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Mitigating versus Managing Epistemic and Aleatory Uncertainty

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This definition retains the ontological dimension of Packard and Clark's conceptualization via (a) but supplements this with a Ramseyean condition in (b). Equivalently, any cases of uncertainty that fail to satisfy (a) will involve aleatory uncertainty. Some forms of aleatory uncertainty are mitigable *pace* Packard and Clark and a similar Ramseyean condition must be met if the agent seeks to manage downside outcomes. It is worth noting that the probabilistic nature of aleatory risk permits the development and sale of instruments (insurance, futures, options...) to mitigate the outcomes of this uncertainty. The markets for these instruments permit the agent to easily calculate the mitigation cost against their subjective utility, given their subjective probability distribution.

We shall argue that this hybrid view of the epistemic–aleatory distinction includes three significant virtues. First, the hybrid account avoids the dilemma that was shown to confront epistemic uncertainty. The incorporation of (b) into the definition provides a clear and non-arbitrary way of delimiting and fixing the domain epistemic uncertainty. Notice that this will generally hold for cases of uncertainty which stem from highly complex causally deterministic systems: the greater the complexity, the higher the costs of resolution. So, these cases are more properly diagnosed as cases of immitigable uncertainty on the hybrid view, though not aleatory.

Second, the hybrid account maintains the ontological flavor of Packard and Clark's original definition by retaining the causally deterministic–indeterministic criterion. The account is ontological and avoids attempting to define uncertainty in wholly epistemic or mind-dependent terms, even though the consequent choice problem is mind-dependent.

Third, the hybrid account makes the kind of uncertainty in question sensitive to context. Rather than imagining what gods could do in principle and thus over-idealizing in an implausible way, this view offers an additional contextual element (agential cost) for characterizing uncertainty. This is more plausible than a "one-size-fits-all" conception. In scenarios in which time is scarce and the dissolution of uncertainty imposes a high cost, a manager may very well deem uncertainty about outcomes to be immitigable, whereas this uncertainty may concern a causally deterministic process and be mitigable if time was more ample. Inclusion of these contextual factors greatly enhances the viability of the definition.

Packard and Clark (2020) have undertaken an important project for management and strategy, providing a needed basis for categorizing the varieties of uncertainty in an ontological way. We follow them in acknowledging the necessity of this venture. We are hopeful that the proposal presented herein is a supplement that will prove useful to their project.

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Mitigating versus Managing Epistemic and Aleatory Uncertainty

We are grateful for Holmes and Westgren's (2020) thoughtful response to our recent article (Packard &

Clark, 2020a). In it, they argued that "a mitigability–immitigability axis does not map well onto the aleatory–epistemic uncertainty axis" (p. 7). This challenge to our delineation casts doubt to its usefulness in strategic theorizing, as we have supposed. They thus proposed a revision to our definitions that encapsulates epistemic uncertainty within the confines of the present state of knowledge and the costs of acquiring such knowledge, allowing strategic analysis of the value of mitigation efforts to be more clearly assessed. While we are open minded toward such a revision to our framework, we do not see the proposed revision as a clear advancement over our original model, for reasons that we shall here expound.

UNCERTAINTY MITIGATION VERSUS MANAGEMENT

A key point, especially in light of Holmes and Westgren's critique, that was abridged in our original article is the distinction between mitigating uncertainty itself and mitigating its consequences. In our article, we pointed to two ways of dealing with uncertainty: mitigation and coping (Packard & Clark, 2020a: 767–768). Consider, for example, an airline that is concerned about the prospect of a rise in oil prices. "Mitigation" refers to reducing the uncertainty through information gathering—the airline could monitor events in various oil-producing countries so as to have lower uncertainty about what will happen. It could also or instead "cope with" or manage the uncertainty's consequences by, for instance, implementing an oil hedge, thereby reducing the financial impact of the feared price rise.

When strategic managers employ, for example, a real options strategy, have they thereby reduced or mitigated uncertainty? Our primary assertion is that uncertainty mitigation strategies are only possible for epistemic uncertainties, and not for aleatory uncertainties. Purchasing futures, diversifying investments, and so forth are techniques for managing the consequences of uncertainty. While the underlying uncertainty itself is not mitigated through such strategies, the risks[1] can be. This distinction requires that we accept a further distinction between "ontological uncertainty," which references an indeterminate state of affairs (e.g., Knight, 1921), and "subjective uncertainty,"[2] which references a state of mind (e.g., Lipshitz & Strauss, 1997). We will return to this distinction again later, but, to summarize, we focused on the former in accordance with so-called "Knightian uncertainty," which was the focus of the special issue.

Strategic action cannot reduce aleatory uncertainty—what one does within the context of aleatory uncertainty has no effect on the underlying uncertainty per se, which, by definition, stands outside the reach of human action. Strategic actions do not mitigate this uncertainty but only the risks that accompany it. This is the essence of effectuation theory, for instance, which attempts to help the actor more effectively bear and navigate the uncertainty. In contrast, epistemic uncertainties are within an actor's grasp and can be reduced. Thus, while "one may argue that we have mitigated a large number of aleatory risks" (Holmes & Westgren, 2020: 870), such an argument must come from a confusion of what we mean by "aleatory" or what we mean by "mitigation," or both.

ON THE BOUNDARIES BETWEEN ALEATORY AND EPISTEMIC UNCERTAINTY

Holmes and Westgren's (2020) primary argument is a criticism of our boundary between epistemic and aleatory uncertainties. We defined "epistemic uncertainties" as those that are mitigable—even if presently unable to do so—and "aleatory uncertainties" as those that are not. But, Holmes and Westgren noted, because some epistemic uncertainties are so complex as to disallow their mitigation given current capabilities, they share more in common with aleatory uncertainties. In our article, we added to complexity also dynamism and stochasticity, which too can disallow prediction or mitigation given the current state of technology (Packard & Clark, 2020a: 769–770). *To the deciding actor*, Holmes and Westgren observed, there is no meaningful difference between innately immitigable aleatory uncertainty and practicably immitigable epistemic uncertainty. Thus, they suggested bringing the boundary of epistemic uncertainty within the confines of presently available information—that is, to define uncertainty as epistemic if it can be mitigated cost effectively with presently available information, and as aleatory if it cannot.

We find this proposition intriguing and remain open to the revision. However, though the revision is

[1] We use "risk" here not in the Knightian sense, but in the sense of what stands to be lost in some uncertain action, as in "financial risk."

[2] We use "subjective" rather than "epistemic" (see Berglund, Bousfiha, & Mansoori, 2020: 31) to distinguish it from the aleatory/epistemic distinction we discuss in our article.

advantageous in some respects, it is disadvantaged in others. While the boundary that Holmes and Westgren have drawn includes the costs of mitigation, we note that our original framework already included mitigation costs as a theoretical (but not definitional) boundary (see Packard & Clark, 2020a: 775–777, as well as Figure 4). Specifically, when dealing with epistemic uncertainty, determining which strategic logic to employ depends on the cost of information gathering required to mitigate the uncertainty. But, while we acknowledge assessed costs as a key factor, we hesitate to make such costs the basis of a definitional boundary in theoretical uncertainty types.

One of the key drawbacks to this revision is that it cannot clearly account for discoverable information. It is not always clear whether yet undiscovered information is right around the corner or eons away. That ancient sky-gazers found the prediction of certain astronomical phenomena (e.g., a lunar eclipse) to be impossible does not mean that such a phenomenon is, in fact, truly unpredictable, as we have since shown through scientific advancement. Thus, the cost-based boundary that Holmes and Westgren proposed is blurry, subjective, and mutable—how much might information that we have not yet discovered cost? The analysis that such a boundary promotes would be overly exclusive of the potential for discovering new information and would steer managers away from considering innovative information discovery as a viable path forward.

Of course, Holmes and Westgren astutely pointed out that our own dividing line between aleatory and epistemic uncertainty types is also not immutable, as some uncertainty that now, to us, appears aleatory may turn out to be epistemic. In essence, we agree. We admit that we cannot always know, a priori, whether an uncertainty is, in fact, epistemic or aleatory. Ours is a nuanced stance in which we begin by assessing the underlying reasons *why* something is unknown. Is it because it is, philosophically, unknowable, or is it because we currently lack the capabilities to fully gather information that is, in principle, knowable? Thus, we accept that information is knowable unless there are underlying principles that point toward that information not existing or as fundamentally inaccessible. This is different from the aforementioned problems of complexity, dynamism, and stochasticity, which are mere impediments to knowability. There are, for instance, cases in which the scientific advancements we have made suggest that a definitive prediction is and must always remain beyond us. Heisenberg's uncertainty principle, for example, is one such. The curious case of free will is, as we have argued, another. Where there is reason to accept fundamental indeterminism, assumptions of aleatory uncertainty are appropriate. Thus, all assumed cases of aleatory uncertainty ultimately rest on philosophical assumptions of indeterminism that have, admittedly, been disputed.

Our argument for the treatment of, at least, free will as a source of aleatory uncertainty is also based on practical and ethical grounds. The assumption that free will is real until proven otherwise is advantageous for several reasons. Not only does promotion of human determinism lead to negative social and ethical outcomes broadly, more specifically, it could lead to bad business strategies. If we believe that people are predictable, we are inclined toward investing in projects such as "big data" and analytics to determine strategy. Our accepting free will as a first cause, however, implies a warning against overreliance on positivist–reductionist research paradigms and pervasive societal techno-optimism (Clark, Robert, & Hampton, 2016). Predictive analytics may not be as promising as widely supposed (see Broussard, 2018); if human action is, in fact, a source of aleatory uncertainty, predictions of behavior will always be limited, no matter how "big" the data are. Predictive successes of the past are unable to guarantee future success, as it is always possible for human actors to change their minds and preferences.

SUBJECTIVE UTILITY THEORY AND ITS DRAWBACKS

Ultimately, Holmes and Westgren have proffered subjective utility theory (Ramsey, 1931; Savage, 1954) as a way of better understanding uncertainty and its mitigation. We are sympathetic to a shift toward a subjective uncertainty concept where uncertainty does not reference a property of some ontological state of affairs but rather a subjective state of mind. However, while Holmes and Westgren's (2020) notion of uncertainty as a subjective "degree of belief" (p. 871) in a particular knowledge claim is highly relevant to the judgment process, such subjective uncertainty is *derivative* of the ontological uncertainties we discussed in our article. In other words, ontological or environmental uncertainty (indeterminism) has a causal influence on how uncertain one becomes *about* the environment. These distinct notions of uncertainty are causally interrelated, but not equivalent—aleatory and epistemic uncertainty are *ontological* uncertainties, and not *subjective* uncertainties, which derive therefrom.

In the case of epistemic uncertainty, such as Holmes and Westgren's example of whether it will rain today, a probability can be ascribed, albeit subjectively inasmuch as uncertainty remains. Whether or not to act toward mitigating the uncertainty hinges on the costs of information gathering versus simply bearing or otherwise coping with the uncertainty, as Holmes and Westgren (2020) (and Ramsey, 1931) aptly point out (see also Figure 4 in Packard & Clark, 2020a). In such cases, labeled "ambiguity" elsewhere (e.g., Packard, Clark, & Klein, 2017), even though one ascribes a subjective probability to the outcome, that probability is (or may be) discounted because it is unknown whether the subjective probability is accurate (Ellsberg, 1961). Thus, a plausible choice option is to defer action until more information can be garnered (Dhar, 1997; Tversky & Shafir, 1992).

In the case of aleatory uncertainty, however, Knight's (1921) point that such probabilities *do not exist* applies. Subjective probabilities *can* be ascribed to imagined possibilities, as put forth by subjective utility theory—one can say that there is a 30% chance Sue will go bowling today. But, in reality, such probability ascriptions are imprecise and often border on the nonsensical. While it is *possible* that Sue goes bowling, there is no probability distribution for that outcome. In fact, Sue's option and outcome sets are *open* and infinite—there are endless opportunities that Sue could instead act upon (Packard et al., 2017). To ascribe a specific probability of 30% is fallacious (Packard & Clark, 2020b). There can be no probabilities for open or infinite sets. Thus, in the case of aleatory uncertainty, neither information gathering nor fallacious guesses at numbers mitigate the uncertainty. Asking Sue her intentions might reduce your *subjective* uncertainty but fails to inform some actual probability distribution, and nor does it inform about any portion of what is unknowable. The necessarily remaining aleatory uncertainty must simply be borne (e.g., managed) or not.

Most real-world decisions comprise *both* aleatory and epistemic uncertainties, and information gathering can be useful to mitigate the epistemic uncertainties of the decision (see Figure 3 in Packard & Clark, 2020a). But any aleatory uncertainties are immitigable a priori and must be borne or managed or avoided. Sue may decide to go bowling and, thus, resolve the uncertainty. But, until she does, you cannot know. The astute theorist might further observe that, until she has finally acted, there is still opportunity for Sue to change her mind. Thus, some aleatory uncertainty remains even between the space of decision and action, if any. If your decision depends on Sue's action, you must bear (e.g., manage) that uncertainty—it cannot be mitigated.

In short, we reject subjective utility theory as a foundation for uncertainty theory, as its applicability is limited to conditions of epistemic uncertainty only. It falls apart quickly and quite completely in the face of aleatory uncertainty. For such cases, we find Shackle's (1949, 1969) theory of potential surprise to be much more apposite.

CONCLUSION

We were pleased to read Holmes and Westgren's (2020) response. Their efforts toward an improved boundary between epistemic and aleatory uncertainty pushed our thinking toward new levels of practicality. We are open to further conversation, as drawing the line as we did at the bounds of mitigability *in principle* does, as they assert, put a lot of weight on epistemic uncertainty and may have cast the "net of epistemic uncertainty too widely" (Holmes & Westgren, 2020: 870). If we mapped the types atop the Knightian distinction between *ambiguity* and *uncertainty*, their hybrid boundary, and not ours, maps better, and there may be merit to advancing such a proposition as a way to understand Knight's work at a more profound level. If such were our goal, we might concede.

However, our real goal was more contentious than that. Our aim was to assert the reality of true indeterminism and to examine its strategic effects. To date, science has been predisposed toward supposing the knowability of all things. This predisposition has, we fear, too often misled rather than informed, and is a likely contributor to the academic–practitioner divide. For example, Harrison (1977) observed that managers found the probabilistic decision models of academia to be unrealistic and impractical for real-world business decision-making. We agree. It is time to take indeterminism and aleatory uncertainty seriously if we are to improve the value of our practicable advice to business strategists and decision-makers.

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