

UNCERTAINTY, KNOWLEDGE PROBLEMS, AND ENTREPRENEURIAL ACTION

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Whether new business ventures emerge in the context of start-ups or corporate giants, one of the enduring and fundamental assumptions underlying theories of entrepreneurial action is that entrepreneurs operate in uncertain environments. And yet, nearly a century since the unveiling of Knightian uncertainty as a precursor to profit-making, the identification, description, and operationalization of uncertainty as a construct continue to exhibit conflicting definitions, tautological measures, and unwitting conflation with more precise constructs along the spectrum of ignorance and unknowingness. The purpose of this study is to review the multiple research streams that together constitute the literature on knowledge problems to identify critical boundary conditions of uncertainty as an analytical construct. Based on this review, we then set forth a multi-level research agenda for exploring entrepreneurial action under conditions of ambiguity, complexity, equivocality, and uncertainty.

INTRODUCTION

For almost a century, the connection between uncertainty and entrepreneurial action has energized research across a wide variety of research fields in social and human sciences (Knight, 1921). And although uncertainty remains fundamental to theories of entrepreneurial action (Packard, Clark, & Klein, 2017), existing conceptions of uncertainty in entrepreneurship research are complex and problematic. On one hand, it is widely recognized that uncertainty creates innumerable challenges for even the most skilled organizational actors (Busenitz & Barney, 1997; Eisenhardt & Zbaracki, 1992; Schwenk, 1995; Wiltbank, Dew, Read, & Sarasvathy, 2006). Because an “unknowable” future stymies attempts by actors to comprehend and predict the consequences of their actions (Huang & Pearce, 2015), uncertainty often thwarts the well-conceived plans of managers and entrepreneurs (Sarasvathy, 2001). Similarly, because decision theories in

neoclassical economic models were never designed to address decision-making under uncertainty (Simon, 1979), the inability to predict the consequences of one’s actions presents theoretical challenges as well. Thus, the probabilistic reasoning that undergirds decision theory breaks down in the presence of uncertainty (Shackle, 1955).

Yet, despite these practical and theoretical challenges, uncertainty cannot be ignored. It is the lifeblood of the entrepreneurial opportunities that are necessary for the rejuvenation of organizations and economies (Venkataraman, 1997). Without human agency and action in the context of *a priori* irreducible uncertainty, there are no mechanisms through which the entrepreneur-opportunity nexus creates value (McMullen & Shepherd, 2006; Sarasvathy, 2001). McGrath, Ferrier and Mendelow (2004) likened this interplay to a ship captain journeying through uncharted waters in search of treasures. Even while the adventuring entrepreneur is unable at any point in time to comprehend fully what lies ahead, he or she is compelled to make a series of “stepping stone” decisions along the twisting river bends of irreducible uncertainty (McGrath & MacMillan, 2000; McMullen, 2015; McMullen & Kier, 2016) that will prove to be

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decisive in determining what, if any, social or economic value the entrepreneur ultimately creates.

Given the problematic yet productive role of uncertainty in human affairs, a wide range of organizational theories have emerged to incorporate various types of uncertainty as analytical constructs (Akerlof, 1995; Alchian & Demsetz, 1972; Cyert & March, 1963; Kahneman & Tversky, 1979; Simon, 1955, 1959; Williamson, 1979). The goal of these theoretical perspectives has been to develop models of decision-making and action that equip organizational actors with the tools to navigate uncertain environments effectively. The problem with these approaches, and with the use of uncertainty more generally, is that both scholars and practitioners use the construct as a synonym for all manner of “unknowingness.” Although unknowingness—which spans the entire landscape of human consciousness lying between ignorance and certainty—truly is ubiquitous, uncertainty is merely a subset of unknowingness. Yet, the implicit familiarity of the term uncertainty (i.e., the perception that we all know what it *means!*), shaped by over a century of use and misuse to describe the epistemological limits of human knowledge, encourages even the most analytically inclined to overlook it or take its meaning for granted when developing what are otherwise rigorous theoretical models.

Being constituted of many states of unknowingness, and as a condition that may be perceived to exist even when it does not, the uncertainty construct is far more problematic than its widespread use might suggest, and its central role in management and organizational research belies rampant imprecision, overuse, and misuse (Packard et al., 2017). With countless scholarly titles and journal abstracts referencing “uncertainty,” it is incumbent upon scholars to ensure that the construct is accurate, intelligible, utilizable, and meaningful. These problems are particularly acute in the study of entrepreneurship (McMullen & Shepherd, 2006; Ramoglou & Tsang, 2016), where the *raison d’être* of entrepreneurial action is inseparable from the state of uncertainty (Knight, 1921; McGrath, 1999; Rumelt, 1987). Among eminent commentators in the history of scholarship in entrepreneurship—Cantillon, Say, Sombart, Weber, Knight, and Schumpeter—the common denominator has always been that the creation, and capture of value is contingent upon the premise that action is taken in the context of some level of unknowingness. Without this premise, an action is simply a perfunctory enactment of known desires with probabilistic outcomes. Yet, the overuse of the term “uncertainty,” the lack of definitional clarity,

and the tendency to operationalize the concept imprecisely have stretched the construct’s boundaries so severely that its theoretical usefulness is at risk. Although recent calls for “a more nuanced view of uncertainty” (Ramoglou & Tsang, 2016) or “[a] better notion of uncertainty” in entrepreneurship theory (Packard et al., 2017) are steps in the right direction, scholarly attempts to continue stretching the boundaries of uncertainty to cover an ever-increasing range of actions under conditions of ignorance, and “unknowingness” threatens the very utility of this valuable construct (McKelvie, Haynie, & Gustavsson, 2011). Thus, there is an urgent need for more research that (i) builds on the seminal work of Knight (1921) and others to disaggregate extant conceptions of uncertainty, (ii) identifies and explicates the nature of knowledge problems that have been subsumed errantly by uncertainty, and (iii) explores alternative models of action that entrepreneurs use to mitigate this array of knowledge problems.

To accomplish these three objectives in this review, we conduct a multi-disciplinary investigation of existing research on the role of uncertainty in theories of entrepreneurial action (McGrath & McMillen, 2000; McMullen & Shepherd, 2006). As a crucial next step toward building more robust theories of entrepreneurial action, our goal is to provide more nuance and depth regarding the role and nature of unknowingness faced by entrepreneurs as well as the causes and consequences of entrepreneurial action undertaken to resolve uncertainty. Making progress in this regard necessitates the development of a more complete, more precise conceptualization of unknowingness, one that extends beyond uncertainty into other closely related knowledge problems: ambiguity, complexity, and equivocality. Ambiguity refers to the collapse of sensemaking (Weick, 1995), when it is impossible to discern what is important or even what is going to happen. Complexity emanates from a combination of detail complexity, which is the quantity of variables involved in a problem, and from dynamic complexity, which is the quantity of the interactions between the variables over time (Clarysse, Tartari, & Salter, 2011). Equivocality refers to the existence of multiple meanings or interpretations that are individually unambiguous but collectively lie in direct conflict with one another (Zack, 2001). To move forward with stronger theory in the entrepreneurship domain, a successful exposition of action requires a richer, more thorough examination of all four knowledge problems and the impediments they generate.

By “knowledge problem,” we refer to an epistemological obstacle to strategic action that manifests in terms of the novelty being confronted along one or more dimensions of action, including what is being done, who is doing it, why they are doing it, and when, where, or how they are doing it. These dimensions may be structural (e.g., where and when) or agentic (e.g., how and why). Simply put, actors may not know what the consequences of their actions will be or even what those actions should be owing to the novelty confronted along one or more of these dimensions of entrepreneurial action (Companys & McMullen, 2007). This knowledge problem leaves them pondering whether to take action, and if so, how? Building on this approach, we conclude the article by introducing a robust agenda for researching a rich and broader set of knowledge problems within the context of entrepreneurial action research.

UNCERTAINTY AND ENTREPRENEURIAL ACTION

To explore the current state of research into the role of uncertainty in theories of entrepreneurial action, we conduct a review of the literature on uncertainty across a core set of entrepreneurship and management scholarly journals. In the first stage of the review, we discuss foundational research explicating the link between uncertainty and entrepreneurial action to highlight key assumptions and perspectives that have shaped this area of research. In the second stage of the review, we conduct a systematic analysis of contemporary research published between 2006–2016. We chose this time period, beginning with the work of McMullen and Shepherd (2006) who linked a theory of entrepreneurial action with the literature on uncertainty, to spotlight the most relevant contemporary themes, perspectives, debates, and omissions in subsequent research. We will elaborate on these sections of the review in the following paragraphs.

Foundational Perspectives on Uncertainty in Theories of Entrepreneurial Action

The concept of uncertainty looms large within the domain of entrepreneurship research, coloring virtually every condition, context, and level of analysis. Uncertainty has been used to characterize entrepreneurial environments (Busenitz, 1996; Gaglio & Katz, 2001; Hannan & Freeman, 1984; Russell & Russell, 1992), new industry sector indeterminacy (York & Venkataraman, 2010), firm-level strategic unknowns

(Barnett and Hansen, 1996; Hage, 1999), and individual-founder expertise (Freel, 2005; Kirzner, 1979; Sarasvathy, 2001; Sarasvathy, 2008) or ignorance (Baron & Ensley, 2006; Hoffman & Hammonds, 1994; Hunt & Kiefer, 2017; Simon, 1979; Tversky & Kahneman, 1974). Modern usage of the term extends back to Cantillon (1755), who was the first to recognize that decentralized, real-world markets were driven by essential links between entrepreneurship, opportunity pursuit, and decision-making in the face of uncertain outcomes (Herbert & Link, 1989).

Knightian risk and uncertainty. Left dormant for nearly two centuries, Frank Knight (1921) resurrected the importance of uncertainty bearing as a key tenet for the existence of profit as a reward for entrepreneurial activity. Knight’s view eschewed the dominant theoretical perspective of the time, which held that in the long run, uncertainty and individual decision-making are of little importance—a view that renders individual entrepreneurial action virtually meaningless in the broad context general market equilibrium. Yet, for Knight (1921), the ubiquity of uncertainty undermines the functioning of the pricing system, thereby necessitating a special class of entrepreneurs capable of bearing that uncertainty on behalf of the economy, thereby earning the right to “profit.” Extending Knight’s line of thinking, both Coase (1937) and Keynes (1937) asserted that uncertainty constitutes the central problem confronted by entrepreneurs, and thus a consensus emerged that uncertainty and entrepreneurial action are inextricably linked in foundational theories of entrepreneurship (Boudreaux & Holcomb, 1989).

Although awareness and acceptance of uncertainty-bearing individuals generates momentum toward the study of entrepreneurship, it does not settle the need for better definitions of uncertainty. Ironically, the ubiquity of uncertainty as a market-based reality, and its influence as a scholarly concept of escalating prominence in theories of entrepreneurship, has facilitated neither the adoption of common definitions nor an evolution toward consistent usage. Within the broader domain of management, organizational theorists have sought to contend with uncertainty in a variety of ways. Lipshitz and Strauss (1997), for example, cataloged an assortment of conceptualizations, including perspectives that equate uncertainty to risk (Anderson, Deane, Hammond, & McClelland, 1981; Arrow, 1965; MacCrimmon & Wehrung, 1986), ambiguity (Hogarth, 1987; March and Olson, 1976), the inability to act deterministically (Thompson, 1967), a paucity of information (Galbraith et al., 1975), turbulence (Terreberry, 1968), equivocality (Weick, 1979),

conflict (March & Simon, 1958), and ignorance (Anderson et al., 1981).

Research in behavioral economics arising from vigorous conversations within the “Carnegie School” of thought posed challenges to existing conceptions of decision-making under uncertainty. These conversations questioned the efficacy of three assumptions: (a) the human brain’s capacity to comprehend and process probabilities with any degree of formal precision, even among professional probability theorists (Gigerenzer, 2003; Gigerenzer & Goldstein, 1996), (b) the presence of known, well-formulated preferences that drive action (March, 1978), and (c) the need for and usefulness of large quantities of information as facilitators of better decisions (Simon, 1996). Sarasvathy (2008) termed these the problems of uncertainty, goal ambiguity, and isotropy, respectively, and showed how expert entrepreneurs learn through the experience of action and interaction to overcome these within the effectual process.

Among these various conceptualizations of uncertainty, none has been more central to the discussion of entrepreneurship than the differentiation between uncertainty and risk. The tendency to conflate the concepts of risk and uncertainty, especially as they pertain to entrepreneurial action, has hindered efforts to identify, distinguish, and model the value-enhancing facets of action under uncertain conditions from other types of ignorance and unknowingness (Dew, 2009). Knight (1921) framed the concern in the following fashion:

“Uncertainty must be taken in a sense radically distinct from the familiar notion of risk, from which it has never been properly separated. . . . The essential fact is that ‘risk’ means in some cases a quantity susceptible of measurement, while at other times it is something distinctly not of this character; and there are far-reaching and crucial differences in the bearings of the phenomena depending on which of the two is really present and operating. . . . It will appear that a measurable uncertainty, or ‘risk’ proper, as we shall use the term, is so far different from an unmeasurable one that it is not in effect an uncertainty at all” (1921:19).

Risk, then, is characterized as the ability to assign a probability distribution to the potential outcomes. In other domains, this is sometimes referred to as Type B uncertainty, in which the assessment end point is fixed but unknown (Hoffmann & Hammonds, 1994). With risk, we do not know for certain what is going to happen next, but we do know what the distribution of all possible outcomes looks

like. For example, *ex ante*, we do not know the outcome of rolling two dice, but we do know the exact probabilities of any two fair dice yielding each value from 2 to 12. The outcome of each roll or each series of rolls is unknown, but a complete set of all the possible outcomes for each roll are known, as is the probability of each outcome occurring. Actors know these probabilities because while the exact outcome is unknown, the range of possible solutions is fixed because there is a limited set of combinatorial solutions based on the number of dice. Thus, risky problems are “insurable” (Knight, 1921)—meaning that risks can be hedged, pooled, or otherwise neutralized by paying insurance to cover the potential occurrence of unfavorable outcomes—whereas certain other types of uncertainty are *a priori* irreducible (McGrath, 1999) and, therefore, “uninsurable” because there are no immediate market pricing mechanisms to cover unforeseen eventualities.

Knight’s careful distinction between risk and uncertainty is particularly critical to theory building in entrepreneurship (Folta, 2007). This is because the facets of the entrepreneurship domain that are not otherwise subsumed by theories drawn from economics, strategic management, sociology, and psychology tend to involve nascent-stage venturing, settings in which the sifting and sorting and processing of an opportunity’s potential plays out on a patently micro-level scale where *a priori* uncertainties cannot be hedged in advance of the entrepreneur taking action. “Though uncertainty is prevalent in business and other social situations, it is pervasive in entrepreneurial settings,” noted Sorenson and Stuart (2008: 530). Folta (2007), in an essay published in the inaugural issue of *Strategic Entrepreneurship Journal* harkens back to Knight, Coase, and Keynes in declaring that in entrepreneurship, “uncertainty rules the day.”

Contrary to the negative connotations that accompany the view of uncertainty in common parlance, the foundational perspective in entrepreneurship research is based on the logic that uncertainty does not constitute a patently aversive state. This distinctive relationship with uncertainty makes the field unique within the social sciences. In fact, the presence of *a priori* uncertainty regarding the viability of an entrepreneurial opportunity is in some sense an essential pre-condition for the very existence of the opportunity (McMullen, Plummer, & Acs, 2007). An entrepreneur’s willingness and ability to bear uncertainty is a decisive determinant of both the path he or she selects and the outcomes that ultimately transpire (Gnyawali & Fogel, 1994; Shepherd, McMullen,

& Jennings, 2007). Rumelt (1987) maintains that an entrepreneur's ability to position himself or herself to capitalize on environmental uncertainty is the key driver in generating and harvesting entrepreneurial rents. Building on Venkataraman (1997), McGrath (1999:31) too refers to the role of uncertainty in real options as follows: "Embracing entrepreneurship, implies accepting all that goes with it, particularly the recognition of *a priori* irreducible uncertainty."

Knight prefaced his update to *Risk, Uncertainty and Profit* in 1957 by noting that, "Universal foreknowledge would leave no place for an entrepreneur" (1957: lxii). Even more pointedly, McMullen, Plummer, and Acs (2007: 279) observed, "...one cannot have opportunity without uncertainty, but because the human condition is characterized by the passage of time, there will always be uncertainty, and therefore, some form of opportunity." Likewise, York and Venkataraman (2010: 454) concluded that, "Entrepreneurs can be viewed as individuals who have a way of producing *value* out of *uncertainty*" (italicized emphasis in the original).

Critiques of knightian risk and uncertainty. Not all scholars share the Knightian distinctions between uncertainty and risk nor do they embrace what some see as a misplaced romanticization of uncertainty in the study of innovation and entrepreneurship (Adner & Levinthal, 2004). Despite the centrality of uncertainty in theories of entrepreneurial action, and in some sense, the essentiality of uncertainty in the pursuit of entrepreneurial opportunities (Hunt & Song, 2015; McMullen & Shepherd, 2006; Venkataraman, 1997), there remains a persistent question as to whether entrepreneurs actually capitalize on irreducible *a priori* uncertainty in practice (Driouchi & Bennett, 2012; Klingebiel & Adner, 2015; Posen, Leiblein, & Chen, 2015). In other words, does the presence of uncertainty positively facilitate micro-level entrepreneurial action directly? Although Knight's distinction constitutes a loosely enforced orthodoxy among entrepreneurship scholars, there are several noteworthy concerns that have been raised and debates that have emerged, the most prominent of which have been captured in the following three critiques.

First, one of the central critiques in the foundational literature on Knight's distinction between risk and uncertainty centered on the arguments that functionally, individuals are unable or unwilling to differentiate between risk and uncertainty at the microlevel (Savage, 1972; Taleb, 2007). The notion that market actors can or should develop probability distributions to assist in decision-making when

confronted by risks seems preposterous to other scholars (e.g. Gigerenzer & Goldstein, 1996). To these scholars, the distinctions drawn between Knightian uncertainty and Knightian risks lack veridicality (Taleb, Goldstein, & Spitznagel, 2009). "Behaviorally, individuals confront uncertainty and risk as though they are one and the same," argued Taleb (2007:128). Arrow's (1951: 417) critique of Knight is particularly poignant when he argued that at macrolevel, "...Knight's uncertainties seem to have surprisingly many of the properties of ordinary probabilities" and that the "...degree of uncertainty (is) reducible by consolidation of many cases, analogously to the law of large numbers" (Arrow, 1951: 417). This distinction is crucial as it suggests that to the extent Knightian uncertainties can be aggregated, they can potentially be mitigated through risk pooling.

Second, others, however, have argued pointedly that the benefits of macro-level "risk pooling" are usually limited in the context of entrepreneurship because micro-level entrepreneurial action is often characterized by "non-divisible, non-seriable experiments" (i.e., entrepreneurs have "one shot" to get it right—Shackle, 1955: 8). So, whereas some actors could obviously insure against catastrophe by aggregating micro-level, situational uncertainties to where an unforeseen catastrophic outcome with any one product or market failure would not create systemic damage in the aggregate, micro-level entrepreneurial action is more susceptible to these failures because they are less able to hedge their risks through pooling together many products or markets. As Sarasvathy, Menon, & Kuechle (2013: 426) note:

"The use of heterogeneity (diversity) to average out losses from firm failure is not an option for the serial entrepreneur; he/she cannot start *n* firms concurrently with the idea of exploiting negatively correlated dependencies between the firms. To paraphrase a well-known example, it may make sense to buy 'shares in a coal and in an ice company' (Samuelson, 1967), but it may not be feasible to start coal and ice companies at the same time."

The crux of this problem, therefore, hinges on key differences between micro-level sources of uncertainty, where the accuracy of individual judgment is thwarted by situational factors and structural sources of uncertainty, which can be transformed into risk by pooling these uncertainties together and insuring against any ill effects they might present.

Third, this situation is distinct from still another form of uncertainty identified in foundational research, involving conditions under which the true

aggregate distributions for a set of parameters are unknown, and the inclusion of new information does not necessarily enable the actor to reduce uncertainty *ex post*. In such cases, not only do we not know what is going to happen next (*a priori* uncertainty) or what the distribution of all potential outcomes look like, new information can actually make the knowledge problem worse for the individual actor. Keynes elaborates on this important point:

“By ‘uncertain’ knowledge... I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty... The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence, or the obsolescence of a new invention... About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know!” (1937: 213–214).

Keynes differentiates situational uncertainties (i.e., a game of roulette) from macro sources of uncertainty where the aggregation of a variety of factors creates an uncertain environment (e.g., prospect of European war) that is at least partially influenced by the micro-level actions of various actors (e.g., political choices of leaders in key European countries influenced the outbreak of war 2 years after he made his statement). In these decision environments, entrepreneurial decisions are characterized by “. . . a non-exhaustive list of possible states of the world known to the entrepreneur” (Basili & Zappia, 2010: 450). To this point, as we noted earlier, Taleb (2007: 128) argued that under such conditions of complexity, “Behaviorally, individuals confront uncertainty and risk as though they are one and the same. . . .” These decision environments are particularly challenging for entrepreneurial actors because the addition of more variables to a decision model often exacerbates the challenges of solving complex knowledge problems. The inclusion of each individual new model parameter can generate an almost infinite range of potential outcomes through interactions among all of the variables. Such complex interactions are not only *a priori* irreducible, but uncertainty is often increased *ex post* based on the unforeseen consequences of operating in complex environments. Taleb (2007: 128) summarized his critiques of Knight’s distinction between risk and uncertainty by arguing that in such complex environments,

“. . . (c)omputable risks are absent from real life” or perhaps even impossible, thereby rendering the risk-uncertainty distinction largely moot because more information does not solve the uncertainty puzzle *ex post*.

Overall, Knight’s distinction between risk and uncertainty has played a crucial role in shaping theories of entrepreneurial action over the past century. Yet, as we will discuss in the following paragraphs, much of the contemporary research in entrepreneurship continues to use uncertainty in an omnibus fashion, stretching the concept of uncertainty to cover many types of ignorance or unknowingness. For example, if uncertainty is defined as a structural feature of the objective world, few remedies exist to resolve it because the information simply does not exist. If uncertainty describes the ignorance of the individual actor, they can resolve it by exploring the external world until the “correct” information is discovered. However, if uncertainty is defined as a fuzzy, unclear set of subjective perspectives or preferences, entrepreneurial actions intended to influence these environments can reduce the overall level of “uncertainty” by creating intersubjective agreement. In each case, the end result is the same (i.e., uncertainty is reduced), but the underlying mechanisms for resolving such states of initial unknowingness are entirely different. Taken together, the *status quo* in entrepreneurship theory is problematic because inconsistent definitions of uncertainty create confusion regarding both the impact of uncertainty on entrepreneurial action and on the effectiveness of the processes and strategies used to resolve it.

Reviewing the Contemporary Literature

The literature on uncertainty contains hundreds of thousands of textual “mentions.” So, for our systematic review of contemporary literature, we began with a winnowing process. We conducted a systematic search of prominent journals to include only those articles with uncertainty in the title, abstract, or keywords. Table 1 identifies the journals we included in the review process and Table 2 lists the citations of the individual articles.

To ensure that each of the articles explored uncertainty as a subject of interest, we identified and excluded articles that simply used the term as an adjective or description of previous research (e.g., “the findings of previous research are ‘uncertain’”). In addition, because the main purpose of this review was to analyze the literature on

TABLE 1
Journals Used in Conducting Our Review

Management:

Academy of Management Review (AMR), Academy of Management Journal (AMJ), Administrative Science Quarterly (ASQ), Journal of International Business Studies (JIBS), Journal of Management Studies (JMS), Management Science (MS), Organization Science (OS), and Strategic Management Journal (SMJ).

Entrepreneurship:

Entrepreneurship Theory and Practice (ETP), Journal of Business Venturing (JBV), Strategic Entrepreneurship Journal, Small Business Economics (SBE), and Journal of Small Business Management (JSBM)

uncertainty as it relates to theories of entrepreneurial action, we then examined each of these articles to ensure that the phenomenon of interest was either independent or corporate entrepreneurship (including family business). This step further refined our final article set to 146 articles. In the following sections, we highlight the key findings from our review.

Boundaries and Construct Clarity in Uncertainty Research A first key finding from our review is that despite the long history and central importance of Knightian uncertainty to theories of entrepreneurial action, there remains a surprising lack of agreement on core definitions of uncertainty in contemporary research. Although there have been several recent attempts to provide a more nuanced view of uncertainty in theories of entrepreneurial action (Packard et al., 2017; Ramaglou & Tsang, 2016), contemporary research continues to stretch the boundaries of the uncertainty-risk continuum to cover numerous states of ignorance and unknowingness (Packard et al., 2017). For example, York and Venkataraman (2010) use Knight's (1921) distinction between risk and uncertainty as a foundational argument for their application of entrepreneurial action to the context of sustainable or environmental entrepreneurship. In their study, they define uncertainty as "risks we cannot assign probability to or predict in an accurate manner" (York & Venkataraman, 2010: 452). They elaborate on this further by noting that, to alleviate environmental degradation, entrepreneurial action "...must address uncertainty and create action in the face of ambiguity" and later argue that "environmental issues are, by their nature uncertain; the future is unknowable, and the framing of environmental issues occurs in a future context" (York & Venkataraman, 2010: 452–3). In this definition, uncertainty and ambiguity are used interchangeably, referring to both the interpretive (i.e., which factors matter and how they should be interpreted?) and prediction problems (i.e., what are the likely consequences of taking or not taking action?) inherent in making decisions about the future.

Kuechle, Boulu-Reshef, and Carr (2016) take a similar approach and define Knightian uncertainty as "...a situation in which the missing information is yet to be created," and contend that "...there is no procedure that can reduce the doubts about the possible courses of action, the possible states of the world and the nature of their outcomes" (Kuechle et al., 2016: 46). They also note that they "...use the terms ambiguity and uncertainty interchangeably" (Kuechle et al., 2016: 46). The interchangeable use of uncertainty and ambiguity also influences how Kuechle et al. (2016: 46) interpret other related research: "The individuals studied by McKelvie et al. (2009)² showed overall aversion to uncertainty and expressed particular concern about the ambiguity surrounding the impact of their own actions..." Overall, Kuechle et al. argue that different types of information will enable entrepreneurial actors to solve uncertainty/ambiguity.

Much of this confusion stemming from a lack of construct clarity in contemporary research occurs in research that attempts to build on normative decision theories in the economic literature. Recent contemporary research has resurrected Ellsberg's (1961) argument that Knightian uncertainty is a type of ambiguity, which he defines as "...a quality of depending on the amount, type, reliability, and 'unanimity' of information, and giving rise to one's degree of 'confidence' in an estimate of relative likelihoods" (Ellsberg, 1961: 657). Yet, later in the article, Ellsberg (1961: 659) also argues that "(a) mbiguity may be high even where there is ample quantity of information, when there are questions of reliability and relevance of information, and particularly where there is conflicting opinion and evidence." This is a crucial point here in that ambiguity is not a function of incomplete information in an environment, but that individuals just might

² The article references and the publication date of McKelvie et al. in 2009 when the article was first available online versus the final publication date of 2011.

TABLE 2
Uncertainty Articles Included in Review (2006-2016)

<p>A</p> <p>Ahlers et al., 2015 Alvarez, 2007 Alvarez & Barney, 2007 Alvarez & Parker, 2009 Andries et al., 2013 Artinger & Powell, 2016 Audretsch et al., 2014 Autio et al., 2013 Autio et al., 2011 Autio et al., 2013</p> <p>B</p> <p>Baron, 2006 Belleflamme et al., 2014 Bhawe et al., 2016 Bianco et al., 2013 Bjørnskov & Foss, 2013 Block, 2012 Boeker & Fleming, 2010 Bowen & De Clercq, 2008 Burns et al., 2016</p> <p>C</p> <p>Cacciotti et al., 2016 Çakar & Ertürk, 2010 Cassar, 2014 Chandler et al., 2011 Chwolka & Raith, 2012 Cobb et al., 2016 Compagni et al., 2015</p> <p>D</p> <p>Dawson, 2016 Dean & McMullen, 2007 Dew et al., 2015 Dimov & Milanov, 2010 Du & Mickiewicz, 2016</p> <p>E</p> <p>Engel et al., 2014 Ensley et al., 2006</p> <p>F</p> <p>Ferrary, 2010 Fiet, 2007 Fischer & Reuber, 2014 Flatten et al., 2015 Folta, 2007 Forbes, 2007 Foss et al., 2007 Foo, 2011</p> <p>G</p> <p>Gaba & Terlaak, 2013 Garrett & Holland, 2015 Gartner & Liao, 2012 Garud et al., 2014 Gaur et al., 2011 Ghosal & Ye, 2015 Gruber, 2008 Guerra & Patuelli, 2016</p> <p>H</p> <p>Halme et al., 2012 Haynie & Shepherd, 2009</p>	<p>Haynie et al., 2009 Haynie et al., 2010 Haynie et al., 2012 Heavey et al., 2009 Henfridsson & Youngjin, 2014 Hmieleski & Baron, 2007 Hmieleski & Baron, 2008 Hmieleski & Baron, 2009 Hmieleski et al., 2015 Holm et al., 2013 Huang & Pearce, 2015</p> <p>J</p> <p>Jones & Casulli, 2014</p> <p>K</p> <p>Kacperczyk, 2013 Kaplan, 2008 Kaul, 2013 Keil et al., 2008 Kirsch et al., 2009 Klingebiel, 2012 Kor et al., 2007 Korsgaard et al., 2016 Kreiser et al., 2010 Kuechle et al., 2016</p> <p>L</p> <p>Lanivich et al., 2015 Langlois, 2007 Le Breton-Miller & Miller, 2015 Lee et al., 2011 Lee, S-H & Makhija, 2008 Levitas & Chi, 2010 Leyden, 2016 Li, 2008 Li, 2013 Li & Chi, 2013 Li & Mahoney, 2011 Li & Zahra, 2012 Lowe & Ziedonis, 2006</p> <p>M</p> <p>Mahnke et al., 2007 Martiarena, 2013 Matusik & Fitza, 2012 Matusik et al., 2008 McKelvie et al., 2011 McMullen & Shepherd, 2006 McVea, 2009 Miller & Sardais, 2015 Miller, 2012 Minola et al., 2016 Moreno-Moya & Munuera-Aleman, 2016</p> <p>P</p> <p>Packalen, 2007 Parker, 2006 Park & Steensma, 2012 Parnell, 2013 Patel & Fiet, 2009 Podoyntsyna et al., 2013 Pollock et al., 2007 Puffer et al., 2010</p>	<p>R</p> <p>Raffiee & Jie, 2014 Ramoglou & Tsang, 2016 Rauch & Hatak, 2016 Raymond et al., 2015 Read et al., 2009 Reuer et al., 2012 Reymen et al., 2015 Rosenbusch et al., 2013</p> <p>S</p> <p>Saroghi et al., 2015 Saxton et al., 2016 Scarbrough et al., 2013 Simsek et al., 2007 Smith & Cao, 2007 Sohn & Kim, 2013 Stephan & Pathak, 2016 Stewart et al., 2008 Sommer et al., 2009</p> <p>T</p> <p>Tang & Wezel, 2015 Tong & Li, 2011 Townsend & Busenitz, 2015 Thornhill, 2006</p> <p>U</p> <p>Ucbasaran, 2008 Uygur & Kim, 2016</p> <p>V</p> <p>Van de Vrande & Vanhaverbeke, 2013 Verreynne et al., 2016 Vrande et al., 2009</p> <p>W</p> <p>Wallace et al., 2010 Welter & Smallbone, 2011 Wennberg et al., 2011 Wiklund et al., 2010 Wiklund et al., 2016 Wiltbank et al. 2006 Wiltbank et al., 2009 Wuebker et al., 2015 Wyrwich et al., 2016 Wu & Knott, 2006</p> <p>Y</p> <p>Yenkey, 2015 York & Venkataraman, 2010 Yu & Lindsay, 2016</p> <p>Z</p> <p>Zacharakis et al., 2007 Zahra et al., 2006 Zander, 2007 Zheng & Mai, 2013 Zott & Amit, 2007 Zott & Huy, 2007</p>
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have conflicting perspectives on how to interpret such information.

Another stream in contemporary entrepreneurship research builds on Garud and Van de Ven's (1992) distinction between ambiguity and uncertainty as the difference between the utility of pursuing certain end goals versus the probability of end goals occurring. Santos and Eisenhardt (2009) define ambiguity as "unknown cause-effect relations and a lack of recurrent, institutionalized patterns of relations and action," and uncertainty as the "inability to predict the probability of specific outcomes." Davis, Eisenhardt, and Bingham (2009) extend this definition of ambiguity as the "lack of clarity such that it is difficult to interpret or distinguish opportunities." They further differentiate environmental ambiguity from related environmental forces such as velocity, complexity, and unpredictability. Rindova, Ferrier, and Wiltbank (2010: 1477) define high ambiguity as creating "... a problem of interpretation because it results from a lack of understanding and/or consensus regarding the applicability of available knowledge." Last, Petkova, Wadhwa, Yao, and Jain (2014: 424) quote Santos and Eisenhardt (2009) directly in their definitions of ambiguity versus uncertainty but emphasize the confusion caused by "multiple interpretations of the meaning, value, and usefulness of new activities, products, and business models." The crucial difference this stream draws between ambiguity and uncertainty centers on the relative effectiveness of organizing strategies to solve different knowledge problems (i.e., searching for information versus creating common interpretive frames and intersubjective agreement).

Much of this second stream of research builds on the work of March (1994: 178), who argues that "ambiguity is related to, but distinguishable from, uncertainty" and that "uncertainty is a limitation on understanding and intelligence. It is reduced through the realizations of history, search, and negotiation." March (1994: 178) also argues that the main idea behind most theories of uncertainty in decision-making is that "... there is a real world that is imperfectly understood." In this sense, March's (1994) perspective resonates with core distinctions between risk and uncertainty in previous entrepreneurship research in that the diffusion of more information over time turns uncertainty into risk. By contrast, though, March (1994: 179) posits that "ambiguity refers to a feature of decision-making in which alternative states are hazily defined or in which they have

multiple meanings, simultaneously opposing interpretations" and that "... (more) information may not resolve misunderstandings of the world... (since) the 'real' world may itself be a product of social construction." Thus, in direct contrast to research that builds on Ellsberg (1961) where uncertainty and ambiguity are conceptualized as the same construct, March (1994) argues that uncertainty is resolved through systematic search, whereas ambiguity can only be resolved through intersubjective agreement.

The locus of uncertainty: Actor or environment?

Construct clarity in uncertainty research is also hampered by a lack of specification of the locus of uncertainty where actors, actions, and environments are all frequently described as "uncertain." At the heart of much of this debate are questions about the "objectivity" and "knowability" of the external environment. Miller (2012):

"Knightian uncertainty goes to objective unknowability, existing in the environment, about potential outcomes and the probability distributions on possible outcomes from actions: these are not knowable *ex ante*. This is distinct from other forms of uncertainty discussed in the management literature, such as 'perceived uncertainty' (Milliken, 1987) or 'adopter-specific uncertainty' (Rogers, 2010), which are both a quality of the individual undertaking an action. These alternative conceptualizations of uncertainty do not address the potential, *ex ante*, understandability of outcomes and probability distributions" (Miller, 2012: 60).

Here, where uncertainty is defined as the "objective unknowability" of the external environment (Miller, 2012), the thrust of much of this research vitiates attempts to predict key outcomes by rendering the environment incomprehensible. Yet, adaptive decision-making processes such as real options reasoning do not always enhance the performance of new ventures in the face of high levels of environmental uncertainty (Podoyntsyna et al., 2013). Others report that various forms of environmental uncertainty (i.e., demand uncertainty) negatively impact key firm-level outcomes such as early-stage capitalization processes (Townsend & Busenitz, 2015). So, although Knightian uncertainty might enable the existence of opportunities, at the same time, it also appears to diminish entrepreneurs' ability to exploit those opportunities successfully (Miller, 2012). In general, much of this research indicates that the locus of uncertainty resides in the

“objective constraints” of environmental uncertainty and exerts a measureable, but largely negative effect on various outcomes associated with entrepreneurial action. Furthermore, this research stream suggests that entrepreneurs who are in a position to receive new information from the environment are able to resolve or mitigate some of the negative effects of environmental uncertainty (Hunt & Song, 2015).

Whereas many articles focus on the objective unknowability of these environments, other research has adopted a subjectivist approach for exploring how entrepreneurs interpret and navigate three different types of uncertainty (Forbes, 2007; McKelvie et al., 2011). This distinction is important as several key articles demonstrate that entrepreneurs display different attitudes toward exogenous (outside the influence of entrepreneurs) versus endogenous (entrepreneurs can influence) sources of uncertainty (Forbes, 2007; Wu & Knott, 2006). When uncertainty is objective and exogenous, uncertainty avoidance reduces the aggregate rate of startup activity and funding patterns across different institutional environments (Li & Zahra, 2012). Subjectivist approaches generally identify three different types of perceived environmental uncertainty—state, effect, and response (Forbes, 2007; McKelvie et al., 2011; Milliken, 1987). In the original framework, Milliken (1987) defines state uncertainty as the difficulty of predicting how an environment is changing. Effect uncertainty addresses the difficulty of understanding how these changes will impact the individual or firm. Response uncertainty refers to the difficulty in understanding the consequences of one’s action. Each of these different types of perceived uncertainty impact entrepreneurs differently and require different types of information to resolve (McKelvie et al., 2011).

Although this line of inquiry is still early stage within the entrepreneurship literature, these distinctions are important because recent research indicates that state uncertainty (perceived environmental uncertainty) does not influence the willingness of entrepreneurs to engage directly in entrepreneurial action (McKelvie et al., 2011). These results are generally consistent with previous research on biases and heuristics in entrepreneurship decision-making, namely, entrepreneurs do not always perceive or acknowledge the “objective uncertainties” in the external environment before taking action (Busenitz, 1996; Busenitz & Barney,

1997; McMullen & Kier, 2016). Present research also supports such a conjecture as both heuristics and analogical reasoning equip entrepreneurs to contend with uncertainties faced by entrepreneurs attempting to internationalize their ventures (Jones & Casuli, 2014). In summary, individual-level theories of uncertainty generally suggest that perceived effect uncertainty (i.e., perceived uncertainties about the effects of uncertainty on the entrepreneur/firm) exerts a negative effect on the willingness of entrepreneurs to engage in entrepreneurial action (McKelvie et al., 2011).

The role of entrepreneurial action in resolving uncertainty. Contemporary entrepreneurial action research also has developed a rich body of literature on the role of cognitive and action-formation mechanisms under various environmental conditions. Effectuation theory (Sarasvathy, 2001), bricolage theory (Baker & Nelson, 2005), and social capital and network theories (Dushnitsky & Lavie, 2010; Hughes et al., 2014) all represent vibrant streams of research focused on exploring how entrepreneurs take action within various environments. Much of this research on the role of action-formation mechanisms is anchored in either general conceptualizations of the environment (i.e., constructing resources in resource-constrained environments in bricolage research—Baker & Nelson, 2005) or co-creating artifacts and taking action in environments involving multiple uncertainties (Sarasvathy, 2008). In each of these cases, entrepreneurs are assumed to hold a high degree of agency both in responding to the constraints of the environment and in enacting various organizing mechanisms.

Effectuation theory (Dew et al., 2015; Sarasvathy, 2001) emphasizes the use of control strategies and the co-creation of social artifacts by expert entrepreneurs in the face of Knightian uncertainty while eschewing the use of predictive strategies due to the unknowability of the future environment. A wide variety of studies have demonstrated the usefulness of such strategies and organizing mechanisms (Davis et al., 2009). Yet, contemporary research on entrepreneurial action under conditions of uncertainty generally suggests that perceived effect uncertainty (i.e., perceived uncertainties about the effects of uncertainty on the entrepreneur/firm) exerts a negative effect on entrepreneurial action (McKelvie et al., 2011). On this point, this research notes that these results appear to conflict with the core tenets of effectuation theory in regard to how outcome uncertainties impact entrepreneurial action. In response, several articles based in effectuation

theory suggest that the superior pattern matching skills of expert entrepreneurs enable them to not just contend with but to capitalize on opportunities in uncertain environments (Dew et al., 2015). Kuechle et al. (2016) suggest that this is because expert entrepreneurs endeavor to seek control of elements within uncertain environments versus attempting to try to predict outcomes. For a fuller and more up-to-date review of this literature stream, see Dew et al. (2015).

Although important, this debate leaves several important questions unanswered. First, despite the willingness of expert entrepreneurs to use control strategies to engage in entrepreneurial action, how might such control strategies be enacted in the face of uncertainties regarding the external consequences of such actions? Garud, Gehman, and Giuliani (2014) contend that “projective stories” designed to set audience expectations often set the firm up to disappoint audiences, given that “inherent objective environmental uncertainties” will force entrepreneurs to adapt miscalibrated plans (Hunt, 2015; Hunt & Lerner, 2012). In other words, despite attempts to socially construct appealing narratives designed to solicit stakeholder approval and engagement (i.e., a control strategy—Garud, Hardy, & Maguire, 2007), the objective environment will still influence the outcomes of entrepreneurial action. For these reasons, perhaps entrepreneurs use multiple logics over time while engaging in entrepreneurial action?

A related stream of research, concerning the processes of social negotiation, explores the ways in which entrepreneurs rely on key levers of social influence, such as empathic accuracy (McMullen, 2015), political skill (Comanys & McMullen, 2007), and/or social skill (Fligstein, 1997) to encourage cooperative behaviors (Dorado, 2005; McMullen, 2010) when mobilizing the collective action needed for institutional innovation and change (Battilana, Leca, & Boxenbaum, 2009; Garud et al., 2007; Hargrave & Van de Ven, 2006). This process of social negotiation—the essence of which Davidson (2001) referred to as “intersubjective agreement”—results in new goals and actions, each of which is made possible by an enlarged pool of resources resulting from the discovery of mutually desirable ends. So, although research in this line of inquiry is still emerging, such articles do provide unique insights into the role of entrepreneurial action in shaping environmental or institutional change through actor-provoked attempts to

resolve uncertainty (Henfridsson & Youngjin, 2014; Sarasvathy, 2008).

Aggregation problems in the emergence of uncertainty. Contemporary research on the nexus of uncertainty and entrepreneurial action is also complicated by the fact that some of the “entrepreneur’s decisions effectively shape the future environment” (Basili & Zappia, 2010: 450). Not only are socially constructed decision environments not solvable *a priori* but also the evolution of these environments is influenced by entrepreneurial action—whether individual or collective (McGrath, 1999). The emphasis in these environments is not just to diagnose the structural features accurately but also to extend understanding regarding how one’s actions might be aggregated into a set of collective choices made by a variety of actors that ultimately influence how these environments evolve and change (Cope, 2011). In these cases, the critical information that is needed to solve the underlying knowledge problem will not exist before action being taken (McGrath et al., 2004). Nor can individual actors always predict or comprehend how their micro-level actions will aggregate across the environment (Acs, Braunerhjelm, Audretsch, & Carlsson, 2009; Agarwal, Audretsch, & Sarkar, 2010). In certain situations, entrepreneurs might narrow the decision space by trying to create partial solutions through intersubjective agreement, which can yield partial solutions, but because these decision environments are a product of social construction, they are not, by nature, predictable in advance of the entrepreneur taking action. They are, however, susceptible to the influences of individual and collective action (Sarasvathy, 2001; Dew & Sarasvathy, 2007).

At the same time, the transformative impact of entrepreneurial action in uncertain environments is primarily a tail-driven phenomenon where power-law distributions of market returns aggregate to just a few winners (Crawford, Aguinis, Lichtenstein, & Davidsson, 2015). Under these circumstances, there is a temptation to attribute these extreme outcomes in theories of entrepreneurial action to the prescient, heroic actions of individual entrepreneurs or teams (Williams & Nadin, 2013). Socioeconomic transformation, it seems, is the inevitable outcome of the actions of highly skilled, expert entrepreneurs who possess an almost omniscient view of markets and industries (Brouwer, 2002). Entrepreneurs fill an economic role that is highly similar to that of the

mythical hero (McMullen, 2017), but this observation highlights just how little we know about the role of entrepreneurial action in uncertain environments, especially when one considers that only about 6 percent of the articles we reviewed explored the cross-level, transformative impact of entrepreneurial action on external environments. Thus, much more research is needed to build a robust micro-to-macro theory in entrepreneurship research.

DISCUSSION AND OPPORTUNITIES FOR FUTURE RESEARCH

As the foregoing review reveals, uncertainty continues to be a problematic construct in contemporary research. Although scholars have addressed some sources of conflation and confusion since Knight's articulation of the risk-uncertainty bifurcation (Camerer & Weber, 1992; Hey et al., 2010), our review of contemporary entrepreneurship literature indicates that the uncertainty construct remains subject to overuse and misuse, especially when used to refer to all manner of unknowingness (Downey, Hellriegel, & Slocum, 1975). Certainly, in some contemporary research, many instances of unknowingness are aptly characterized as uncertainty, in precisely the fashion that Knight originally conceived; other instances involve risk rather than uncertainty because some measure of probability can be assigned to the potential outcomes. Still others, however, defy simple categorization as either uncertainty or risk.

As noted from the outset, a knowledge problem is any decision-making state in which the decision-maker has moved past ignorance—that is, he or she possesses at least some minimal awareness that a decision, judgment, prediction, observation, or assessment must be made—but the individual does not possess certitude regarding either the relevant factors or likely consequences of action. When this occurs, there exists a state of unknowingness. Such conditions reign supreme within the entrepreneurial context and, in some sense, are necessary for the existence of entrepreneurial opportunities (McMullen & Shepherd, 2006). Yet, although uncertainty is essential to an understanding of management and organizational decision-making, it loses its meaning and value when it is used to refer to the entire landscape of informational contexts lying between ignorance

and incontrovertible fact. Therefore, given the central role and extraordinarily nuanced role of unknowingness to entrepreneurial action, the need for better definitions and greater precision are clearly indicated.

Recent work by Packard et al. (2017) takes steps to address these issues by attempting to expand the multi-dimensionality of Knightian uncertainty to cover multiple states of unknowingness while underscoring the continuous and dynamic nature of decision-making under uncertainty: "Over time, entrepreneurs face different uncertainties as decisions are made, new information is obtained, and the entrepreneur or environment changes. As a result, entrepreneurial judgments are regularly revisited, renewed, and revised" (2017: 1). These are important considerations and further disaggregation of the uncertainty construct into more nuanced categories is a welcome development. Yet, such a textured typology of uncertainty runs the risk of conflating the decision rules, logics, and inherent problems posed by different states of unknowingness. This is because there is not a "spectrum of uncertainty" but rather a "spectrum of unknowingness"—ranging from ignorance to certitude—some portion of which involves the problem of uncertainty. The remainder is comprised of other knowledge problems, each of which uses a distinct decision rule and logic, and poses a distinct decision problem for entrepreneurial actors. In particular, in our review, we have identified three sources of unknowingness that have been consistently and errantly subsumed by conceptions of uncertainty in contemporary entrepreneurial action research: complexity, ambiguity, and equivocality. In the following sections, we will describe these three additional knowledge problems and discuss key boundary conditions surrounding each knowledge problem and how this more nuanced approach to knowledge problems enriches and extends entrepreneurial action theory.

Uncertainty as One among Many Knowledge Problems

Regardless of whether unknowingness manifests as ambiguity, complexity, equivocality, or uncertainty, or even various combinations of these four knowledge problems, the multi-dimensional nature of unknowingness will remain a persistent confound until definitions and empirical operationalizations are more precisely articulated in contemporary entrepreneurial

action research. The commonplace practice of defining one knowledge problem in terms of the others fails to meet the minimum standard of disambiguation (Stevenson & Wilks, 2003). The price tag for this imprecision and conflation is stymied progress in understanding the nexus between actors and their respective environments. Most of human judgment and decision-making is influenced by informational assumptions that fall somewhere between ignorance and certainty, consisting of neither pure ignorance, nor pure certainty. Yet, approaches to unknowingness that label this entire region “uncertainty” or that categorize all knowledge problems as a subset of uncertainty fail to provide a substantive basis for the consideration of human action. As the foregoing discussion reveals, unknowingness takes various forms, each of which involves different decision-making processes and entrepreneurial actions. Because entrepreneurial action depends on the presence of unknowingness for opportunities to be discovered (Kirzner, 1997; Shane & Venkataraman, 2000), created (Alvarez & Barney, 2007), effectuated (Sarasvathy, 2001), or imagined (Klein, 2008), well-intended uses of knowledge problems that suffer from conflation tend to obfuscate the nature and importance of the impediments to entrepreneurial action. So, although the risk-uncertainty bifurcation is sound, the unintended consequence is that entrepreneurial action research since 1921 has viewed uncertainty as a synonym for unknowingness and as a catchall for any set of conditions in which no probability distribution can be generated for the set of possible outcomes.

Furthermore, despite the shared search for socially and semantically appropriate decision logics, knowledge taxonomies that situate knowledge problems as subgroups underneath uncertainty (e.g., Kahneman & Tversky, 1982; Lytras & Pouloudi, 2006; Smithson, 2008) miss important facets of the causes and cures of unknowingness that are unique to each of the knowledge problems. For example, Daft, Lengel, and Trevino (1987: 359) argued that equivocality differs quite markedly from uncertainty in that “no certain answers exist and perhaps the right questions have yet to be formulated.” Ambiguity and equivocality, unlike uncertainty, involve the absence of factual answers (Murphy & Pinelli, 1994), whereas complexity involves a state of unknowingness that is constrained by the need to discover effective tools to address massive volumes and vexing convolutions (Zack, 1999). In these cases, the appropriate decision rules

and logics as well as the likely impact of entrepreneurial action on resolving these problems differ considerably based on the epistemic differences in each type of knowledge problem. Taxonomic classifications that attempt to subordinate complexity, ambiguity, and equivocality under uncertainty (Lytras & Pouloudi, 2006; Smithson, 2008), rather than situating uncertainty as one of myriad knowledge problems, result in addled conceptions of knowledge problems, methods, and solutions.

Ambiguity. *Ambiguity* refers to what Weick calls the collapse of sensemaking, the conditions that emerge when people suddenly feel that the world is no longer constituted as a rational, orderly system (Weick, 1995). “Ambiguity refers to features of decision environments in which alternative states are hazily defined or in which they have multiple meanings” and that “...the ‘real’ world may itself be a product of social construction” (March, 1994: 179). In both cases, uncertainty and ambiguity might be solved by including more information (March, 1994; Weick, 2015) but differ based on whether the decision environment is objective versus socially constructed (March, 1994). To this point, uncertainty can be resolved by searching for additional information in the world, whereas ambiguity is solved through the construction of intersubjective agreement.

Ambiguity is a central topic of inquiry in the decision theories of both economics and organization theory. In the economics literature, research on ambiguity emerged from the criticisms concerning the application of probabilistic reasoning in decision theory (i.e., Savage, 1951) and criticisms of Knight’s distinction between risk and uncertainty (1921). Although entrepreneurship researchers largely assume that mentions of Knightian uncertainty refer to something closely akin to Venkataraman’s (1997: 124) “a fundamental uncertainty that cannot be insured against or diversified away,” decision theorists in economics equate Knightian uncertainty with ambiguity (Fox & Tversky, 1995). For example, Holm, Opper, and Nee (2013: 1672) define risk and ambiguity as a nonstrategic form of uncertainty where outcomes are not contingent upon the actions of entrepreneurs. Essentially, ambiguity is defined as decision environments where actors possess information about potential consequences of their decision, but lack information to specify the probabilities of these various outcomes (Holm et al., 2013). Such ambiguities may remain high even when there is an abundance of information if questions remain about the reliability of

key information or if there are conflicting interpretations of such data (Ellsberg, 1961).

In organization theory, despite the tendency to conflate ambiguity with various other knowledge problems, scholars' emphasis on the subjectivist nature of ambiguity is a cornerstone of behavioral approaches to decision theory. For example, March and Olsen (1976) argue that ambiguity arises from "...goals that are unclear, technologies that are imperfectly understood, histories that are difficult to interpret, and (because of) participants who wander in and out" (Cohen, March, & Olsen, 1972: 8). Ambiguity is also a central facet of Weick's theory of sensemaking and organization (1979; 2001). Following McCasky (1982) and March and Olsen (1976), Weick (2001) identifies a broad set of factors that create ambiguity. Generally, these factors are derived from unclear problems, conflicting values and goals, or limited understanding of cause-effect relationships. Garud and Van de Ven (1992: 95) adopt a slightly different perspective than Weick and argue that in the context of corporate entrepreneurship, uncertainty "implies imperfect knowledge about causal relationships between means and ends," whereas ambiguity exists when entrepreneurs are unclear about which ends are worth pursuing.

Out of all of the other knowledge problems discussed in entrepreneurial action research, uncertainty is most often confused with ambiguity in the articles reviewed in this study. This conflation, in turn, perpetuates a variety of maladies, including a lack of definitional clarity and construct boundaries, and questions about the microfoundations of entrepreneurial actions to contend with and resolve ambiguity. In recent years, interest has grown among scholars to differentiate ambiguity from other related knowledge problems (Alvarez & Barney, 2010; Davis et al., 2009; Maitlis & Christianson, 2014), and to explore the role and resolution of ambiguity through entrepreneurial action (Rindova et al., 2010; Santos & Eisenhardt, 2009). Ironically, this attempt to draw a distinction between uncertainty and ambiguity collides with still another oft-conflated knowledge problem, equivocality.

Equivocality

Equivocality refers to knowledge problems stemming from the existence of multiple meanings or interpretations (Daft & Macintosh, 1981). Although

often conflated with ambiguity, equivocality is a distinct condition because each interpretation is individually unambiguous, but collectively, the interpretations differ. In fact, the competing conceptions of reality that characterize equivocality are often either mutually exclusive or in conflict (Daft & Weick, 1984; Weick, 1995). Equivocality is a condition for which individuals and firms do not suffer for want of more information. No amount of new information has the capacity to resolve equivocality, thereby radically differentiating it from uncertainty, for which there is an unquenchable pursuit for clarifying information in the greatest achievable quantity. In fact, additional information only serves to exacerbate equivocality into isotropy, making it virtually impossible to decipher which data are relevant and which not in any given decision or action situation (Saravathy and Dew, 2005).

High equivocality implies confusion. "The key problem in an equivocal situation," wrote Frishammar, Florén, and Wincent (2011:553), "is not that the real world is imperfectly understood and that additional information will render it understandable; instead, the problem is that additional information may not actually resolve misunderstandings." The prototypical decision-maker confronting equivocal circumstances—the Weickian sensemaker (1995)—faces too many meanings, not too few, so that the problem is not ignorance but rather confusion.

By definition, equivocal situations have no objective answers (Weick, 1979). Instead, equivocality is characterized by multi-sided contests to define reality (Daft & Weick, 1984). Important historical examples of equivocality are numerous, including vigorous debates over social Darwinism and eugenics (Hofstadter, 1944), and disputes over the scientific foundations of second-hand smoke carcinogenicity (Ong & Glantz, 2000), lead in drinking water (Reiman & Banks, 2004), and the global warming effects of greenhouse gases (Bastianoni, Pulselli, & Tiezzi, 2004). Recent industrial examples of equivocal circumstances include the ongoing battle to define commercializable parameters of cloud computing (Armbrust et al., 2010), education (Ball, 2013), cyber-security (Byres & Lowe, 2004; Choo, 2011) and nano-scale technologies (Baird, Nordmann, & Schummer, 2004).

Entrepreneurship has largely ignored the challenges posed by equivocality to theories of entrepreneurial action. Apart from a few textual citations, equivocality remains an underexplored decision environment and ill-defined impediment to entrepreneurial action. The one notable exception comes

from Gartner, Bird, and Starr (1992), who explore the behaviors and actions of entrepreneurs. Specifically, they argue as follows:

“Emerging organizations are thoroughly equivocal realities (Weick, 1979) that tend toward non-equivocality through entrepreneurial action. In emerging organizations, entrepreneurs offer plausible explanations of current and future equivocal events as non-equivocal interpretations. Entrepreneurs talk and act ‘as if’ equivocal events were non-equivocal. Emerging organizations are elaborate fictions of proposed possible future states of existence. In the context of the emerging organization, action is taken in expectation of a non-equivocal event occurring in the future. . . . An emerging business is embedded in an equivocal reality where the possible results of specific actions taken in the present can only have assumed future consequences” (Gartner et al., 1992: 17–18).

Gartner et al. (1992) further argue that the almost infinite range of behaviors available to entrepreneurs reflect a significant degree of equivocality in many decision environments. Over time, the emergence of specific decision environments might calcify around certain normative assumptions, but the exact role of emergent organizing processes in resolving equivocality remains an open question, as does its discrete differentiation from the uncertainty construct. Thus, Gartner et al. (1992: 19) contention that “(g)iven the equivocal nature of the process of emergence. . . the phenomenon of organization emergence has yet to be specified in a comprehensive manner” remains both apt and prescient regarding entrepreneurial action research in equivocal decision environments.

However, since 1992, only a 2011 AMR article by Navis and Glynn has journeyed significantly into the relationship between equivocality and entrepreneurship. In their study of entrepreneurial identities propounded by new ventures and the sensemaking undertaken by potential investors, Navis and Glynn develop a framework that positions institutional primes and equivocal cues as the building blocks on which investors interpret entrepreneurial identities (2011). Their insight is that the combined force of institutional primes and equivocal cues create the means through which the legitimate distinctiveness of market opportunities is confirmed or denied. The cues are considered “equivocal” precisely because “the existence of ‘numerous or disputed interpretations’ (Powell & Colyvas, 2008: 283) precipitates the search for meaning and certainty (Weick, Sutcliffe, & Obstfeld, 2005: 414)” (Navis & Glynn, 2011: 488).

More recently, Maitlis and Christianson (2014) undertook a panoramic treatment of sensemaking. Although their treatment was not framed by an examination of the entrepreneurship context, like Navis and Glynn (2011), they recognize the importance of equivocal cues in eliciting senseseeking and sensemaking actions. The subtext to these more recent treatments is that equivocality constitutes a relatively untapped source of fresh insights about when and how innovators and society interact to adjudicate the fate of novel goods and services. Effectuation theory (Sarasvathy, 2001) functionally aims to convey the same point, although it does so without explicitly invoking the equivocality construct. Instead, Sarasvathy and Dew (2005: 539) explore the problem of isotropy defined as “. . . the fact that in decisions and actions involving uncertain future consequences it is not always clear *ex ante* which pieces of information are worth paying attention to and which not” (Fodor, 1987). The resolution to isotropy in effectuation is provided by commitments from self-selected stakeholders to particular courses of action, each of which aims to shape, influence, and co-create the environment rather than derive justification from it. This could arguably be seen as consistent with Weick’s premise that the only viable response to equivocality is itself equivocality (Weick, 1979).

Complexity

Complexity knowledge problems emanate from a combination of detail complexity, which is the multiplicity of variables involved in a problem, and from dynamic complexity, which is the multiplicity of the interactions that occur between these variables over time (Simon, 1959; Zack, 1999). Complexity research is a vibrant area of inquiry within several fields in organizational research. Of these fields, research on institutional complexity (Greenwood, Raynard, Kodeih, Micelotta, & Lounsbury, 2011), managing complex knowledge within organizations (Kogut & Zander, 1992; Tsoukas, 2005) or across interorganizational networks (Reagans & McEvily, 2003), or even research on managing complex strategic actions and responses to establish or maintain competitive advantages (Barney, 1991; Rivkin, 2000) remain important areas of organizational research. The rapid rise of research exploring systems dynamics and complexity science is a testament to the central importance of these perspectives across a variety of scientific fields (Benbya & McKelvey, 2006; Macy & Willer, 2002; Page, 2015; Wolfram, 2002).

Complexity research in the field of entrepreneurship has been led for decades by a cadre of scholars who have explored the role of complexity and systems dynamics in shaping organizational emergence (Gartner et al., 1992; Katz & Gartner, 1988; Lichtenstein, Carter, Dooley, & Gartner, 2007; Tornikoski & Newbert, 2007). The inherent nonlinearity of complex systems has made this line of inquiry attractive to many entrepreneurship scholars to provide models of organizational emergence and environmental change (Schindehutte & Morris, 2009; Uhl-Bien, Marion, & McKelvey, 2007). Despite the depth and intellectual importance of this research, recent evidence suggests that important outcomes in entrepreneurship are best characterized as power-law distributions where “average” returns are heavily influenced by relatively rare, alpha-tail events (Crawford et al., 2015). Such patterns suggest the need to develop new theories of entrepreneurial action and entrepreneurship (Crawford et al., 2015) across a variety of subfields within entrepreneurship such as social entrepreneurship (Dorado & Ventresca, 2013), entrepreneurial finance (Drover et al., 2017), new venture creation, and processes of organizational emergence (Lichtenstein, Dooley, & Lumpkin, 2006), among many other areas.

Yet, present research on the inherent knowledge problems associated with entrepreneurial action in complex environments remains sparse as uncertainty has been stretched to try to address aspects of unknowingness that are better conceptualized as complexity. In present entrepreneurship research, complexity is defined as the “heterogeneity and range of factors that have to be taken into account” (Clarysse et al., 2011: 140). In this sense, complex environments are thought to be difficult for entrepreneurs to compete within because they invoke an inability to identify all of the relevant factors that might influence the actions of the entrepreneurs and because they pose inherent difficulties for determining how these factors will interact (Clarysse et al., 2011). Davis et al. (2009: 420) define environmental complexity as “the number of opportunity contingencies that must (be) addressed successfully.”

Murky distinctions between uncertainty and complexity complicate research into the emergent, interrelated subsystems of entrepreneurial action—for example, sensemaking interactions among entrepreneurs, stakeholders, firms, and markets (Selden and Fletcher, 2015)—and the micro-foundational impacts of complexity on entrepreneurial action (Clarysse et al., 2011; Jones & Casulli, 2014; Palmié et al., 2016; Shepherd, 2011). For example, at the

individual level of analysis, one of the key lines of inquiry in present research explores how cognitive complexity (Malmström et al., 2015), belief structures (Kiss & Barr, 2015), and other cognitive factors impact entrepreneurial decision-making (Garrett & Holland, 2015).

In certain cases, “practicing analogical reasoning over many novel and complex problems increases reasoning capability” (Jones and Casulli, 2014:55) and simplifying heuristics ostensibly create the simple rules used to guide entrepreneurial action in complex environments (Davis et al., 2009; Eisenhardt, 2013; Sull & Eisenhardt, 2015). The difficulty is that scholarly recommendations for decision-making in the context of high-velocity, nascent-stage venturing similarly prescribe analogical reasoning and pattern matching for ambiguous, equivocal, and uncertain conditions, as well. When small initial differences between decision environments can generate massive differences in performance and survival outcomes (Crawford et al., 2015), definitional distinctions between knowledge problems take on added significance.

Establishing Boundary Conditions among Entrepreneurial Knowledge Problems

If construct conflation with uncertainty and other knowledge problems across the landscape of unknowingness is the problem, then careful boundary setting is the solution. Although colloquial and scholarly usage of the four knowledge problems has often exacerbated the fuzzy boundaries and rampant misuse, there are key points of differentiation. Table 3 builds on the findings of our review of foundational and contemporary literature by incorporating the new insights and highlighting a more complete set of factors that differentiate the four knowledge problems from one another—namely, the decision rule, the decision logic, and the nature of the knowledge problem. We will outline these boundary conditions in more detail in the following paragraphs.

Structure of decision rules. First, knowledge problems can be differentiated based on the typical structure of the decision rules that reflect the role of information or the steps taken to resolve the knowledge problem.³ For example, March (1994: 178)

³ Our intent with discussing the structure of the decision rules is not to imply that these decisions are rational choices but rather we simply wish to identify the key epistemological problems each type of knowledge problem addresses.

TABLE 3
Boundary Conditions among Entrepreneur Knowledge Problems

	Uncertainty	Complexity	Ambiguity	Equivocality
Structure of typical decision rule	Can action X cause outcome Y? (Is there a rule that $X \rightarrow Y$?)	Do actions X1 or X2 cause outcome Y? (Does $X1 * X2$ change the first-order rules that $X1 \rightarrow Y$ or $X2 \rightarrow Y$?)	Does action X cause outcome Y in situation Z? (Does the rule $X \rightarrow Y$ apply in situation Z?)	Which action, X1 or X2, should I take to produce outcome Y given what I know about situation Z? (Which rule, $X1 \rightarrow Y$ or $X2 \rightarrow Y$, applies in situation Z?)
Decision logic	Decision environment: probabilistic Logic of consequence Question about whether cause-effect or if-then rule exists Is the technical relationship between action and outcome understood?	Decision environment: probabilistic Logic of consequence Question about whether cause-effect or if-then rule exists Is the technical relationship between action and outcome understood?	Decision environment: vague Logic of appropriateness Question about when application of cause-effect or if-then rule is justified Is the situational appropriateness of the relationship between action and outcome understood?	Decision environment: vague Logic of appropriateness Question about when application of cause-effect or if-then rule is justified Is the situational appropriateness of the relationship between action and outcome understood?
Role of entrepreneurial action in resolving decision problem	Decisions concerning actions in isolation The actor knows the question being asked, the rule being considered, and thus how to interpret the data such that data constitute information. Thus, the discovery of critical data through entrepreneurial action will resolve the knowledge problem.	Decisions concerning actions in comparison The actor is confronted by multiple questions and decision rules. As a result, how to interpret the data is not clear such that data do not equal information. Thus, the discovery of more data through entrepreneurial action complicates the scope of relevant information and degrades decision-making accuracy.	Decisions concerning actions in isolation The actor knows the question being asked, the rule being considered, and thus how to interpret the data such that data constitute information. Thus, the creation or generation of critical data through entrepreneurial action will resolve the knowledge problem.	Decisions concerning actions in comparison The actor is confronted by multiple questions and decision rules. As a result, how to interpret the data is not clear such that data do not equal information. Thus, the creation or generation of more data through entrepreneurial action complicates the scope of relevant information and degrades decision-making accuracy.

asserts that the main idea behind uncertainty is that "...there is a real world that is imperfectly understood," whereas "ambiguity refers to feature of decision-making in which alternative states are hazily defined or in which they have multiple meanings ... (since) the 'real' world may itself be a product of social construction." For a decision rule, actors resolve uncertainty by collecting information to confirm whether action X causes outcome Y. For ambiguity, however, the socially constructed nature of the world implies that action X only causes outcome Y under a specific set of Z (social/intersubjective) conditions. By contrast, the decision rule under conditions of complexity addresses the potential for nonlinear interactions among the decision criteria to explore the extent to which "...interactions produce higher order structures (self-organization) and functionalities (emergence)" (Page, 2015: 22). These higher order outcomes derived from the interactions among key decision criteria produce the nonlinearities that thwart attempts by entrepreneurs to estimate key outcomes. Furthermore, as we noted earlier, complexity knowledge problems are often exacerbated by inclusion of new information. Hayek (1945), Taleb (2007), among others, discuss the inherent futility of attempting to compute the probabilistic outcomes of complex environments. No new information will resolve such complex computations. As such, much of the present research on operating in complex environments emphasizes the importance of fast and simple rules. On the other hand, both ambiguity and uncertainty can be resolved by gathering more information but differ based on whether this additional information improves the predictability of outcome probabilities (uncertainty) or improves the predictability of outcome preferences (ambiguities). Importantly, so when March (1994) argues that ambiguity cannot be solved by gathering more information, he is arguing that the predictability of ambiguous preferences is not resolved through search, but can be solved through imagination and through the development of intersubjective agreement.

Decision logic. Knowledge problems can also be differentiated based on the types of decision logic used to resolve the underlying problems. Specifically, uncertainty and complexity use a logic of consequences, whereas ambiguity and equivocality use a logic of appropriateness. According to March (1994: 2), the logic of consequences refers to decisions that are "...consequential in the sense that action depends on anticipations of the future effects of future actions." In the case of action under conditions of uncertainty, concern with the future

consequences of action often stimulates search or incremental processes of action (McKelvie et al., 2011). Under conditions of complexity, entrepreneurial action involves simplifying the decision environment to minimize the challenges of comprehending the dynamic interactions of factors in the decision environment. Conversely, ambiguity often invokes a logic of appropriateness in that the "reasoning process is one of establishing identifies and matching rules to recognized situations." In ambiguous and equivocal situations, unclear preferences invoke identity claims and other interpretive frames to establish a basis for the outcome preferences.

Role of entrepreneurial action. Last, these knowledge problems invoke different conceptualizations of the role of entrepreneurial agency and action in resolving each knowledge problem. In the case of uncertainty, although the outcome probabilities based in the functioning of the real world are likely not influenced directly by the actions of the entrepreneur, undertaking more systematic search processes to discover additional relevant information will enable entrepreneurs to resolve uncertainty. Emergent processes in complex environments limit the extent to which entrepreneurial actions shape the external environment once the interactive complexity of the environment begins to control the processes of change. Under these conditions, more data do not always equate to more information—especially when these data produce nonlinear outcomes. For ambiguity, the factors suggest that actions taken by entrepreneurs to bracket or frame the external environment can enable the development of intersubjective consensus. Because these environments are the product of social construction, entrepreneurial actions that generate these intersubjective agreements can shape these environments. Finally, although the knowledge problems in equivocal environments are exacerbated by the inclusion of the new information, these environments are also the product of social construction and thus are influenced by the actions taken by entrepreneurs to produce intersubjective agreement (Dew, Velamuri, & Venkataraman, 2004). In these cases, proactive framing strategies or political maneuvering can help ensure that desired outcomes are achieved through entrepreneurial action (Santos & Eisenhardt, 2009).

Opportunities for Future Research

It is clear from our review that despite the breadth of present research on knowledge problems and entrepreneurial action, numerous gaps remain in our

understanding of the role entrepreneurial action plays in resolving each of the knowledge problems. In this section, we outline several of the opportunities for future research. Although a complete list of these opportunities is beyond the scope of this article, our intention here is to highlight a few intriguing avenues for further inquiry.

Misdiagnosis of knowledge problems. One of the major implications of this review is that entrepreneurs face a more pluralistic set of environments than is typically imagined in the Knightian universe of risk and uncertainty. Because these environments operate under different decision logics (i.e., logic of consequences versus logic of appropriateness) and are impacted differentially by information (i.e., more information helps resolve uncertainty/ambiguity while more information exacerbates complexity and equivocality), the misdiagnosis of a knowledge problem and the resulting actions taken by entrepreneurs to resolve these problems hold major significance concerning the relative effectiveness of organizing mechanisms used by entrepreneurs. For example, one of the important contributions of effectuation research to theories of entrepreneurial action is the comparative emphasis on using social artifacts to provide interpretive frames for environments characterized by Knightian uncertainty (Sarasvathy & Kotha, 2001). Under ambiguity, these artifacts at least partially enable entrepreneurs to socially construct elements of their operating environment and to operate “as-if” the venture possesses legitimacy (Gartner et al., 1992; Wiltbank et al., 2006). What is less known is whether such strategies enable or constrain entrepreneurial action in complex environments.

In a sense, complex environments present some of the same challenges effectuation is designed to address as the problem of emergence in complex environments often prevents effective forecasting or prediction (Fisher, 2012; Read, Dew, Sarasvathy, Song, & Wiltbank, 2009). At the same time, it remains to be seen whether organizing around the resources/means currently controlled by the entrepreneurs would facilitate effective action in complex environments. The evolution of complex environments is strongly influenced by initial, local conditions (Aldrich & Martinez, 2001; Mainela & Puhakka, 2009; Miller, 1983), but ultimately these tend to change, often in unexpected ways. Although strategies exist for “making do with the resources at hand,” (Baker, Miner, & Eesley, 2003) there is no guarantee that such actions will enhance the firm’s long-term effectiveness, particularly if precious resources are

channeled toward combatting the wrong knowledge problem.

Consistent with this point, Davis et al. (2009) use the tools of analytical theory to demonstrate the varying influences of situational mechanisms on the organizing strategies of firms as they are embedded in different environments. The authors demonstrate that ambiguous and complex environments exert distinct influences on the organizing strategies of firms and that in the case of ambiguity, these organizing strategies often yield mediocre long-term performance. These studies effectively demonstrate the influence of situational mechanisms on firm organizing decisions, but extant research has yet to take the additional step of addressing whether and how a mismatch between the perceived knowledge problem and the actual knowledge problem influences the entrepreneur’s long-term prospects. An entrepreneur who applies the logic of consequences, when perceiving uncertainty, would be at odds with the prevailing knowledge problem impediment if the actual environmental conditions were ambiguous, a condition that functions in accordance with the logic of appropriateness. Such a mismatch could foster a dogmatic approach to market entry prospects for a novel business model, rather than a facilitative approach that embraces a social constructive perspective of shared discovery, an approach that may be more conducive to resolving the ambiguous environmental conditions, as opposed to the uncertain conditions perceived by the entrepreneur.

Among the knowledge problems elaborated in this review, there are 16 possible pairings between the knowledge problem that an entrepreneur perceives and the knowledge problem that actually exists. Only four of these pairings will produce alignment between the perceived and actual knowledge problems. For example, an entrepreneur pursuing an opportunity may perceive environmental conditions to be ambiguous when in fact they are ambiguous. Under these circumstances, the entrepreneur’s organizing efforts to apply the logic of appropriateness and the pursuit of more information are aligned with the environmental realities. Similarly, perceived versus actual pairings of complex–complex, equivocal–equivocal, and uncertain–uncertain exhibit alignment between the knowledge problem impediments and the entrepreneur’s organizing action. However, the other 12 pairings involve misalignment; for example, perceived ambiguity versus actual uncertainty. In these 12 instances, the perceptions and organizing activities of entrepreneurs are not congruent with the knowledge problem impediments posed by

the operating environment. For scholars, unchaining extant theories of opportunity pursuit from both the overly broad application of Knightian uncertainty and the overly narrow conception of knowledge problems opens the door to new theory and new empirical pathways regarding the questions of when, why, and how ventures succeed or fail in their efforts to achieve market acceptance.

The price tag for misdiagnosing the environment can be high. For example, from 2008 to 2015, Hewlett-Packard acquired 20 businesses, costing more than \$45 billion, in its effort to establish market relevance in information management, networking, and cloud computing software. The acquisitions were driven by Hewlett-Packard's perception that the emerging opportunities in hybrid cloud services constituted a complex knowledge problem, just as its corporate culture had influenced and directed the firm for 70 years (Kotter, 2008). In fact, however, the operating environment for cloud services throughout this era was more reflective of equivocality, conditions in which competing conceptions of cloud computing's future were still playing out. The logic of appropriateness was far more relevant to the conditions than were the tool-building and brute force problem-solving approaches that characterize the logic of consequences, wherein the end point is well understood, but the pathway requires development. The misalignment between perceived complexity and actual equivocality proved costly to Hewlett-Packard. In time, some \$20 billion was eventually written off as a permanent loss due to asset impairment (Darrow, 2016).

Additional research to explore how knowledge problem "misdiagnoses" occur and to what end could provide important insights for scholars seeking to establish a firmer foundation for the articulation of transformative mechanisms that are more conducive to multi-level analysis. It would also be interesting to see if the effects of some knowledge problem mismatches wield a more potent influence than others. Some misdiagnoses may be "merely" costly, whereas others may prove to be fatal.

The multi-level, multi-dimensional, multi-temporal nature of knowledge problems. Further compounding the challenges of knowledge problem "diagnosis" is the reality that knowledge problems are not "well-behaved" confounds insofar as they are constantly evolving as the market participants and environmental conditions change. Moreover, knowledge problems are not democratic. As Weick famously demonstrated in his knowledge problem deconstruction of the Mann Gulch disaster (1993), not all of the firefighters were equally

well equipped to assess the circumstances and respond accordingly. The same inequity holds true when knowledge problems impact market participants at the firm level, industry level, and national level of analysis. Some forms of unknowingness may impact all humans, everywhere, whereas other forms' unknowingness may cause perceived uncertainty among some individuals but not others. Similarly, the perception of complexity across an entire industry does not mean that all individuals will also perceive complexity. The vantage points of individual actors matter. By any measure then, knowledge problems constitute a multi-level set of challenges that exist simultaneously in multiple states. Scholars wishing to assess the role of knowledge problems will necessarily engage research designs that are capable of multi-level analysis. In no small way, the dynamic capabilities literature (Teece, Pisano, & Shuen, 1997; Winter, 2003)—including specific foci in the realm of entrepreneurship (Zahra, Sapienza, & Davidsson, 2006)—constitutes an attempt to differentiate firm-level effectiveness in managing the vagaries continually shifting operational requirements. Multi-level analysis is crucial as it encompasses both situational and transformative mechanisms that constitute the essence of Coleman's macro-to-micro-to-macro approach to action theory (Kim et al., 2016).

Knowledge problems are also multi-dimensional. As the foregoing discussion of knowledge problem diagnosis demonstrated, mismatched pairings are an expensive source of complication for individuals and firms that misread the nature of unknowingness being confronted. In fact, however, these one-to-one pairings may over-simplify circumstances in which multiple forms of unknowingness are faced simultaneously, at various levels of analysis and potentially in combination with one another. For example, a "born global" energy company may simultaneously face threats to its ability to create and capture value by all four knowledge problems: uncertainties in forecasting foreign market growth rates; ambiguities in responding to diverse local, state, and federal regulations; complexities in developing high-performance distillates; and equivocality in addressing the trade-offs between renewable and nonrenewable energy. Each of these knowledge problems constitutes a distinctive form of unknowability that requires a different resolution, even while all four exist simultaneously.

The challenges of addressing such multi-dimensionalities are compounded by the multi-temporal nature of unknowingness. Multi-temporality occurs in two forms, both of which have a significant

impact on how knowledge problems are identified and processed. The first involves the simultaneous occurrence of more than one tempo. Different individuals and firms will have differing levels of resources, capabilities, insights, and commitment, each of which impacts the willingness and ability (Gnyawali & Fogel, 1994) to move fast or slow in identifying and pursuing an opportunity. Even within firms, differing tempos exist. Some of these are done on purpose, depending on the knowledge problem being encountered. For example, marketing and sales personnel are highly motivated to resolve demand uncertainties through aggressive expenditures on test markets and promotion. Conversely, research and development may require decades to develop technologies and algorithms capable of targeting novel therapies based on insights from gene sequencing. Among entrepreneurs, some market actors may interpret the presence of uncertainty as a signal that speed-to-market strategies are favored. Another entrepreneur, confronting the identical set of circumstances, may opt for a slower approach in deference to concerns about coexistent equivocality over which solution set is likely to best interface with existing technologies. Each entrepreneur functions at a different tempo based on idiosyncratic assumptions regarding the knowledge problems being faced.

The second form of multi-temporality involves capturing the same individual or organization across multiple timeframes. It is essentially a time-lapsed sequence of snapshots, showing the changes that occur over time, like a flower bud evolving into a blossom. Similarly, unknowingness changes over time as resolving events occur, new tools are developed, or sociocultural battles are won or lost. Scholars have convincingly applied real options reasoning to the role this continual state of change is marked value-creating and value-destroying interactions of time, entrepreneurs, and opportunities (McGrath, 1999). Such efforts have tended to focus exclusively on the relationship between entrepreneurs and uncertainty; however, a continual state of change affects the nature and substance of all forms of unknowingness, not just uncertainty. For scholars, this means that the methods and techniques used to observe the antecedents and outcomes of decision-making under conditions of unknowingness must function in pulse-like fashion to capture the changes as they occur over time. Reliance on self-report surveys, cross-sectional data sets, and retrospective archives is likely to result in biases and confounds when investigating the ways in which individuals and firms address unknowingness over time.

Organizations as portfolios of knowledge problems. Given the potent challenges of multi-level, multi-dimensional, and multi-temporal effects of unknowingness facing entrepreneurs, scholars may be well served by approaching scholarly inquiry as a process of identifying and resolving problems. With a multitude of interactions continually occurring over time, across and within various levels that involve all four knowledge problems, it is virtually impossible to parse the forms of unknowingness encountered by any one individual or firm, much less a population of market actors. Accordingly, scholars attempting to better understand and incorporate unknowingness may be well served by thinking about organizations as portfolios of knowledge problems. In the same way that financial, R&D, product, capital project, and business line portfolios are comprised of highly interrelated, statistically, strategically, and operationally nonindependent elements (Blichfeldt & Eskerod, 2008), so too are the evolving knowledge problems confronted by an organization over time. Organizational structures and activities are only useful to the extent that they enable mitigation of or coexistence with the knowledge problems that substantively frame an organization's situation. This is particularly evident among entrepreneurs where the arc of opportunity development involves identifying and confronting various forms of unknowingness in evolving fashion throughout the life cycle of a nascent-stage venture.

Because entrepreneurship entails the willingness and ability to monetize unknowingness (McGrath, 1999; McGrath and MacMillan, 2000), entrepreneurship scholars are likely to benefit from a reconceptualization of organizations as a portfolio of perceptions and behaviors stemming from the various forms of unknowingness over the course of entrepreneurial opportunity development (Ardichvili, Cardozo, & Ray, 2003). Through the efforts to cope with the four knowledge problems, early-stage firms will recruit new employees and implement business approaches that structure the organization the ability to monetize unknowingness. Over time, the organization literally forms as an outgrowth of this evolving portfolio of people and processes intended to broaden and deepen the organization's capacity to survive and thrive in the midst of unknowingness.

Strategic uses of knowledge problems. By thinking of organizations as portfolios of knowledge problems, it follows that because each specific portfolio will differ from all others, heterogeneous firm strategies and firm performance will emerge over time. Although it is important to diagnose and identify the

knowledge problems inherent in local decision environments accurately to deploy organizing mechanisms effectively, prior research also indicates that entrepreneurs might be able to use these knowledge problems strategically. Notable theories such as the resource-based view of the firm acknowledge the importance of “causal ambiguity” in preventing mimicry by competitors (Barney, 1991). The benefits of strategic uses of ambiguity might extend well beyond mitigating problems with *mimesis* by competitors. Eisenberg (1984) suggests that strategic uses of ambiguity enable organizations to create “unified diversity.” In other words, among entrepreneurs, the lack of clarity about the primary functional uses of a particular technological product or service might enable the entrepreneur to use a common product platform to appeal to a diverse set of customer groups (Muegge, 2013; Reed & DeFillippi, 1990; Santos & Eisenhardt, 2009). Or perhaps, an entrepreneur might use an ambiguous strategic orientation to appeal to a diverse set of investors. It is not entirely clear where the boundaries between the benefits of clarity and ambiguity exist in many strategic scenarios faced by entrepreneurs. Rather than assuming that clarity is always beneficial, it remains an open question for future research to explore how strategic ambiguity might facilitate entrepreneurial action.

Other research in management is studying how issue equivocality shapes stakeholder relations among and within firms (Daft & Macintosh, 1981; Daft & Weick, 1984; Lewis, 2004). Given the diversity of stakeholder ties, issue equivocality creates numerous challenges for managers and social change agents (Sonenshein, 2016) and also opens up room for strategic action to enhance the flexibility of strategic options enjoyed by the firm. Because equivocal issues can be interpreted in multiple ways, the use of framing strategies might potentially enable entrepreneurs to draw the attention of stakeholders to interpretations that better accommodate their desired strategic aims (Santos & Eisenhardt, 2009).

CONCLUSION

After almost a century of research framed around the question of risk and uncertainty, the overuse of the term “uncertainty,” a lack of definitional clarity, and a tendency to operationalize the concept imprecisely have led to increasing calls for more nuance and a better conceptualization of uncertainty in entrepreneurship theory (Packard et al., 2017; Ramoglou & Tsang, 2016). To address these problems, we conduct a multi-

disciplinary review of existing research to consider how uncertainty impacts and is influenced through entrepreneurial action. Based on this review, although we agree that more construct clarity is needed regarding the role and resolution of uncertainty as a knowledge problem impeding entrepreneurial action, a central contribution of this review is to extend the range of knowledge problems beyond uncertainty to consider also how ambiguity, complexity, and equivocality impact entrepreneurial action. Through these efforts, we identify a wide range of potential research questions to explore how entrepreneurial action overcomes the inherent epistemological obstacles to strategic action that manifests in terms of the novelty being confronted along one or more dimensions of action.

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