HOW IS STRATEGY USEFUL IN A WORLD OF KNIGHTIAN UNCERTAINTY? (AND HOW IS KNIGHTIAN UNCERTAINTY USEFUL TO STRATEGY RESEARCH?)

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Abstract

I address the usefulness of strategy (both as a practice and as a field of research) in a world of Knightian uncertainty (KU), as well as the dual issue of how useful KU is to strategy research (in the sense that including KU will increase the explanatory power and reach of strategy research). A key issue here is understanding what is meant by KU as this influences the assessment of the usefulness issue. Strategic decisions that may initially be characterized by KU (e.g., in the sense of ambiguity or unawareness) can be transformed into risk, notably by experimentation or otherwise acquiring more knowledge. However, some strategic decisions are non-divisible (i.e., there is only one trial) and crucial (i.e., they change the conditions under which they are made) and cannot be remedied by experimentation (i.e., non-empirical uncertainty). These are the strategic decisions that are subject to KU proper, and where the dual issue of the usefulness of strategy emerges. Adopting a theory-based lens, I introduce a heuristic distinction between "pre-decision" strategy analysis and "post-decision" analysis. This serves to isolate what current strategy theory can and cannot say about strategic decisions that are made under KU (proper) and where theory development may usefully concentrate. The case of Thomas Edison's introduction of the first electric lightning ecosystem is used as an example throughout.

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INTRODUCTION

Knightian uncertainty (henceforth, KU) has become an important theme in important parts of finance, economics, and decision science (Dorobat, McCaffrey, Foss, & Klein, 2024), and is routinely applied to investment behaviors (Nishimura & Ozaki, 2007), incomplete contracts (Mukherji, 19989), financial markets (Mukherji & Tallon, 2001), and general equilibrium theory (Beissner & Riedel, 2019).[1] Partly this development has taken place in tandem with experimental work in behavioral economics which has drawn attention to the vagueness of beliefs in situations involving KU, as well as evidence that among practitioners "black swans" are seen as crucial issues and that insurance companies are not happy about insuring "new risks" (such as pandemics or the potential consequences of global warming) (Taleb, 2008).

Like many (other) social scientists, strategy scholars have become increasingly interested in KU (see the review in Arend, 2024). The following reasons may explain this increasing interest. First, it is intuitive that KU is an aspect of much important real-world strategic decision-making (Kay & King, 2020), may have become increasingly important, given less stable conditions (Furr & Eisenhardt, 2021), and that strategy research cannot afford to neglect it. A second reason has to do with the central mandate of strategy research, namely explaining competitive heterogeneity, and particularly "outlier returns." Projects, investments, and strategies that are engulfed by KU may be particularly interesting from the point of view of strategy, as their uniqueness may mean that they are partly shielded from competition because others are unaware of their return implications (or disagree), translating into strategic factor market advantages and potentially massive returns (which other actors that possess complementary capabilities may share in). More broadly, KU may be an important part of the equation when it comes to explaining the existence of competitive advantage, rents, and profits (Rumelt, 1987; Lippman & Rumelt, 2003). Third, KU is closely bound up with ideas that strategic decision making is anchored in theories (Felin & Zenger, 2017), representations (Levinthal, 2011), or judgment (Foss & Klein, 2012; Spender, 2014), and may be seen as a basic assumption in cognitive approaches to strategy. Fourth, KU may help generate new insight in key issues in strategy, such as employee entrepreneurship (Kaul, Ganco, & Raffiee, 2024), or the

[1] The key to this development has been the definition of Knightian uncertainty as "ambiguity" (Gilboa, 2004), which is understood either in terms of representing the decision-makers beliefs on the state space by non-additive probabilities (called "capacities"), or in terms of multiple probabilities (see e.g. Ghirardato & Marinacci, 2004). This is now the dominant understanding of KU in the analytical/formal literature. Still, the contributions to the KU are extremely different in terms of analytical styles, interpretations of what Knightian uncertainty is, and the implications of uncertainty they examine (see Dorabat, et al., 2024).

foundations of scenario methods (Feduzzi, Faulkner, Runde, Cabantous, & Loch, 2022). KU may point to new mechanisms (cf. the strategic factor market point above) and new phenomena that strategy scholars should grapple with. Thus, taking KU into account has the potential to expand the domain and problem-solving capacity of strategy research (e.g., Furr & Eisenhardt, 2021).

Despite such promises, of the approximately 700 articles published since 1921 that address Knightian uncertainty in a substantive manner, only about 20 may be categorized as strategy papers (Dorobat, et al., 2024). Many more articles and books *hint* at Knightian uncertainty or talk about situations of Knightian uncertainty without using the term. For example, theorizing strategy in "high-velocity environments" and under high "technological dynamism" typically points to knowledge conditions that may be described as KU (cf. Furr & Eisenhardt, 2021). Similarly, it could perhaps be argued that the analytical core of the enormously influential (among practitioners) distinction between the "red" and the "blue" oceans of strategy (Kim & Mauborgne, 2005) is one between a world of "risk" and one of "uncertainty." Still, while strategy scholars may wish to heed calls to "take uncertainty seriously" (Alvarez et al., 2020: 169), implementing such calls in academic strategy research seems challenging.

One reason is definitional and a matter of "construct clarity" (Townsend, Hunt, McMullen, & Sarasvathy, 2018). A prevalent default definition is that KU is "uncertainty that is not risk" (e.g., Alvarez et al., 2018). However, that residual is a big and heterogeneous set. It includes the inability to put "objective" (or, indeed, any) probabilities on (known) outcomes, that is, "ambiguity" in its various manifestations Gilboa, 2004), as well as the inability to fully characterize the state space that is relevant to decision making in terms of the nature and identity of future states, and the complete (which involves different degrees of unawareness; Schipper, 2014; Svetlova, 2021). These are different and have different behavioral consequences (Roy & Zeckhauser, 2015; Townsend et al., 2018). However, both understandings of KU are present in the original statement of KU, that is, Knight (1921) (Scoblic, 2020), and many (including me) seem to agree that both are relevant and interesting to how we may want to think about KU in strategy. Indeed, models from decision science, game theory, and economics that address different aspects of KU in this broad sense have already been deployed in strategy research to provide rigorous treatments of such different understandings of KU (for applications to strategy, see Lovallo, Clark, & Camerer, 2012; Bryan, Ryall, & Schipper, 2022; Camuffo et al., 2024). A potential problem is that importing a particular model-based interpretation of KU and decisions under KU (e.g., the case-based decision

theory of Gilboa & Schmeidler, 1995, as in Lovallo et al., 2012) may only capture a part of KU as it applies to strategy.

Here, I sketch an alternative, more "demand-driven" way to think about KU in the context of strategy (where I understand "strategy" to refer to both the practice of strategy and strategy as a research field, unless otherwise indicated). The starting point is the uncontroversial proposition that uncertainty is a property of strategic decisions (Leiblein, Reuer, & Zenger, 2022; Rumelt, 2023)—that is, decisions that have potentially major firm-level consequences and are risky (i.e., they involve the potential for a major downside; irreversible (Arrow & Lind, 1970; Ghemawat, 1991); involve critical interdependencies (Leiblein, Reuer & Zenger, 2018); and produce coherence and consistency across other decisions involved in these interdependencies (Steen, 2017; Rumelt, 2023). While this already excludes many firm-level decisions, the remaining set of decision is still large and heterogenous, ranging from P&G's choice of price points for their upgraded Oil of Olay products (Laffley, Martin, Rivkin, & Siggelkow, 2012) to "visionary strategy" (Schilling, 2018), such as Thomas Edison's launch of the world's first electric lightning ecosystem. The latter kind of strategy—typically involving decisions that are high in firm-level consequences, irreversibility, resource commitment, and decision interdependence—takes place under non-empirical uncertainty, that is, KU that cannot be reduced to risk by means of experimentation (which I here take to exclude experimentation understood as mental simulation by means of models).

In strategy, the emerging theory-based view is intended to grapple with these decision situations (Felin & Zenger, 2017; Ehrig & Schmitt, 2023; Felin & Foss, 2023). However, an issue which is both particularly important and thorny and not solved is how we can characterize "good" theories under KU in terms of formal characteristics of such theories (beyond very high-level characteristics, as in e.g. Felin & Zenger, 2017). Theories guide behaviors under KU, and because they involve claims about causality, they are inherently predictive. Ideally, decision makers want theories that minimize prediction errors (cf. Ehrig & Foss, 2024). However, the status of this criterion is unclear in a world of KU where states of the world are not given but are created by decision makers (Machina, 2003). However, rather than asking about what an "optimal" theory may mean in a KU world, it may be more productive to turn the attention to, first, the conditions under which theories are generated and evaluated, and second, bearing in mind that firms need to secure buy-in from relevant stakeholders, communicated, evaluated, revised, etc. This is "productive" in the sense that it serves to delineate where strategy is helpful in a world of KU, and where it currenlyt isn't and where theory-development may usefully concentrate.

To start off the discussion of these issues I briefly recount the case of Thomas Edison's innovation of the first electric lightning ecosystem, which serves to lend insight into the usefulness and reach of strategic management theory under KU. I organize this in terms of a distinction between "pre-decision analysis" and "post-decision analysis" where the making of a strategic decision based on a reasonably developed theory of value creation divides the two kinds of analysis. Existing strategy theory offers insight into both kind of analysis, but new insight also needs to be developed. Specifically, pre-decision analysis is taken up with the issue of how decision makers arrive at "good" theories, for example, by deciding on how much knowledge of the past is "transportable" (Lee, 2024) in the context of decision-making about the future (Griffiths & Tenenbaum, 2009), reducing cognitive bias, and devising administrative and governance mechanisms that facilitate the relevant "processes of inquiry" into the generation and evaluation of theories (Foss, Nickerson, & Weber, 2024). Post-decision analysis is (among other things) taken up with shared cognition, communication, and conviction in the context of collaboration to realize a new theory of value creation (Felin & Foss, 2023). When firms seek to collaborate with stakeholders, such as complementors, suppliers, and customers, differing beliefs may cause obstacles to cooperation. Communication aimed at overcoming cognitive gaps and disbelief becomes critical. The plausibility of the new theories of value creation needs to be communicated to stakeholders who may need to be convinced of the soundness of the theory.

THOMAS EDISON AND THE FIRST ELECTRIC LIGHTNING ECOSYSTEM: THE USEFULNESS OF STRATEGY IN A WORLD OF KNIGHTIAN UNCERTAINTY

While Thomas Edison is often credited with the invention of the electric light bulb, his invention (conventionally dated to October 21, 1877) of the first practically successfully incandescent light (the bulb burned for 14,5 hours!) was the culmination of a long series of experiments carried out by others, such as Ludwig Boehm's innovations in blowing glass to make light bulbs and Charles Batchelor's experiments with filaments. Edison's interest in electric lightning was initiated by when an acquaintance of his, the physics professor George Barker, invited him to see an arc light system that had been by William Wallace and Moses Farmer. But it was only when Edison and his assistants placed a carbonized cotton thread inside a glass bulb, established a vacuum inside the bulb (with a specially designed air pump) and sealed the bulb that electric light became a reality.[2]

[2] The information in this section on Edison mainly draws from the biographical details on the Rutger-New Brunswick School of Arts and Sciences page dedicated to Edison and the Edison papers: https://edison.rutgers.edu/ (Accessed 6 May, 2024) as well as on Edmund Morris' (2019) biography.

The aim of Edison's experimentation was of course to commercialize electric light, and arguably his main real innovation was pioneering the electric lightning innovation ecosystem. To introduce this novelty, Edison again relied on the experimentation of others, such as John Kruesi's experiments with various designs of electric dynamos and further improvements of filaments, pulling various independently made innovations together relying on the principles of organized science and teamwork in the context of industrial research laboratory (the first of its kind). Edison was completely transparent about the broad contours of the intended ecosystem which had taken form in his mind because of a week's concentrated effort after his exposure to the Wallace and Farmer arch light system (The Sun, 1878). The aim was to replace gaslight in lower Manhattan with electrical light and the "theory" was that this was feasible by having the electricity generated by several large dynamos and distributing the electricity by making use of existing infrastructure assets (gas pipes, lampposts) fully.

Edison's understanding of the social aspects of research and innovation processes gave him an astute understanding of the importance of communication and persuasion in overcoming ignorance and uncertainty in the face of major novelty. Fundamentally, Edison understood that the commercialization of electric light was a major systemic innovation (Teece, 1986; Foss, Schmidt, & Teece, 2024) under Knightian uncertainty and involving numerous interdependent but independent actors. It required a particular approach to make ecosystem participants (notably potential customers) buy into the notion of general electric power and light for households and industry (Hargadon & Douglas, 2001).

His persuasion efforts began with a public demonstration in his Menlo Park facilities of the incandescent light bulb on December 31, 1879, and culminated with a public demonstration in Manhattan in the evening September 4, 1882. The illumination by electric light of the windows of a major Manhattan bank building was visible miles away. These demonstrations helped to establish a general belief that electric light could work, also as part of people's homes.

An important part of creating awareness and persuading potential stakeholders to cooperate was playing down the novelty of the innovation ecosystem; for example, knowing that many homeowners had invested in gas infrastructure to light their buildings, Edison ran the first electrical wires through the gas lines that already existed, so that the new innovation ecosystem could be seen as "just another system for the delivery of light." The new lamps would be placed in converted gas fixtures, and the revenue model was like the one under the gas system: customers would be charged by a meter very similar to that used by the gas companies. This would bring savings, define useful

technical parameters for further innovation within the electricity ecosystem, and ease the communication and understanding of the advantages of electricity. In 1882 Edison helped form the Edison Electric Illuminating Company of New York, which brought electric light to parts of New York.

Pre-decision and Post-decision Analysis Under Knightian Uncertainty

The Edison case is highly illustrative in the context of understanding 1) the usefulness of strategy in a world of KU, and therefore also 2) the limitations of existing strategy theory with respect to identifying the gaps in our understanding of strategy. Building on the Edison case, I address these points in the context of pre-decision and post-decision analysis; see Figure 1.

[Insert Figure 1 Here]

Edison's decision making no doubt took place under KU (in any understanding of that notion): While electric light per se was not unknown, his specific take on the electric bulb was a technical novelty and his embedding of that invention in a technical and business ecosystem was a commercial novelty. There was no objective basis for putting probabilities on the members of the of various possible outcomes of the innovation, and the set may have been partially unknown to Edison. In composing his new theory of value creation, Edison could draw on only few relevant data points and few "analogies." Still, he managed to engage in successful theory-based causal induction (Griffith & Tenenbaum, 2009, as reflected in his initial theorizing which he accomplished single-handedly, in less than a week's concentrated work effort cf. The Sun, 1878), based on few data points, but also based on abstraction and long paths of analytical reasoning (cf. Schilling, 2018). This resulted in a firmly held core theory of the electrical lightning ecosystem but with revision of the more peripheral parts of the theory. Specifically, Edison formed a set of beliefs about the various technical and commercial components of the ecosystem he envisaged, and their intertemporal interdependencies, sticking to some core beliefs (notably, the commercial potential in scalable electricity production and distribution), while discarding or adding other beliefs (e.g., about the materials used for the filament in the incandescent light bulb), in essence creating a new state of the world (i.e., one in which electrical lightning is a general feature).

The analysis of the (plausible) reasoning processes, beliefs, etc. of Edison that led to the formation of his new theory of value creation exemplifies pre-decision analysis under KU. Much existing strategy theory can plausibly inform parts of such pre-decision analysis. Thus, in the specific case considered here, ecosystem theory (e.g., Adner, 2012) has emphasized the crucial importance of structural interdependencies in ecosystems. Indeed, Edison was clearly attentive to

this, offering detailed accounts of such interdependence in his initial theorizing of the content and contours of his planned ecosystem. He made sure he had access to the necessary complementary assets. Cognitive approaches to strategy have highlighted the role of "analogy" (Gavetti, Levinthal, & Rivkin, 2005) and therefore the role in theorizing of transportability from the past of relevant entities (e.g., the existence of complementary dynamos and gas-lightning infrastructure), specific causal relationships (e.g., electricity produced by dynamos will illuminate lightning bulbs when connected through appropriate wiring), and their functional forms (e.g., specific levels voltage levels require specific wiring) (Griffith & Tenenbaum, 2009). Detailed inquiry may examine the specific contracts Edison made with other actors in the ecosystem. It may be that Edison was also attentive to possible future competition and that timing issues played into his decision to commercialize electric lightning. Still, the KU that surrounded his project was also partly a barrier to competition, as the novelty and ambiguity in the situation may have kept competitors at bay (for some time).

Indeed, we can amass so much case detail and so much strategy theory that in retrospect, Edison's decisions may come across as fully explainable (and, possibly, rational). Some think that this is how social science should explain (Popper, 1967). However, it is also the case that we are largely in the dark concerning how exactly visionary strategists move from few data points to their visionary strategies (Schilling, 2018), as Edison did. Edison built on others' experimentation efforts and engaged in considerable experimentation himself to hone individual components of his theory (notably, the various experiments involving the lightning bulb). But why he settled on exactly the theory of an electric lightning ecosystem he did may not be fully explainable even *ex post*. It would be farfetched to claim to be able to say from an *ex ante* perspective that Edison's theory was in some sense the "optimal" theory. Edison exercised judgment, that is, he made resource allocation decisions in a situation where data points and decision making frameworks were not sufficient for making a decision (Foss & Klein, 2012).[3]

We are on more secure ground when it comes to post-decision analysis. Thus, Edison's subsequent thinking about how to modify his theory was done in close cooperation and under the

[3] While Knight argued that such judgment is necessary in the face of uncertainty, he also regarded it as not accessible to scientific reasoning. While we may point to an improved understanding of creativity and its combinatorial basis since Knight wrote, his point is logical rather than psychological or cognitive: Choices must be made about which rules, frameworks, etc. to apply for decision-making. There may be meta-rules, etc., but ultimately we end up with an act of judgment (Winter, 1971).

impact of discussions with assistants and associates (Edison's "muckers"),[4] akin to "framing contests" in strategy making (Kaplan, 2008). His theory served as a "focusing device" (Rosenberg, 1969) or "Suchbild" (Felin, Kauffman, & Zenger, 2023) that shaped subsequent search efforts. Edison also understood the importance of stakeholders and of shaping their beliefs to get them to join the value-creating effort. To shape those beliefs, Edison skillfully utilized analogies, built conviction narratives, and showcased relevant artefact "prototypes" to build cognitive legitimacy (Hargadon, 2007; Foss et al., 2024). His investments in the emerging electricity ecosystem were supported by his complementary assets (not the least the massive media scrum that he nurtured). Edison and other ecosystem actors, as well as other individuals with similar ideas, learned from Edison's experimentation and commercialization efforts. Over time the well-known industry and technology dynamics concerning the division of labor across actors, as well as establishment and stabilization of cognitive categories, artefacts, that is familiar from theories of industry evolution (Grodal, Gotsopoulos, & Suarez, 2015), took place.

In sum, at least in the Edison case, a large swath of strategy and strategy research seem highly applicable and relevant, even if Edison was clearly maneuvering, particularly in the beginning of his efforts, in a world of KU. However, as already suggest, strategy research may also have significant gaps with respect to understanding decisions in such a world. As indicated, these gaps are to a large extent cognitive in nature. However, they relate not just to issues of composing and revising theories of value creation under KU, but also to issues of making others buy in to the relevant theory. Again, we are not completely in the dark concerning these processes, but there are certainly significant gaps in our understanding. They are further explored in the following from the perspective of the theory-based view in strategy and sticking to the above distinction between pre- and post-decision analysis.

PRE-DECISION ANALYSIS: STRATEGIC DECISIONS, UNCERTAINTY, AND THEORIES

Dimensions of Strategic Decisions

The central strategy problem is "the problem of judging, discovering, and creating the values of resources" (Lippman & Rumelt, 2003: 1083), and strategic decision-making revolves around framing, analyzing, and providing solutions to this problem. Somewhat less abstractly strategic

[4] Edison famously took the social nature of discovery to the extreme. "I never had an idea in my life," he declared. "My so-called inventions already existed in the environment—I took them out. I've created nothing. Nobody does. There's no such thing as an idea being brain-born; everything comes from the outside" (Haden, 2019).

decision-making involves those decisions that have potentially major firm-level performance implications (even if they do not necessarily involve major resource commitments), but are also correspondingly risky (i.e., they involve the potential for a major downside, and irreversible (Arrow & Lind, 1970; Ghemawat, 1991), and involve critical interdependencies. They produce coherence and consistency across other decisions involved in these interdependencies (Leiblein et al., 2018; Rumelt, 2023). To achieve such coherence and consistency (and assess performance implications, etc.), strategic decisions are based on representations of current and future conditions (Csaszar, 2018), or—more broadly, forward-looking, and generative—, theories of value creation (Felin & Zenger, 2017).

Strategic decisions may be described along the above dimensions, as well as such dimensions as novelty and uniqueness (e.g., Schilling, 2018). The set of strategic decisions is a large one, allowing for considerable variety. Edison's strategic decision-making indeed ticks off the items on the list of criteria for strategic decision making. Other strategic decisions may look "trivial" (e.g., the above P&G pricing example), but may still have, for example, major performance implications, even if they are not necessarily that irreversible (e.g., P&G tried out multiple price points; Laffley et al., 2012).

Knight (1921) linked the more extreme members of the set of strategic decision to entrepreneurship (and to profit and firm formation; Foss & Klein, 2012). He reserved what has been called "high impact, low frequency" decisions (Camuffo, Gambardella, & Pignatora, 2023) for the formation of "estimates" and the exercise of "judgment" (Knight, 1921)—in other words, the decisions that take place under "uncertainty." Knight's reasoning was that their very uniqueness means that relevant historical analogies would not present themselves to the decision maker, and it was therefore not possible to construct comparison classes from which probabilities may be inferred (Foss & Klein, 2012; Scoblic, 2020). As a result, there has been a tendency in the literature on KU to associate uniqueness and uncertainty, such that the former implies the latter (and, conversely, that multiplicity implies risk) (e.g., Makridakis, Hogarth, & Gaba, 2009; Kay & King, 2020). Of course, Bayesian decision theorists have long protested this distinction. But the distinction also obscures a key point in Knight (1921): his key idea isn't the distinction between "risk" and "uncertainty" *per se*, but rather that decisions can be thought of in terms of the "degree of uniqueness" they involve (Scoblic, 2019), that is, the extent to which they can be put into classes of instances (or, the extent to which we can come up with good analogies). It also obscures another key point in Knight, namely, that the degree of uniqueness is partly endogenous: decisions that may initially be unique

may be given to experimentation such that a class of reference cases can be created. This is what P&G did with their experiments with the pricing of their Olay products. However, it arguable that not all strategic decisions are given to such experimentation, so that strategic decisions (also) differ with respect to the extent to which they are amenable to experimentation (Gans, Stern, & Wu, 2019). The key challenge in pre-decision analysis lies in grappling with uncertainty that is "non-empirical" (Al-Naijjar & Weinstein, 2015) in the sense that beliefs (or sets of beliefs, as in theories of value creation) about uncertainty are not given to test by experimental means.[5]

Causes of Non-empirical Uncertainty

Knight reached a similar conclusion based on his observation that there are decisions that are "far too unique … for any sort of statistical tabulation to have any value for guidance" (Knight, 1921: 231). However, he did not explain why experimentation cannot transform *all* "uncertainty" into "risk." However, agreeing with Knight's emphasis on uniqueness of decision situations, the economist G.L.S. Shackle (1955) dug deeper into this issue; indeed, his emphasis in his early work was exactly on "non-remediable" uniqueness and on devising a formalism for handling choice under decision situations characterized by such uniqueness (the "potential surprise" framework; see Shackle, 1955: Chpt. 4; Derbyshire, 2017). Thus, he argued that many decisions are "non-divisible" in the sense that only one trial is possible (Svetlova, 2021: 993) and "crucial," that is, the relevant decisions change the conditions under which they are made (and may even have important transformative consequences for the decision-maker herself; Paul, 2014) (Shackle, 1955: Chpts. 1-3). Thus, in making non-divisible and crucial decisions, actors do not face given states of world; rather, they create these (Machina, 2003). To the extent that strategic decisions are non-divisible and crucial, they are characterized by non-remediable uniqueness that, by definition, cannot be remedied by experimentation. Decision makers cannot use experiments to "look before [they] leap" (Savage, 1954), and the uncertainty they confront is non-empirical.

In terms of the earlier discussion of the features of strategic decisions that contribute to producing non-remediable uniqueness two such features stand out. First, executing the relevant strategic decisions may be highly resource demanding. As an admittedly extreme example, think Elon Musk's "strategy" of colonizing Mars. While parts of this strategy are given to experimental trials, the sheer costs of experimentation mean that experimentation must be inherently limited. Ultimately, the "experiment" is the execution of the strategy. Second, non-remediable uniqueness is

[5] This is related, but not identical to the distinction between "epistemic uncertainty" and "aleatory uncertainty" (e.g., Packard & Clark, 2020).

rooted in the key aspect of strategic decisions that they involve (often many) critical interdependencies (Steen, 2017; Leiblein, Reuer & Zenger, 2018; Rumelt, 2022). Consider again Musk's Mars plans. Here the problem is that while part of the strategic decision may rest on knowledge that is validated, for example, through experimental means, making the decision also rests on knowledge that is inherently conjectural and unproven (Ehrig & Foss, 2022b). This becomes a problem when there are strong interdependencies between the different parts of the strategic decision. The core issue is whether the parts of the decision problem that can be taken to be empirically well understood and the parts that are characterized by KU add up in the sense that they allow for a rational, maximizing decision.

Consider further the example of Airbnb (Gallagher, 2017). Founded in 2008, Airbnb was based on the 2007 seemingly simple notion of roommates Brian Chesky and Joe Gebbia that putting an air mattress in the living room of their San Francisco flat and turning it into a bed & breakfast on a temporary basis may be a much more broadly scalable idea. Chesky and Gebbi were joined by Nathan Blecharczyk and launched Airbedandbreakfast.com in August 2008 which initially met with some, albeit modest success. Venture capitalist Paul Graham invited the founding team to 2009 training session of his startup incubator, Y Combinator, and supplied modest funding in exchange for a 6% interest in the company. The founders used the website and the funding to mobilize additional funding and began scaling the business in earnest. They were successful. But when Paul Graham met with the founding team in 2008, there were very basically no data points that would support the notion that Cheskia and Gebbia's local tinkering was a scalable idea. The basic problem was the initial "strategic" decision (renting out part of the Cheskia and Gebbia flat) was not related in an empirically demonstrable manner to a much more ambitious and not yet made decision about scaling Airbnb globally.

However, the experience of the founders had been sufficiently positive that they wished to carry on. As Graham (2020) observed: "That experience was why the Airbnbs didn't give up. They knew they'd discovered something. They'd seen a glimpse of the future, and they couldn't let it go." Apparently, Graham was sufficiently convinced that the leap from the "glimpse of the future" to the actual future was sufficiently credible that he decided to finance the founding team. Rumelt (2022: 32) calls a strategy based on such a leap a "…'creation' because it is nonobvious to most others, the product of insight and judgment rather than an algorithm." But the same may be said about Graham's decision to fund the founders of Airbnb. Both the founders and Graham exercised "judgment," that is, they made decisions based on "judgment" (Knight, 1921; Foss & Klein, 2012)

(in fact, Graham exercised judgment about judgment). They acted based on "estimates" that may have been related to existing data points (e.g., that hotel capacity may often fall short when cities host major conferences) but not in any "algorithmic" manner.

Such "leaps" seem to be an inherent part of the theories that guide strategic decision making (see more broadly, Griffith & Tenenbaum, 2009). Theories are sets of conditional assumptions that are causally linked in often complex ways (Felin & Zenger, 2017; Ehrig & Foss, 2022b; see also Ehrig & Schmitt, 2023). Some of these assumptions may individually be unproblematic, for example, because they have been validated by experimental means. Others may be completely shrouded in uncertainty.[6] Under non-empirical uncertainty, some assumptions will be entirely conjectural. Edison's theory of the electric lightning ecosystem was a collection of assumptions. Some of these—for example, that it possible to light up an electric lightbulb for an extended period—became validated by Edison's own experiments. Others could not be validated by experimental means. The assumption that public would be willing to pay for the new energy source was highly uncertain. It was also fundamental or decisive—and therefore the one that Edison concentrated on.[7] A related, more contemporary case may be "experimenting" with Power-to-X ecosystems involving a substantial time horizon and complex coordination and cooperation challenges stemming from coordinating multiple partners in heterogeneous industries, having to undertake ecosystem-specific investments. Many of the individual assumptions underlying the theory that Power-to-X will take off as a key part of future energy systems are unproblematic (e.g., electrolysis is not exactly a new technology), but the theory is only really on trial when a Power-to-X ecosystem is launched for real, that is, when non-divisible, crucial decisions are made. Like Edison, actors involved in strategic decisions then face a problem of making valid inferences from the subset of assumptions that are, or can be, tested to "validating" the full theory of value creation (Ehrig & Foss, 2022b).

These kind of situations are inherently "large worlds" (Savage, 1954), and although small world representations are useful for illuminating parts of the decision problem, the strategic

[6] Moreover, even if all the individual assumptions of the theory are individually unproblematic (i.e., we can treat them as being justified true beliefs) there are still issues remaining, notably whether all the necessary assumptions for the theory to hold true have been identified. Indeed, a key assumption is that the conjunction of all the assumptions "add up" to a determinate prediction.

[7] Edison's decision making resembles Rumelt's (2022: 4) notion of "The Crux": "I began to use the term *crux* to denote the outcome of a three-part strategic skill. The first part is judgment about which issues are truly important and which are secondary. The second part is judgment about the difficulties of dealing with these issues. And the third part is the ability to focus, to avoid spreading resources too thinly, not trying to do everything at once."

decision itself cannot be treated as if it is amenable to an analysis which decision makers know all available choices, states of the world, consequences, and probabilities (see also Binmore, 2008).[8] Of course, cognitive constructs like "models" (Knudsen et al., 2019), "representations" (Gavetti, Levinthal, & Rivkin, 2005), "theories" (Felin & Zenger, 2017) or "scenarios" (Feduzi & Runde, 2014; Feduzi et al., 2022) are all small world representations. The argument that decision makers seek to maneuver in the large world by means of small world representations is unproblematic (Levinthal, 2011).[9] What is perhaps more problematic is the argument that decision makers facing KU impose a preferred representation, treat it as a Bayesian prior, test it experimentally, and use the results to form a posterior, as in Zellweger and Zenger (2023).

This approach may work well when strategic decision situations are simple, such that the relevant theory of value creation is composed of assumptions that are well understood or at least individually testable (perhaps at low cost) and are related in a non-complex manner. The launch of rental electric motorbikes to a new market (e.g., Milano in 2017) may, perhaps, be an example of such a decision problem (see Spina & Frontreddy, 2022). Moreover, the approach works well for tweaking a "proven" theory; for example, Airbnb can tweak its well-established business model in terms of changes in the pricing strategy in a well-understood existing market and evaluate the results in a Bayesian manner (Ehrig & Foss, 2022b). However, for strategic decision-making when uncertainty is non-empirical, this approach is much more questionable.[10]

Composing Firm-specific Theories of Value Creation

The presence of non-empirical uncertainty does not imply decision paralysis, as decision makers can apply basic rules of thumb (such as maximin or robust satisficing), and can engage in imitation, analogical reasoning, abductive reasoning, and mental simulation (Lafley, et al., 2012; Feduzzi & Runde, 2014; Garbuio, Lovallo, Porac, & Dong, 2025; Ehrig & Schmidt, 2023; Camuffo

[8] Savage (1954) himself seems to have believed that practical application of Bayesian principles may start from representing the real world, which he of course acknowledged is a large world, into a small one that only exist as a mental representation that isolates key variables (see in particular, Savage, 1954: 16), and proceed on this "as if" basis, updating the representation in a Bayesian manner (Foss, 2023).

[9] The origin of such representations (Gavetti et al., 2005; Camuffo et al., 2023) as well as how they are updated (Runde et al., 2022) have been identified as key challenges in the literature on representations. From a Bayesian perspective, representations are of course updated by applying Bayes' theorem.

[10] The argument has been made that the approach it does not consider the possibility of frame-breaking, novel events that requires a new small world representation (cf. Ehrig & Foss, 2022a,b). (But see Karni and Vierø (2017) for an attempt to grapple with this within a (reverse) Bayesian framework). Most fundamentally, it does not address the origin of theories, but take these as given.

et al., 2024) that informs their judgment concerning future states of the world. The latter takes the form of making explicit assumptions about what needs to be true so that a particular future, expressed in form of a conjecture can materialize (Laffley et al., 2012). Firm-specific theories of value creation do this (Felin & Zenger, 2017). They causally relate what is known or testable today to future observable outcomes in unique, novel ways; are clusters of hierarchically ordered beliefs or assumptions that differ in importance (Loasby, 1986; Van Den Steen, 2017; Rumelt, 2022); and evolve by updating, adding, discarding beliefs (Bradley, 2017). As such they function as a "sieve or lens for enabling firms to uniquely sense and see opportunities in their environments" (Felin & Foss, 2023: 479; see also Felin et al., 2023).

New theories emerge from a "creative act" that "does not create something out of nothing; it uncovers, selects, re-shuffles, combines, synthesizes already existing facts, ideas, faculties, skills" (Koestler, 1964: 120). For example, the creative act underlying the original Airbnb theory may be reconstructed as bringing together the following statements: 1) owners or renters of flats often do not live in these constantly but may be away from the flat from extended periods; 2) it is possible to rent out a flat (or part of a flat) temporarily to a third party for purposes of accommodation; 3) people make use of hotels to take care of their temporary accommodation needs (cf. Witt, 2009). Of course, this simple propositional network has various objects in common that allow for a meaningful combination, resulting in the basic initial Airbnb founder theory that people who otherwise look to hotels to cover their accommodation needs may be served by people who are willing to rent out their flat. Because these objects (i.e., the basic needs, the availability of temporarily unused accommodation, etc.) are present across many locations, the theory further implies scalability of such a market-making venture.

While strategies based on such theories face non-empirical uncertainty, decision-makers will seek to reduce the uncertainty they face. They can then learn from objections against the theory and thereby discover, for instance, hidden assumptions in their reasoning (Laffey et al., 2012; Ehrig & Schmidt, 2023). Moreover, they can engage in "fact-free" learning (Aragones, Gilboa, Postlewaite, & Schmeidler, 2005), that is, learning in non-empirical (e.g., non-Bayesian) ways, for example, by noticing new regularities in the data in an existing database or realizing new implications of knowledge one already possesses, where these regularities or implications may be transportable to predictions about future conditions. Such learning may help to uncover new valuable resource combinations within the "vast reservoir of unpriced resources and resource combinations" (Lippman and Rumelt, 2003: 1085). The above reconstruction of the Airbnb founders' reasoning

processes exemplifies fact-free learning. Such learning reduces the decision-maker's unawareness of relevant implications of her knowledge set (Karni & Vierø, 2013; Feduzzi & Runde, 2014; Schipper, 2014; Ehrig & Schmidt, 2023).

Composing Theories of Value Creation: Processes of Inquiry

Much thinking about strategic decision-making under uncertainty takes the perspective of a single decision-maker (e.g., a "strategist" or a "firm"). This is partly warranted in cases such as Edison's launch of the first electric lightning ecosystem where the initial theory of the electric lightning ecosystem was put together single-handedly by Edison. However, even in this case the initial theory was subsequently evaluated, revised, and updated because of interaction with Edison's associates (and, of course, the experiences of ultimately implementing the strategy suggested by the theory). In general, processes aimed at building theories under KU, revising these, and acting on them in terms of making strategic decisions are likely to be social activities, particularly when the strategic decisions that will be informed by the theory are major ones in terms of resources and complexity that reach beyond the boundaries of the firm. From the perspective of pre-decision analysis, social activity manifests as fact-free social learning in which individuals involved in the strategy-making process may have access to (roughly) the same knowledge base but hold different views of a particular strategic issue. One individual may then challenge and change the beliefs and views of another individual, not by communicating new facts, but by making the other individual aware of a regularity or implication that he has overlooked (Aragones et al., 2005: 1356).

A particular kind of such learning processes is represented by "framing contests" in which participants in strategy processes push rival takes on strategy, even if they hold essentially the same knowledge (Kaplan, 2008). Different framing may result from different interests (the focus in Kaplan, 2008). But participants may simply look at the "facts" and their implications for future strategy differently, in short, they hold different theories of value creation. In such cases, there is a need for procedures that can structure "processes of inquiry" that help to address not just conflicts of interest, but also conflicts of cognition (Foss, Nickerson, & Weber, 2024).

Complex decisions that reach into the future are particularly likely to be characterized by ambiguous evaluation (i.e., difficulties of identifying tradeoffs and difficulties on agreeing on decision weights), a set of well know decision biases, problems of anticipating contingencies that may shape decisions regarding commitment versus pivoting, and only partly congruent sense-making. For example, it is well established that people tend to place too much confidence in their own estimates, including how much of the future they think they can account for (Roy &

Zeckhauser, 2015: 49). Gavetti et al. (2005) highlight analogy as a tool of thinking about the future, and case-based decision theory (Gilboa & Schmeidler, 1995) describes decision-making as involving a similarity function that maps current decision problems to similar "cases" in the memory of the decision-maker. Less rational processes may dictate the choice of analogy, such as the salience associated with past events (Roy & Zeckhauser, 2015: 50). In any case, theories of value creation are likely to transport many causal beliefs, etc. using analogy (cf. the above Airbnb example). Indeed, decision-makers likely search for *the* best analogy (Scoblic, 2020)—the one whose structure is most like the current situation—around which the new theory is then constructed. The availability heuristic shapes this process but may result in overestimating events that are close to the salient analogy. Confirmation biases may kick in, reinforcing the tendency to stick to one supposedly superior analogy. Of course, similar biases may shape the process of evaluating theories.

Given these pitfalls of composing (and evaluating) theories, there is a need for structured processes of inquiry, that is, mechanisms that can address conflicts of interest and cognition by creating common understanding and creating motivation through a normative frame. Foss et al. (2024) consider the context of firms adapting to disturbances and theorize the ability of different processes of inquiry to deal with devise response to different disturbances. For "small" problems of adaptation (i.e., the problems are local and characterized by a low degree of ill-structuredness), no formal process of inquiry is needed as such adaptation can be handled by semi-autonomous actors. Bigger problems (i.e., they are high in ill-structured and influence several organizational units), structured processes of inquiry are needed. These will differ depending on the strength of conflicts of interest and conflicts of cognition. Transferred from an adaptation context to a context of composing theories of value creation, some new theories may introduce conflicts over organizational resources. This may create motivated reasoning, even if the new theory is well understood by all participants to the strategy-creating process. The problem is here one of establishing negotiated processes of inquiry such that the "losing" side is compensated or somehow aligned with the rest of the organization by means of normative integration. Problems of interest and problems of cognition are particularly pressing when decision-makers compose theories leading to strategic decisions that are novel, irreversible, involve many interdependencies, etc. These are also the decisions that are likely to be made under non-empirical uncertainty. Processes of inquiry are here needed to build common understanding and motivation through communication and normative framing.

The Limits to Strategy in Pre-decision Analysis Under Knightian Uncertainty

Strategy is highly useful to pre-decision analysis under KU. It lends structure to thinking about the imagined, deemed possible by helping to identify relevant entities (potential competitors, complementors, suppliers, etc.), causal relationships between these, and the forms of such relations (Griffith & Tenenbaum, 2009). As such, strategy may help decision-makers engage in fact-free learning that reduce their unawareness of possible future states. Strategy helps understand which decisions are particularly likely to be susceptible to non-empirical uncertainty, that is, the kind of KU that cannot be transformed into risk by means of experimentation. Thus, strategic decisions that are particularly high in dimensions such as novelty, decision complexity, and the level of irreversible resources are particularly likely to be subject to such uncertainty. It is also here that the limits of strategy are encountered. While strategy research has proffered constructs such as "representations" (Gavetti et al., 2005), "strategic option generation" (Garbuio, Lovallo, Porac, & Dong, 2015), "theories" (Felin & Zenger, 2017), and "strategy creation" (Furr & Eisenhardt, 2021) as ways of thinking about cognition under this kind of KU, to some extent these are labels for our ignorance: We do not have powerful criteria for what is a good theory under KU. What we do know, however, is that the process aspects of theories (i.e., composing, evaluating, revising, discarding theories) are linked to familiar conflicts of interest and cognition. What we can do is to devise conditions under which decision-makers are more likely to avoid such conflicts or reduce them when they occur.

POST-DECISION ANALYSIS: THEORIES, COMMUNICATION, AND GOVERNANCE

As Knight (1921) stressed cognition is forward-looking intelligence, and much of cognition is about trying to pull the uncertain into the realm of the predictable and controllable. This takes place partly by cognitive specialization as well as delegating cognitive functions to the environment to reduce cognitive limitations and uncertainty (Magnani, 2009). Seen from the point of view of strategy firms may wish to occupy the cognitive niches that makes them different from the competition; on the other hand, cooperation often requires sharing a firm-specific theory. While the former point is well understood, the latter is less so, but the former point still has unexplored implications, notably with respect to factor market advantages.

Knightian Uncertainty, Firm-Specific Theories, and Factor Market Advantage

Taking firms' simplified representations of how things are furthers the understanding of many aspects of strategy, including competitive heterogeneity (Levinthal, 2011; Csaszar, 2018; Menon, 2018). Relatedly, considering firms' simplified theories of how things may be(come) under

conditions of KU has the potential to further our understanding of competitive heterogeneity. Felin et al. (2023) consider the strategic factor market logic that is foundational to the resource-based view in strategy (Barney, 1986) from a theory-based perspective, and I here follow their lead, but with more of an explicit emphasis on KU.[11]

According to the basic factor market argument logic resources can only be sources of competitive advantage if they are acquired at a price below their net present value for the acquirer which can come about through luck, private information (Barney, 1986), serendipity (Denrell, Fang, & Winter, 2001), or heterogeneous resource complementarity (Adegbesan, 2009). This argument can be represented using the standard tools of information economics (Makadok & Barney, 2001). In this world of risk (Hirshleifer & Riley, 1992), strategic factor market advantage derives from being best at assessing probabilities because of some private information advantage. For example, real estate developers in a given geographical area may all hold probability distributions over the returns associated with buying a piece of land that is currently up for sale and building the 1,200 homes that is the maximum allowed by local regulations. These probability distributions reflect the probabilities of other neighboring development activities that may influence land value. However, the developer who, say, is the only one to learn of plans of a major neighboring development may update his distribution in such a way that he may place the winning bid in the sealed-bid auction. Thus, private information (linked to the luck of being the first in the know) is the source of advantage in this setting.

However, adding KU to the strategic factor market logic complicates the situation in interesting ways that illuminates the understanding of factor market advantage associated with strategic decisions. Thus, think of KU as including both the inability to put objective probabilities on outcomes and the inability to fully characterize the nature and identity of (some) possible states of the world. In this situation, a theory of value creation helps decision makers think about likelihoods of outcomes (even if precise probabilities that add to 1 cannot be conceived) (Derbyshire, 2017) and reduce unawareness of future states; it is therefore a potential source of advantage. Suppose one of the above developers, say, the most seasoned and savvy one, develops a new theory of creating value from using land to build the 1,200 homes. No other developer holds a similar theory, so this developer is the only one whose state-space includes the developed piece of land. He approaches the current owner of the land, asking him to sell the relevant piece of land.

[11] Furr and Eisenhardt (2021) provide a fuller discussion of the RBV which they think of as mainly applicable to "low predictable and interpretable" markets where "Executives have foresight and time to build and renew resources and leverage them into related markets" (p.1917).

Supposing the seller has no idea that land may be developed in the way envisaged by the developed and does not seek to stimulate competition among other buyers, this knowledge condition is the most favorable one for a potential buyer, that is, the one that brings the largest strategic factor market advantage. The reason lies in the absence of competition. Of course, in this situation the private information of the developer as well as his savviness (i.e., the above two reasons for a strategic factor market advantage) are still relevant, but the absence of competition brought about by being the only one in the know is the feature introduced by Knightian uncertainty.

The example may be extended, for example, by considering that even if other developers come to know of the possibilities of bidding for the land, some of them may still want to stay clear of this opportunity because of its novelty (Bhidé, 2006), which also limits competition. After all, while data points informing the decision may exist (e.g., relating to other developments projects in the same region), the development project is likely to be characterized by the characteristics of strategic decisions (high levels of non-reversible commitment of resources, decision complexity, etc.) that were previously associated with non-empirical uncertainty.

Theories as Instruments of Collaboration Under Knightian Uncertainty

The above example follows standard strategic factor market logic in emphasizing not just informational conditions, but also competition. In this logic, the less competition that faces a would-be buyer, the more likely the buyer is to realize a factor market advantage. Thus, buyers with a theory that implies a better assessment (or awareness) of strategic factor market opportunities will not want the theory to disseminate to the competition (or to sellers). However, firms may often need to share a theory to actualize it, a sort of "reverse strategic factor market problem." Recall the Airbnb financing event above. It is possible that Graham based his decision to provide initial financing to Airbnb simply based on the confidence and enthusiasm conveyed by the founders of Airbnb, that is, his funding decision was based on affect rather than cognition. But it is also quite likely that the founders presented Graham with a convincing theory of value creation, and that Graham found it convincing because it captured "some important fundamental properties of the underlying context" (Knudsen, Levinthal, & Puranam, 2019: 1) in a novel manner, and that acting on this theory would be a profitable proposition.

Thus, theories may establish common ground between firms and their stakeholders. The reason is that theories inherently incorporate causal, temporal, etc. information regarding events and actors, allowing actors to imagine and assess possible futures. As such, they are laden with cognition, but also affect and motivation. Thus, good theories may function as successful

"conviction narratives" (Johnson, Bilovich, & Tuckett, 2022) that serve to persuade other actors to overcome their aversions to risk, ambiguity and novelty and join a value-creating effort. Such theory-based conviction efforts may be necessary because while potential collaborators may be lured by the prospect in sharing from the focal firm's (potential) tail returns, they may not fully understand the mapping of actions, investments, and performance consequences embedded in the theory. Thus, potential collaborators or stakeholders who put financial or real capital at stake (e.g., by making specific investments) will need to be convinced. In other words, potential conflicts of interest and cognition may cause obstacles to collaboration, and stakeholders will be wary of the same kind of issues that may characterize the composition and evaluation of theories in pre-decision analysis (i.e., misaligned incentives, errors of judgment, non-congruent cognitive frames, etc.).

The situation is particularly challenging in the case of new ecosystems. The reason is not only that ecosystems may involve multiple participants, but also multilateral interdependencies that are not reducible to dyadic relations. Consequently, the potential coordination and cooperation problems that emerge in the case of ecosystem emergence under KU are many and complex (Foss, Schmidt, & Teece, 2022). The decision to launch a new ecosystem manifests all the characteristics of those strategic decisions that are made under non-empirical uncertainty, as illustrated above with the Edison case. While a firm's theory may indeed enable "it to search for, identify and develop the right partnerships, complementarities and types of interdependence that enable its realization" and "once matches are identified, there are varied types of governance modes (alliances, JVs, and so forth) for *how* to ensure the alignment of interests and incentives (Felin & Foss, 2023: 481), part of the matching process is overcoming initial conflicts of cognition and interest.

Ecosystem leaders are likely to engage in "cognitive leadership" (Foss, Schmidt, & Teece, 2024) that revolve around communication that exploits familiarity with existing categories and concepts. Edison facilitated the adoption of electric light by cognitively embedding his innovation in concepts others were familiar with. Dattée et al. (2018) show how communicating interdependencies can lead to complementors realizing that a joint effort towards a new value proposition might be worthwhile. For familiar reasons, communication gains in credibility when it is costly. Leading by example by making irreversible investments in realizing the theory is one way in which ecosystem leader can transmit signals that help convince others to join the ecosystem. Malcolm McLean provides another example. To convince complementors to buy into his theory of containerized shipping, McLean sold off his shares in the well-established trucking company he had previously owned and invested in a shipping company (Mayo & Nohria, 2005).

The Limits to Strategy in Post-decision Analysis Under Knightian Uncertainty

The same conclusions as applied to pre-decision analysis above applies to post-decision analysis: Strategy is highly useful to post-decision analysis under KU, that is, the analysis of realizing strategies based on theories of value creation. Again, strategy lends structure to execution efforts, for example, realizing factor market advantages and engaging with actors that are necessary to realize strategies under KU. But here too there are limits to the usefulness of current strategy research. The above examples of strategic factor markets and ecosystem leadership exemplifies this. Thus, little is known about strategic factor market behaviors under KU. Felin et al. (2023) suggests that theories may help to "hack" factor markets, and I argued above that such "hacking" derives from firm-specific theories limiting competition in such markets. However, the mere appearance of a new buyer may raise a seller's level of awareness and make him add a state to his state space in which the resource under his control is worth considerably more because of a use that the seller had not initially expected (Karni & Vierø, 2013). Very little is currently known about these kinds of dynamics, which also applies to, for example, product market competition (Menon, 2018) and CSR issues (Asmussen et al., 2024). With respect to the issue of getting others on board in a joint effort to realize the strategy emerging from a specific theory, more may be known, but there is little theory that directly addresses persuasion efforts, communication between different parties, and processes of inquiry under KU, and even less theory that addresses how these differ depending on context.

DISCUSSION

Strategy and Knightian Uncertainty

The purpose of this paper was to discuss the dual questions, How useful is strategy in a world of Knightian uncertainty? And, how useful is Knightian uncertainty to strategy research? While these have been meaningful questions to ask as long as there has been a strategy field, it is only relatively recently that strategy scholars have begun to consider KU. As such strategy mirrors the rest of social science, in particular economics. For a long time, KU was seen as either irrelevant to social science (Lucas, 1978), *or* destructive of it (see Derbyshire, 2017; Svetlova, 2021), *or* not fundamentally at variance with the subjective expected utility theory (Arrow, 1951) that became the dominant decision-making paradigm in social science from the mid-1950s (Hirshleifer & Riley, 1992; Cabantous & Gond, 2015). This has changed dramatically across economics and decision science, and strategy scholars may be about to follow suit. Accordingly, this paper has partly been a brief stocktaking, informed by a historical example, of the usefulness of strategy in a world of KU,

and some reflections on how KU may align with and perhaps challenge and push some important parts of strategy research. Since the KU literature is not only difficult and heterogeneous, but also huge, many issues have been skirted. Some major omissions relate to the issue of predictability under KU (e.g., Zabell, 1992), and therefore issues such as the extent to which Bayesian learning is compatible with KU (Zabell, 1992; Karni & Vierø, 2013, 2017; Zellweger & Zenger, 2023; Ehrig & Foss, 2022b), issues of degrees of awareness of future states (e.g., Kreps, 1992; Schipper, 2014; Asmussen, Fosfuri, & Foss, 2024), and the usefulness of scenario methods as tools for outlining consequences of possible futures (Derbyshire, 2017; Scoblic, 2020; Feduzzi et al., 2022).

Still, the case has been made that a large swath of strategy research is quite useful in such a world. KU is not destructive of received strategy (theory). Rather, it exposes several gaps and limitations. The other part of the paper has been taken up with identifying some of these gaps and shortcomings—mainly of a cognitive nature—, and cautiously suggesting some ways in which strategy researchers may address them to expand the scope and depth of strategy research. The argument has been made that the social aspects of cognition under KU are deserving of special attention, and that those composing theories of value creation and strategies and trying to communicate these to relevant stakeholders need to be particularly attentive to cognitive "frictions" in the form of biases as well as non-overlapping or conflicting thought worlds that may to be bridged through properly designed processes of inquiry. There are, however, many hindrances on the way to realizing such opportunities.

Whither Knightian Uncertainty in Strategy Research?

As noted, while the KU literature has expanded considerably over the last few decades (Gilboa, 2004; Townshend et al., 2018; Dorabat et al., 2024), it has found limited application in the strategy literature. Even so, different notions of KU are present in the literature (Arend, 2024), and the notion has been used for a variety of different purposes, reflecting, perhaps, that the project of including KU in strategy has not been well-defined (and may not even have been seen as a distinct project): What is it that can be explained in a better way and how? Which dependent variables will be better understood? Does the inclusion of Knightian uncertainty introduce new interesting dependent variables? New mechanisms? How we think about these issues arguably depends on how we perceive of KU and its usefulness to strategy research. Specifically, KU may manifest in strategy research as a framing device, in a supply-driven way, or in a demand-driven way.

KU as a framing device. Perhaps because of the lack of a well-defined KU project in strategy, scholars have embraced Knightian uncertainty in a pragmatic manner and often used it as mainly a

framing device. For example, Kaul, Ganco and Rafifee (2024) model employee entrepreneurship as performing "judgment" under KU.[12] Drawing on Foss and Klein (2012) they interpret judgment as entrepreneurial ideas and argue that such ideas are too idiosyncratic to fully communicate to others at low costs. Kaul et al. use the idea to build a predictive theory of spinouts from employee entrepreneurship. Specifically, they assume that the value (V) of an entrepreneurial idea can be only partially demonstrated analytically or statistically (e.g., to an employer) prior to commercialization: (1- μ) V. This lends insight into different kinds of spinouts, depending on factors such as how specialized to the firm a given employee entrepreneur is. For example, an employee entrepreneurship that is not particularly specialized to the company and believes he create the full value V outside the firm but can only communicate (and be rewarded for) (1- μ)V inside the firm will obvious be strongly incentivized to spinout. While Kaul et al.'s (2024) theory is elegant, it is questionable whether it really is about KU, as the latter is not essential to their reasoning: Asymmetric information about (parts of) the value of the entrepreneurial idea will suffice (see also Arend, 2022).

Formal models of KU drives strategy research. There is a huge existing supply of thinking on KU in economics, decision science, game theory, and finance. It is huge, rigorous, and has plenty of implications for strategy research. For example, Nishimura and Ozaki (2007) examine the implications of Knightian uncertainty (modeled as ambiguity) on irreversible investment decisions, showing that such uncertainty reduces the value of an irreversible investment opportunity (while risk increases it).[13] While the authors study the problem in the context of a single firm's investment decisions, in principle their model may, for example, be embedded in models of strategic interaction where sunk cost investment acts as signaling devices (e.g., to keep entry at bay). The introduction of Knightian uncertainty may then be shown to result in different outcomes relative to games with a deterministic or probabilistic structure. Another example of how formal models of Knightian

[12] Other examples may be found in the recent (2020) "special topic forum" of the *Academy of Management Review* on "The Implications of Uncertainty for Management and Organization Theories" (Alvarez & Porac, 2020) offers examples. Thus, Arikan, Arikan and Koparan (2022) ask what motivates entrepreneurs to act under conditions of uncertainty, given that they "have no rational, profit-maximizing reason to begin the process of forming an opportunity." Knight (1921) noted that entrepreneurs believe they are right, while everyone else is wrong, but Arikan et al. tell a story about curiosity-driven "creation" of opportunities. Knightian uncertainty is mainly a framing device. In their contribution, Lampert, Kim, and Polidoro (2020) examine configurations of complementary asset (investments) in firms' value chains using classical ideas on commitment versus flexibility (e.g., Jones & Ostroy, 1984; Trigeorgis & Reuer, 2017). However, since it is not clear whether a similar story couldn't be told relying on a classic probabilistic (e.g., Bayesian; see Gans, Stern, & Wu, 2019) reasoning, again, Knightian uncertainty is primarily a framing device.

[13] The key to this result is that the assumption that the firm is "uncertainty-averse," such that it computes the expected profit by identifying the worst-outcome element in the set of the probability measures that describe Knightian uncertainty and chooses its investment strategy to maximize profit (i.e., the maximin criterion).

uncertainty may be exploited in a strategy context relates is the games-with-unawareness literature (Schipper, 2014, 2021). Thus, Bryan, Ryall, and Schipper (2022) analyze the implications for value capture of unawareness in a cooperative game theory mode, showing that the introduction of unawareness dramatically changes the conclusions of value capture model. As a final example, Asmussen, Foss and Fosfuri (2024) model the revelation of new state spaces (i.e., "surprise" or "novelty") in their examination of CSR strategies under different knowledge conditions (i.e., multinational enterprises can be unaware, partially aware, and fully aware of supplier actions). They derive several novel results, for example, that for the partially aware multinational enterprises being "paranoid" (i.e., an upwards bias towards monitoring suppliers on the part of the firm (i.e., paranoia) serves as a commitment to monitor more than what would be credible for an unbiased firm.

A demand-driven approach. While it is important to utilize rigorous modelling when such is available, there is also the risk of opportunistically latching to whatever modelling technology is available. This may result in the production of a string of unconnected insights that are entirely driven by the available technology (such as arguably happened to IO economics; see Fisher, 1989). In contrast to such a supply-driven approach, it may make sense to rather start from the demand-side and ask what kind of model of uncertainty we want, given the core questions that strategy asks. This is what I have tried to do in this paper. Strategy scholars place strategic decisions at the center of their research, which is an obviously convenient starting point because KU is a property of decisions. A particular class of strategic decisions—those that are characterized by non-empirical uncertainty—are challenging to strategy, both in practice and in research. The reason is the absence of a clear decision-making technology. Simple heuristics for thinking about "better "decisions under KU do exist, and scenario methods also offer insight, but leave very considerable wiggle-room. Ultimately, a demand-driven approach must be rigorous. There is a fair concern that the emphasis on taking action in the face of an unknowable future and "leap before you look" could cause some managers to be hopeful and resist "show stoppers" to their imagined future success.[14] The theory-based view (e.g., Felin & Zenger, 2017; Ehrig & Schmidt, 2023) is an attempt to impose some structure on the formation of theories of value creation by making assumptions explicit, tracing the implications of such assumptions, considering their conjunctions, and so on. However, this project, while promising, has only just started.

Conclusions

[14] Thanks to Steve Postrel for this point.

Strategy scholars have discovered an alluring box, namely that of KU, and they are peeking inside it. Its allure derives from its age, the fact that while many have been aware of its existence for a long time few have dared opening it in earnest, and its promise of throwing a more penetrating light on the conditions under which value and competitive advantages are created. The message of this paper is an optimistic one: Opening the box is not going to be destructive of much (most) received strategy theory. Our models do not fundamentally rely on assumptions of perfect foresight (or its probabilistic version, rational expectations). However, how to embrace and use KU is the big challenge. KU should not be a license to drop data-driven analysis where such analysis is helpful or an excuse for undisciplined flights of the imagination. If so, KU will become a Pandora's box. But KU does challenge us to consider several crucial, but undertheorized issues, such as the origin of theories of value creation, the characteristics of good theories of value creation, how to establish processes of inquiry that shape processes of composing, evaluating, etc. theories in the right direction and manner, and other social aspects of theories, such as communicating these to, for example, relevant participants in ecosystems. Thus, in essence KU has the potential to take cognitive approaches in strategy in exciting new directions.

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Table 1: ***Pre- and Post-Decision Analysis under Knightian Uncertainty***

	Pre-decision Analysis	**Post-decision Analysis**
Meaning	The reasoning processes of strategic decision-makers that lead them to form theories that inform their decision-making. Involves e.g., fact-free learning, abduction, imitation, use of analogy, etc.	How strategic decision making gets implemented. How the novelty that the new strategic decision represents gets disseminated, adapted to.
Examples	Edison forming his theory of an electric lightning ecosystem; the Airbnb founders' forming their theory of a platform-based scalable business model for temporarily renting non-hotel accomodation.	Edison's marketing efforts on behalf of his innovation, involving public demonstrations and other means of building acceptance of his theory among stakeholders.
How is strategy useful?	Basic strategy frameworks (e.g., 5 forces framework) useful for assessing possible future competitive conditions. Ecosystems ideas help identifying relevant future collaborators as well as interdependencies that need attention. Scenario methods help identify possible extreme cases that may build preparedness.	The same frameworks are useful for understanding competitive and collaborative interaction after making strategic decisions under KU.
Theory gaps for strategy research	What are the criteria for good theories? What are the conditions under which good theories are likely to be generated? How does KU influence strategic factor market competition?	Little is know about firms deal with the "reverse strategic factor market problem" of making others buy into a theory.