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Opportunity Evaluation as Rule-Based Decision Making

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ABSTRACT We draw from cognitive science literature on rule-based thinking to develop and empirically test a theoretical framework of entrepreneurial opportunity evaluation. We argue that entrepreneurs make use of socially constructed rules to discern the attractiveness of an opportunity, for them, specifically. Using conjoint analysis data of 498 decisions made by 62 entrepreneurs, we find that entrepreneurs' use of rules regarding opportunity novelty, resource efficiency, and worst-case scenario significantly influences entrepreneurs' evaluations of opportunities and that individual differences in opportunity market and technology knowledge augment the effect of the rules on opportunity attractiveness. Additionally, we document that the worst-case scenario diminishes the positive effect of other rule criteria (e.g. novelty, resource efficiency) on opportunity evaluation and that market and technology knowledge further influence the negative effects of the worst-case scenario.

Keywords: cognition, entrepreneurship, evaluation, opportunity, rule-based decision making

INTRODUCTION

Innovative organizations and enterprising individuals must keep pace with emerging trends and unmet needs by taking advantage of opportunities to introduce new business models, services, or products (Dutton and Jackson, 1987; Gartner, 1985; Shane and Venkataraman, 2000). This is a difficult charge because managers and entrepreneurs are not always equipped with the 'alert antennae' and 'cognitive skills' required to recognize the value of an opportunity (Kirzner, 1979; Wood et al., 2012). Prior research has documented cognitive prototypes (Baron and Ensley, 2006), intuition (Mitchell et al., 2005), learning (Corbett, 2007), and other mechanisms individuals use to identify opportunities. However, identifying an opportunity is a necessary, but *insufficient* condition, for entrepreneurial action (McMullen and Shepherd, 2006; Shane and Venkataraman, 2000).

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Subsequent to the identification of an opportunity, managers and entrepreneurs must *evaluate* the opportunity as they decide whether or not to act (Bhave, 1994; Keh et al., 2002). Interestingly, comparatively less attention has been paid to the cognitive dynamics and decision-making frameworks entrepreneurs use to evaluate opportunities. Prior work suggests that opportunity evaluation is a conceptually distinct (Dimov, 2007; Tumasjan et al., 2012) and interpretive endeavour (Barreto, 2012) whereby mindful (Corbett and McMullen, 2007) individuals attend to exogenous decision criteria (e.g. technologies, resources, etc.) and apply knowledge to make judgments regarding the personal pursuit of opportunity. This suggests that evaluations of 'is this an attractive opportunity for me' rest on the use of various cognitive structures and informational cues (Grégoire et al., 2011; Walsh, 1995). Much of the opportunity evaluation research to date is in line with the structure/cue perspective, but has largely focused on how entrepreneurs' perceptions of risk (cf. Foo, 2011; Keh et al., 2002) or complementarities between an opportunity and an entrepreneur's knowledge (Haynie et al., 2009) impact their opportunity evaluations. Despite these advances, we lack an integrative framework that identifies the cognitive structure (e.g. ways of thinking) and range of informational cues that underlie entrepreneurs' efforts to separate those opportunities that 'make the cut' from those that do not. As a result, our ability to track opportunities from identification to venture creation is mitigated in the absence of theory that more fully explains the cognitive structures, judgment criteria, and knowledge resources entrepreneurs use to evaluate opportunities. Thus, the purpose of our research is to address the following questions: *What decision-making framework underpins the opportunity evaluations of enterprising individuals, and what are the effects of the informational cues and knowledge resources brought to bear within that framework?*

Our research addresses these questions by introducing and empirically testing an opportunity evaluation framework conceptually grounded in decision-making theory whereby entrepreneurs make use of rule-based decision making to structure opportunity evaluation decisions by applying 'rule' content. Specifically, we conceptualize that entrepreneurs use rule-based thinking to systematically integrate rule content regarding opportunity novelty, resource efficiency, and the worst-case scenario as they discern opportunity attractiveness. Further, we hypothesize that the main effects of these rules are contingent upon individual differences in knowledge resources, specifically knowledge of the opportunity market and opportunity technology. We test our theory using a conjoint experiment with a group of entrepreneurs, and our findings from their decisions provide preliminary evidence that entrepreneurs use specific rules and knowledge resources in their opportunity evaluations and that those applications occur within a rule-based framework that provides structure to entrepreneurs' judgments.

Our theoretical model and empirical findings are important because they improve our understanding of 'how entrepreneurs evaluate opportunities' and 'what influences are brought to bear on those evaluations' (Haynie et al., 2009, p. 338). Specifically, the unique contributions of our study are new insights regarding the decision-making framework entrepreneurs use to systematically evaluate opportunities and the decision criteria and knowledge brought to bear as rule-based logic is applied to evaluation as a decision problem. In doing so, we introduce a nuanced framework that explains the type of thinking individuals use to judge the personal potential of an opportunity. This contribution is especially helpful, because opportunity evaluation studies to date are rather

fragmented, and our framework introduces a way to begin unifying that research into a theoretically-consistent ensemble – an idea we elaborate on in the discussion.

Further, our model identifies and empirically measures the effect of specific decision rules that inform entrepreneurs' thinking as they implement rule-based frameworks in evaluation activities. For example, our modelling of the effects of the worst-case scenario is novel because it reflects how entrepreneurs think (cf. Bryant, 2007), but has been largely overlooked because it is not clear how such interpretive factors become part of the entrepreneur's evaluations. Our theory and results suggests that rule-based thinking is one way the worst-case scenario, and other interpretive factors, are cognitively implemented. Finally, by considering the moderating effects of market and technology knowledge we advance the literature by moving us beyond the understanding that 'knowledge matters' (Haynie et al., 2009; Mitchell and Shepherd, 2010) to identify what knowledge matters and how it matters in opportunity evaluation. In some cases, the effects are counterintuitive, which adds richness to recent conversation on the interpretivist view of opportunities (e.g. Barreto, 2012; Wood and McKinley, 2010) and helps to explain why an entrepreneur might pursue one opportunity while passing on others.

THEORY AND HYPOTHESES

Opportunity Evaluation as a Distinct Phenomenon

Entrepreneurial opportunities involve the introduction of new products, services, or ways of doing business (cf. Casson, 1982; Venkataraman and Sarasvathy, 2001). From this perspective, entrepreneurial opportunities are subjective interpretations about a set of circumstances and what could be done in these situations (Dimov, 2011; Foss et al., 2008). As such, it has been conceptualized that opportunities unfold sequentially through opportunity recognition, evaluation, and exploitation (Grichnik et al., 2010; Shane and Venkataraman, 2000; Wood et al., 2012). While these phases are inextricably linked, researchers have shown that there are distinct phenomena associated with each 'phase' (Tumasjan et al., 2012), and thus it is theoretically and empirically useful to study them separately (cf. Grichnik et al., 2010; Haynie et al., 2009; Keh et al., 2002; Wood et al., 2012). In the current study, we are focused on understanding the opportunity evaluation phase of the entrepreneurial process.

Scholars have argued that opportunity evaluation is distinct from recognition and exploitation. Grégoire and Shepherd (2012, p. 756), for example, argue that 'identifying a potential opportunity (i.e. forming initial beliefs that applying a new technology in a particular market represents an opportunity for someone) is conceptually and empirically separate from deciding whether, when, and how to personally act upon these beliefs'. McMullen and Shepherd (2006) assert that different types of opportunity beliefs underpin one's initial attention to an opportunity (i.e. recognition) and the subsequent evaluation of the personal risk/reward equation if the opportunity is pursued. Further, Tumasjan et al. (2012) show that there is an influential temporal spacing between evaluation and exploitation, while Wood et al. (2012) posit that entrepreneurs must shift their thinking as they transition between the various phases of the entrepreneurial process. Viewed together, these studies support the validity and necessity of studying opportunity evaluation as a distinct phenomenon.

We anchor our study within the opportunity evaluation domain by building upon three key conceptual assumptions. First, we adopt Haynie et al.'s (2009, p. 338) perspective that 'opportunity evaluation represents a first-person – rather than a third-person – assessment'; thus, evaluation decisions determine whether or not a specific set of circumstances represents an opportunity *for me* or *my firm*. Second, we follow Tumasjan et al.'s (2012) evidence that there is a temporal sequencing to opportunity evaluation, such that evaluation flows from the initial recognition of an opportunity, but precedes exploitation action. Third, rather than dwell on whether or not these recognitions are the function of objective discontinuities (Shane, 2000) or creative actions (Sarasvathy, 2008), we focus on the interface between individuals and circumstances as they discern the personal meaning of information sets. In that way, we assume that evaluation of the personal attractiveness of an opportunity involves interpretation (cf. Barreto, 2012; Dimov, 2007) that takes the form of a multi-criteria structured decision problem (Corner et al., 2001). This approach means that we adopt the perspective that boundedly-rational entrepreneurs attend to exogenous information (Dutton, 1993) and use mental templates (Fiske and Taylor, 1984) to assimilate, represent, and evaluate opportunities (Baron, 2006; Dutton and Jackson, 1987; Krueger, 2000; Mitchell and Chesteen, 1995). These templates act as perceptual screens that emerge through a nexus of cognitive structure (i.e. ways of thinking) and content (i.e. what they think about) (March, 1994; Walsh, 1995). Taken together, these assumptions form a foundation for delineating the type of cognitive structure and content likely to influence entrepreneurs' evaluations of opportunity.

Rule-Based Thinking as a Cognitive Structure for Opportunity Evaluation

Discerning the attractiveness of an opportunity involves interpretation whereby entrepreneurs must translate data into understanding (Barreto, 2012; Daft and Weick, 1984). Once data has been attended to and an opportunity identified, entrepreneurs must evaluate if the opportunity is personally attractive enough to at least form intentions to pursue the opportunity (Haynie et al., 2009; Krueger, 2000). In order to do this, entrepreneurs need a structured way to think about the new information, and cognitive science research suggests individuals make use of 'rule-based' thinking to systematically frame decision problems, such as evaluating the risk/reward payoff of introducing a new technology (Brewer, 1988; March, 1994; Smith and DeCoster, 2000; Smith and Sloman, 1994). When adopting a rule-based decision framework, individuals make use of symbolically-represented and intentionally-accessed knowledge in the form of rules of reasoning to guide judgments, drive solutions (Chaiken and Trope, 1999; Evans, 2008; Sloman, 1996; Smith and DeCoster, 2000), and determine the value and consequence of action (March, 1994). In that way, rule-based decision-making is a structured way to think about a complex decision problem.

Rule-based thinking involves developing a series of rules via formal education, day-to-day experiences, and interacting with others (Chaiken and Trope, 1999; Smolensky, 1988). Logical and sequential application of rules enables individuals to evaluate contexts, situations, and information using attribution thinking and consequential reasoning. In that way, rule-based thinking allows one to use 'laws of logic and causal inference' (Chaiken and Trope, 1999, p. 324) to judge the situation and determine an appropriate

response (Chaiken, 1980; Devine, 1989; Gilbert, 1991). Hence, rule-based thinking provides a structured cognitive frame, but it is the 'rules' individuals draw upon that ultimately drive their judgments and decisions (March, 1994).

The concept of rule-based decision-making is especially useful for conceptualizing how entrepreneurs go about evaluating the potential of entrepreneurial opportunities because it helps explain how entrepreneurs develop and apply cognitive templates of opportunity. Prior research has shown that managers and entrepreneurs make sense of new situations by matching the characteristics of the situation with information stored in memory (Baron, 2006; Jackson and Dutton, 1988; Walsh, 1995), and a rule-based framework provides a nuanced explanation for how this happens. In this regard, social psychologists demonstrate that rule-based logic is most frequently activated when judgment tasks are complex and take place under conditions of ambiguity (Sloman, 1996); the exact conditions inherent in entrepreneurship (Dimov, 2010). As Denrell et al. (2003, p. 981) put it, the real problem with entrepreneurial opportunities is that they are 'needles in a haystack of mistakes' and one must judge whether the 'needle' or the 'straw' has been found. We argue that a rule-based framework is an influential way of thinking, one that allows individuals to bring rules and knowledge resources to bear that are central to discerning between the needle and the straw. However, rule-based thinking is an *explanatory framework* (e.g. Smith and DeCoster, 2000) to which content (i.e. rules) must be added in order to make specific predictions. This parallels Walsh's (1995, p. 282) proviso that researchers must 'uncover the attributes of a particular knowledge structure', and we posit that use of rule-based frameworks to evaluate opportunities involves invoking domain specific knowledge (i.e. rule content) to evaluate the personal attractiveness of an opportunity.

Content of Rule-Based Opportunity Evaluation

Prior entrepreneurship research studies parallel the idea of rule-based thinking as they suggest that entrepreneurs rely on opportunity-specific attributes to make judgments about the worth of opportunity ideas. For example, Ardichvili et al. (2003) theorize that entrepreneurs pay close attention to return objectives and resources in their opportunity evaluations. Foo (2011) and Keh et al. (2002) find that risk perceptions critically influence entrepreneurs' opportunity evaluations. Haynie et al. (2009) showed that entrepreneurs favourably evaluate opportunities related to their existing knowledge. For their part, Mitchell and Shepherd (2010) reveal that entrepreneurs evaluate opportunities more favourably when the window of opportunity (time available to profitably invest) is wide as opposed to narrow.

Linking the literature outlined above with conceptualizations of entrepreneurial opportunities as complex considerations of supply and demand (cf. Casson, 1982; Venkataraman and Sarasvathy, 2001), we note that entrepreneurs tend to develop opportunity templates around at least three broad categories of rule content. The first are those that relate to demand-side considerations (e.g. windows of opportunity). The second are those that relate to supply-side considerations (e.g. resources). Finally, there are those that involve the entrepreneur's personal considerations (e.g. goals and consequences such as risk or return). This means that the content in rule-based opportunity

evaluation encompasses both supply- and demand-side issues as entrepreneurs strive to introduce new means–ends relationships (Block and MacMillan, 1985; Shane, 2003). As such, we develop our framework around the notion that evaluating the potential of an opportunity requires one to determine the extent to which bringing supply- and demand-side considerations together is consistent with rule templates regarding the profit potential and personal consequences if the opportunity is pursued (Bryant, 2007; Grégoire and Shepherd, 2012). Hence our theoretical model considers demand-side rules (novelty), supply-side rules (resource efficiency), and personal consequences (the worst case scenario) as a supply–demand nexus rule as well as how these rules interact with each other.

Novelty as a demand-side rule. The degree of novelty associated with an opportunity is likely to be an important demand-side rule template that entrepreneurs use to evaluate opportunities. We define novelty as something new, innovative, or unusual, and we note that entrepreneurial opportunities involve the introduction of *new* means–ends relationships (Shane, 2003). When juxtaposed, these two concepts suggest that for an idea to truly represent an entrepreneurial opportunity, it must be novel in some way (cf. Schumpeter, 1934; Shane, 2003). The level of novelty impacts considerations of risk and reward such that the more novel the introduction, the greater the risk and the greater the potential reward. Novelty implies rarity, such that a similar product or service does not currently exist in the marketplace, thus increasing the potential value of introduction by giving consumers something new and different (Choi and Shepherd, 2004). Similarly, greater novelty is associated with an increase in uncertainty over the value of the product, or the distribution of returns from the product (Sapienza and Gupta, 1994) because while being different is important, the market may not value the newness.

Not all entrepreneurs introduce novel means–ends relationships. Some entrepreneurs offer incremental changes to existing products or services as opposed to pioneering something truly novel (D'Aveni, 1990; Tushman and Anderson, 1986). However, despite the uncertainty involved, novelty is generally considered desirable as a characteristic of entrepreneurial opportunities. By offering something new, entrepreneurs exploit a number of key tenants of acquiring and maintaining competitive advantage. Rumelt (1987) argues that generation of entrepreneurial rents requires the uniqueness that cannot be easily imitated. Further, a novel offering may provide first-mover advantages (Lieberman and Montgomery, 1988). Novelty also provides differentiation, giving entrepreneurs a means to separate themselves in the marketplace (Porter, 1980). As such, novelty provides significant demand-side advantages for an entrepreneur, increasing the potential value of the opportunity, and the entrepreneur's possibility of appropriating that value. All of this suggests that entrepreneurs evaluating an opportunity apply a demand-side rule that a more novel opportunity holds greater potential and will be evaluated as more personally attractive than those that are less novel. This logic suggests:

> *Hypothesis 1*: Entrepreneurs evaluate an opportunity as more attractive, for them specifically, when novelty is high rather than low.

Resource efficiency as a supply-side rule. Entrepreneurs may also engage in opportunity evaluation using supply-side considerations of how productively resources can be

deployed if the venture were to be physically constructed. Alvarez and Busenitz (2001, p. 762) highlight the importance of optimal resource deployment by recognizing that both Kirzner (1979) and Schumpeter (1934) 'describe the entrepreneurial role as the decision to direct inputs into certain processes rather than into other processes'. In that way, entrepreneurs seek to find the optimal productive deployment of resources (Barney, 1991; Shane, 2003). We call these optimal deployments '*resource efficiency*' and define the construct as resources being applied to their 'first and best use'.

Resource efficiency is important in opportunity evaluation because the entrepreneur must determine if the resources that need to be mobilized will be put to sufficiently good use so that it justifies not using them to exploit a different opportunity. Research has shown that resources are frequently under-employed (Ardichvili et al., 2003), and this results in a lack of sustainable competitive advantage and corresponding challenges in generating entrepreneurial rents (Penrose, 1959; Rumelt, 1987). Thus, deploying resources for maximum efficiency is an important part of venture performance and survival (Hanlon and Saunders, 2007; Salimath et al., 2008; Wu et al., 2008), especially when resources are constrained (Baker and Nelson, 2005; Starr and Macmillan, 1990).

Further, prior research indicates that resource availability is a key attribute of opportunity (Dutton and Jackson, 1987) and that strategic opportunities involve either 'new resources, or new uses for existing resources' (Denrell et al., 2003, p. 981). Thus it follows that transformations, such as the pursuit of opportunity, occur when the financial returns from new resource applications 'are predicted to be better than the returns from the current deployment of resources' (Thornberry, 2001, p. 529). All of this suggests that entrepreneurs develop cognitive templates around the knowledge that opportunities are more promising when resource efficiency is high. As such, entrepreneurs' evaluations of opportunities are likely to be more favourable when resource efficiency is perceived to be high, relative to other possible opportunities. This suggests the following hypothesis:

> *Hypothesis 2*: Entrepreneurs evaluate an opportunity as more attractive, for them specifically, when resource efficiency is high rather than low.

Worst-case scenario as a supply-demand nexus rule. Entrepreneurship typically involves substantial personal risk (cf. Foo, 2011; Knight, 1921). As such, entrepreneurs are likely to consider the consequences of their actions as well as the valence of those consequences. March (1994, p. 102) asserts that when individuals make rule-based judgments, considerations of consequential choice are simply 'one of the rules that may be evoked and followed when deemed appropriate'. Hence, we argue that considerations of personal consequences likely play a key role in opportunity evaluation and that the magnitudes (risk versus reward calculations) of the personal consequences associated with the opportunity are a judgment rule applied as the opportunity is evaluated. Not all opportunities are the same, and uncertainty and corresponding personal consequences vary by opportunity (McKelvie et al., 2011).

Consistent with the view that opportunity evaluation is a necessary precursor to entrepreneurial action (Shane and Venkataraman, 2000), we consider personal consequences to be the perceived effects of the most probable outcome if the *opportunity under consideration* is exploited. In that vein, recent research by Bryant (2007) shows that

entrepreneurs often frame personal consequences by asking themselves 'what is the worst that can happen', leading to a formulation of the 'worst-case scenario' which is a mental template used to screen opportunities.

The worst-case scenario is consistent with what is often referred to as 'counterfactual reasoning' (Dunning and Parpal, 1989; Plous, 1993) because it involves considerations of imaginary events. Counterfactual reasoning is important because it is how people try to anticipate and avoid situations where they will regret their choices (Loomes and Sugden, 1982). As one considers possible outcomes, emotions such as fear can creep in (Roese, 1997), and negative emotions such as fear, impact entrepreneurs' evaluations of opportunities negatively (cf. Grichnik et al., 2010; Welpe et al., 2012). Taken together, this suggests that entrepreneurs thinking in terms of the worst-case scenario are likely to engage in counterfactual thinking, try to avoid regret, and in turn may experience fear. This means that when entrepreneurs apply the rule that pursing an opportunity with severe negative consequences is unwise, the entrepreneur would be less likely to evaluate the opportunity positively. This suggests a third hypothesis:

> *Hypothesis 3*: Entrepreneurs evaluate an opportunity as more attractive, for them specifically, when the magnitude of the worst-case scenario is conceptualized as mild rather than severe.

Bryant (2007) goes on to argue that consideration of the worst-case scenario usually follows evaluations of strategies and markets, and thus suggests that the considerations of the worst-case scenario may impact consideration of other opportunity rules, such as the relationships between novelty (Hypothesis 1) and resource efficiency (Hypothesis 2) with opportunity attractiveness evaluations. Viewed in this light, if an entrepreneur deems the effects of the worst-case scenario as severe, he/she likely loses faith in the opportunity. An opportunity with a severe worst-case scenario means an increased likelihood of regret over loss of time, money, and effort. Thus the opportunity attractiveness stimulated by positive evaluations of novelty and resource efficiency may be weakened in the presence of a severe worst-case scenario judgment. As such, entrepreneurs' evaluations of the worst-case scenario of an opportunity moderate the relationship between other rule criteria, namely novelty and resource efficiency, and entrepreneurs' evaluations of the opportunity such that:

> *Hypothesis 4a*: The positive relationship between novelty and opportunity attractiveness is less positive when the worst-case scenario is severe rather than mild.

> *Hypothesis 4b*: The positive relationship between resource efficiency and opportunity attractiveness is less positive when the worst-case scenario is severe rather than mild.

Prior Knowledge and Rule-Based Opportunity Evaluation

Because entrepreneurial action is a function of both promising opportunities and enterprising individuals (Shane and Venkataraman, 2000), it becomes important not only to examine the effects of opportunity-based rules, but also to consider how application of

those rules may be augmented by differences between individuals. Shane (2003, p. 7) points out that without differences between entrepreneurs, 'everyone would recognize and act on all opportunities'. The individual difference that has emerged as especially salient for entrepreneurship is prior knowledge (Hayek, 1948; Krueger, 2007; Shane, 2000), and research on opportunity evaluation reinforces the importance of the type and amount of opportunity-related knowledge held by the entrepreneur. Haynie et al. (2009) and Mitchell and Shepherd (2010) each look at the role of opportunity-related knowledge, writ-large, and find that opportunities are more attractive when they are related to the entrepreneurs' existing knowledge base. For their part, Choi and Shepherd (2004, p. 377) found that 'entrepreneurs are more likely to exploit opportunities when they perceive more knowledge of customer demand for the new product and more fully developed necessary technologies'. Prior research indicates that for those entrepreneurs whose objectives are to launch a venture with the maximum chances of success (Stinchfield et al., 2012), they will more favourably evaluate opportunities in domains where they have a relative information advantage over others.

We build on the findings outlined above and move the literature forward by theorizing that the knowledge that is important in opportunity evaluation is likely more nuanced than previously considered. Specifically, the knowledge required involves concrete knowledge of demand-side and supply-side considerations. It is, after all, the match between supply- and demand-side conceptualizations that drive entrepreneurial action (Baron and Ensley, 2006; Grégoire and Shepherd, 2012). Thus, we consider the entrepreneurs' knowledge of the opportunity technology (supply-side consideration) and knowledge of opportunity markets (demand-side consideration) as specific contextual knowledge that is likely to differ across entrepreneurs and influence the outcome of the rule-based thinking in opportunity evaluation.

Knowledge of opportunity technology and opportunity markets. In order to effectively apply rules, individuals must have a deeper level of knowledge that informs the cause and effect attributions involved in rule-based judgment and decision making (Chaiken and Trope, 1999; Smith and DeCoster, 2000). In other words, those with opportunity-related knowledge are better able to develop richer conceptualizations of the potential of the opportunity, have more refined mental templates (Krueger, 2007), and may be better able to envision the effects and likelihood of the downside outcomes (Dunbar, 1995). Building on these insights and taking into consideration prior research that finds that increases in opportunity-related knowledge impact evaluations of opportunities (Haynie et al., 2009; Mitchell and Shepherd, 2010), along with research that shows the importance of entrepreneurs matching technology and markets (Baron and Ensley, 2006; Grégoire et al., 2010), we argue that more positive opportunity evaluations occur when entrepreneurs have greater prior knowledge of the opportunity technology and/or the opportunity market. As such, increases in opportunity-related prior knowledge, related to either the technology and/or the market, strengthens the relationship between rule-based criteria and assessments of opportunity attractiveness. Stated formally:

Hypothesis 5a: Prior knowledge of the opportunity technology and markets moderates the relationship between novelty and opportunity attractiveness such that the positive

relationship is more positive when prior knowledge is high than when prior knowledge is low.

Hypothesis 5b: Prior knowledge of the opportunity technology and markets moderates the relationship between resource efficiency and opportunity attractiveness such that the positive relationship is more positive when prior knowledge is high than when prior knowledge is low.

Hypothesis 5c: Prior knowledge of the opportunity technology and markets moderates the relationship between the worst-case scenario and opportunity attractiveness such that the negative relationship is less negative when prior knowledge is high than when prior knowledge is low.

METHOD

We utilize conjoint analysis to capture entrepreneurs' decision-making policies. A conjoint experiment allowed us to tap into entrepreneurs' evaluations of opportunities by asking respondents to make a series of judgments based on theory-driven profiles (detailed below). Conjoint analysis has proven an especially valuable tool for gaining insight into individuals' decisions (Green et al., 2001; Huber, 1987), including those of entrepreneurs and investors (cf. McKelvie et al., 2011; Murnieks et al., 2011). Despite criticisms that conjoint experiments do not consider all relevant information and do not reflect the emotional importance of real world situations (Gigerenzer, 1984), there is ample evidence that the decisions captured in conjoint experiments 'can predict the real behavior of real individuals' in real situations (Louviere, 1998, p. 114). Most importantly, conjoint experiments are uniquely positioned to capture decisions that surveys or other methods would not (Shepherd and Zacharakis, 1997), and we concur with Lohrke et al.'s (2009) review of conjoint analysis in entrepreneurship research which explicitly discussed the utility of conjoint analysis for unpacking the decision criteria associated with *opportunity evaluation* phenomena. As such, conjoint analysis is a highly appropriate method to investigate entrepreneurs' evaluations of opportunities.

Sample

We solicited experienced entrepreneurs to participate in our study, defining an experienced entrepreneur as any individual who has started at least one business that is, was, or was intended to be, his/her primary source of income. To identify and recruit entrepreneur-participants, we worked with a regional Entrepreneurship Center (EC) in the Eastern United States, and we also tapped into the personal networks of entrepreneurship students at two major universities located in the Central and Eastern United States. In total, participation requests were sent to 320 entrepreneurs via an email letter from the researchers. Following the guidance of Dillman (2000), our initial request was followed by two subsequent requests sent at one-week intervals. A total of 62 entrepreneurs completed the experiment (response rate of 19.4 per cent), and these participants completed a total of 498 decisions. Our sample size is consistent with published studies

investigating entrepreneurial decision-making via the conjoint approach (cf. Haynie et al., 2009: n = 73; Priem and Rosenstein, 2000: n = 33; Shepherd and Zacharakis, 1997: n = 66; Zacharakis and Meyer, 1998: n = 53).

Our sample consisted of 15 females and 47 males; they ranged in age from 20 to 72 years, with a mean of 47.11 years. Each participant verified that he or she had started at least one business that was intended to be his/her primary source of income. In terms of experience, the number of business starts per entrepreneur ranged from 1 to 11 with a mean of 2.84, and average experience as an entrepreneur was 13.96 years. In terms of education, 6.5 per cent of participants held a high school diploma, 11.3 per cent held a two-year degree, 40.3 per cent had earned a bachelor's degree, and 41.9 per cent had earned advanced degrees.

Research Design and Instrument

Description of the opportunity. Participant-entrepreneurs were presented with instructions describing the research task (described further below). They were then presented with a description of an entrepreneurial opportunity. Our opportunity description was predicated on the conceptualization that technological change is often a source of business opportunities (McMullen and Shepherd, 2006; Shane, 2000), and we followed a technique used by Grégoire et al. (2010) and later by Grégoire and Shepherd (2012) where we identified an actual change in technology. The new technology is called In-Situ Plating (ISP) and is based on an innovative material coating process that improves the electrical conductivity of common metals and reduces the number of steps required to coat non-conductive materials. Columbia University's Technology Transfer Office has patented the coating technology and is currently marketing it as a bona-fide entrepreneurial opportunity on the Kauffman Foundation's *iBridge Network*, a website designed to facilitate the commercialization of university-held intellectual property.

Once identified, we wrote a description of the technology/opportunity using the characteristics of recognized entrepreneurial opportunities documented in the literature (e.g. Baron and Ensley, 2006). In that regard, the technology must be desirable and feasible (Krueger, 2000; McMullen and Shepherd, 2006; Shapero and Sokol, 1982), ought to represent a match between the functional needs of the market and functional characteristics of the technology (Grégoire et al., 2010), and should be a problem-based solution, with reasonable risks such that timely cash flow generation is possible (Baron and Ensley, 2006). Based on these criterion, we organized the *iBridge* technology/opportunity description to fit within theses characteristics and we provide the complete opportunity description used in our experiment in Appendix 1.

Conjoint instrument design. The design of our instrument follows published conjoint studies (Aiman-Smith et al., 2002; Choi and Shepherd, 2004; Haynie et al., 2009; McKelvie et al., 2011; Shepherd and Zacharakis, 1997). The instrument was presented via a web-based interactive process and consisted of instructions for completing the experiment, description of the opportunity (outlined above), descriptions of the variables, a series of conjoint profiles, and a post-experiment questionnaire. In the conjoint portion of the experiments, entrepreneurs were asked to evaluate a series of hypothetical

attribute profiles, each of which described a different configuration of novelty, resource efficiency, and worst-case scenario. After each scenario, the subject was asked: 'Based on the attributes described above, how attractive is the opportunity for you specifically?'

In designing the profiles, we used an orthogonal full factorial design (2 novelty × 2 resource efficiency × 2 worst-case scenario), which resulted in eight full-profile descriptions. We chose the orthogonal approach variable because intercorrelations are zero and thus multicollinearity is not an issue (Huber, 1987). In addition to the eight profiles, participants also received three repeat profiles included as reliability checks. Profile presentation was randomized (Hair et al., 2006), and profiles were presented on separate screens. Participants were not allowed to refer back to previous profiles. Before evaluating the profiles, participants were instructed that they would be making a series of opportunity evaluation decisions and that they would be judging the viability of creating a new business based on the opportunity described and the additional information presented in each profile. They were also instructed that when making decisions they were to answer questions as if they were actually in the situation. They were also told to assume they had the financial resources to pursue the entrepreneurial opportunity if they chose to do so.

Variables and Measures

Independent variable manipulations. The independent variables were the demand, supply, and personal consequence rules: novelty (low vs. high), resource efficiency (low vs. high), and worst-case scenario (mild vs. severe). We constructed profiles by varying the levels of each of these opportunity attributes until all possible combinations had been included in the conjoint profiles. The variables, levels, and descriptions for each level of the variables have been provided in Appendix 2.

Dependent variable. The dependent variable was the entrepreneur's evaluation of each opportunity described as attractive for them, specifically. In other words, the dependent variable measures a personal evaluation as a function of the attractiveness of the opportunities presented to each entrepreneur. Opportunity attractiveness was captured using a 7-point scale ranging from 'not at all attractive' (1) to 'highly attractive' (7). We selected a metric rating scale because it captures gradation in opportunity attractiveness and allows for the investigation of interactive relationships (Hitt and Barr, 1989). It should be noted that the use of single item measures is usually considered problematic (Boyd et al., 2005). However, this is not the case in conjoint techniques because reliability is established by comparing responses on original versus repeat profiles rather than factor loadings and Cronbach's alphas. As such, single item measures are the norm when capturing responses to conjoint profiles (cf. Haynie et al., 2009; Shepherd and Zacharakis, 1997; Wood and Pearson, 2009; Zacharakis and Meyer, 1998). A sample conjoint profile is provided in Appendix 3.

Moderator variables. Knowledge of the opportunity technology and knowledge of the opportunity market were moderator variables. Knowledge of the technology was captured by asking participants how much they knew about the technology presented in the

opening opportunity description. Knowledge of the market was captured by asking participants how much they knew about the market needs for the technology presented in the opening opportunity description. In each case, participants responded using a 7-point scale ranging from 'no knowledge at all' (1) to 'extensive knowledge' (7). Both the technology and market knowledge questions directly followed the general description of the opportunity and preceded the attribute descriptions and profiles.

Control variables. Prior research shows that experience matters when it comes to evaluating opportunities (Baron and Ensley, 2006; Haynie et al., 2009; Mitchell and Shepherd, 2010). Thus our post-experiment questionnaire captured experience-related information as control variables in our analysis. Specifically, we controlled for the participants' level of education and years of experience as an entrepreneur. In addition, recent research has shown that learning and application of general knowledge plays a central role in opportunity evaluation (Corbett, 2005, 2007; Mitchell and Shepherd, 2010; Wood et al., 2012). As such, extant research suggests that when taking a cognitive approach to opportunity evaluation, the effects of variations in general knowledge and learning should be controlled for. We do so by controlling for meta-cognitive knowledge, defined by Haynie and Shepherd (2009, p. 699) as the 'extent to which the individual relies on what is already known about oneself, other people, tasks, and strategy when interpreting, planning, and implementing goals to manage a changing environment'. Meta-cognitive knowledge was measured using an 11-item scale previously developed and validated by Haynie and Shepherd (2009). As expected, the scale proved reliable with our sample of entrepreneurs ($\alpha = 0.83$). In line with the conjoint literature, the effects of control variables were captured and are reflected within the intercept coefficient.

Pilot Test and Reliability Check

A pilot test was conducted to ensure face validity, clarity of variable descriptions, and likelihood of completing the instrument in a reasonable length of time (Hitt et al., 2004). Four management doctoral students and four experienced entrepreneurs participated in the pilot test. Participants noted that some of the instrument content was ambiguous, but once revisions had been completed, they felt that the instrument was clear and the time required was reasonable. Finally, as an indicator of face validity, we asked the three experienced entrepreneurs if the data provided in the profiles was the type of data they would use in making opportunity evaluation decisions, and they all indicated that they would use the opportunity attributes described to make real-life assessments of opportunity viability.

After collecting our experimental data and before proceeding with empirical analysis, it was necessary to ensure that our experiment was completed in a reliable manner. To do this, we examined responses to the original conjoint profiles and compared them to the repeat profiles. The assumption was that if the entrepreneurs were giving reliable responses, there would be a significant correlation between average responses on each of the original profiles and those of the three repeat profiles (Green and Srinivasan, 1990; Hair et al., 2006). Results indicated that all three matched profiles were highly correlated

($r(60) = 0.73,\ p < 0.001;\ r(60) = 0.80,\ p < 0.001;\ r(60) = 0.83,\ p < 0.001$). These results suggest reliable responses on the part of our entrepreneur-participants.

Empirical Model

Our data is multilevel in nature because we asked participants to evaluate a series of profiles (level one – within-participant), and at a second level, we collected information on variables thought to influence decision making at large (level two – between-participant). As such, our hypotheses for the interactions between the manipulated variables and the individual differences of technology and market knowledge represent cross-level interactions. Hierarchical Linear Modelling (HLM) is an analytic technique designed for modelling multi-level effects (Heck et al., 2010) and has been widely used in published conjoint studies in entrepreneurship (Haynie et al., 2009; Mitchell and Shepherd, 2010; Murnieks et al., 2011). Thus, we follow extant research and used HLM to model and analyse our data.

In order to test for multi-level effects, it is first necessary to verify systematic variance within- and between-participants (Heck et al., 2010). A variance analysis for our sample revealed that evaluation varies by the individual and the opportunity attributes, with more variance attributable to the opportunity (59.4 per cent) than the individual (40.6 per cent). Once systematic variance had been confirmed, we then developed the fixed effects model. This model included the opportunity attributes and the interactions between those attributes. We then developed the random effects model and the cross-level interaction between the individual difference variables (e.g. knowledge of market) and the manipulated factors (e.g. novelty). In HLM, parameter estimates are generated, and the *t*-values associated with these parameters indicate the significance of the opportunity attribute (or the interaction between attributes) as a determinant of the level of attractiveness as rated by the entrepreneur, holding differences between individuals constant (Hofmann, 1997). The parameter estimates can be interpreted as unstandardized regression coefficients and indicate the amount of change in the dependent variable as a function of a one-unit change in the independent variable (e.g. a move from the low to high condition).

RESULTS

Table I presents the descriptive statistics and correlations for the measured variables. The mean value for opportunity attractiveness across all scenarios is 2.31.

Table II reports the results of the HLM analyses. We first observed that the coefficient for novelty was positive and significant ($b = 0.47,\ p < 0.01$). This indicates that opportunity attractiveness increased significantly when the novelty of the opportunity is high as opposed to low. This finding provides support for Hypothesis 1. Next, we observed that the coefficient for resource efficiency was positive and significant ($b = 0.62,\ p < 0.001$). This indicates that opportunity attractiveness is significantly higher when the resource efficiency associated with the opportunity is high as opposed to low. This finding provides support for Hypothesis 2. We then observed that the coefficient for the worst-case scenario was negative and highly significant ($b = -1.22,\ p < 0.001$). This indicates that

Table I. Means, standard deviations, and correlations for measured variables

Variable	*Mean*	*SD*	*1*	*2*	*3*	*4*	*5*
1. Education level	3.31	1.04					
2. Entrepreneurial experience (yrs)	13.96	11.44	0.06				
3. Metacognitive knowledge	8.53	1.31	–0.21**	0.06			
4. Knowledge of opp. technology	2.29	1.59	0.18**	0.08	0.17**		
5. Knowledge of opp. market	2.21	1.51	0.08	0.07	0.08	0.86**	
6. Opportunity Attractiveness	2.31	1.71	0.02	0.07	0.08	0.19**	0.28**

** $p < 0.01$.

Table II. Hierarchical linear modelling results for opportunity attractiveness

Final estimation of fixed effects (robust standard errors)	*Full model with cross-level moderation*	
	Unstandardized coefficients	*Standard error*
Level 1 effects (within-individual)		
Main effects of rule-based content		
Novelty	0.471**	0.184
Resource efficiency	0.615***	0.171
Worst-case scenario	–1.221***	0.176
Interactions		
Novelty × worst-case scenario	–0.409*	0.211
Resource efficiency × worst-case scenario	–0.508**	0.203
Intercept	2.490***	0.192
Level 2 effects (between-individual)		
Opportunity knowledge interactions		
Knowledge of opportunity technology ×		
Novelty	0.210*	0.966
Resource efficiency	0.244*	0.931
Worst-case scenario	–0.215*	0.942
Knowledge of opportunity market ×		
Novelty	0.319***	0.089
Resource efficiency	0.308***	0.092
Worst-case scenario	–0.365***	0.096

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$ interaction terms entered one at a time/centred. Decision level N = 498; Individual level N = 62. Controls: education, entrepreneurial experience, and meta-cognitive knowledge. Aggregate effect of control variables reflected within intercept coefficient.

opportunity attractiveness significantly decreases when the worst-case scenario associated with the opportunity is severe as opposed to mild. This finding supports our third hypothesis. Viewed holistically, we observed that the coefficient for the worst-case scenario is clearly the largest (–1.22), followed by resource efficiency (0.62), and then by novelty (0.47). This indicates that, when holding all else constant, participants considered

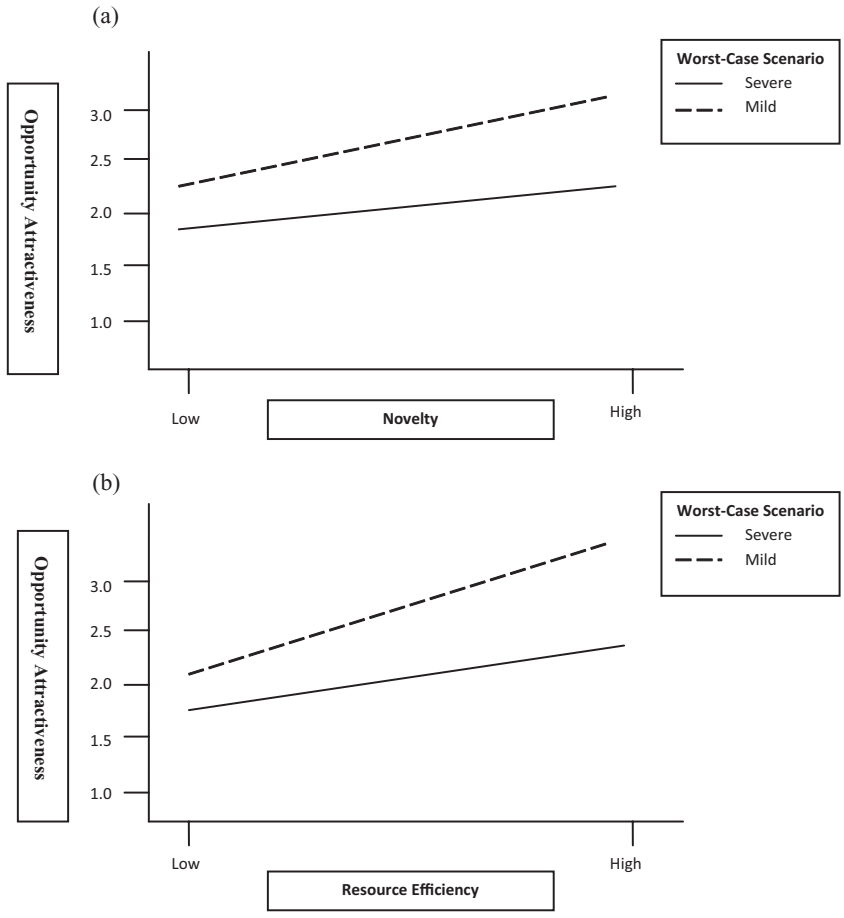

Figure 1. Moderating influence of the worst-case scenario on rules for opportunity attractiveness. (a) Worst-case scenario and novelty interaction. (b) Worst-case scenario and resource efficiency interaction

the worst-case scenario to be the most important opportunity characteristic in their evaluations of opportunity attractiveness.

After testing the main effect hypotheses, we then examined the results for the interaction effects between the opportunity rule main effects. We observed that the coefficient for the relationship between novelty and the worst-case scenario interaction term was significant ($b = -0.41$, $p < 0.05$). To interpret this effect, we graphed the interaction (Figure 1a) using estimated marginal means, and the graph revealed that as the worst-case scenario goes from mild to severe, the positive effect of high novelty becomes less positive. These results provide support for Hypothesis 4a. Finally, we found that the coefficient for the interaction term between resource efficiency and the worst-case scenario was significant ($b = -0.51$, $p < 0.05$). Figure 1b shows the graph of the interaction effect and reveals that as the worst-case scenario goes from mild to severe, the positive effect of resource efficiency becomes less positive. These findings provide support for Hypothesis 4b.

Moderating Role of Opportunity Knowledge

In addition to the main and interaction effects of the opportunity characteristics, Table I also reports cross-level interactions between opportunity rules and individual differences. These interaction terms test for the moderation effects of the entrepreneur's knowledge of the opportunity technology and knowledge of the opportunity markets. For knowledge of the opportunity technology, we observe positive and significant interactions with novelty ($b = 0.21$, $p < 0.05$) and resource efficiency ($b = 0.24$, $p < 0.05$) and a negative and significant interaction with worst-case scenario ($b = -0.22$, $p < 0.05$). For knowledge of the opportunity market, Table I also reveals positive and significant interactions with novelty ($b = 0.32$, $p < 0.001$) and resource efficiency ($b = 0.31$, $p < 0.001$) and a negative and significant interaction with worst-case scenario ($b = -0.37$, $p < 0.001$). Figure 2a–c plots the effects of the independent variable (*x*-axis) on opportunity attractiveness (*y*-axis) for low and high levels of knowledge of the technology, and Figure 3a–c plots the effects for low and high levels of knowledge of the opportunity market.

Figures 2a (3a) and 2b (3b) demonstrate that the effect of moving from low to high novelty and resource efficiency is slightly stronger for those with greater knowledge of the technology (opportunity market). These findings support Hypotheses 5a and 5b. Figures 2c and 3c tell a slightly different, and perhaps counter-intuitive, story regarding knowledge and the worst-case scenario. Specifically, we see that the rate at which attractiveness diminishes as one moves from a mild to severe worst-case scenario is greater for those with extensive knowledge of the opportunity technology or market. This suggests that as knowledge of the opportunity technology or market grows, a severe worst-case scenario has greater negative effect. Thus, the relationships stated in Hypothesis 5c are not supported. This is intriguing because rule-based logic suggests the confidence that comes with knowledge might lead one to place less of emphasis on the worst-case scenario rule, yet we found the opposite to be true. We explore this rather counter-intuitive finding in detail in the Discussion section.

DISCUSSION

We found support for our baseline idea that entrepreneurs consistently use rules (e.g. about novelty, resource efficiency, and the worst-case scenario) to systematically evaluate opportunities. Specifically, entrepreneurs evaluated opportunities more positively when the opportunity had high novelty, high resource efficiency, and a mild worst-case scenario. Additionally, the worst-case scenario moderated the relationship between the other two rule criteria and entrepreneurs' opportunity assessments such that a severe worst-case scenario weakened the positive effect of both novelty and resource efficiency on opportunity attractiveness. Finally, we found that, consistent with the entrepreneur-opportunity nexus perspective (e.g. Shane, 2003), individual differences in market and technology knowledge enhanced the positive relationship between both novelty and resource efficiency and opportunity attractiveness. Interestingly, higher levels of market and technology knowledge also strengthened, rather than mitigated, the negative influence of the worst-case scenario on entrepreneurs' opportunity evaluations.

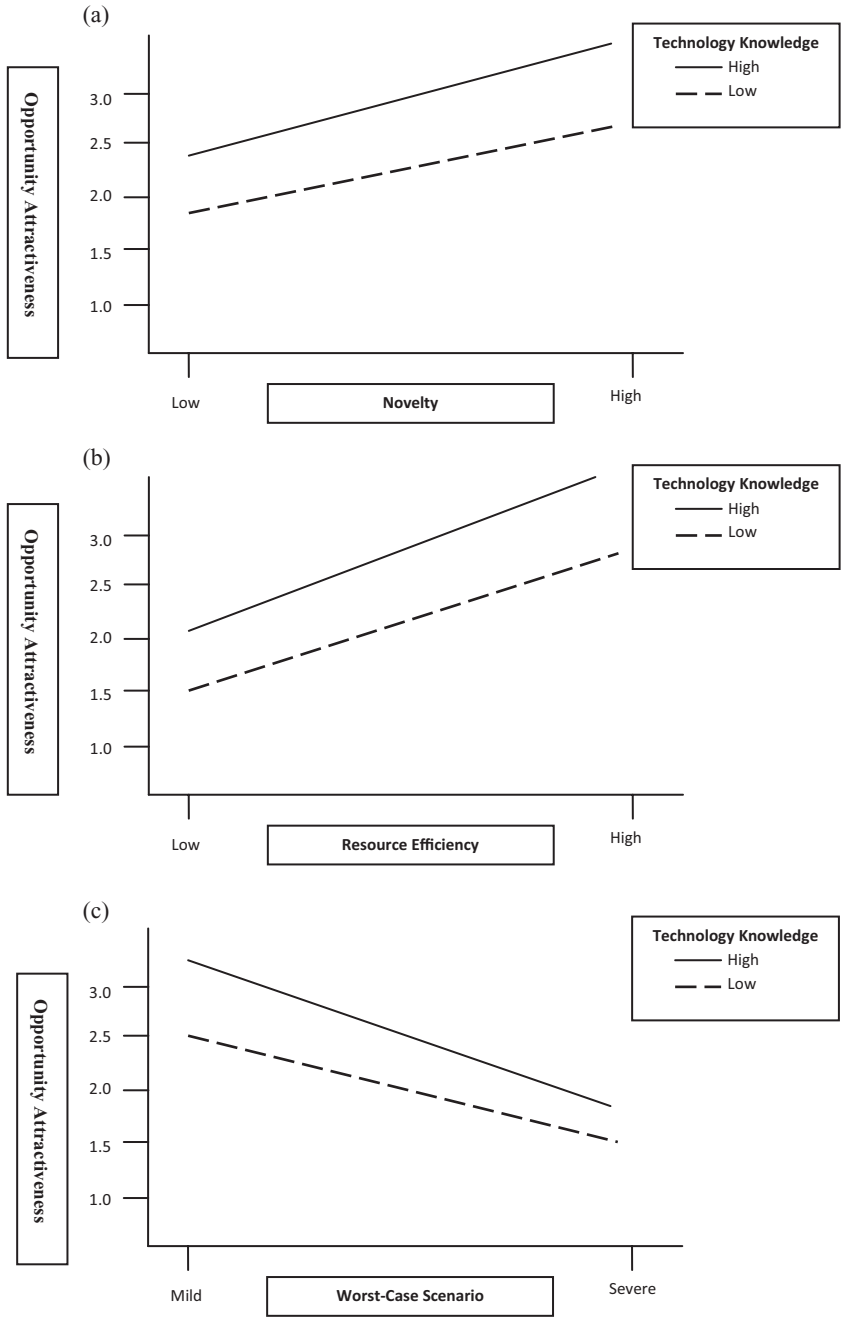

Figure 2. Moderating influence of opportunity technology knowledge on rules for opportunity attractiveness. (a) Knowledge of opportunity technology and novelty interaction. (b) Knowledge of opportunity technology and resource efficiency interaction. (c) Knowledge of opportunity technology and worst-case scenario interaction

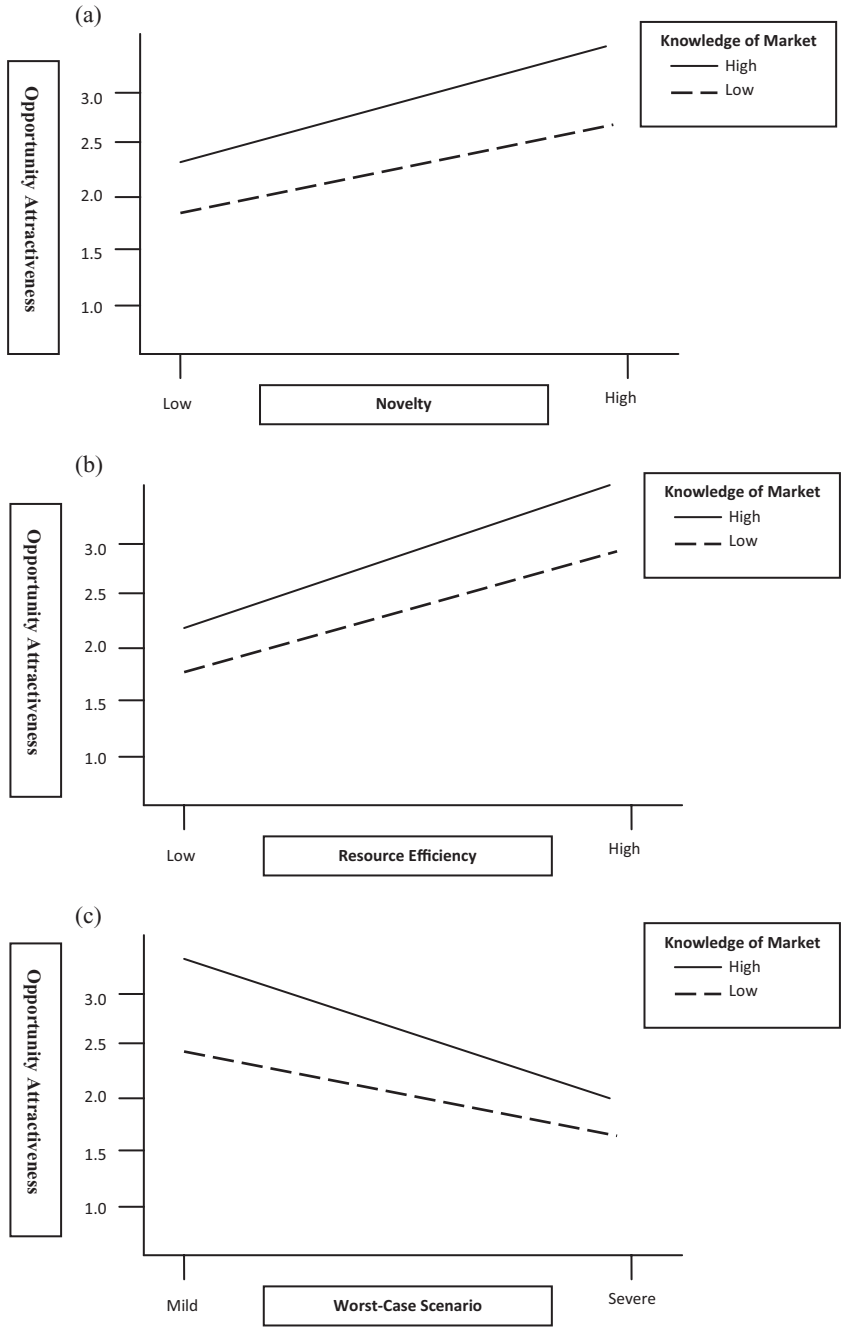

Figure 3. Moderating influence of knowledge of the opportunity market on rules for opportunity attractiveness. (a) Knowledge of opportunity market and novelty interaction. (b) Knowledge of opportunity market and resource efficiency interaction. (c) Knowledge of opportunity market and worst-case scenario interaction

Implications for Theory

A primary contribution of our work is to show that rule-based thinking appears to be one of the ways in which entrepreneurs systematically evaluate the potential of an opportunity. Thus, entrepreneurs appear to draw upon logic of 'rules for riches' as they determine if an opportunity is attractive, for them. These findings enhance our understanding of the individual-opportunity nexus because they provide new insights regarding (1) how entrepreneurs and managers determine if a potential opportunity is worthy of their time, attention, and efforts, and (2) why an individual selects 'Opportunity A' over 'Opportunity B' (Haynie et al., 2009). In order to do this, entrepreneurs or managers need a structured way in which to think about their subjective expectations of an unknowable future (Foss et al., 2008; Mahoney and Michael, 2005) as they ultimately choose which opportunity and/or if the opportunity is 'worth it'. Our findings provide evidence of the validity of our conceptualization that rule-based thinking is an important cognitive structure used as enterprising individuals attend to exogenous information (Dutton, 1993) and apply mental templates (Fiske and Taylor, 1984; Walsh, 1995) to understand and evaluate opportunities (Krueger, 2007; Mitchell and Chesteen, 1995).

Rule-based thinking, then, represents a useful and flexible framework to integrate prior – and future – research on opportunity evaluation while providing a starting point for an overarching 'theory of opportunity evaluation'. Such a theory has yet to be introduced, but our framework and findings provide a useful first step as it draws attention to the range of findings that parallel the 'rule' logic that underpins our current model. For example, prior empirical examinations of opportunity evaluation suggest the use of 'rule-like' criteria, such as minimizing risk perceptions (Keh et al., 2002), matching the opportunity to knowledge (Haynie et al., 2009), or finding the right window of opportunity (Mitchell and Shepherd, 2010). Our results, however, suggest a broader and more integrative theoretical framework for understanding opportunity evaluation: that rule-based thinking is a systematic and structured way to make opportunity evaluation decisions. Accordingly, we provide a way forward for studying opportunity evaluation by developing a deeper explanation of what rules enterprising individuals employ and the trade-offs and configurations that emerge as one evaluates if an opportunity is personally worth pursuing.

Another notable contribution to theory that also has practical implications (discussed in detail below) is our findings that the most personal of rules – the worst-case scenario – had the strongest main effect, as well as a substantial mitigating effect on the positive influence of other opportunity characteristics. These findings are insightful because the research to date has failed to consider the role of personally-subjective considerations like what do *I* think will happen to *me* if things go wrong if I pursue the opportunity? This suggests that highly-personal aspects of the decision can significantly bound the application of opportunity-specific rules and provide further evidence of the subjective nature of opportunities (e.g. Sarasvathy, 2008). Given the highly personal nature of opportunity-related processes (Wood and McKinley, 2010), a fruitful avenue for future theoretical advances is conceptualizing the degree to which feelings (Mitchell et al., 2007), emotions (Foo, 2011; Grichnik et al., 2010), and passion (Cardon et al., 2009) may moderate the degree to which rule-based content is used in opportunity evaluation. It may be that

these variables strengthen one's reliance on established rule knowledge structures or they may diminish them. As such, more research is needed that investigates the conditions under which rule-based content is likely to be used and the consequent dynamics of such behaviour.

Implications for Enterprising Individuals

While theory tells us that certain 'rules' should matter (e.g. novelty), empirical work is required to determine if and how enterprising individuals use these 'rules' in their opportunity evaluation decisions. Accordingly, our results provide useful insights regarding how the use of specific decision problem content, or rules, influence entrepreneurs' evaluations of opportunities. Further, we find that some rules are more dominant than others. For example, the magnitude of the worst-case scenario had the strongest independent effect on entrepreneurs' evaluations of opportunities, and it also weakened the effect of other opportunity characteristics (i.e. novelty and resource efficiency). The fact that the worst-case scenario was such a powerful cognitive factor is intriguing, but it also parallels research on regret in entrepreneurship (e.g. Baron, 2000) that asserts individuals spend considerable cognitive effort on trying to make decisions that do not end with regret. However, prior research has not paid much attention to the worst-case scenario, and our findings for the worst-case scenario are in line with the interpretivist view (cf. Barreto, 2012) that entrepreneurs contextualize and frame the riskiness of an opportunity in a very personal way (Palich and Bagby, 1995). Further, our findings are consistent with recent work that reveals entrepreneurs carefully consider loss, such as what level of loss is 'affordable' (Dew et al., 2009) and that entrepreneurs would rather 'risk missing than sinking the boat' (Mullins and Forlani, 2005, p. 47). The net effect could be that considerations of the worst-case scenario become significant barriers to the formation of entrepreneurial intent (Krueger, 2000) and the realization of entrepreneurial action (McMullen and Shepherd, 2006). Exploring this avenue could prove a fruitful area for future research.

Another implication of our research is that entrepreneurs apply rule-based logic that assumes a 'rule for riches' that 'a highly novel opportunity is a good opportunity for me'. Although there are definitely benefits to novelty, as outlined in the development of Hypothesis 1, prior research shows that novelty is not always a 'good' thing and may cause complexity that the entrepreneur (and his/her top management team) may struggle to accommodate (Amason et al., 2006). Hence, entrepreneurs focused on novelty face serious liabilities of newness issues (Stinchcombe, 1965), and the first-mover does not always perform better than those who follow (Aldrich, 1990; Lieberman and Montgomery, 1988). So, although our first hypothesis is supported, the rule that more novelty is better may not always be accurate. As such, it is relevant to consider what factors alter entrepreneurs' use of rules such as novelty. We found that the positive effect of novelty on entrepreneurs' opportunity evaluation is mitigated by other opportunity characteristics (e.g. the worst-case scenario) but is enhanced by individual differences in knowledge about an opportunity's market and underlying technology. These findings suggest that novelty, as a rule for evaluating opportunities, is highly dependent on a number of factors and future research could more fully address the boundary conditions

of novelty by investigating the conditions under which a focus on novelty might be detrimental.

Finally, we demonstrate that entrepreneurs seem to apply rule-based logic regarding the productive deployment of resources, as they find opportunities with more resource efficient configurations to be more attractive. By evaluating opportunities with the 'first and best use' cognitive template, entrepreneurs likely decide to exploit opportunities that minimize the resource constraints faced by most new ventures (cf. Baker and Nelson, 2005; Stinchfield et al., 2012) to make 'the most of a valuable opportunity' (Haynie et al., 2009, p. 344). However, opportunities are often under-exploited (Plummer et al., 2007), and resources are frequently under-employed (Ardichvili et al., 2003) despite the important role that resource efficiency plays in venture performance and survival (Hanlon and Saunders, 2007; Salimath et al., 2008; Wu et al., 2008). As such, entrepreneurs may use resource efficiency as a rule when evaluating potential opportunities, but our results document that this rule does not influence their evaluations as strongly as other opportunity rule content. This is puzzling given the known connection between resource utilization and venture success (Barney, 1991; Penrose, 1959). Thus, future research should examine the use of opportunity evaluation rules, such as resource efficiency, and the eventual performance of ventures launched in line with this rule.

Implications for Prior Knowledge and the Entrepreneurial Process

Individual differences in prior knowledge play a pivotal role in entrepreneurship, and research has advanced our understanding that prior knowledge influences opportunity-related cognitions (Baron and Ensley, 2006; Haynie et al., 2009). Adding to this understanding, we find that higher levels of both market and technology knowledge lead to more positive evaluations of opportunity attractiveness. While this is rather intuitive, we also document a previously undiscovered effect where higher levels of prior knowledge of the market and/or technology strengthened entrepreneurs' applications of rules for novelty and resource efficiency and also *strengthened the negative relationship* between the worst-case scenario and their opportunity attractiveness evaluations. Thus, our results provide evidence that the level of knowledge about the opportunity market and technology matter because they influence entrepreneurs' use of different rules for opportunity evaluation. In situations where the rules have a positive effect, more knowledge strengthens that relationship. However, in cases where the rules have a negative effect, that relationship is also strengthened. In our view, higher levels of knowledge strengthening the negative effect is counter-intuitive and cannot be well explained by existing theory. We speculate that knowledgeable entrepreneurs hold well developed cognitive prototypes of opportunities (cf. Baron and Ensley, 2006) that enhance confidence in their images of what will happen if the worst-case scenario comes to pass. While seemingly rational, this is interesting because it challenges the dominant theme in the literature that more knowledge increases the odds of entrepreneurial action (e.g. Haynie et al., 2009; Shane, 2000) because we find that in some circumstances more knowledge may increase the odds of *inaction*. This is an important contribution of our study because it opens up an entirely new line of research that investigates the nuances of knowledge in opportunity

evaluations. Specifically, it raises questions regarding the conditions under which knowledge paralyses the hands of entrepreneurs.

A final implication of our findings that market and opportunity knowledge matter is that entrepreneurship education should consider the degree to which knowledge should be discussed within the context of opportunity evaluation. Specifically, if entrepreneurs or students of entrepreneurship do not have personal experience with evaluation rules, they need not despair because the knowledge needed for opportunity evaluation can be codified and learned. First, entrepreneurs can be taught how to use rule-based thinking to structure the systematic evaluation of sensed opportunities. Second, they can actively seek to learn more about the possible markets for an opportunity as well as the underlying technology upon which the opportunity is based. Finally, entrepreneurs can learn specific rules that aid in evaluating opportunities; such as an attractive opportunity is one where resources are put to their first and best use. As researchers uncover additional 'rules' and the conditions under which each rule is valid, this knowledge can be incorporated into what we teach entrepreneurs about opportunity evaluation. However, it is important to note that we do not suggest that these opportunity evaluation rules are 'rules for riches' with universal application. Rather, they should be treated like the normative prescriptions from the Resource-Based View (Barney, 2001) in that the rules generally hold true, but the application of the rules is nuanced and involves unique personal considerations.

LIMITATIONS

The limitations of our research may be informative for future research on opportunity evaluation. First, although the conjoint methodology allows us to test for inter-opportunity and inter-entrepreneur differences in opportunity evaluation, it does so by using hypothetical opportunities. As such, it may be viewed as not realistic. In order to minimize this limitation, we did two things. One, we developed our conjoint following best practices in the field (cf. Priem et al., 2011; Shepherd, 2011), and we based the conjoint experiment on an actual bona-fide opportunity, as presented by Columbia University (cf. Grégoire et al., 2010). Two, we pilot tested the experiment to ensure that the rules selected from the literature were relevant and realistic for entrepreneurs. While there are many possible rules that influence entrepreneurs' evaluation judgments, we carefully grounded our choice of rules in the entrepreneurship literature, yet we encourage future research to explore additional opportunity-related rules. Further, we encourage additional research that explores rule-based thinking as opportunity evaluations unfold in the field, as well as studies that use the latest methods from neuroscience to tap into rule-based cognitive structures (Krueger and Day, 2010). Findings from these studies could overcome the limitations of experimental methods and help validate our study's results.

Further, our study measures entrepreneurs' opportunity evaluations at a single point in time. However, opportunities may unfold in more of an iterative process where one cycles through identification, evaluation, and action (cf. Wood and Mckinley, 2010). Future research should explore which rules entrepreneurs employ as they move through 'each stage of their development' (Ardichvili et al., 2003, p. 111). For example, do entrepreneurs become more rational in their use and application of rules as they get

closer to creating a new venture and must sell their idea to additional stakeholders such as employees and venture capitalists? Alternatively, do entrepreneurs become increasingly irrational in their use and application of rules the longer they have been invested in the opportunity's development? Are entrepreneurs prone to 'editing' rule-based cognitions such that negative situations are rationalized in a way that makes them less negative? Such questions provide rich avenues for future research.

A final limitation of our study is that we assumed entrepreneurs to be reasonably rational (Simon, 1955) and mindful (Corbett and McMullen, 2007), and we acknowledge that there are instances where this may not be the case. Future studies could be conducted by using our findings as a platform for investigating the conditions under which rule-based thinking is more or less rational as well as the consequences of such behaviour.

CONCLUSION

In this paper, we examine how entrepreneurs evaluate opportunities. We develop and test a theoretical model of opportunity evaluation centred on rule-based thinking, specifically testing three 'rules' that entrepreneurs are likely to use to evaluate opportunities. We further consider how individual differences in knowledge of opportunity technology and markets strengthen or attenuate the influence of those rules. In doing so, we build on the view of entrepreneurship as distinct 'phases' such as evaluation (e.g. Shane and Venkataraman, 2000) and on models of entrepreneurial action (e.g. McMullen and Shepherd, 2006) to provide a way forward to understand how entrepreneurs make use of rules to discern between opportunities that are viable and attractive 'for them' and those that hold seemingly far less potential.

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APPENDIX 1: DESCRIPTION OF ENTREPRENEURIAL OPPORTUNITY

Columbia University has announced the identification of a business opportunity based on the development of a new technology that revolutionizes the way materials are coated or plated to improve electrical conductivity and to make it easier to coat non-conductive materials.

Functional needs of the market: Materials often need to be coated or plated with metal layers to improve electrical conductivity and this is achieved via an electroplating process. This process involves passing electrical current between electrodes which results in the deposit of metal ions on the material. Non-conductive coatings prevent ions from reaching the native surface and thus metals such as aluminium and tungsten are very difficult to coat. Existing techniques to coat such metals require numerous and expensive steps.

Functional characteristics of the technology: To solve the problem and meet the needs of the market, Columbia researchers have developed a new technology called In-Situ Plating

(ISP) designed to improve the process of coating non-conductive materials. The new process involves first etching the oxide film to clean up the surface of material and then applying traditional electroplating techniques to the desired metal. The new cleaning/etching process can be combined with electroplating in the same system which leads to a significant reduction in processing steps. This leads to major reductions in processing time, raw materials, and physical space required for plating lines and results in important cost saving benefits.

ISP is a business opportunity that is *desirable* because it improves the finished product and reduces production costs. ISP is *feasible* because it builds on existing electroplating technology but is innovative and provides a *problem-based* solution. This reduces *opportunity related risk* and increases expectations that the business opportunity can quickly *generate cash flows*.

APPENDIX 2: OPPORTUNITY ATTRIBUTE DESCRIPTIONS

Novelty – High: In-Situ Plating (ISP) technology *is considered extremely novel* by industry experts.

Novelty – Low: In-Situ Plating (ISP) technology is *not considered particularly novel* by industry experts.

Resource Efficiency – High: The resources required to implement In-Situ Plating (ISP) have many potential uses and experts *consider ISP to be the first and best* use of plating production resources.

Resource Efficiency – Low: The resources required to implement In-Situ Plating (ISP) have many potential uses and experts *do not consider ISP to be the first and best use* of plating production resources.

Worst-Case Scenario – Severe: If creating a venture based on In-Situ Plating (ISP) results in production problems or is not well received by the market, the worst-case scenario is that the entrepreneur will *likely lose everything*.

Worst-Case Scenario – Mild: If creating a venture based on In-Situ Plating (ISP) results in production problems or is not well received by the market, the worst-case scenario is that the entrepreneur will *likely lose a modest amount that can be readily handled*.

APPENDIX 3: EXAMPLE DECISION PROFILE

The business opportunity is characterized as follows:

Novelty – High: In-Situ Plating (ISP) technology is considered *extremely novel* by industry experts.

Resource Efficiency – Low: The resources required to implement In-Situ Plating (ISP) have many potential uses and experts *do not consider ISP to be the first and best use* of plating production resources.

Worst-Case Scenario – Severe: If creating a venture based on In-Situ Plating (ISP) results in production problems or is not well received by the market, the worst-case scenario is that the entrepreneur will *likely lose everything*.

Based on the attributes described above, how attractive is the opportunity for *you specifically*?

Not at all attractive						Highly attractive
1	2	3	4	5	6	7

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