# Uncertainty, Knowledge Problems, and Entrepreneurial Action

**Article** · January 2018

CITATIONS
0

READS
1,560

**4 authors:**

David M. Townsend
Virginia Polytechnic Institute and State University
**24** PUBLICATIONS **379** CITATIONS
SEE PROFILE

Richard A Hunt
Colorado School of Mines
**24** PUBLICATIONS **72** CITATIONS
SEE PROFILE

Jeffery S. McMullen
Indiana University Bloomington
**75** PUBLICATIONS **4,375** CITATIONS
SEE PROFILE

Saras D. Sarasvathy
University of Virginia
**105** PUBLICATIONS **6,820** CITATIONS
SEE PROFILE

# UNCERTAINTY, KNOWLEDGE PROBLEMS, AND ENTREPRENEURIAL ACTION

David M. Townsend
Union Junior Faculty Fellow in Entrepreneurship
Academic Director of Apex Center for Entrepreneurs
Department of Management
Pamplin College of Business
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061
Email: dtown@vt.edu

Richard A. Hunt
Assistant Professor of Strategy & Entrepreneurship
Research Director of Apex Center for Entrepreneurs
Department of Management
Pamplin College of Business
Virginia Polytechnic Institute & State University
Blacksburg, VA 24061
Email: rickhunt@vt.edu

Jeffery S McMullen
Dale M. Coleman Chair in Management
Department of Management & Entrepreneurship
Kelley School of Business
Indiana University
Bloomington, IN 47405
Email: mcmullej@indiana.edu

Saras D. Sarasvathy
Paul M Hammaker Professor in Business Administration
Darden School of Business
University of Virginia
Jamuna Raghavan Chair
Professor in Entrepreneurship
Indian Institute of Management, Bangalore
Email: sarasvathys@darden.virginia.edu

Authors' Note: This version is currently under third round of editorial review at *The Academy of Management Annals.* Please contact the lead author for updated details if you wish to cite this paper in your research.

# UNCERTAINTY, KNOWLEDGE PROBLEMS, & ENTREPRENEURIAL ACTION


## ABSTRACT

Whether business venturing emerges in the context of nascent-stage 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 continues to exhibit conflicting definitions, tautological measures, and unwitting conflation with more apt, more precise constructs in entrepreneurship and organization theory. 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.



**KEYWORDS:** Entrepreneurial Action; Uncertainty; Multilevel theory; Knowledge; Ambiguity; Complexity; Equivocality

## INTRODUCTION

Whether business venturing emerges in the context of nascent-stage start-ups or corporate giants, one of the enduring and fundamental assumptions underlying theories of entrepreneurial action is that entrepreneurs operate in uncertain environments. Existing conceptions of uncertainty are complex and problematic. As such, it is widely recognized that uncertainty creates innumerable challenges for even the most skilled organizational actors (Wiltbank et al., 2006; Busenitz & Barney, 1997; Schwenk, 1995; Eisenhardt & Zbaracki, 1992). 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 classical 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).

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 (Knight, 1921). 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) without which no value, economic or societal, could be achieved and the very notion of human progress would be in jeopardy.

Given the productive but problematic role of uncertainty in human affairs, a wide range of organizational theories have emerged to incorporate various types of uncertainty as analytical constructs (Kahneman & Tversky, 1979; Williamson, 1979; Ackerlof 1995; Alchian & Demsetz 1972; Cyert & March 1963; Simon 1955, 1959). 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 employ 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.

As one 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, Clark, & Klein, 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'etre* of entrepreneurial action is inseparable from the state of uncertainty (Knight, 1921; McGrath 1997; 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 has 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, Clark, & Klein, 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 towards 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. To move forward with stronger theory in the entrepreneurship domain, a successful exposition of action requires a richer, more thorough examination of 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 paper by introducing a robust agenda for researching a full set of knowledge problems, encompassing uncertainty, ambiguity, complexity, and equivocality, as both obstacles and sources of opportunities through entrepreneurial action.

## UNCERTAINTY & 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 below.

**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 1988).

*Knightian Risk and Uncertainty.* Left dormant for nearly two centuries, Frank Knight (1921) resurrects the importance of uncertainty bearing as a key tenet of opportunity pursuit and entrepreneurial activity. Knight's view eschews 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 thwarts the convergence of the economy towards a general equilibrium and necessitates a special class of entrepreneurs capable of restoring balance to the system. Extending Knight's line of thinking, both Coase (1937) and Keynes (1937) assert 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).

While awareness and acceptance of uncertainty-bearing individuals generates momentum towards the study of entrepreneurship, it does not settle the need for better definitions of uncertainty. Ironically, the ubiquitousness 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 towards 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, catalogue an assortment of conceptualizations, including perspectives that equate uncertainty to risk (Anderson et al. 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 (1973), 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 poses challenges to existing conceptions of decision making under uncertainty. These conversations question 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 & Goldstein 1996; Gigerenzer 2003); (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) terms these the problems of uncertainty, goal ambiguity and

isotropy, respectively, and shows 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) frames 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 endpoint 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 don't know the outcome of rolling two dice, but we do know the exact probabilities of any two fair dice yielding each value from two to twelve. 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 since 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 – while 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* hearkens 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 (Knight 1921; McGrath, Ferrier & Mendelow 2004; Sorenson & Stuart 2008). 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 1996; 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. "Embracing entrepreneurship, implies accepting all that goes with it, particularly the recognition of *a priori* irreducible uncertainty," argued McGrath (1999:13).

Applying the lens of real options reasoning, McGrath suggests that, consistent with conceptions originated by Knight (1921), *ex ante* uncertainty is an indispensable driver of value generation. Knight writes in the 1957 preface to his work *Risk, Uncertainty and Profit* that, "Universal foreknowledge would leave no place for an entrepreneur" (1957: lxii). Even more pointedly, McMullen, Plummer, & Acs (2007: 279) observe, "...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) conclude 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; McGrath, 1999; McMullen & Shepherd 2006), there remains a persistent question as to whether entrepreneurs actually capitalize on irreducible *a priori* uncertainty in practice (Driouchi & Bennett 2012; Klingebiel & Adner 2014; Posen, Leiblein & Chen, 2015). In other words, does the presence of uncertainty positively facilitate micro-level entrepreneurial action

directly? While 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.

One of the central critiques in the foundational literature on Knight's distinction between risk and uncertainty centers on the arguments that functionally, individuals are unable or unwilling to differentiate between risk and uncertainty at the micro-level (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 lacks veridicality (Taleb, Goldstein, & Spitznagel 2009). "Behaviorally, individuals confront uncertainty and risk as though they are one and the same," argues Taleb (2007:128). Arrow's (1951: 417) critique of Knight is particularly poignant when he argues that at a macro-level, "…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), and thus Knightian uncertainties can be addressed through the risk pooling of many uncertainties.

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 while 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, entrepreneurial ventures are less able to pool micro-level uncertainties to help resolve situational uncertainties. 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 versus structural risks where such situational uncertainties can be insured against through risk pooling.

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 looks like, new information can actually make the knowledge problem worse for the individual actor. Keynes elaborates upon this important point in poignant fashion:

> "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).

What makes Keynes' argument poignant here is that he 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 two 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) argues 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. Consistent with these arguments, Taleb (2007: 128) summarizes 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 since 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 below, much of the contemporary research in entrepreneurship continues to utilize 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 since 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 ignorance are entirely different. Taken together, the status quo is problematic because inconsistent definitions of uncertainty create confusion regarding both the impact of uncertainty on entrepreneurial action, and upon the effectiveness of the processes and strategies utilized 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 conduct a systematic search of prominent journals to include only those articles that utilize uncertainty in the title, abstract, or keywords. Table 1 presented below identifies the journals we include in the review process and Table 2 lists the citations of the individual articles.

Please Insert Tables 1 & 2 about Here

Our first challenge is to ensure that each of the articles explored uncertainty as a subject of interest and did not simply appear as an adjective or description of previous research (e.g., we would exclude articles that argue "the findings of previous research are 'uncertain'"). Next, because our main purpose in this review is to analyze the literature on uncertainty as it relates to theories of entrepreneurial action, we examine each of these articles to ensure that the phenomenon of interest is either independent or corporate entrepreneurship (including family business) . This step further refines 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 (Ramaglou & Tsang, 2016; Packard et al., 2017), 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) utilize 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 & Venktaraman, 2010: 452). They elaborate on this further by noting that entrepreneurial action to alleviate environmental degradation "…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 do we interpret them?) and prediction problems (i.e., what are the likely consequences of taking or not taking action?) inherent in making decisions about the future.

Kuechle and colleagues (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, Boulu-Reshef, & Carr, 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 and colleagues (2016: 46) interpret other related research: "The individuals studied by McKelvie et al (2009)[1] showed overall aversion to uncertainty and expressed particular concern about the ambiguity surrounding the impact of their own actions…" Overall, Kuechle and colleagues 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 upon 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 have conflicting perspectives on how to interpret such information.

Another stream in contemporary entrepreneurship research builds upon 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 and colleagues (2009) extend this definition of

[1] The article references the publication date of McKelvie and colleagues in 2009 when the article was first available online versus the final publication date of 2011.

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 and colleagues (2010: 1477) define high ambiguity as creating a "…a problem of interpretation because it results from a lack of understanding and/or consensus regarding the applicability of available knowledge." Lastly, Petkova et al. (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 upon 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. In 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

(1962) where uncertainty and ambiguity are conceptualized as the same construct, March (1994) argues that uncertainty is resolved through systematic search while ambiguity can only be resolved through intersubjective agreement.

***Multilevel Research on the Role of Uncertainty in Entrepreneurial Action***

Construct clarity in uncertainty research is also hampered by a lack of specification of levels of analysis where actors, actions, and environments are all frequently described as "uncertain." Figure 1, reported below, summarizes our analysis of the implicit and explicit uses of various mechanisms based on corresponding levels of analysis in contemporary research. Across the 146 articles, approximately 55% of the research analyzed in the review is conducted at a single level of analysis – split evenly between articles exploring the role of uncertainty at the firm or individual level of analysis. The next largest category is comprised of papers that utilize a multilevel framework where the impact of environmental uncertainty is linked with key firm-level outcomes, although many of these papers to not recognize explicitly the multilevel nature of the model.

Please Insert Figure 1 about Here

*Single-level Approaches to Uncertainty Research.* As mentioned above, approximately 55% of the articles explore the role of uncertainty largely at single level of analysis. In general, much of this research focuses on exploring the role of uncertainty in shaping organizational processes such as resource mobilization and investment (Ahlers et al., 2015; Levitas & Chi, 2010; Ferrary, 2010), strategic investment and business model development (Halme et al., 2012), organizing strategies and logics (Foss et al., 2007; Zander, 2007), or in exploring the relative effectiveness of planning versus adaptive approaches to organizing (Wiltbank et al., 2006). Table 3 presented below summarizes key articles in this stream of contemporary research.

Please Insert Table 3 about Here

At the heart of much of this debate are questions about the "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, 2003), 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, uncertainty is defined as the "objective unknowability" of the external environment (Miller, 2012). The thrust of much of this research suggests that such objective unknowability 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 (Podoynitsyna 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 while Knightian uncertainty might enable entrepreneurs to identify opportunities, at the same time, it also appears to diminish their ability to exploit the opportunities successfully (Miller, 2012). In general, much of this research suggests that the "objective constraints" of environmental uncertainty exert a measureable, but largely negative effect on various outcomes associated with entrepreneurial action. Further, 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).

While many articles constructed at an environmental or firm-level focus on the objective unknowability of these environments, individual level uncertainty research often utilizes a subjectivist approach for exploring how entrepreneurs interpret and navigate three different types of uncertainty -- state, effect, and response uncertainty (McKelvie et al., 2011; Forbes, 2007). In the original framework, Milliken (1987) defines state uncertainty as the difficult 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).

While this line of inquiry is still early stage within the entrepreneurship literature, 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 & Barney, 1997; Busenitz, 1996). Current research also supports such a conjecture as both heuristics and analogical reasoning equips 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).

*Multilevel Approaches to Uncertainty.* While single-level studies are important, on occasion the lack of attention paid to the multi-level nature of uncertainty creates confusion regarding the exact nature of the problems posed by uncertainty (e.g., is the environment "uncertain" or is the entrepreneur "uncertain?" or perhaps both are "uncertain?"). According to our review, approximately 45% of the articles reviewed in current research utilize an explicitly multilevel framework to explore these questions.[2] The majority of these studies focus on the link between firm and environmental uncertainty (22% of articles) or the link between environments and individuals (14% of articles). Table 4 summarizes several key articles from contemporary, multilevel research.

Please Insert Table 4 about Here

Along these same lines, only a few articles explore the role of transformative mechanisms that link micro-level action with macro-level consequences. The paucity of research on these questions remains a critical gap in current theories of entrepreneurial action. Several promising directions are emerging to explore how acts of social negotiation in which the entrepreneur relies on empathic accuracy (McMullen, 2015), political skill (Companys & McMullen, 2007), and/or social skill (Fligstein, 1997) to encourage the cooperation or complicit behaviors (Dorado, 2005; McMullen, 2010) to mobilize the collective action needed for institutional innovation and change (Hargrave & Van de Ven, 2006; Battilana, Leca, & Boxenbaum, 2009; Garud, Hardy, & Maguire, 2007). This process of social negotiation – the essence of which Davidson (2001) referred to as "intersubjective agreement" – results in new goals and actions made possible by an enlarged pool of resources resulting from the discovery of

[2] One of the inherent challenges of entrepreneurial action research is that the level of analysis is not always specified in individual studies often leading to confusion regarding the nature of the knowledge problem and corresponding mechanisms that are utilize to resolve it.

mutually desirable ends. So although multilevel approaches to uncertainty and entrepreneurial action research are rare, articles employing multilevel frameworks do provide unique insights into the role of entrepreneurial action in shaping environmental or institutional change (Henfridsson & Youngin, 2014; Sarasvathy et al. 2008).

Multilevel research also offers new insights into the role of uncertainty in shaping entrepreneurial decision-making. Several key articles demonstrate that entrepreneurs display different attitudes towards exogenous versus endogenous sources of uncertainty (Wu & Knott, 2006; Forbes, 2007). Uncertainty also influences how investors evaluate the quality of potential investment targets (Li & Mahoney, 2011; Zacharakis, McMullen, & Shepherd, 2007), including how they evaluate management teams (Matusik, George, & Heeley, 2008) and decide whether to replace them during the funding process (Pollock, Fund, & Baker, 2009). In uncertain environments, the presence of uncertainty avoidance reduces the aggregate rate of startup activity and funding patterns across different institutional environments (Li & Zahra, 2012). Yet, these and other articles are clearly the exception and thus the goal of disentangling objective and subjective elements of uncertainty remains elusive in current research based on a lack of multilevel studies designed to explore various multilevel and cross-level mechanisms.

***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 (Sarasvathy, 2001; Dew et al., 2015) 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, Eisenhardt & Bingham, 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 regards 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 enables them to not just contend with but to capitalize upon opportunities in uncertain environments (Dew et al., 2015). Kuechle and colleagues (2016) suggest 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, (2016)

Although important, the inherent limitations of this debate leave several important questions unanswered. First, despite the willingness of expert entrepreneurs to utilize 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 and colleagues (2014) contend that "projective stories" designed to set audience expectations often set the firm up to disappoint audiences since ostensibly the "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 influence of the objective environment will still influence the outcomes of entrepreneurial action. For these reasons, perhaps entrepreneurs utilize multiple logics over time while engaging in entrepreneurial action?

***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 prior to action being taken (McGrath, Ferrier & Mendelow, 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 2010). In certain situations, entrepreneurs might narrow the decision space by trying to create partial solutions through intersubjective agreement, yielding partial solutions, but since these decision environments are a product of social construction, they are not, by nature, predictable in advance of the entrepreneur taking action; however, they are susceptible to the influences of individual and collective action (Sarasvathy, 2001; Sarasvathy & Dew, 2007).

At the same time, in contrast to Knight (1921), who argues that entrepreneurial action under uncertainty would return markets to a general equilibrium, 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 et al., 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). Socio-economic 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 are de facto, modern heroes (McMullen, 2017), but such arguments betray our relative lack of sophistication in building theories to explore the role of entrepreneurial action in uncertain environments. Since only about 6% of the articles we reviewed explored the cross-level, transformative impact of entrepreneurial action on external environments, much more research is needed to build a robust micro-to-macro theory in entrepreneurship research.

## DISCUSSION & OPPORTUNITIES FOR FUTURE RESEARCH

As the foregoing review reveals, uncertainty continues to be a problematic construct in contemporary research. While 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 the contemporary entrepreneurship literature indicates that the uncertainty construct remains subject to overuse and misuse, especially when it is 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 simply 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 and colleagues (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 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 utilizes 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 as well as how this more nuanced approach to knowledge problems enriches and extends entrepreneurial action theory.

**Uncertainty as One Among Many Knowledge Problems**

Regardless of how unknowingness is manifested 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) and the

price tag for 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 neither of pure ignorance, nor pure certainty. Yet, approaches to unknowingness that label this entire region "uncertainty" or that categorize all knowledge problems as a sub-set of uncertainty fail to provide a substantive basis for the consideration human action. As the foregoing discussion reveals, unknowingness takes various forms, each of which involves different decision-making processes and entrepreneurial actions. Since entrepreneurial action depends upon 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 while 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 catch-all 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 sub-groups underneath uncertainty (e.g. Kahneman & Tversky 1982; Smithson 2008; Lytras & Pouloudi 2006) miss important facets of the causes and cures of unknowingness that are unique to each of the knowledge problems. For example, Daft, Lengel, & 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), while 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 decisions rules and logics, as well as the likely impact of entrepreneurial action on resolving these problems differs considerably based on the epistemic differences in each type of knowledge problems. Taxonomic classifications that attempt to subordinate complexity, ambiguity and equivocality under uncertainty (Smithson 2008; Lytras & Pouloudi 2006), rather than situating uncertainty as one of varied knowledge problems results in addlepated 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 feature of decision making 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 (Weick, 2015; March, 1994) but differ based on the 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, while 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) as well as criticisms of Knight's distinction between risk and uncertainty (1921). While

entrepreneurship researchers largely assume that mentions of Knightian Uncertainty refer to something closely akin to McGrath's (1999) "a priori irreducible uncertainty", decision theorists in economics equate Knightian Uncertainty with ambiguity (e.g., Fox & Tversky, 1995). For example, Holm and colleagues (2013: 1672) define risk and ambiguity as a non-strategic 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, Opper, & Nee, 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 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," while 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, Eisenhardt, & Bingham, 2009; Maitlis & Christianson 2014), and to explore the role and resolution of ambiguity through entrepreneurial action (Santos & Eisenhardt, 2009; Rindova et al., 2010). 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). Though 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.

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 (Ambrust 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 and colleagues (1992) who explore the behaviors and actions of entrepreneurs. Specifically, they argue:

> "Emerging organizations are thoroughly equivocal realities (Weick, 1979) that tend towards 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 and colleagues (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 and colleagues' (1992: 19) contention that "(g)iven the equivocal nature of the process of emergence…the phenomenon of organization emergence has yet to 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 upon 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. While their treatment was not framed by an examination of the entrepreneurship context, per se, they followed Navis and Glynn (2011) in identifying the importance of equivocal

cues in eliciting sense-seeking and sense-making actions. The sub-text to these more recent treatments is that equivocality constitutes a relatively untapped source of fresh insights regarding 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, though it does so without explicitly invoking the equivocality construct. Sarasvathy's conception of entrepreneurs seeking to control an unpredictable future rather than seeking to predict an uncertain one, connotes an action-orientation that rises to Weick's acclamation 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 the variables over time (Simon 1969; 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 (Rivkin, 2000; Barney, 1991) 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 (Page, 2015; Benbya & McKelvey, 2006; Wolfram, 2002; Macy & Willer, 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 (Katz & Gartner, 1988; Gartner, Bird & Starr 1992; Lichenstein, 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 (Uhl-Bien, Marion & McKelvey 2007; Schindehutte & Morris, 2009). 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 sub-fields 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, current 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 current 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 due to the inability to identify all of the relevant factors that might influence the actions of the entrepreneurs as well as due to the inherent difficulties in determining how these factors will interact (Clarysse et al., 2011). Davis

and colleagues (2009: 420) define environmental complexity as "the number of opportunity contingencies that must (be) addressed successfully."

The impact of murky distinctions between uncertainty and complexity is complicated when research delves into the emergent, interrelated subsystems of entrepreneurial action -- entrepreneur/sense-making, interaction with stakeholders, interaction with firm, interaction with 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 2010). For example, at the individual level-of-analysis, one of the key lines of inquiry in current research explores the role of cognitive complexity (Malmström, et al. 2015), belief structures (Kiss & Barr, 2015) and other cognitive factors impacts 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 utilized 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 takes on added significance.

**Establishing Boundary Conditions among Entrepreneur 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 5, presented below, 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 below.

Please Insert Table 5 about Here

*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) asserts that the main idea behind uncertainty is that "…there is a real world that is imperfectly understood" while "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 infers that action X only causes outcome Y under a specific set of Z (social/intersubjective) conditions. In 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

[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.

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 (1967), 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 current 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*. The knowledge problems can be differentiated based on the types of decision logic employed to resolve the underlying problems. Specifically, uncertainty and complexity utilize a logic of consequences, while ambiguity and equivocality utilize a logic of appropriateness. According to March (1994: 2), the logic of consequences refers to decision that are "…consequential in the sense that action depends upon 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 in order 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 such interpretive frames in order to establish a basis for the outcome preferences.

*Role of Entrepreneurial Action.* Lastly, these knowledge problems invoke different conceptualization of the role of entrepreneurial agency and action in resolving each knowledge problem. In the case of uncertainty, while 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 in order 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 does 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. Since these environments are the product of social construction, entrepreneurial actions that generate these intersubjective agreements can shape these environments. Lastly, while 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 current 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. While a complete list of these opportunities is beyond the scope of this paper, 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. Since these environments operate under different decision logics (i.e., logic of consequences versus logics 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 holds major significance concerning the relative effectiveness of organizing mechanisms employed by entrepreneurs. For example, one of the important contributions of effectuation research to theories of entrepreneurial action is the comparative emphasis on utilizing 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 possessing legitimacy (Gartner et al., 1992; Wiltbank, Dew, Read & Sarasvathy 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. While 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 towards combatting the wrong knowledge problem.

Consistent with this point, Davis and colleagues (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. While such studies are quite effective in demonstrating the influence of situational mechanisms on firm organizing decisions, extant research has not taken the additional step of addressing how a mismatch between the perceived knowledge problem and the actual knowledge problem may influence 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 or 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 sixteen 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 logics 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 twelve pairings involve misalignment; for example, perceived ambiguity versus actual uncertainty. In these twelve 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 H-P'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 logics of appropriateness were 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 H-P. 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, while 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, while 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. Multilevel analysis is crucial as it encompasses both situational and transformative mechanisms 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 non-renewable 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 this is 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, while another entrepreneur, confronting the identical set of circumstances, opts for a slower approach, in deference to concerns regarding co-existent equivocality regarding 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 snap-shots, 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 socio-cultural 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 (e.g. McGrath 1999). Such efforts have tended to focus exclusively on the relationship between entrepreneurs and uncertainty; however, the passing of 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 upon 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 inter-related, statistically, strategically and operationally non-independent 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 co-existence with the knowledge problems that substantively frame an organization's fate. 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 lifecycle of a nascent-stage venture.

Since entrepreneurship entails the willingness and ability to monetization 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 in a fashion whereby the organization is literally structured around the ability to monetize unknowingness. Over time, the organization literally forms of 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 since each specific portfolio will differ from all others, a heterogeneity of 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 in order to deploy

organizing mechanisms effectively, prior research also indicates that entrepreneurs might be able to utilize 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 utilize 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 utilize 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) but also opens up room for strategic action to enhance the flexibility of strategic options enjoyed by the firm. Since equivocal issues can be interpreted in multiple ways, the use of framing strategies might potentially enable entrepreneurs to draw the attention to stakeholders to interpretations that are more accommodating to their desired strategic aims (e.g., 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 (Ramoglou & Tsang, 2016; Packard et al., 2017). 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, while 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.

## REFERENCES


Acs, Z. J., Braunerhjelm, P., Audretsch, D. B., & Carlsson, B. (2009). The knowledge spillover theory of entrepreneurship. *Small Business Economics*, *32*(1), 15-30.

Adner, R., & Levinthal, D. A. (2004). What is not a real option: Considering boundaries for the application of real options to business strategy. *Academy of Management Review*, *29*(1), 74-85.

Agarwal, R., Audretsch, D., & Sarkar, M. B. (2010). Knowledge spillovers and strategic entrepreneurship. *Strategic Entrepreneurship Journal*, *4*(4), 271-283.

Ahlers, G. K. C., Cumming, D., Günther, C., & Schweizer, D. (2015). Signaling in Equity Crowdfunding. *Entrepreneurship: Theory & Practice*, *39*(4), 955-980.

Akerlof, G. (1995). The market for "lemons": Quality uncertainty and the market mechanism. In *Essential Readings in Economics* (pp. 175-188). Macmillan Education UK.

Alchian, A. A., & Demsetz, H. (1972). Production, information costs, and economic organization. *The American Economic Review*, *62*(5), 777-795.

Aldrich, H. E., & Martinez, M. A. (2001). Many are called, but few are chosen: An evolutionary perspective for the study of entrepreneurship. *Entrepreneurship Theory and Practice*, *25*(4), 41-56.

Alvarez, S. A., & Barney, J. B. (2007). Discovery and creation: Alternative theories of entrepreneurial action. *Strategic Entrepreneurship Journal*, *1*(1‐2), 11-26.

Alvarez, S. A., & Barney, J. B. (2010). Entrepreneurship and epistemology: The philosophical underpinnings of the study of entrepreneurial opportunities. *The Academy of Management Annals*, *4*(1), 557-583.

Anderson, B. F., Deane, D. H., Hammond, K. R., & McClelland, G. H. (1981). *Concepts in Judgment and Decision Research.* New York: Praeger.

Ardichvili, A., Cardozo, R., & Ray, S. (2003). A theory of entrepreneurial opportunity identification and development. *Journal of Business Venturing*, *18*(1), 105-123.

Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R., Konwinski, A., ... & Zaharia, M. (2010). A view of cloud computing. *Communications of the ACM*, *53*(4), 50-58.

Arrow, K. J. (1951). Alternative approaches to the theory of choice in risk-taking situations. *Econometrica: Journal of the Econometric Society*, 404-437.

Baker, T., & Nelson, R. E. (2005). Creating something from nothing: Resource construction through entrepreneurial bricolage. *Administrative science quarterly*, *50*(3), 329-366.

Baker, T., Miner, A., & Eesley, D. (2003). Improvising firms: Bricolage, account giving and improvisational competencies in the founding process. *Research Policy*, *32*(2), 255-276.

Baird, D., Nordmann, A., & Schummer, J. (2004). *Discovering the nanoscale*. IOS Press.

Ball, S. J. (2013). *The education debate*. Policy Press.

Barnett, W. P., & Hansen, M. T. (1996). The red queen in organizational evolution. *Strategic Management Journal*, *17*(S1), 139-157.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99-120.

Baron, R. A., & Ensley, M. D. (2006). Opportunity recognition as the detection of meaningful patterns: Evidence from comparisons of novice and experienced entrepreneurs. *Management Science*, *52*(9), 1331-1344.

Basili, M., & Zappia, C. (2010). Ambiguity and uncertainty in Ellsberg and Shackle. *Cambridge Journal of Economics*, *34*(3), 449-474.

Bastianoni, S., Pulselli, F. M., & Tiezzi, E. (2004). The problem of assigning responsibility for greenhouse gas emissions. *Ecological Economics*, *49*(3), 253-257.

Battilana, J., Leca, B., & Boxenbaum, E. (2009). 2 how actors change institutions: towards a theory of institutional entrepreneurship. *Academy of Management Annals*, *3*(1), 65-107.

Benbya, H., & B. McKelvey (2006). Toward a Complexity Theory of Information Systems Development. *Information Technology and People*, 19: 12–34.

Blichfeldt, B. S., & Eskerod, P. (2008). Project portfolio management–There's more to it than what management enacts. *International Journal of Project Management*, *26*(4), 357-365.

Boudreaux DJ & Holcombe RG. (1989). The Coasian and Knightian theories of the firm. *Managerial and Decision Economics, 10*: 147-54

Brouwer, M. T. (2002). Weber, Schumpeter and Knight on entrepreneurship and economic development. *Journal of Evolutionary Economics*, *12*(1), 83-105.

Busenitz, L. W. (1996). Research on entrepreneurial alertness. *Journal of Small Business Management*, *34*(4), 35.

Busenitz, L. & Barney, J. (1997). Differences between entrepreneurs and managers in large organizations: Biases and heuristics in strategic decision-making. *Journal of Business Venturing*, *12*(1), 9-30.

Byres, E., & Lowe, J. (2004, October). The myths and facts behind cyber security risks for industrial control systems. In *Proceedings of the VDE Kongress* (Vol. 116, pp. 213-218).

Camerer, C., & Weber, M. (1992). Recent developments in modeling preferences: Uncertainty and ambiguity. *Journal of Risk and Uncertainty*, *5*(4), 325-370.

Cantillon, R. ([1755] 1959). *Essai sur la nature du commerce en général.* Translated and edited by Henry Higgs. London: Frank Cass.

Choo, K. (2011). The cyber threat landscape: Challenges and future research directions. *Computers & Security*, *30*(8), 719-731.

Clarysse, B., Tartari, V., & Salter, A. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. *Research Policy*, *40*(8), 1084-1093.

Coase, R. H. (1937). The nature of the firm. *Economica*, *4*(16), 386-405.

Cohen, M. D., March, J. G., & Olsen, J. P. (1972). A garbage can model of organizational choice. *Administrative Science Quarterly*, 1-25.

Companys, Y. E., & McMullen, J. S. (2007). Strategic entrepreneurs at work: the nature, discovery, and exploitation of entrepreneurial opportunities. *Small Business Economics*, *28*(4), 301-322.

Cope, J. (2011). Entrepreneurial learning from failure: An interpretative phenomenological analysis. *Journal of Business Venturing*, *26*(6), 604-623.

Crawford, G. C., Aguinis, H., Lichtenstein, B., Davidsson, P., & McKelvey, B. (2015). Power law distributions in entrepreneurship: Implications for theory and research. *Journal of Business Venturing*, *30*(5), 696-713.

Cyert, R. M., & March, J. G. (1963). *A Behavioral Theory of the Firm.* Englewood Cliffs, NJ, 2.

Daft, R. L., Lengel, R. H., & Trevino, L. K. (1987). Message equivocality, media selection, and manager performance: Implications for information systems. *MIS quarterly*, 355-366.

Daft, R., & Macintosh, N. (1981). A tentative exploration into the amount and equivocality of information processing in organizational work units. *Administrative Science Quarterly*, 207-224.

Daft, R. L., & Weick, K. E. (1984). Toward a model of organizations as interpretation systems. *Academy of Management Review*, *9*(2), 284-295.

Darrow, B. (2016). Meg Whitman and HP five years later: Mission accomplished? *Fortune*, Sept 2016. http://fortune.com/2016/09/27/whitman-hp-five-year/

Davidson, D. (2001). *Subjective, intersubjective, objective* (Vol. 3). Oxford University Press.

Davis, J. P., Eisenhardt, K. M., & Bingham, C. B. (2009). Optimal structure, market dynamism, and the strategy of simple rules. *Administrative Science Quarterly*, *54*(3), 413-452.

Dew, N. (2009). Serendipity in entrepreneurship. *Organization Studies*, *30*(7), 735-753.

Dew, N., Grichnik, D., Mayer‐Haug, K., Read, S., & Brinckmann, J. (2015). Situated entrepreneurial cognition. *International Journal of Management Reviews*, *17*(2), 143-164.

Dew, N., Velamuri, S. R., & Venkataraman, S. (2004). Dispersed knowledge and an entrepreneurial theory of the firm. *Journal of Business Venturing*, *19*(5), 659-679.

Dorado, S. (2005). Institutional entrepreneurship, partaking, and convening. *Organization Studies*, *26*(3), 385-414.

Dorado, S., & Ventresca, M. J. (2013). Crescive entrepreneurship in complex social problems: Institutional conditions for entrepreneurial engagement. *Journal of Business Venturing*, *28*(1), 69-82.

Downey, H. K., Hellriegel, D., & Slocum Jr, J. W. (1975). Environmental uncertainty: The construct and its application. *Administrative Science Quarterly*, 613-629.

Driouchi, T., & Bennett, D. J. (2012). Real options in management and organizational strategy: A review of decision‐making and performance implications. *International Journal of Management Reviews*, *14*(1), 39-62.

Drover, W., Busenitz, L., Matusik, S., Townsend, D., Anglin, A., & Dushnitsky, G. (2017). A Review and Road Map of Entrepreneurial Equity Financing Research: Venture Capital, Corporate Venture Capital, Angel Investment, Crowdfunding, and Accelerators. *Journal of Management*, 0149206317690584.

Dushnitsky, G., & Lavie, D. (2010). How alliance formation shapes corporate venture capital investment in the software industry: a resource‐based perspective. *Strategic Entrepreneurship Journal*, *4*(1), 22-48.

Eisenberg, E. M. (1984). Ambiguity as strategy in organizational communication. *Communication Monographs*, *51*(3), 227-242.

Eisenhardt, K. M. (2013). Top management teams and the performance of entrepreneurial firms. *Small Business Economics*, *40*(4), 805-816.

Eisenhardt, K. M., & Zbaracki, M. J. (1992). Strategic decision making. *Strategic Management Journal*, *13*(S2), 17-37.

Ellsberg, D. (1961). Risk, ambiguity, and the Savage axioms. *Quarterly Journal of Economics*, 643-669.

Ferrary, M. (2010). Syndication of Venture Capital Investment: The Art of Resource Pooling. *Entrepreneurship: Theory & Practice, 34*(5), 885-907.

Fisher, G. (2012). Effectuation, causation, and bricolage: a behavioral comparison of emerging theories in entrepreneurship research. *Entrepreneurship theory and practice*, *36*(5), 1019-1051.

Fligstein, N. (1997). Social skill and institutional theory. *American Behavioral Scientist*, *40*(4), 397-405.

Folta, T. B. (2007). Uncertainty rules the day. *Strategic Entrepreneurship Journal*, *1*(1‐2), 97-99.

Forbes, D. P. (2007). Reconsidering the strategic implications of decision comprehensiveness. *Academy of Management Review*, *32*(2), 361-376.

Foss, K., Foss, N. J., Klein, P. G., & Klein, S. K. (2007). The entrepreneurial organization of heterogeneous capital. *Journal of Management studies*, *44*(7), 1165-1186.

Fox, C. R., & Tversky, A. (1995). Ambiguity aversion and comparative ignorance. *Quarterly Journal of Economics*, *110*(3), 585-603.

Freel, M. S. (2005). Perceived environmental uncertainty and innovation in small firms. *Small Business Economics*, *25*(1), 49-64.

Frishammar, J., Florén, H., & Wincent, J. (2011). Beyond managing uncertainty: Insights from studying equivocality in the fuzzy front end of product and process innovation projects. *IEEE Transactions on Engineering Management*, *58*(3), 551-563.

Gaglio, C. M., & Katz, J. A. (2001). The psychological basis of opportunity identification: Entrepreneurial alertness. *Small Business Economics*, *16*(2), 95-111.

Galbraith, J. K. (1973). Economics and the public purpose.

Garrett, R. P., & Holland, D. V. (2015). Environmental effects on the cognitions of corporate and independent entrepreneurs. *Small Business Economics*, *45*(2), 369-381.

Gartner, W. B., Bird, B. J., & Starr, J. A. (1992). Acting as if: Differentiating entrepreneurial from organizational behavior. *Entrepreneurship Theory and Practice*, *16*(3), 13-31.

Garud, R., Gehman, J., & Giuliani, A. P. (2014). Contextualizing entrepreneurial innovation: A narrative perspective. *Research Policy*, *43*(7), 1177-1188.

Garud, R., Hardy, C., & Maguire, S. (2007). Institutional entrepreneurship as embedded agency: An introduction to the special issue. *Organization Studies*,28(7), 957 - 969

Garud, R., & Van de Ven, A. (1992). An empirical evaluation of the internal corporate venturing process. *Strategic Management Journal*, *13*(S1), 93-109.

Gigerenzer, G. (2003). *Reckoning with risk: learning to live with uncertainty*. Penguin UK.

Gigerenzer, G., & Goldstein, D. G. (1996). Reasoning the fast and frugal way: models of bounded rationality. *Psychological Review*, *103*(4), 650.

Gnyawali, D. R., & Fogel, D. S. (1994). Environments for entrepreneurship development: key dimensions and research implications. *Entrepreneurship Theory and Practice*, *18*, 43-43.

Greenwood, R., Raynard, M., Kodeih, F., Micelotta, E. R., & Lounsbury, M. (2011). Institutional complexity and organizational responses. *Academy of Management Annals*, *5*(1), 317-371.

Hage, J. T. (1999). Organizational innovation and organizational change. *Annual Review of Sociology*, *25*(1), 597-622.

Halme, M., Lindeman, S., & Linna, P. (2012). Innovation for Inclusive Business: Intrapreneurial Bricolage in Multinational Corporations. *Journal of Management Studies, 49*(4), 743-784.

Hannan, M. T., & Freeman, J. (1984). Structural inertia and organizational change. *American Sociological Review*, 149-164.

Hargrave, T. J., & Van de Ven, A. H. (2006). A collective action model of institutional innovation. *Academy of Management Review*, *31*(4), 864-888.

Hayek, F. A. (1945). The use of knowledge in society. *American Economic Review*, 519-530.

Hey, J. D., Lotito, G., & Maffioletti, A. (2010). The descriptive and predictive adequacy of theories of decision making under uncertainty/ambiguity. *Journal of Risk and Uncertainty*, *41*(2), 81-111.

Herbert, R. F., & Link, A. N. (1989). In search of the meaning of entrepreneurship. *Small Business Economics*, *1*(1), 39-49.

Henfridsson, O., & Youngjin, Y. (2014). The Liminality of Trajectory Shifts in Institutional Entrepreneurship. *Organization Science, 25*(3), 932-950.

Hoffman, F. O., & Hammonds, J. S. (1994). Propagation of uncertainty in risk assessments: the need to distinguish between uncertainty due to lack of knowledge and uncertainty due to variability. *Risk Analysis*, *14*(5), 707-712.

Hofstadter, R. (1944). *Social Darwinism in AmericanThought*. Beacon Press.

Hogarth, R. M. (1987). *Judgement and choice: The psychology of decision*. John Wiley & Sons.

Holm, H. J., Opper, S., & Nee, V. (2013). Entrepreneurs under uncertainty: An economic experiment in China. *Management Science*, *59*(7), 1671-1687.

Huang, L., & Pearce, J. L. (2015). Managing the unknowable: The effectiveness of early-stage investor gut feel in entrepreneurial investment decisions. *Administrative Science Quarterly*, *60*(4), 634-670

Hughes, M., Morgan, R. E., Ireland, R. D., & Hughes, P. (2014). Social capital and learning advantages: a problem of absorptive capacity. *Strategic Entrepreneurship Journal*, *8*(3), 214-233.

Hunt, R. A., & Lerner, D.A. (2012). Reassessing the entrepreneurial spinoff performance advantage: a natural experiment involving a complete population. *Frontiers of Entrepreneurship Research*, *32*(12), 2.

Hunt, R. A. (2015). Contagion Entrepreneurship: Institutional Support, Strategic Incoherence, and the Social Costs of Over‐Entry. *Journal of Small Business Management*, *53*: 5-29.

Hunt, R.A., & Kiefer, K. (2017). The Entrepreneurship Industry: Influences of the Goods and Services Marketed to Entrepreneurs. *Journal of Small Business Management,* Forthcoming.

Hunt, R.A., & Song, Y. (2015). Internationalizing Entrepreneurs: Bridging Real Options Reasoning and Affordable Loss Logics. In *Academy of Management Proceedings* (Vol. 2015, No. 1, p. 10013). Academy of Management.

Jones, M. V., & Casulli, L. (2014). International entrepreneurship: exploring the logic and utility of individual experience through comparative reasoning approaches. *Entrepreneurship Theory and Practice*, *38*(1), 45-69.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, 263-291.

Kahneman, D., & Tversky, A. (1982). Variants of uncertainty. *Cognition*, *11*(2), 143-157.

Katz, J., & Gartner, W. B. (1988). Properties of emerging organizations. *Academy of Management Review*, *13*(3), 429-441.

Keynes, J. M. (1937). *General Theory of Employment, Interest and Money*. A Harvest/HBJ Book, New York and London

Kim, P. H., Wennberg, K., & Croidieu, G. (2016). Untapped riches of meso-level applications in multilevel entrepreneurship mechanisms. *The Academy of Management Perspectives*, *30*(3), 273-291.

Kirzner, I. M. (1979) *Perception, Opportunity and Profit.*

Kirzner, I. M. (1997). Entrepreneurial discovery and the competitive market process: An Austrian approach. *Journal of Economic Literature*, *35*(1), 60-85.

Kiss, A. N., & Barr, P. S. (2015). New venture strategic adaptation: the interplay of belief structures and industry context. *Strategic Management Journal*, *36*(8), 1245-1263.

Klein, P. G. (2008). Opportunity discovery, entrepreneurial action, and economic organization. *Strategic Entrepreneurship Journal*, *2*(3), 175-190.

Klingebiel, R., & Adner, R. (2015). Real options logic revisited: the performance effects of alternative resource allocation regimes. *Academy of Management Journal*, *58*(1), 221-241.

Knight, F.H. [1921] (1957). *Risk, uncertainty and profit*. New York: Hart, Schaffner and Marx.

Kogut, B., & Zander, U. (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science*, *3*(3), 383-397.

Kotter, J. P. (2008). *Corporate culture and performance*. Simon and Schuster.

Kuechle, G., Boulu‐Reshef, B., & Carr, S. (2016). Prediction‐and Control‐Based Strategies in Entrepreneurship. *Strategic Entrepreneurship Journal*, *10*(1), 43-64.

Lewis, M. (2004). The influence of loyalty programs and short-term promotions on customer retention. *Journal of marketing research*, *41*(3), 281-292.

Li, Y., & Zahra, S. A. (2012). Formal institutions, culture, and venture capital activity: A cross-country analysis. *Journal of Business Venturing*, *27*(1), 95-111.

Lipshitz, R., & Strauss, O. (1997). Coping with uncertainty: A naturalistic decision-making analysis. *Organizational Behavior and Human Decision Processes*, *69*(2), 149-163

Lichtenstein, B. B., Carter, N. M., Dooley, K. J., & Gartner, W. B. (2007). Complexity dynamics of nascent entrepreneurship. *Journal of Business Venturing*, *22*(2), 236-261.

Lichtenstein, B. B., Dooley, K. J., & Lumpkin, G. T. (2006). Measuring emergence in the dynamics of new venture creation. *Journal of Business Venturing*, *21*(2), 153-175.

Lytras, M. D., & Pouloudi, A. (2006). Towards the development of a novel taxonomy of knowledge management systems from a learning perspective: an integrated approach to learning and knowledge infrastructures. *Journal of knowledge management*, *10*(6), 64-80.

MacCrimmon, K. R., & Wehrung, D. A. (1986). Assessing risk propensity. In Recent *Developments in the foundations of utility and risk theory* (pp. 291-309). Springer Netherlands.

Macy, M. W., & Willer, R. (2002). From factors to factors: computational sociology and agent-based modeling. *Annual Review of Sociology*, *28*(1), 143-166.

Maitlis, S., & Christianson, M. (2014). Sensemaking in organizations: Taking stock and moving forward. *The Academy of Management Annals*, *8*(1), 57-125.

Malmström, M., Johansson, J., & Wincent, J. (2015). Cognitive constructions of low‐profit and high‐profit business models: A repertory grid study of serial entrepreneurs. *Entrepreneurship Theory and Practice*, *39*(5), 1083-1109.

Mainela, T., & Puhakka, V. (2009). Organising new business in a turbulent context: Opportunity discovery and effectuation for IJV development in transition markets. *Journal of International Entrepreneurship*, *7*(2), 111-134.

March, J. G. (1978). Bounded rationality, ambiguity, and the engineering of choice. *The Bell Journal of Economics*, 587-608.

March, J. G. (1994). *Primer on decision making: How decisions happen*. Simon and Schuster.

March, J. G., & Olsen, J. P. (1976). Organizational choice under ambiguity. *Ambiguity and choice in organizations*, *2*, 10-23.

March, J. G., & Simon, H. A. (1958). *Organizations*.

Matusik, S. F., George, J. M., & Heeley, M. B. (2008). Values and judgment under uncertainty: evidence from venture capitalist assessments of founders. *Strategic Entrepreneurship Journal*, *2*(2), 95-115.

McCaskey, M. B. (1982). *The Executive Challenge: Managing Change and Ambiguity*. Harpercollins College Div.

McGrath, R. G. (1999). Falling forward: Real options reasoning and entrepreneurial failure. *Academy of Management review*, *24*(1), 13-30.

McGrath, R. G., Ferrier, W. J., & Mendelow, A. L. (2004). Real options as engines of choice and heterogeneity. *Academy of Management Review*, *29*(1), 86-101.

McGrath, R. G., & MacMillan, I. C. (2000). *The entrepreneurial mindset: Strategies for continuously creating opportunity in an age of uncertainty* (Vol. 284). Harvard Business Press.

McKelvie, A., Haynie, J. M., & Gustavsson, V. (2011). Unpacking the uncertainty construct: Implications for entrepreneurial action. *Journal of Business Venturing*, *26*(3), 273-292.

McMullen, J. S. (2010). Perspective taking and the heterogeneity of the entrepreneurial imagination. In *What is so Austrian about Austrian Economics?* (pp. 113-143). Emerald Group Publishing Limited.

McMullen, J. S. (2015). Entrepreneurial judgment as empathic accuracy: A sequential decision-making approach to entrepreneurial action. *Journal of Institutional Economics*, *11*(03), 651-681.

McMullen, J. S. (2017). Are we confounding heroism and individualism? Entrepreneurs may not be lone rangers, but they are heroic nonetheless. *Business Horizons, 60*: 257-259.

McMullen, J. S., & Kier, A. S. (2016). Trapped by the entrepreneurial mindset: Opportunity seeking and escalation of commitment in the Mount Everest disaster. *Journal of Business Venturing*, *31*(6), 663-686.

McMullen, J. S., Plummer, L. A., & Acs, Z. J. (2007). What is an entrepreneurial opportunity? *Small Business Economics*, *28*(4), 273-283.

McMullen, J. S., & Shepherd, D. A. (2006). Entrepreneurial action and the role of uncertainty in the theory of the entrepreneur. *Academy of Management Review*, *31*(1), 132-152.

Miller, D. (1983). The correlates of entrepreneurship in three types of firms. *Management Science*, *29*(7), 770-791.

Miller, J. I. (2012). The mortality problem of learning and mimetic practice in emerging industries: Dying to be legitimate. *Strategic Entrepreneurship Journal*, *6*(1), 59-88.

Milliken, F. J. (1987). Three types of perceived uncertainty about the environment: State, effect, and response uncertainty. *Academy of Management Review*, *12*(1), 133-143.

Muegge, S. (2013). Platforms, communities, and business ecosystems: Lessons learned about technology entrepreneurship in an interconnected world. *Technology Innovation Management Review*, *3*(2).

Murphy, D. J., & Pinelli, T. E. (1994). NASA/DOD Aerospace Knowledge Diffusion Research Project. Report 30: Computer-Mediated Communication (CMC) and the communication of technical information in aerospace. Rensselaer Polytechnic Inst. Report.

Navis, C., & Glynn, M. A. (2011). Legitimate distinctiveness and the entrepreneurial identity: Influence on investor judgments of new venture plausibility. *Academy of Management Review*, *36*(3), 479-499.

Ong, E. K., & Glantz, S. A. (2000). Tobacco industry efforts subverting International Agency for Research on Cancer's second-hand smoke study. *The Lancet*, *355*(9211), 1253-1259.

Packard, M.D., Clark, B.B., & Klein, P.G. (2017). Uncertainty types and transitions in the entrepreneurial process. *Organization Science, 28*(5): 840-856.

Page, S. E. (2015). What sociologists should know about complexity. *Annual Review of Sociology*, *41*, 21-41.

Palmié, M., Zeschky, M., Winterhalter, S., Sauter, P. W., Haefner, N., & Gassmann, O. (2016). Coordination mechanisms for international innovation in SMEs: effects on time-to-market and R&D task complexity as a moderator. *Small Business Economics*, *46*(2), 273-294.

Petkova, A. P., Wadhwa, A., Yao, X., & Jain, S. (2014). Reputation and decision making under ambiguity: a study of US venture capital firms' investments in the emerging clean energy sector. *Academy of Management Journal*, *57*(2), 422-448.

Podoynitsyna, K., Song, M., van der Bij, H., & Weggeman, M. (2013). Improving new technology venture performance under direct and indirect network externality conditions. *Journal of Business Venturing*, *28*(2), 195-210.

Pollock, T. G., Fund, B. R., & Baker, T. (2009). Dance with the one that brought you? Venture capital firms and the retention of founder‐CEOs. *Strategic Entrepreneurship Journal*, *3*(3), 199-217.

Posen, H. E., Leiblein, M. J., & Chen, J. S. (2015). A behavioral theory of real options. AoM Proceedings, Vancouver, Canada.

Powell, W. W., & Colyvas, J. A. (2008). Microfoundations of institutional theory. *The Sage handbook of organizational institutionalism*, *276*, 298

Read, S., Dew, N., Sarasvathy, S. D., Song, M., & Wiltbank, R. (2009). Marketing under uncertainty: The logic of an effectual approach. *Journal of Marketing*, *73*(3), 1-18.

Reagans, R., & McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly*, *48*(2), 240-267.

Reed, R., & DeFillippi, R. J. (1990). Causal ambiguity, barriers to imitation, and sustainable competitive advantage. *Academy of management review*, *15*(1), 88-102.

Reimann, C., & Banks, D. (2004). Setting action levels for drinking water: are we protecting our health or our economy (or our backs!)?. *Science of the Total Environment*, *332*(1), 13-21.

Rindova, V., Ferrier, W. J., & Wiltbank, R. (2010). Value from gestalt: how sequences of competitive actions create advantage for firms in nascent markets. *Strategic Management Journal*, *31*(13), 1474-1497.

Rivkin, J. W. (2000). Imitation of complex strategies. *Management Science*, *46*(6), 824-844.

Ramoglou, S., & Tsang, E. W. (2016). A realist perspective of entrepreneurship: Opportunities as propensities. *Academy of Management Review*, *41*(3), 410-434.

Rumelt, R. (1987). Theory, strategy, and entrepreneurship. *The Competitive Challenge*, *137*, 158.

Russell, R. D., & Russell, C. J. (1992). An examination of the effects of organizational norms, organizational structure, and environmental uncertainty on entrepreneurial strategy. *Journal of Management*, *18*(4), 639-656.

Santos, F. M., & Eisenhardt, K. M. (2009). Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. *Academy of Management Journal*, *52*(4), 643-671.

Sarasvathy, S. (2001). Causation and effectuation: Toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Academy of Management Review*, *26*(2), 243-263.

Sarasvathy SD. 2008. *Effectuation: Elements of entrepreneurial expertise*. Cheltenham, UK: Edward Elgar.

Sarasvathy, S. D., & Kotha, S. (2001). Managing knightian uncertainty in the new economy. *E-Commerce and Entrepreneurship. Greenwich, CT: IAP*, 31-62.

Savage, L. J. (1951). The theory of statistical decision. *Journal of the American Statistical Association*, *46*(253), 55-67.

Savage, L. J. (1972). *The Foundations of Statistics*. Courier Corporation.

Schindehutte, M., & Morris, M. H. (2009). Advancing strategic entrepreneurship research: The role of complexity science in shifting the paradigm. *Entrepreneurship Theory and Practice*, *33*(1), 241-276.

Schwenk, C. R. (1995). Strategic decision making. *Journal of Management*,*21*(3), 471-493.

Selden, P. D., & Fletcher, D. E. (2015). The entrepreneurial journey as an emergent hierarchical system of artifact-creating processes. *Journal of Business Venturing*, *30*(4), 603-615.

Shackle, G. L. S. (1955). *Uncertainty in Economics and other Reflections*. CUP Archive.

Shepherd, D. A., McMullen, J. S., & Jennings, P. D. (2007). The formation of opportunity beliefs: Overcoming ignorance and reducing doubt. *Strategic Entrepreneurship Journal*, *1*(1‐2), 75-95.

Simon, H. (1955). Behavioral model of rational choice. *Quarterly Journal of Economics*, 99-118.

Simon, H. A. (1959). Theories of decision-making in economics and behavioral science. *The American Economic Review*, *49*(3), 253-283.

Simon, H. A. (1979). Rational decision making in business organizations. *The American Economic Review*, *69*(4), 493-513.

Simon HA. 1996. *The sciences of the artificial*. MIT press.

Smithson, M. J. (2008). Social theories of ignorance.

Sonenshein, S. (2016). How corporations overcome issue illegitimacy and issue equivocality to address social welfare: The role of the social change agent. *Academy of Management Review*, *41*(2), 349-366.

Sorenson, O., & Stuart, T. E. (2008). 12 Entrepreneurship: a field of dreams?. *Academy of Management Annals*, *2*(1), 517-543.

Sull, D., & Eisenhardt, K. M. (2015). *Simple rules: How to thrive in a complex world*. Houghton Mifflin Harcourt.

Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable*. Random House.

Taleb, N. N., Goldstein, D. G., & Spitznagel, M. W. (2009). The six mistakes executives make in risk management. *Harvard Business Review*, *87*(10), 78-81.

Teece, D., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509-533.

Terreberry, S. (1968). The evolution of organizational environments. *Administrative Science Quarterly*, 590-613.

Thompson, J. D. (1967). *Organizations in action: Social science bases of administrative theory*. Transaction publishers.

Tornikoski, E. T., & Newbert, S. L. (2007). Exploring the determinants of organizational emergence: A legitimacy perspective. *Journal of Business Venturing*, *22*(2), 311-335.

Townsend, D. M., & Busenitz, L. W. (2015). Turning water into wine? Exploring the role of dynamic capabilities in early-stage capitalization processes. *Journal of Business Venturing*, *30*(2), 292-306.

Tsoukas, H. (2005). *Complex knowledge: Studies in organizational epistemology*. Oxford University Press.

Uhl-Bien, M., Marion, R., & McKelvey, B. (2007). Complexity leadership theory: Shifting leadership from the industrial age to the knowledge era. *The leadership quarterly*, *18*(4), 298-318.

Weick, K. E. (1979). *The Social Psychology of Organizing*. New York: McGraw-Hill.

Weick, K. E. (1995). *Sensemaking in organizations*. Sage.

Weick, K. E. (2001). *Making Sense of the Organization,* John Wiley & Sons.

Weick, K. E. (2015). Ambiguity as grasp: the reworking of sense. *Journal of Contingencies and Crisis Management*, *23*(2), 117-123.

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science*, *16*(4), 409-421.

Williams, C. C., & Nadin, S. J. (2013). Beyond the entrepreneur as a heroic figurehead of capitalism: re-representing the lived practices of entrepreneurs. *Entrepreneurship & Regional Development*, *25*(7-8), 552-568.

Williamson, O. E. (1979). Transaction-cost economics: the governance of contractual relations. *The Journal of Law & Economics*, *22*(2), 233-261.

Wiltbank, R., Dew, N., Read, S., & Sarasvathy, S. D. (2006). What to do next? The case for non‐predictive strategy. *Strategic Management Journal*, *27*(10), 981-998.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic management journal*, *24*(10), 991-995.

Wolfram, S. (2002). *A New kind of Science* (Vol. 5). Champaign: Wolfram media.

York, J. G., & Venkataraman, S. (2010). The entrepreneur–environment nexus: Uncertainty, innovation, and allocation. *Journal of Business Venturing*, *25*(5), 449-463.

Zack, M. (1999). Developing a knowledge strategy. *California Management Rev*, *41*(3):125-145.

Zacharakis, A. L., McMullen, J. S., & Shepherd, D. A. (2007). Venture capitalists' decision policies across three countries: an institutional theory perspective. *Journal of International Business Studies*, *38*(5), 691-708.

Zahra, S. A., Sapienza, H. J., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: A review, model and research agenda. *Journal of Management Studies*, *43*(4), 917-955.

Zander, I. (2007). Do you see what I mean? An entrepreneurship perspective on the nature and boundaries of the firm. *Journal of Management Studies*, *44*(7), 1141-1164.

**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:**

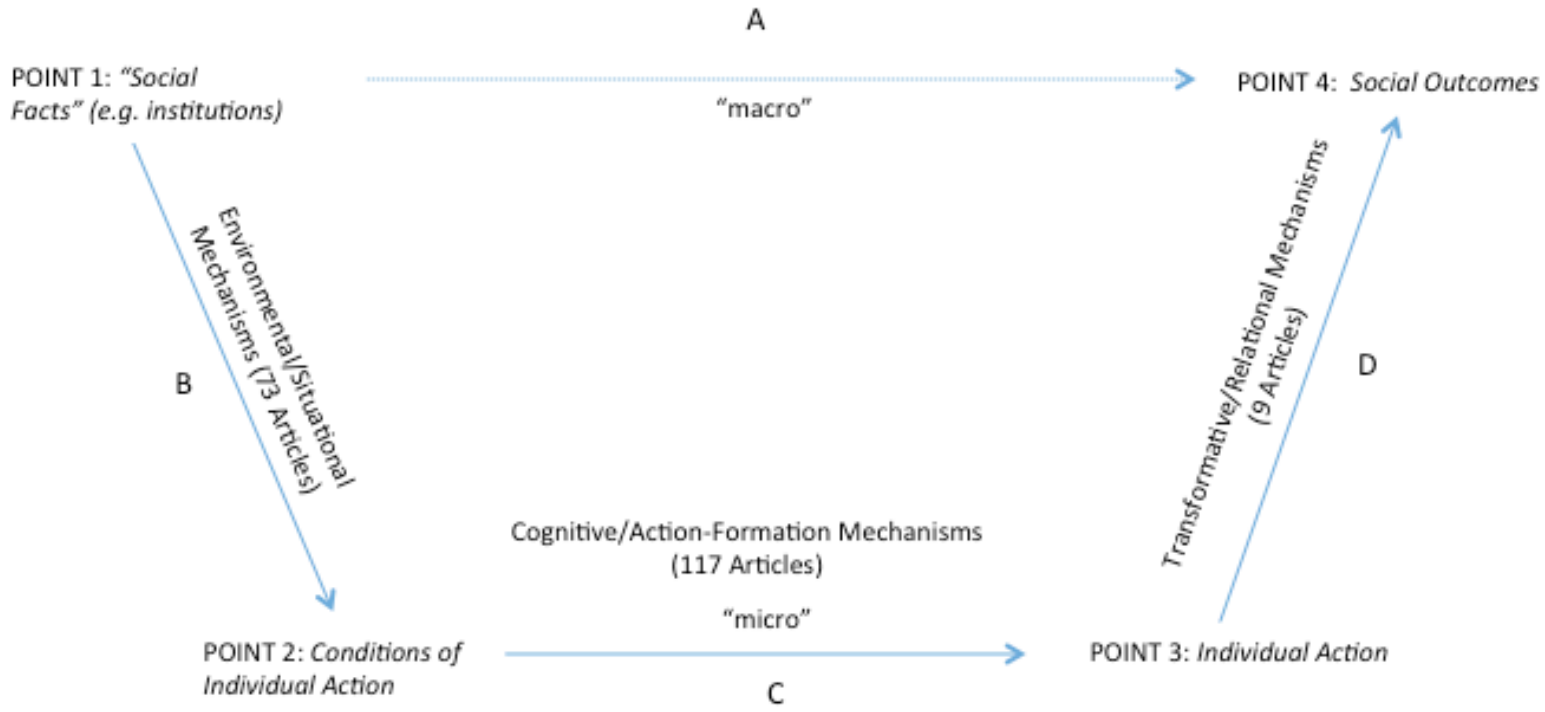
*Entrepreneurship Theory & Practice (ETP), Journal of Business Venturing, (JBV), and Strategic Entrepreneurship Journal, Small Business Economics (SBE), and Journal of Small Business Management (JSBM)*

**Table 2: Uncertainty Articles Included in Review (2006-2016)**

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; 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; Cacciotti et al. , 2016, Çakar & Ertürk, 2010; Cassar, 2014; Chandler et al., 2011; Chwolka & Raith, 2012; Cobb et al., 2016, Compagni et al., 2015; Dawson, 2016; Dean & McMullen, 2007; Dew et al., 2015; Dimov & Milanov, 2010; Du & Mickiewicz, 2016; Engel et al. , 2014; Ensley, Pearce, & Hmieleski, 2006; Ferrary, 2010; Fiet, 2007; Fischer & Reuber, 2014; Flatten et al.,2015; Folta, 2007; Forbes, 2007; Foss, Foss, Klein, & Klein, 2007; 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; Halme et al., 2012; Haynie & Shepherd, 2009; Haynie, Shepherd, & McMullen, 2009; Haynie et al., 2010; Haynie et al., 2012; Heavey, Simsek, Roche, & Kelly, 2009; Henfridsson & Youngjin, 2014; Hmieleski & Baron, 2007; Hmieleski & Baron, 2008; Hmieleski & Baron; 2009; Hmieleski et al., 2015; Holm et al., 2013; Huang & Pearce, 2015; Jones & Casulli, 2014; Kacperczyk, 2013; Kaplan, 2008; Kaul, 2013; Keil, Autio, & George, 2008; Kirsch, Goldfarb, & Gera, 2009; Klingebiel, 2012; Kor, Mahoney, & Michael, 2007; Korsgaard et al., 2016; Kreiser et al., 2010; Kuechle et al. , 2016; 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; Mahnke, Venzin, & Zahra, 2007; Martiarena, 2013; Matusik & Fitza, 2012; Matusik, George, & Heeley, 2008; Foo , 2011; McKelvie et al., 2011; McMullen & Shepherd, 2006; McVea, 2009; Miller & Sardais, 2015; Miller, 2012; Minola et al., 2016; Moreno-Moya & Munuera-Aleman, 2016; Mouri et al., 2012; Packalen, 2007; Parker, 2006; Park & Steensma, 2012; Parnell, 2013; Patel & Fiet, 2009; Podoynitsyna et al. , 2013; Pollock, Fund, & Baker, 2007; Puffer et al. , 2010; Raffiee & Jie, 2014; Ramoglou & Tsang, 2016; Rauch & Hatak, 2016; Raymond et al.; 2015; Read, Song, & Smit, 2009; Reuer et al., 2012; Reymen et al.,

2015; Rosenbusch et al., 2013; Sarooghi et al., 2015; Saxton et al. , 2016; Scarbrough et al., 2013; Simsek, Veiga, & Lubatkin,2007; Smith & Cao, 2007; Sohn & Kim, 2013; Stephan & Pathak, 2016; Stewart, May, & Kalia, 2008; Sommer, Loch, & Dong, 2009; Tang & Wezel, 2015; Tong & Li, 2011; Townsend & Busenitz, 2015; Thornhill, 2006; Ucbasaran, 2008; Uygur & Kim, 2016; Van de Vrande & Vanhaverbeke, 2013; Verreynne et al. , 2016; Vrande, Vanhaverbeke, & Duysters, 2009; Wallace et al., 2010; Welter & Smallbone, 2011; Wennberg et al., 2011; Wiklund et al., 2010; Wiklund et al. , 2016; Wiltbank, Dew, Read, & Sarasvathy, 2006; Wiltbank, Read, Dew, & Sarasvathy, 2009; Wuebker et al., 2015; Wyrwich et al., 2016; Wu & Knott, 2006; Yenkey, 2015; York & Venkataraman, 2010; Yu & Lindsay, 2016; Zacharakis, McMullen, & Shepherd, 2007; Zahra, Yavuz, & Ucbasaran, 2006; Zander, 2007; Zheng & Mai, 2013; Zott & Amit, 2007; Zott & Huy, 2007.

**Figure 1: Uncertainty Articles By Focal Mechanisms**



## Table 3: Select Single-level Articles on Uncertainty and Entrepreneurial Action

| Reference | Publication Year | Journal | Article Type | Level of Analysis | Key Contribution |
|---|---|---|---|---|---|
| Wiltbank, Dew, Read, & Sarasvathy | 2006 | SMJ | Conceptual | Firm | Study differentiates between planning and adaptive approaches to strategic decision making. The central argument holds that the unique combination of control with non-predictive strategies enables firms to contend with uncertain environments. |
| McMullen & Shepherd | 2006 | AMR | Conceptual | Individual | Study reinvigorates the emergence of entreprenerial action theory and proposes a two-stage conceptual model of entrepreneurial action under conditions of uncertainty. |
| McKelvie et al. | 2011 | JBV | Empirical-Quantitative | Individual | Study examines the role of uncertainty in shaping an individual's willingness to engage in entrepreneurial action. Results indicate that various types of uncertainty differentially impact propensities to engage in entrepreneurial action. |
| Chandler et al. | 2011 | JBV | Empirical-Quantitative | Individual | Study develops and tests new measures for examining causation and effectuation logics among entrepreneurs. Empirical results indicates that causation logics are negatively associated with higher levels of uncertainty while experimentation (effectual logics) is positively associated with uncertainty. |
| Andries et al. | 2013 | SEJ | Empirical-Qualitative | Firm | Study explores the relative trade-offs for ventures in focusing their early commitments versus engaging in experimentation to reduce uncertainty. Results indicate that while focused commitment increases short-term growth, simultaneously experimentation increase long-term survival. Implications for action versus planning perspectives on contending with uncertainty are discussed. |
| Autio et al. | 2013 | AMJ | Empirical- Quantitative | Firm | Study examines the extent to which access to information shapes the opportunity evaluation process and determines whether an entrepreneur engages in entrepreneurial action. Results of the study indicate that information which reduces demand uncertainty is a central factor in increasing the likelihood of entrepreneurial action. |

| | | | | | |
|---|---|---|---|---|---|
| Dew et al. | 2015 | JBV | Empirical-Quantitative | Individual | Study examines the role of entrepreneur expertise in the use of prediction versus control strategies in uncertain environments (i.e., predictability and controllability). Entrepreneurial expertise improve the use of control strategies in uncertain environments. |
| Huang & Pearce | 2015 | ASQ | Empirical-Multi-method | Individual | Study examines the decision processes of angel investors and finds a mix of intuition and formal decision models to contend with such extreme uncertainty that the future is unknowable. |
| Artinger & Powell | 2016 | SMJ | Empirical-Quantitative | Individual | Study examines two competing explanations for the failure of entrepreneurial action: market uncertainty (statistical failure) and excess entry (overconfidence). Experiemental results indicate that overconfidence is a stronger influence than market uncertainty on entrepnreurial entry decisions -- although these effects are complementary and suggest both simultaneously explain over-entry by overconfident entrepreneurs. |
| Kuechle et al. | 2016 | SEJ | Empirical-Quantitative | Individual | Study examines the use of prediction and control strategies under conditions of uncertainty. Study finds that control-based strategies are more willing to accept bets in ambiguous environments and to accept a bet after a favorable outcome. |
| Packard et al. | 2017 | OS | Conceptual | Individual | Study develops a process model of entrepreneurial action under conditions of uncertainty. The emphasis of the paper is on exploring how uncertainty changes through the entrepreneurial process. |

## Table 4: Select Multilevel Articles on Uncertainty and Entrepreneurial Action

| Reference | Publication Year | Journal | Article Type | Level of Analysis | Key Contribution |
|---|---|---|---|---|---|
| Zacharakis, McMullen, & Shepherd | 2007 | JIBS | Empirical-Quantitative | Individual-Environment | Study examines the effects of institutional environments on decision policies of venture capitalists across three different institutional contexts. Study finds that economic institutions shape the degree to which VCs utilize specific types of information when evaluating potential investment deals. |
| Gruber | 2008 | JBV | Empirical-Quantitative | Environment-Firm | Study examines the effects of strategic planning on venture peformance. Environmental dynamism weakens this relationship. |
| Dimov & Milanov | 2010 | JBV | Empirical-Quantitative | Firm (Dyadic) | Study examines the interplay of two types of uncertainty: ego centric (making the right decision) versus altercentric (being an attractive partner to a deal). The study then explores how status and reputation enable VC firms to set up syndicates for novel deals. Results indicate that higher status facilitates the development of a syndicate while higher reputation does not. The study offers novel insights on the "relational aspect(s) of uncertainty." |
| Welter & Smallbone | 2011 | JSBM | Conceptual | Firm-Environment | Study proposes a conceptual model of how entrepreneurs may contribute to institutional change in uncertain, ambiguous, and turbulent environments. |
| Podoynitsyna et al. | 2013 | JBV | Empirical-Quantitative | Firm-Environment | Study explores the interaction of various strategies under differing conditions of external uncertainty. Results point to limits of flexible strategies based in real options logic under varying conditions of uncertainty. |

| | | | | | |
|---|---|---|---|---|---|
| Fischer & Reuber | 2014 | JBV | Empirical-Quantitative | Firm-Environment | Study examines whether social media messaging can reduce audience uncertainty about the quality of entrepreneurial firms. Multi-dimensional communicative systems which signal quality, relational orientation, distinctiveness, and positive affect) enable firms to improve audience assessment of quality and distinctiveness. |
| Henfridsson & Youngjin | 2014 | OS | Empirical-Qualitative | Individual-Firm-Environment | Study explores the mechanisms which enable institutional entrepreneurs to identify the limits of existing institutional arrangments and to establish new innovation trajectories. |
| Compagni et al. | 2015 | AMJ | Empirical-Quantitative | Firm-Environment | Study examines the mechanisms of diffusion through investigating how isomorphic pressures from the external environment facilitate the diffusion of a new technology even when there is considerable and persistent technological and economic uncertainty. |
| Cacciotti et al. | 2016 | JBV | Empirical-Qualitative | Environment-Individual | Study explores how "fear of failure" manifests and influences entrepreneurial action in uncertain environments. The paper demonstrates the multi-dimensional cues from the environment that determine an entrepreneur's fear of failure and argue for the primacy of a socially-situated cogntive approach to understanding fear of failure as a construct. |
| Ramaglou & Tsang | 2016 | AMR | Conceptual | Individual-Environment | Study develops a critical realist account regarding the ontological basis of entrepreneurial opportunities. Defines opportunities as propensities for action in entrepreneurial environments. Study also argues for a more nuanced theory of uncertainty in entrepreneurial action research. |

## Table 5: 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→Y?) | Do actions X1 or X2 cause outcome Y? (Does X1 * X2 change the first-order rules that X1→Y or X2→Y)? | Does action X cause outcome Y in situation Z? (Does the rule X→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→Y or X2→Y applies in situation Z?) |
| Decision Logic | Logic of Consequence<br><br>Question about whether cause-effect or if-then rule exists<br><br>Is the technical relationship between action and outcome understood? | Logic of Consequence<br><br>Question about whether cause-effect or if-then rule exists<br><br>Is the technical relationship between action and outcome understood? | Logic of Appropriateness<br><br>Question about when application of cause-effect or if-then rule is justified<br><br>Is the situational appropriateness of the relationship between action and outcome understood? | Logic of Appropriateness<br><br>Question about when application of cause-effect or if-then rule is justified<br><br>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<br><br>The actor knows the question being asking, has a pretty good idea of the rule being considered, and thus how to interpret the data such that data constitutes information.<br><br>Thus, the discovery of critical data through entrepreneurial action will resolve the knowledge problem. | Decisions Concerning Actions in Comparison<br><br>The actor is confronted by multiple questions and decision rules. As a result, it is not clear to interpret the data and thus data does not equal information.<br><br>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<br><br>The actor knows the question being asking, has a pretty good idea of the rule being considered, and thus how to interpret the data such that data constitutes information.<br><br>Thus, the creation or generation of critical data through entrepreneurial action will resolve the knowledge problem. | Decisions Concerning Actions in Comparison<br><br>The actor is confronted by multiple questions and decision rules. As a result, it is not clear to interpret the data and thus data does not equal information.<br><br>Thus, the creation or generation of more data through entrepreneurial action complicates the scope of relevant information and degrades decision-making accuracy. |