictive strategy, then, is centered on the 'incrementalism' of the firm's (or entrepreneur's) predictions—a non-predictive strategy is high in incrementalism, preferring smaller judgments at shorter intervals, and regularly revisiting and revising those judgments based on new information learned in that short span (Packard et al., 2017). A predictive strategy instead attempts to make longer-term predictions of future outcomes so as to plan and coordinate the firm's actions to most optimally take advantage of the predicted future state (Wiltbank et al., 2006). Thus, due to smaller commitments per decision and shorter prediction time horizons, the potential for prediction error is smaller under a non-predictive strategy, but the costs (broadly speaking) of such a strategy tend to be higher, requiring constant environmental scanning, information absorption, and plan revision. Strategic planning, in contrast, mitigates many of these costs by facilitating efficient and optimized preparations early, but these cost savings are accompanied by a much higher risk of predictive error and, thus, failure.

The basic premise of effectuation theory is that, under conditions of Knightian uncertainty and resource constraints, experienced and successful entrepreneurs tend toward 'effectual' rather than 'causal' decision logic (Sarasvathy, 2001). An effectual approach to entrepreneurship advocates that the entrepreneur "begin with a given set of means, focus on affordable loss [i.e. what they can afford to lose], emphasize strategic alliances, exploit contingencies, and seek to control an unpredictable future;" a causal approach would instead "begin with a given goal, focus on expected returns, emphasize competitive analyses, exploit preexisting knowledge, and try to predict an uncertain future" (Perry et al., 2012: 839). Thus, causation is predictive while effectuation is non-predictive in nature. Theorists have described the logic underlying effectuation as one of 'control' such that, "to the extent that we can control the future, we do not need to predict it" (Sarasvathy, 2001: 252). However, we observe that control is only possible with causal closure. Effectual entrepreneurs, thus, do not control the future in a literal sense, their goal attainment dependent upon uncontrollable market actors; instead, what effectuation theorists mean by this is a "focus on the controllable aspects of an unpredictable future" (Sarasvathy, 2001: 252) to maximize the chances of a preferred outcome. Thus, strictly speaking, effectuation's non-predictive logic is, as we have described, a predictive incrementalism.

Effectuation theory posits two essential boundary conditions under which a non-predictive or effectual learning approach would be strategically preferable to a predictive or causal planning approach: (1) Knightian uncertainty and (2) resource constraints bounded by the commitments of stakeholders within their 'affordable loss' (Arend et al., 2015; Sarasvathy & Dew, 2005). However, these conditions do not appear sufficient to necessarily imply a preference for an effectuation approach. Thus, effectuation theory has been criticized for having "no precise competitive landscape (complete with dependent variable specification) from which to compare alternative processes to determine which is best under which conditions; without this, there is no reason for a practitioner to use an effectual process rather than a different process" (Arend et al., 2015: 640; Welter, Mauer, & Wuebker, 2016). That is, there seems to be no clear guidance or instruction for when effectuation procedures would be preferable to causal decision processes, thereby limiting its practical value. If uncertainty is mitigable, why not pursue an uncertainty mitigation strategy that facilitates prediction and causal planning? At what point does uncertainty become too strong for such a causal approach (cf. Ansoff, 1991)?

This criticism is underscored by an "implicit assumption… that the context does not remain uncertain over time" because "an experimental learning process—like effectuation—is expected to reduce ambiguity, over time, through actions taken" (Arend et al., 2015: 633). Indeed, Sarasvathy (2001) does suggest that effectual logic can and ought to give way to causal logic over time as the radical uncertainty that entrepreneurs face resolves into more predictable Knightian risk (Perry et al., 2012). This assumption, of course, is strained by our recognition of aleatory uncertainty.

Furthermore, proponents of effectuation theory hold that effectuation is *generally* preferable to causal approaches within conditions of uncertainty (Read, Song, & Smit, 2009). However, absent a more nuanced concept of uncertainty, grounding for such a position is tenuous theoretically and unavailing practically. For example, Reymen and colleagues (2015) find that ventures tend to employ both causal and effectual logics throughout the new venture development process, and suggest that such a combinatory judgment model may be ideal. Similarly, Packard et al. (2017) argue that entrepreneurs shift between causal and effectual logics according to the nature of the judgment and type of uncertainty that is perceived. Thus, it is not clear that effectual judgment logic is always and necessarily preferable under all conditions of uncertainty. Under conditions of epistemic uncertainty, for example, it may be possible and even prudent to purposively mitigate uncertainty toward a predictive strategy, especially if the perceived costs of uncertainty mitigation are low. Thus, as Arend et al. (2015; Welter et al., 2016) suggest, the risk-uncertainty boundary, the prevailing boundary between predictive versus non-predictive strategies (Sarasvathy, 2001; Wiltbank et al., 2006), is unsatisfactory.

Here we propose the epistemic-aleatory distinction to be a preferable theoretical boundary to explain a normative preference for predictive versus non-predictive strategic logics (see Figure 4). This is not the only boundary condition—epistemic uncertainty does not necessarily imply predictive strategy, nor does aleatory uncertainty always imply a non-predictive strategy. For example, the costs associated with acquiring new information also play a key role. However, the epistemic-aleatory boundary is theoretically primary and is, thus, our starting point.

Insert Figure 4 about here

Election of Predictive versus Non-predictive Strategy

Uncertainty is broadly understood to be the primary determinant of a firm's strategic decision logic, at least in a normative sense. Wiltbank and colleagues (2006) distinguish three types of uncertainty: the known, the unknown, and the unknowable. Known uncertainty, or Knightian risk, is generally manageable through predictive strategy. The other two types correspond to our depictions of epistemic and aleatory uncertainty, respectively. Under *unknown* or epistemic uncertainty, "it is in principle always possible to make predictions (even if it takes time to learn how to do it well), and use prediction as a means of controlling outcomes" (p. 988). But in *unknowable* or aleatory uncertainty, it may be preferable to adapt to and shape changing environments and its outcomes rather than attempting to predict outcomes (Sarasvathy, 2001).

We expound, first, on the aleatory uncertainty condition. Again, a decision is characterized by aleatory uncertainty inasmuch as and to the extent that other human actors have influence over the outcome. While some (e.g. Wiltbank et al., 2006: 988) have suggested that unknowable outcomes are characterized by "true unpredictability," we note that attempts to predict aleatorically uncertain outcomes are possible. Per Lachmann (1976: 55), "[t]he future is to all of us unknowable, though not unimaginable." The human mind is capable of imagining possibilities and, from them, forming expectations, even for and within indeterminate circumstances (Byrne, 2005; Nanay, 2016; Shackle, 1949, 1969). One can even be quite confident in their predictions under such circumstances. For example, while human behavior might be inherently indeterminate, one can become reasonably confident, in spite of this indeterminacy, that actors will behave in a certain way due to, for example, previouslydemonstrated preferences and established tastes.

However, while the notion of prediction is compatible with aleatory uncertainty, Hult and colleagues (2017) remind us that what managers think people want is often wrong and consumers often do not know what they themselves will want (cf. Witt, 2001). Because outcomes are unknowable *ex ante* within aleatory uncertainty, managers typically cannot afford to bet on a single expected outcome, and should thus prefer non-predictive strategies.

An exception to this normative rule is the case of low risk of loss (i.e. the resources at risk are relatively few and low-value). Here we do not mean 'risk' in the Knightian sense, but in the investment sense of how much one stands to lose. Where risk is low, the value of non-predictive strategy's lesser chance of error is attenuated. Thus, the cost-benefit calculus is altered, and the comparatively higher costs of effectual strategy may not be warranted. In aleatory uncertainty, then, non-predictive strategy is generally preferable, but this normative preference is weakened or inverted under conditions of comparatively low risk of loss (see Figure 4).

Proposition 3a: Managers/entrepreneurs facing aleatory uncertainty will tend toward non-predictive (effectual) logics.

Proposition 3b: The normative preference for non-predictive (effectual) logics under conditions of aleatory uncertainty is moderated by the risk of loss such that a low risk of loss diminishes the downside of prediction and, thus, increases the desirability of predictive (causal) logics relative to non-predictive (effectual) logics.

Within conditions of epistemic uncertainty, the choice between predictive and non-predictive strategy hangs principally on the costs of uncertainty mitigation relative to the benefits of prediction. The risk of loss, the costs of information gathering, and predictive calculation are also relevant to the cost-benefit calculus within aleatory uncertainty; however, in the interest of space, to avoid repetitiveness, and to emphasize where risk of loss and cost-benefit concepts might be most prominent, we limit our discussion to cost-benefit logic. While successful prediction tends to produce superior performance outcomes (Brinckmann et al., 2010), the costs of accurate prediction can vary depending on the nature and complexity of the uncertainty. Under comparatively strong epistemic uncertainty, firms may still elect prediction by striking a satisfactory balance between the costs of information acquisition and risks of error, according to the manager's risk tolerance. For example, in something of a predictive or causal version of the more moderate effectual models, Chwolka and Raith (2012) provide a decision tree that accounts for the value and costs of planning relative to the remaining uncertainty at various stages of the firm's development.

In general, managers and entrepreneurs facing epistemic uncertainty should, normatively, tend toward causal logics, but this relationship is moderated by the costs of acquiring and using information, given the technologies of the day (see Figure 4). Some information may be prohibitively costly, time-consuming, or even impossible, given state-of-the-art limitations. For example, in a 2016 letter to shareholders, Amazon CEO Jeff Bezos remarked, "most decisions should probably be made with somewhere around 70% of the information you wish you had. If you wait for 90%, in most cases, you're probably being slow." The risk of error increases correspondingly with increases in key information deficits. Where the risk of error outweighs the benefits of prediction, a non-predictive approach may be preferable within epistemic uncertainty.

Proposition 4a: Managers/entrepreneurs facing epistemic uncertainty will tend toward predictive (causal) logics.

Proposition 4b: The normative preference for predictive (causal) logics under conditions *of epistemic uncertainty is moderated by the costs of information such that high costs of obtaining and utilizing information predictively increases the downside of prediction and, thus, decreases the desirability of predictive (causal) logics relative to non-predictive (effectual) logics.*

The Disaggregation of Uncertainties

A key consideration is that most decision contexts—especially in business—are not comprised of a single uncertainty, but of *many* uncertainties. These various uncertainties generally include both epistemic *and* aleatory uncertainties from various possible factors (see Figure 3). This multiplicity of uncertainties complicates the selection of decision logics greatly. For while some uncertainties may be mitigated, other uncertainties cannot, and it becomes far less straightforward whether and to what extent predictive versus non-predictive logics would be more or less successful. The choice in decision logics, then, is rarely a simple, single, discrete choice, but tends to be a complex and dynamic process involving multiple choices.

As a simple rule of thumb, non-predictive logics should prevail where the immitigable uncertainties are more consequential—where the costs of error are higher—in aggregate than the mitigable uncertainties; predictive logics should be preferred otherwise. Such consequence, however, is not always clear or determinate. Uncertainty's immitigability, practically speaking, includes both aleatory uncertainties as well as those epistemic uncertainties that are beyond the human and technological capabilities that can feasibly be employed to the task of mitigation. Although such technological capabilities may be developed in the process of uncertainty mitigation, doing so can often be prohibitively costly and, even, itself uncertain. In all, this rule of thumb implies often complex cost-benefit analyses of uncertainty reduction. Yet, standard cost-benefit analyses of risk management tend to be simplistic, treating all uncertainties as epistemic, and could be improved by a more nuanced understanding of mitigability.

Of particular note, epistemic uncertainty's practical mitigability depends on various factors, including the observational and computative capacities, both human and technological, that can be committed to such mitigation. Such capacities are both evolutionary and dynamic. They are evolutionary because cognitive skills are, in part, learnable, and human capacities to observe and calculate can develop over time. Furthermore, observational and computative technologies are progressive, with information collection and processing capabilities expanding at an exponential rate (Wiggins & Ruefli, 2005). These capacities are also dynamic because firms' resources, and their ability to commit those resources to such observational and computative tasks can quickly shift with performance outcomes and strategic change. Thus, the practical mitigability of epistemic uncertainty, as might be determined as a cost-benefit ratio, shifts dynamically over time. Correspondingly, a dynamic approach to judgment of decision logics tends to be preferable to a discrete choice approach in the face of multiple uncertainties (Packard et al., 2017).

A Dynamic Approach

We subscribe to the general view that both logics should be employed over time in a dynamic synthesis of both logics (Brinckmann et al., 2010; Chwolka & Raith, 2012; Packard et al., 2017; Reymen et al., 2015). However, while this literature validates the need of such a balanced and dynamic approach, it offers limited guidance as to *when* to shift logics. For example, Reymen et al. (2015) note that such shifts can and, perhaps, ought to occur with changes in the firm's scope of activities, but their qualitative exploration provided limited insight as to *when* or *why* such a change in scope should lead to such a shift.

Our delineation of uncertainty types, and the framework depicted in Figure 4, offer important nuance and clarity to this process. Over time, particular uncertainties become resolved and new uncertainties arise as actions and their consequences play out, actors and other factors leave the scope of the decision or newly come into play, new knowledge and technologies arise, etc., shifting the balance between epistemic and aleatory uncertainties. These shifts derive from both intrinsic (to the actor) changes (e.g. learning, new observational/computative skills, etc.) and extrinsic changes (e.g. technological change, changes in population, etc.). For example, Reymen et al. (2015) argue that a widening of the scope of the firm—an intrinsically-sourced change—ought to lend to a shift toward non-predictive logics. The theoretical mechanisms underlying such a shift can be found in the corresponding increase in aleatory uncertainty, as more and different actors become relevant to the firm's success.

Interestingly, it is typically understood that effectual logic is more apropos earlier in the entrepreneurial process, where uncertainty (both epistemic and aleatory) is especially high, and that the entrepreneur ought to "transition to causal strategies as the new firm and market emerge out of uncertainty into a more predictable situation" (Perry et al., 2012: 838). However, our framework suggests a more nuanced and complex understanding of this process. Specifically, entrepreneurial judgment comprises multiple judgments over multiple processes in the face of multiple, distinct uncertainties, comprised of both epistemic and aleatory sources. Only the epistemic uncertainties dissipate over time; aleatory uncertainties do not. For example, general preferences and tastes (i.e. what I usually like), are epistemic and knowable, while immediate, time- and context-dependent preferences (i.e. what I want at a certain moment) are aleatory and cannot ever be perfectly predictable. The entrepreneur may predict aleatory uncertainties based on the information available, but those predictions can always be wrong, no matter how often they are right.

In all, managers and entrepreneurs typically face multiple uncertainties of both types, epistemic and aleatory, and of varying magnitudes and relevancies. Managing these uncertainties does not entail a single judgment or decision strategy, but multiple and simultaneous on-going strategies as they attempt to mitigate and manage the various types of uncertainty as they come and go. Strategic management, then, is an endless process of uncertainty management. Successful management can be bolstered by a superior understanding of the nature of the uncertainties one faces, and the decision strategies that best align with them, to facilitate effective strategic dynamism while avoiding erraticism (Robert Mitchell, Shepherd, & Sharfman, 2011).

Proposition 5a: Managers/entrepreneurs will (normatively) shift toward predictive (causal) decision logics over time as intrinsic and/or extrinsic changes to the decision context increase uncertainty's(ies') mitigability.

Proposition 5b: Managers/entrepreneurs will (normatively) shift toward non-predictive (effectual) decision logics over time as intrinsic and/or extrinsic changes to the decision context decrease uncertainty's(ies')mitigability.

Additional Factors

Scholars have found other factors to also be relevant to the determination of strategic decision logics. For example, personality, motivation, cognitive style, social influences, and a general proclivity for improvisation all account for a tendency toward non-predictive activities (Hmieleski & Corbett, 2006). Culture, such as uncertainty avoidance, may play a role, and the benefits of planning tend to be stronger over time as firms become more established (Brinckmann et al., 2010). The scope of the firm's or venture's activities may be a factor in managers' choices of decision-making logics, which scope is affected by perceptions of uncertainty, resource constraints, and stakeholder influences (Reymen et al., 2015).

Recognizing that there may be various other factors that can influence the determination of strategic logics that we have not here acknowledged, we hold that such factors, would be *non-normative*, biasing the decision. From a strictly normative perspective the choice in strategic logics should be based wholly in the cost-benefit analysis of uncertainty mitigation. However, the imprecision of such analyses tends to leave a lot of room for subjective and, often, emotional reasons to enter the decision, which ought to be (and have been) the focus of additional study.

In all, the epistemic-aleatory distinction provides important nuance and explanation to the debate between predictive and non-predictive approaches to strategic decision-making, and provides a superior boundary condition, or the foundations for one, toward more complete and robust strategic management theory.

CONCLUSIONS

Returning to our original question, when should managers and entrepreneurs forecast and plan, and when should they adopt a more dynamic, adaptive strategy? While answers to this question will certainly vary subjectively, we think the core of the riddle lies within the nature of uncertainty that the actor faces. As we look more closely into the predictability of future states, and the mitigability of that unpredictability, we find that the nature of uncertainty hinges on deep and unresolved philosophical questions regarding human nature and the existence of free will. Our attempt, here, at a dispassionate reading of the free will debate has led us to conclude that the default position of science ought to be *voluntarism*—the scientific acceptance of (or failure to reject) free will as an original source of change in the causal chain of events.

The acceptance of the voluntarist position implies a consequential revision to how we understand uncertainty: all choices originating within the conscious will are rendered *a priori* *unknowable*. It implies true aleatory uncertainty, immitigable even in principle. Such uncertainty is, or may be, predictable (i.e. able to be predicted), but never perfectly. Accepting the immitigability of human-sourced uncertainty offers important insight into our question of the normative boundary between predictive and non-predictive strategies, a point of some contention (e.g. Arend et al., 2015; Welter et al., 2016). Specifically, to the extent that uncertainty can be mitigated (i.e. epistemic in nature), mitigative strategies may be apropos, depending on the costs of such mitigation. However, when facing aleatory uncertainty, such mitigation strategies are futile, and an adaptive strategy will tend to be (or, perhaps, *ought* to be) preferred.

Importantly, we should consider that the uncertainty that managers face is *predominantly aleatory* rather than epistemic—the uncertainties that they must manage primarily concern human agents: consumers, investors, employees, and other stakeholders. This observation casts into question decades of prior research on strategic decision making and the normative foundations of modern behavioral science. While these game theoretic foundations may continue to prove useful, we question their generalizability to a world full of aleatory uncertainty (cf. Berg & Gigerenzer, 2010; Felin, Koenderink, & Krueger, 2017). A more fundamental shift toward a voluntaristic subjectivism in behavioral science may be required to capture and portray the actual decision processes that actors in fact employ in making real-world judgments.

Such a 'voluntarist turn' would imply a rather radical shift for the broader management domain. Certainly, many of management's core theories are already consistent with a voluntarist position: self-determination theory (Ryan & Deci, 2004), goal-setting theory (Kasser & Sheldon, 2004), social cognition theory (Bandura, 2008), and others. That human intentions are uncaused is implicit in social psychological theories of self-regulation as well as subjectivist notions of beliefs, goals, and expectations (Bandura, 2008; Kihlstrom, 2008; Mises, 1998). However, we advocate a stronger and more complete voluntarist turn, which would, perhaps, land us in the meta-theoretical realm of interpretivism (Burrell & Morgan, 1979), which has gained some traction already in management (e.g. Chia, 1995; Packard, 2017). Such a turn would require much greater modesty within our science, especially as it pertains to the precision and power of our theories, as it implies that human behavior is not ever fully caused or predictable (cf. Bergh, Sharp, Aguinis, & Li, 2017; Open Science Collaboration, 2015).

The implications for management theory of adopting the voluntarist position and its resultant aleatory uncertainty are broad, and include changes to theories and to their predictions or recommendations in consequence of the assumption of human actors as a source of irreducible uncertainty due to free will. Let us illustrate this point with an exemplar: rational choice theory. We could have chosen any number of examples, such as entrepreneurship (Shane, 2003), organizational behavior and job satisfaction (Judge, Parker, Colbert, Heller, & Ilies, 2001), allocation of ownership control in corporations and startups (Alvarez & Parker, 2009), causal ambiguity in preventing imitation of valuable and rare resources (Barney, 1991), the effectiveness of exploration and ambidextrous behaviors (Mom, Fourné, & Jansen, 2015), and many others. More generally, any theory where direct A → B effects with uncertainty as an antecedent, and theories where uncertainty is a moderator of A → B relationships, is a candidate for careful reconsideration. Rational choice theory is an obvious candidate as it models decisions as being shaped by contextual factors, but only to the extent that they shape the perception of the choice between options. This choice is a maximization of (subjective) utility (Savage, 1954). Specifically, choice is traditionally modelled (in theory) by *direct effects*, determined by various internal and external factors (see Figure 1). A voluntarist approach reconceptualizes choice as a *moderated* model (see Figure 2) where, although various factors *influence* choice, those factors, individually or collectively, do not fully *determine* the choice. Instead, contextual factors may influence behavior to a greater or lesser extent, depending on the valence and potency of the actor's will to choose.

Rational choice theory's predictions would also, as a result of this voluntarist shift, necessarily be revised. Rational choice theory predicts, generally, that individuals will, in choice situations, attempt to maximize their utility. Prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992), however, observes that, in many cases, actors act 'irrationally,' electing suboptimal options. It extends rational choice theory by extending behavioral prediction even into apparently irrational (inefficient) choices by exposing the consistent use of heuristics and other biases and effects, with the stated goal of mitigating them (Ariely, 2009; Kahneman, 2011; Schwartz, 2004). Voluntarism, however, revises this understanding of heuristics, noting that they are useful and intentional in directing behavior within conditions of uncertainty, such as first-time or novel contexts. For example, Maitland and Sammartino (2015) found that, under conditions of high uncertainty, heuristic-based judgment outperformed rational decision models centered on outcome optimization. Harrison (1977) found that managers recognized rational choice theory to be overly simplistic and ill-representative of the (aleatory) uncertainty that they faced. Human agency makes all contexts involving human actors novel or 'first-time' in a strict sense. Whereas actors use past experience as a guide for present action, it is common and even sensible to expect identical action in the face of apparently identical circumstances. Yet, as Lachmann (1977: 92) astutely observed, "[a]s soon as we permit time to elapse, we must permit knowledge to change." With people, there can never be truly identical circumstances, for time must have necessarily elapsed and the actor has learned. The implication is that rational choice theory mistakenly ascribes low uncertainty to contexts involving human actors in familiar decision contexts, thus undervaluing effectual and heuristic decision making. Specifically, proper attribution of conscious agents as a source of aleatory uncertainty may, at times, switch the theory-driven recommendation from employing an optimization model to an adaptation model.

Rational choice theory is merely a single case where changes to theory and its predictions or recommendations flow from the assumption of free will. Generally, this assumption pushes us to treat human subjects as *actors* and not just another link in the inevitable causal chain. Questions and arguments surrounding this assumption are not new to us. They have been widely discussed in philosophy and philosophy of science (e.g. Dilthey, 1989; Popper, 2000; Searle, 1983; van Inwagen, 2008), psychology and neuroscience (Baer et al., 2008; Nahmias, 2014; Searle, 2015; Shariff, Schooler, & Vohs, 2008; Wegner, 2003), and within the field of management itself (Child, 1972, 1997; Heugens & Lander, 2009). Contributing to this discussion, we have argued that the proper 'default' position for science is *voluntarism* and not determinism. From this, we have contributed to the uncertainty literature in showing that human-caused uncertainty is, from a voluntarist position, immitigable and aleatory in nature whereas it has commonly been understood as epistemic and mitigable. Building further from this insight, we have shed light on an ongoing question regarding the boundaries of strategic choice between various decision logics, which we have delineated here as predictive (causal) and non-predictive (effectual) (cf. Wiltbank et al., 2006).

When should managers and entrepreneurs plan, and when should they adopt a more adaptive strategy? The voluntarist turn that we advocate implies a far greater place in management theory, perhaps a predominant one, for non-predictive and adaptive approaches to decision-making. In the end, however, it seems we must leave the answer to this riddle for managers to decide.

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FIGURE 1

The Determinist View of Free Will and Choice

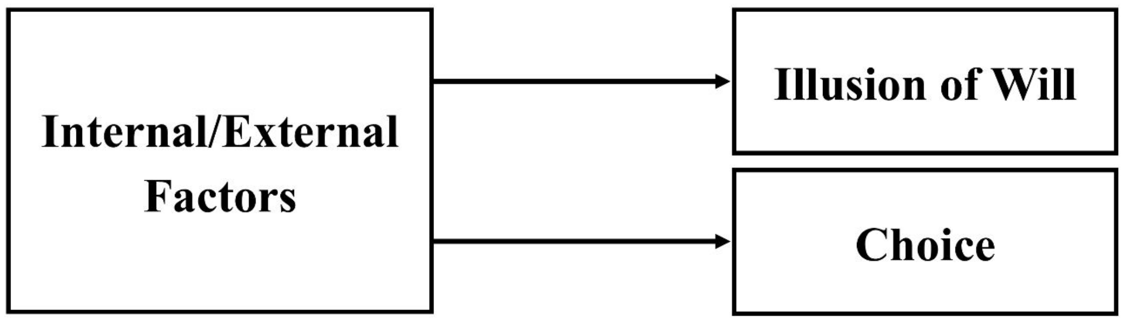


FIGURE 2

The Voluntarist View of Free Will and Choice

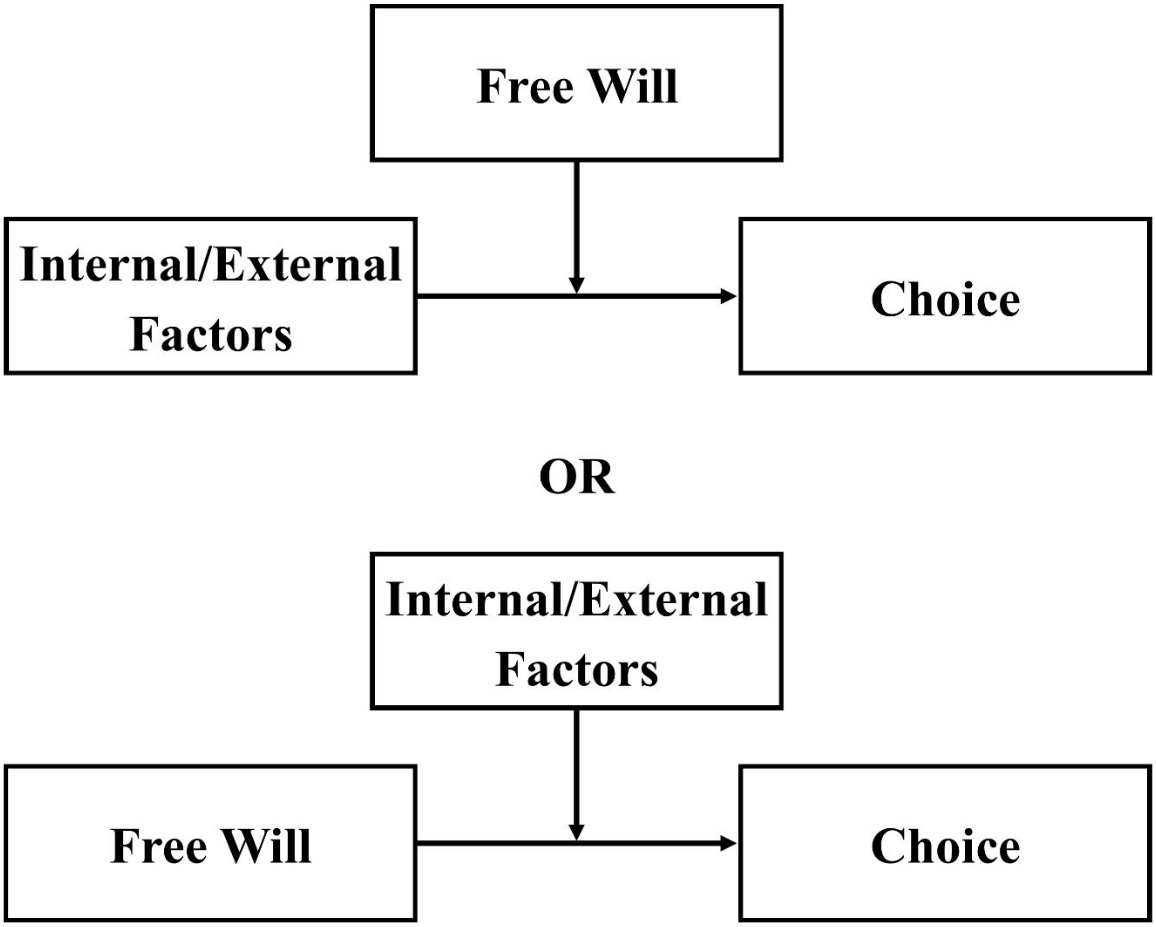


FIGURE 3

The Limits of Uncertainty's Mitigability

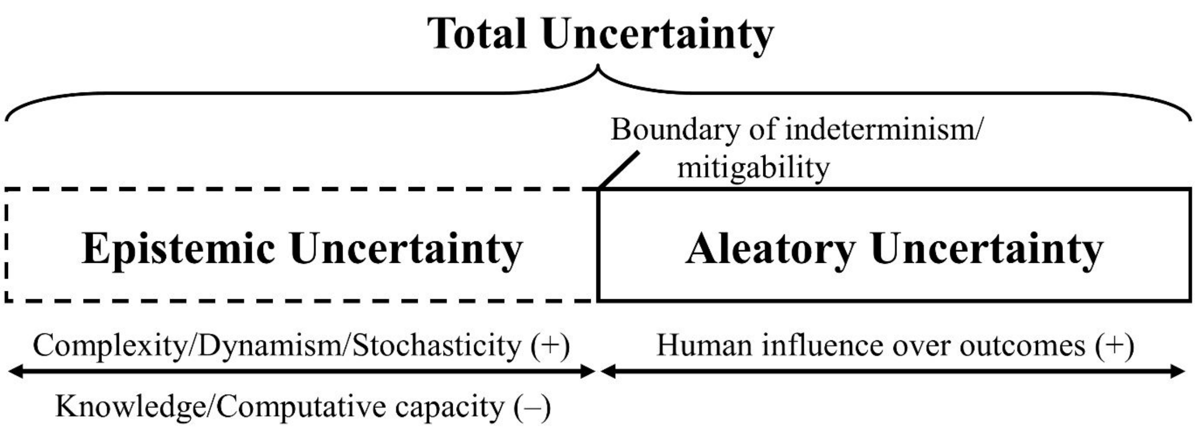
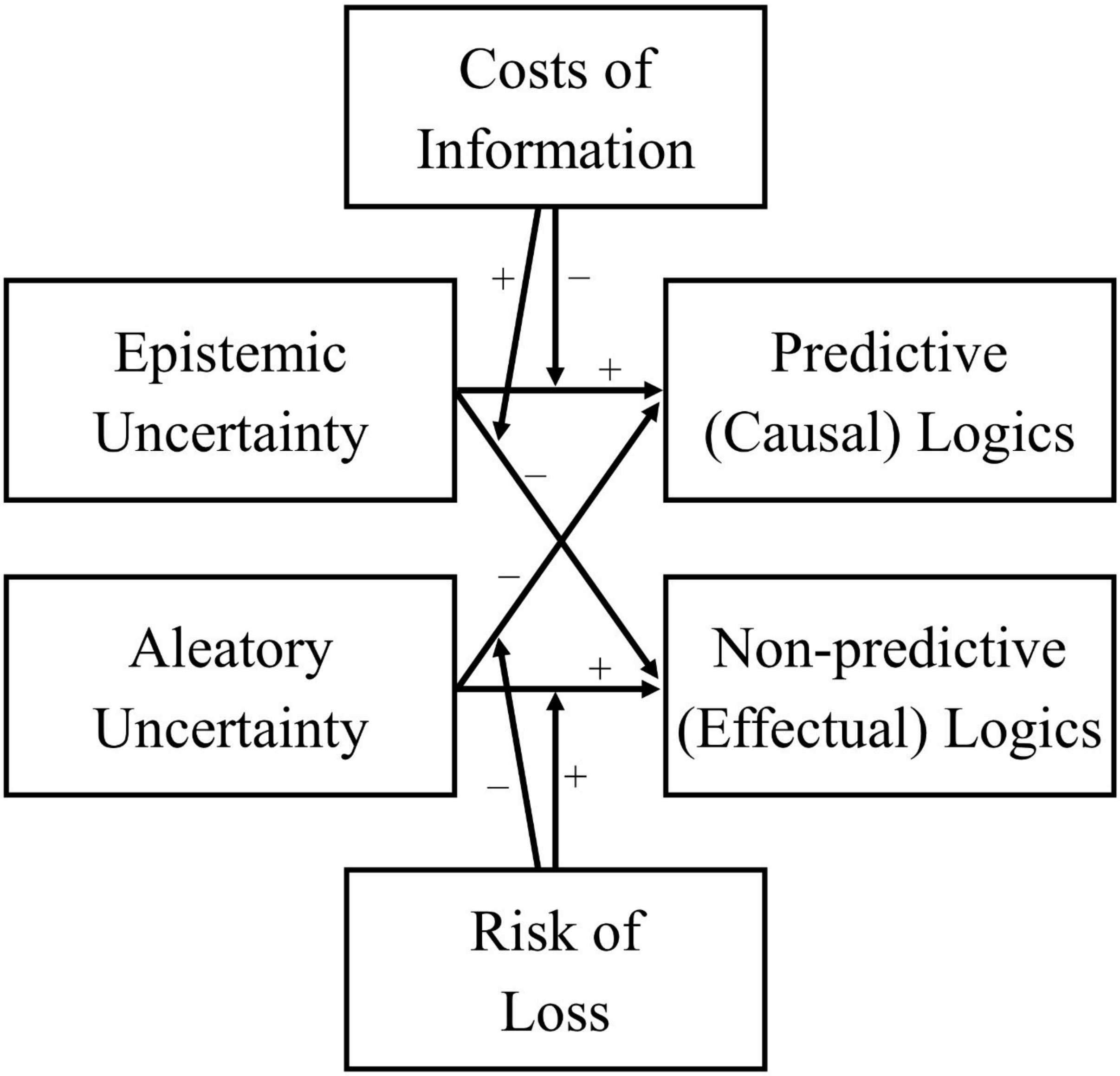


FIGURE 4

The Normative Determination of Strategic Logics



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