OPPORTUNITY RECOGNITION: A CONTINGENCY FRAMEWORK OF INDIVIDUAL ATTRIBUTES, TIME PRESSURE, AND UNCERTAINTY

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OPPORTUNITY RECOGNITION: A CONTINGENCY FRAMEWORK OF INDIVIDUAL ATTRIBUTES, TIME PRESSURE, AND UNCERTAINTY

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ABSTRACT

This dissertation clarifies individual differences in opportunity recognition as a precursor to starting a new business. Using a contingency perspective, time pressure and uncertainty are hypothesized to moderate the effects of individual attributes – entrepreneurial self-efficacy, tolerance of uncertainty, and prior experience – on opportunity recognition. This framework answers the question whether certain individuals can leverage tensions to their benefit more than others. In this study, opportunity recognition has been operationalized by two technology-centric tasks and measured as opportunity quantity and quality. A total of 227 usable responses were collected from students enrolled at the Bloch's REP program through an on-line experiment. I implemented negative binomial and linear regression analyses to measure quantity and quality respectively, and to test the individual differences of the focal variables. The analytical results demonstrate different main effects of entrepreneurial self-efficacy on quantity and quality. More importantly, the results deny the commonly-held assumption that time pressure and uncertainty adversely affect all individuals. My findings reinforce the importance of cultivating tolerance of uncertainty in students and practicing entrepreneurs for effective decision-making under high pressure business situations. This study's theoretical framework has implications for research on

opportunity recognition involving technology, and for policies designed to increase entrepreneurial behaviors.

APPROVAL PAGE

The faculty listed below, appointed by the Dean of the Henry W. Bloch School of Management, have examined a dissertation titled "Opportunity Recognition: A Contingency Framework of Individual Attributes, Time Pressure, and Uncertainty," presented by Sumita Sarma, candidate for the Doctor of Philosophy degree, and certify that in their opinion it is worthy of acceptance.

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CHAPTER 1

INTRODUCTION

"The problem is not the problem; the problem is the way we think about the problem."

– P. Watzlawick, J.H. Weakland, & R. Fisch, 2011

"The real act of discovery consists not in finding new lands but in seeing with new eyes."

– Marcel Proust, French Novelist

Do individual attributes matter for opportunity recognition? Do some individuals leverage tensions (arising out of time pressure and uncertainty) to their benefit while recognizing opportunities? These are the questions that I have attempted to answer.

Entrepreneurship research abounds in models of entrepreneurial action in both theory (e.g., McMullen & Shepherd, 2006; Sarasvathy, 2001; Shane & Venkataraman, 2000), and practice (Osterwalder & Pigneur, 2010, Osterwalder, Pigneur, Bernarda, & Smith, 2014; Ries, 2011). Entrepreneurship cannot exist without entrepreneurial opportunities (Shane & Venkataraman, 2000). Entrepreneurial opportunities are the first steps leading to entrepreneurial action (Eckhardt & Shane, 2003). Opportunities are "situations in which new goods, services, raw materials, markets and organizing methods can be introduced through the formation of new means, ends, or means-ends relationships" (Eckhardt & Shane, 2003: 336). Research on the origins of opportunities is required to explain the micro-foundations of both entrepreneurial action (Shepherd, 2015) and early stages of new venture creation (Daviddson, 2015). Accordingly, my dissertation examines opportunity recognition, which is defined as the capability to identify novel business opportunities as a precursor to starting a business (Shane & Venkataraman, 2000).

Opportunity recognition is the process through which the entrepreneur identifies a solution that has future market value (Shane, 2003). It is the initial action that culminates in other entrepreneurial actions such as opportunity evaluation and exploitation in new ventures as well as in organizations (Grégoire, Barr & Shepherd, 2010). New opportunities could be recognized during the various phases of a new venture (Shepherd, McMullen, & Ocasio, 2017). In economics, opportunity recognition means "the identification of a chance to create a new means-ends framework for recombining resources that the entrepreneurs believe will yield a profit" (Shane, 2003: 18). Opportunity recognition is a non-trivial process. Opportunities do not appear in a pre-packaged form (Venkataraman, 1997). They are either created or discovered by entrepreneurs (Alvarez & Barney, 2007). With the same baseline information, an entrepreneur could fail to recognize an opportunity or identify the wrong opportunity. Nonetheless, entrepreneurs are the most important sources of innovation and of new business ideas (Schumpeter, 1934).

The literature identified various roles and responsibilities of an entrepreneur. These are innovation, management, risk-taking, strategic planning, uncertainty-bearing, ultimate control and responsibility (Schere, 1982). Uncertainty-bearing and ultimate control and responsibility could not be delegated (Knight, 1921). They are concentrated in the hands of a single individual, the entrepreneur (Schere, 1982), as opposed to being diffused as for an entrepreneurial manager in an organization. To carry out these roles, entrepreneurs need certain attributes. The attribute of tolerance for uncertainty is required to bear environmental uncertainty during the opportunity recognition phase. To retain ultimate control and responsibility for birthing a new venture, entrepreneurial self-efficacy and experience are necessary. These attributes are regularly recognized as significant influencers of human

behavior. Also, these attributes could be acquired and mastered over time. It thus appears justified to measure these individual attributes of entrepreneurial self-efficacy, tolerance of uncertainty, and prior experience to fulfill the entrepreneurial roles of uncertainty-bearing, and ultimate control and responsibility.

Entrepreneurship research has demonstrated that opportunity recognition, as a precursor to starting a new venture, is correlated with individual attributes (e.g., entrepreneurial self-efficacy). Hmieleski, Carr and Baron (2015) found that psychological capital such as optimism, self-efficacy, and resilience positively influence opportunity creation in dynamic industry conditions that are uncertain. Dimov (2007b) stated that an opportunity is not separate from the individual. Davidsson and Honig (2003) and Dimov (2007a) conceptualized opportunity as a stream of continuously developed and modified ideas. In the same vein, McMullen and Shepherd (2006) stated that an opportunity is intertwined with individual beliefs. Klein (2008) and Shackle (1979) suggested that an opportunity exists only in the entrepreneur's imagination.

Ardichvili, Cardozo, and Ray (2003), and Shane (2000) developed models of opportunity recognition with individual attributes (e.g., knowledge derived from prior experience, self-efficacy) as antecedents. In a similar vein, stress tolerance and the willingness to bear uncertainty have been identified as antecedents of opportunity identification (Frese & Gielnik, 2014). But, the individual attribute, tolerance of uncertainty, is rarely examined, defined, or measured in entrepreneurship studies. Although similar constructs such as willingness to bear uncertainty and stress tolerance have been emphasized, they were either assumed or controlled away (McKelvie, Haynie, & Gustavsson, 2011). Taken together, the constructs of entrepreneurial self-efficacy, tolerance of uncertainty, and

prior experience are rarely examined empirically for their influence on opportunity recognition, or else their results have been inconclusive (Busenitz & Barney, 1997; Shepherd, Williams, & Patzelt, 2015). Accordingly, this study focuses on these three individual attributes. These attributes are motivational or cognitive antecedents of entrepreneurship and are important constructs related to the tasks of entrepreneurs (Frese & Gielnik, 2014).

Entrepreneurship studies that did examine these individual attributes have investigated only their main effects on opportunity recognition. Other studies focused on the main effects of situational variables (e.g., environmental uncertainty) and their influences on opportunity recognition and evaluation. For example, drawing from Milliken's (1987) typology of external uncertainty, McKelvie et al. (2011) manipulated the various types of uncertainty to test their main effects on opportunity evaluation. Packard, Clark and Klein (2017) stressed the importance of the situational factors at the point of entrepreneurial decision-making. Too often, researchers have focused on the universal or main-effects-only models. They examined either the main effects of individual attributes or situational factors on opportunities. How individual attributes vary with situational contingencies (e.g., time pressure) to influence opportunity recognition is rarely examined. To explain greater variance in opportunity recognition, a contingency model is required (Wiklund & Shepherd, 2005), especially a model that depicts a person-situation nexus for opportunity recognition (Davidsson, 2015) emerging from technology (Nambisan, 2017).

To address the gap, I developed a model of opportunity recognition driven by individual attributes of entrepreneurial self-efficacy, tolerance of uncertainty, and prior experience. The model further examined the interacting effects of two situational

(contingent) variables: time pressure and uncertainty. Hence, this study delves deeper into the basic questions of: *how does the entrepreneur perform in opportunity recognition tasks under time pressure and uncertainty?* In this study, I examined opportunity recognition through a cognitive psychological approach and with the use of an experimental design. A cognitive psychology perspective is suitable for investigating opportunity recognition. Scholars advocated this perspective for measuring entrepreneurial potential, decision-making, and actions (Baron, 2004; Begley & Boyd, 1987; Schere, 1982; Shepherd, 2015). By adopting an experimental design, I heed the words of Grégoire, Barr et al. (2010) and Grégoire, Shepherd, and Schurer Lambert (2010). They suggested manipulation of situational contingencies such as time pressure and uncertainty to simulate real-time behavior of individuals in opportunity recognition tasks, instead of depending on self-reported measures of opportunity recognition.

In my on-line experiment, I randomly assigned 227 undergraduate business students registered in the university's REP (Research Engagement Pool) to high- or low-pressure groups. The participants were presented with two scenarios about new technologies (presented in random order). They had to write down as many opportunities as possible that conveyed a meaningful concept based on a description and short video (1.5 minutes duration) of two new technologies – soft robot and virtual reality. In addition, I directly measured their entrepreneurial self-efficacy, tolerance of uncertainty, prior experience, and familiarity with the new technology. My findings show that (1) the individual attributes predict opportunity quantity and quality differently, and (2) time pressure differently moderates the relationships between individual attributes and opportunity recognition, and (3) uncertainty differently moderates these individual attributes-opportunity recognition relationships.

The main effects of the individual attributes on opportunity recognition extends Shane's (2000) finding that new technology does not generate obvious business opportunities that every entrepreneur can see. Recognizing a good quality opportunity depends on individual capabilities. Tolerance of uncertainty has been found to be an important attribute that is integral to opportunity quantity and quality. Further, in the context of new technology, entrepreneurs do not gain much through formal planning, market analysis, or information search. Information about the market or use of the new technology does not yet exist. My study's findings explain one way of birthing a new venture without a formal search. Rather, given limited information, it depended on how an individual thought about the problem and acted on it at the point of decision-making (Packard et al., 2017).

In addition to enhancing the explanatory power of opportunity recognition models, my findings suggest an extension of entrepreneurship theory. Most of the entrepreneurship models assume the existence and ubiquity of time pressure and uncertainty. But how individuals cope and how they handle these high-pressure situations were not deeply examined. My results of the moderating effects counter the commonly-held assumption that high time pressure or uncertainty are stressors that deplete individual performance. Time pressure and uncertainty are performance enhancers to certain individuals. The ability to withstand time pressure and uncertainty are crucial for being the first in the market (McCaffrey, 2014).

The remainder of the dissertation is structured as follows. Chapter 2 provides the theoretical development for the main effects and moderating effects relationships between opportunity recognition, individual attributes, time pressure, and uncertainty. The chapter then introduces the conceptual model and hypotheses of the dissertation. Chapter 3

transitions to the research method, providing information on the experiment setting, research material, sample and data collection, and study measures. My experiment had two technology-centered scenarios or studies, which were independently analyzed. As such, the analyses and results for the two scenarios are dealt with in separate chapters. Chapter 4 provides the manipulation check results, analytical strategy and regression results, and robustness checks for the soft robot scenario. Chapter 5 provides the manipulation check results, analytical strategy and regression results, and robustness checks for the virtual reality scenario. Finally, Chapter 6 provides a broader discussion of the results, implications for theory and practice, limitations of the current study, and suggestions for future research.

CHAPTER 2

THEORETICAL DEVELOPMENT

ENTREPRENEURIAL OPPORTUNITIES

Entrepreneurship literature has extensively studied the ontological and epistemological nature of opportunities (Alvarez & Barney, 2007; Foss & Klein, 2010). The literature has also equated opportunities with new venture creation (Nicolaou, Shane, Cherkas & Spector, 2009). The basic premise behind opportunities or venture creation was the introduction of new goods, services, raw materials and organizing methods to the market. These new things allowed outputs to sell higher than their cost of production (Shane, 2000). Among the earlier research, Stevenson (1983: 3) defined entrepreneurship as "the pursuit of opportunity without regard to resources that currently controlled." Venkataraman's (1997) seminal work encouraged scholars to delve deeper into understanding the concept of "opportunity" and its dependency on the individual entrepreneur. Opportunities are said to exist because of individual differences in beliefs and experiences about the relative value of resources when they are converted from inputs to outputs (Alvarez & Busenitz, 2001). The conceptualization of opportunities demonstrated the emphasis placed on the individuals for their entrepreneurial pursuits. Nonetheless, opportunity has proved to be an elusive construct with a divergent range of definitions as Table 1 shows.

OPPORTUNITY RECOGNITION

The concept of opportunities is underpinned by the perspectives of discovery and/or creation as a precursor of creating a new venture. Opportunity discovery implies that opportunities objectively exist as undiscovered entities (Kirzner, 1973; Shane & Venkataraman, 2000). On the other hand, the opportunity creation perspective (Alvarez &

Table 1: Definitions of Entrepreneurial Opportunity

Work	Definition
Shane & Venkataraman (2000)	Situations in which new goods, services, raw materials, and organizing processes can be introduced and sold at greater prices than their cost of production.
Shane (2003)	A situation in which a person can create a new means–ends framework for recombining resources that the entrepreneur believes will yield a profit.
Eckhardt & Shane (2003)	Unexploited profitable combinations of what is technologically feasible and market feasible. Exist independent of human perception.
Dimov (2003)	A perceived possibility of economic gain.
Sarasvathy, Dew, Velamuri, & Venkataraman (2003)	New ideas or inventions that may or may not lead to the achievement of one or more economic ends that become possible through those ideas or inventions. Beliefs about things favorable to the achievement of possible valuable ends. And actions that generate and implement those ends through specific (imagined) new economic artifacts.
Nicolaou et al. (2009)	Opportunity recognition is the identification of a chance to combine resources in a way that might generate a profit.
Grégoire & Shepherd (2010)	Situations that are relevant for introducing new or improved products, services, or ways of doing business to better serve the needs of consumers in one or more market(s).
Wood & McKinley (2010)	Opportunities concern the introduction of new and/or improved means of supply (e.g., new products, services, or ways of doing business) to better serve the needs of consumers in one or more markets.
Davidsson (2015)	Opportunities are divided into three constructs: (1) External enablers – aggregate-level circumstances like regulatory changes, technological breakthroughs and other contexts that can affect a variety of new venture creation. (2) New Venture Ideas – denotes the "imagined future ventures." (3) Opportunity Confidence – the individual's subjective evaluation of the attractiveness or lack thereof of a stimulus.

Barney, 2007) denies that opportunities are pre-existing entities in the external environment. This perspective advocates that opportunities are created endogenously through entrepreneurial agency (Sarasvathy, 2001: Wood & McKinley, 2010) and constructivist reorientation (Venkataraman, Sarasvathy, Dew, & Forster, 2012). Another emergent perspective related to opportunity is the "actualization approach" (Ramoglou & Tsang, 2016). This approach conceptualizes opportunities as unactualized propensities. It serves a dual role by maintaining the "objectivity" of opportunities without the shortcomings of the "discovery" perspective. Opportunity recognition does involve subjective efforts to comprehend one's environment and imagine the "to-be" (e.g., how to introduce a new technology) (Grégoire, Shepherd et al., 2010). Opportunity recognition is underpinned by the formation of subjective beliefs that an opportunity exists for the willing and able, as distinct from evaluating the opportunity (Grégoire, Shepherd et al., 2010). Table 2 sums up the definitions of opportunity recognition and its related concepts.

Table 2: Definitions of Opportunity Recognition and Closely-related Concepts

Opportunity Recognition	**Opportunity Discovery**	**Opportunity Creation**	**Opportunity Actualization**
A process wherein efforts are made to make sense of signals of change (e.g. new information about new conditions) to form beliefs regarding if enacting a course of action to address this change could lead to net benefits (for instance, in terms of profits, growth, competitive jockeying, and/or other forms of individual or organizational gains) (Grégoire, Barr et al., 2010).	Entrepreneurs discover opportunities that pre-exist independently of entrepreneurs as empirically undiscovered entities (Alvarez & Barney, 2007).	Opportunities do not exist until they are created endogenously by entrepreneurs (Alvarez & Barney, 2007).	Opportunities are propensities that exist independently of potential entrepreneurs, in the form of unmet or possible market demand that can be actualized into profits (Ramoglou & Tsang, 2016).

A debate on the distinctions between opportunity recognition and the three similar constructs (discovery, creation, and actualization) is a comprehensive topic on its own and is beyond the scope of this study. The emphasis is on the fact that, irrespective of the definition, the act of recognizing or discovering or creating an opportunity lies at the core of entrepreneurship. This concept is especially relevant prior to birthing a new venture and earning an entrepreneurial profit in the market (Alvarez & Barney, 2007). For example, "smart cities" is an emerging phenomenon that caters to rapid urbanization. However, to start a venture in the context of smart city, entrepreneurs must first recognize/discover/create opportunities that will make a city "smart" (e.g., through digital inter-connectedness, by reducing the digital divide and so forth). Hence, for any new context, the process of opportunity recognition is necessary and critical before any changes can be enacted.

INDIVIDUAL ATTRIBUTES AND OPPORTUNITY RECOGNITION

The entrepreneurship literature has identified six influential antecedents of opportunity recognition. At the micro-level, opportunity recognition correlates with heuristics (Alvarez & Busenitz, 2001; Holcomb, Ireland, Holmes & Hitt, 2009; Shepherd et al., 2015), prior knowledge (Shane, 2000), information asymmetry and alertness (Kirzner, 1997; McCaffrey, 2014), human and social capital (Davidsson & Honig, 2003), and networks (Ozgen & Baron, 2007). Cognitive traits such as pattern recognition (Baron & Ensley, 2006), learning ability (Corbett, 2005, 2007), connecting the dots (Baron, 2006), and structural alignment (Grégoire, Barr et al., 2010) also influence opportunity recognition. Shane (2000) asserted that opportunity recognition requires distinctive cognitive feats by individuals. Prior knowledge and experiences of entrepreneurs help in accomplishing those feats. At the macro-

level, opportunity recognition correlates with environmental conditions (George, Parida, Lahti & Wincent, 2016). For a detailed review, also see Vogel (2017).

Corbett (2007) and Shepherd and DeTienne (2005) experimentally established that learning and prior knowledge respectively influenced opportunity recognition (Ardichvilli et al., 2003; DeTienne & Chandler, 2004; Dimov, 2003; Eckhardt & Shane, 2003; Hayek, 1945). They found that prior knowledge positively influenced both opportunity quantity and quality. To build on their findings, the authors identified self-efficacy as an antecedent of opportunity recognition (Shepherd & DeTienne, 2005). In their model, Grégoire, Barr et al. (2010) conceptualized opportunity recognition as a cognitive process of structural alignment in individuals. They collected data through think-aloud protocols. They used a sample of entrepreneurs who had to identify new opportunities emerging from new technologies. As future research, the authors suggested experiments with contingency factors (e.g., time pressure). Manipulations in an experimental setting allow researchers to observe the decision-making behavior of individuals in real time as opposed to just recalling past experiences (Gaglio & Katz, 2001).

Entrepreneurship literature has established that individual-level attributes affect opportunity recognition. It is obvious that not all individuals can identify all opportunities. This raises the question: Are certain individual attributes more important than others for opportunity recognition, especially under high pressure situations and contingencies? To answer these question, I focused on three individual attributes: entrepreneurial self-efficacy, tolerance of uncertainty, and prior work experience. In the following paragraph, I briefly explain why I selected these three individual attributes as opposed to others. I address these

issues in detail in subsequent discussions of individual attributes and their relationships with opportunity recognition.

Entrepreneurial self-efficacy and prior experience are shown to influence decision-making related to opportunity recognition. The third attribute, tolerance of uncertainty, is yet to be empirically established as an important contributor of opportunity recognition. The entrepreneurship literature has theoretically established that the willingness to bear uncertainty or stress tolerance is an important skill of the entrepreneur (Frese & Gielnik, 2014). However, empirical evidence to support this theoretical notion has been lacking so far. To address this gap, I considered tolerance of uncertainty as an important driver of opportunity recognition.

Additionally, individuals who possess one or more of these three attributes show higher adaptive behaviors to reach their goals, even when faced with obstacles (Bandura, 1977, 1997; Hmieleski et al., 2015; Packard et al., 2017). These attributes are closest to action and action intentionality (Boyd & Vozikis, 1994) and have been identified as important motivational and cognitive antecedents of opportunity recognition (Frese & Gielnik, 2014). Literature has pointed out various roles and responsibilities of an entrepreneur. These are innovation, management, risk-taking, strategic planning, uncertainty-bearing, ultimate control and responsibility (Schere, 1982). Uncertainty-bearing and ultimate control and responsibility cannot be delegated (Knight, 1921). They are concentrated in the hands of a single individual, the entrepreneur (Schere, 1982) as opposed to being diffused for an entrepreneurial manager in an organization. To carry out these roles, entrepreneurs need certain attributes. The attribute of tolerance for uncertainty is required to bear environmental uncertainty during the opportunity recognition phase. To retain ultimate control and

responsibility for birthing a new venture, entrepreneurial self-efficacy and experience are necessary. Moreover, these attributes can be acquired and mastered over time. It thus appears justified to measure the three individual attributes of entrepreneurial self-efficacy, tolerance of uncertainty, and prior experience to fulfill the entrepreneurial roles of opportunity recognition and examine how these individual attributes vary to situational contingencies of time pressure and uncertainty during the opportunity recognition phase. To test my study hypotheses, I developed a contingency-effects (two-way interactions) model in an attempt to explain greater variance in opportunity recognition. FIGURE 1 shows my conceptual model.

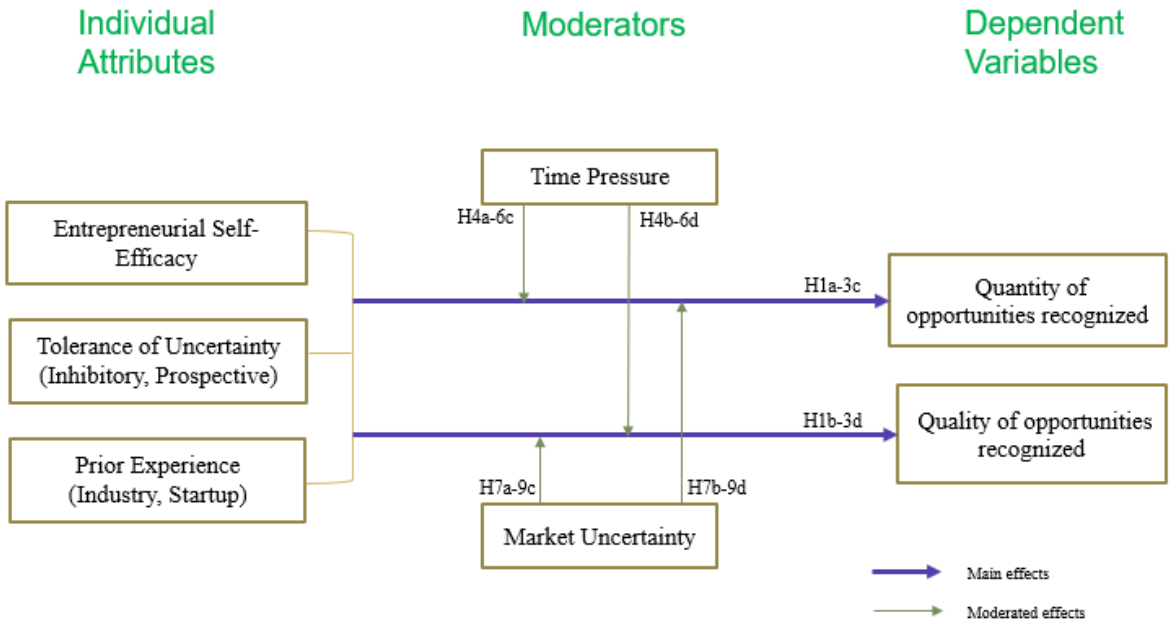

Figure 1. Conceptual Model

Entrepreneurial Self-efficacy and Opportunity Recognition

Entrepreneurial self-efficacy has been derived from Bandura's (1977) social cognitive theory. Entrepreneurial self-efficacy is task-specific and is the "strength of a person's belief that he or she is capable of successfully performing the various roles and tasks of entrepreneurship" (Chen, Greene & Crick, 1998: 295). It is closely linked with action and the

intentionality of action (Boyd & Vozikis, 1994) and is identified as a motivational antecedent of entrepreneurship (Frese & Gielnik, 2014). Several entrepreneurship studies have examined both the general construct of self-efficacy as well as the specific construct of entrepreneurial self-efficacy. The entrepreneurial intentions literature has extensively examined the theory of self-efficacy (Chen et al., 1998; Krueger, Reilly & Carsrud, 2000; Zhao, Seibert & Hills, 2005), and to a lesser extent by the opportunity recognition literature (Ardichvilli et al., 2003; Gibbs, 2009; Hmieleski & Corbett, 2008; Krueger et al., 2000; Ozgen & Baron, 2007; Tumasjan & Braun, 2012).

Krueger and Dickson (1994) showed that opportunity recognition positively correlated with general self-efficacy among managers. Ardichvilli et al. (2003) argued that individuals with high self-efficacy focused on pursuing potentially valuable opportunities. In contrast, those with low self-efficacy tended to avoid risks and perceived threats rather than opportunities (Krueger & Dickson, 1994). In the same line, Chen et al. (1998) found that entrepreneurial self-efficacy distinguishes entrepreneurs from managers (Markman, Balkin & Baron, 2002). Likewise, Baum and Locke (2004) showed positive correlation between entrepreneurial self-efficacy and new venture growth. Hmieleski and Corbett (2008), and Forbes (2005) found positive correlations between entrepreneurial self-efficacy and new venture performance. In yet another study on opportunity recognition, Ozgen and Baron (2007) found that highly self-efficacious individuals engaged in a more proactive search and were more confident in opportunity recognition (Wilson, Kickul & Marlino, 2007).

In summary, extant research demonstrated positive correlations between opportunity recognition and self-efficacy. However, heeding the reasons put forth by entrepreneurship scholars, I focused on *entrepreneurial* self-efficacy in my study. Task-specific self-efficacy

is superior in predicting task-specific performance compared to general self-efficacy (Bandura, 1977, 1997; Chen et al., 1998; Shinnar, Hsu, & Powell, 2014; McGee, Peterson & Sequeira, 2009). Further, research shows that entrepreneurial self-efficacy is a more precise measure in studies of opportunity recognition and venture growth (Baum & Locke, 2004; Forbes, 2005; Gibbs, 2009; Hmieleski & Corbett, 2008; Tumasjan & Braun, 2012). Scholars have advocated further investigation of self-efficacy and opportunity recognition in order to understand the relationship between individuals' self-proclaimed competence at identifying opportunities and the actual quantity (number) and quality of opportunities they recognized (Shepherd & DeTienne, 2005: 106; Tumasjan & Braun, 2012).

The existing studies that examined the link between self-efficacy and opportunity recognition have several shortcomings. These studies are mostly conceptual in nature (Gibbs, 2009; Tumasjan & Braun, 2012). The few empirical studies that examine the relationship between self-efficacy and opportunity recognition depend on self-reported measures of opportunity recognition (Ozgen & Baron, 2007) or they depend on self-reported opportunity recognition perceptions and beliefs. These studies do not measure opportunity recognition per se (Gibbs, 2009), which requires individuals to think on the spot and generate opportunities, rather than just recalling past experiences (Gaglio & Katz, 2001). Hence, these studies face criticisms of suffering from self-report bias (Grégoire, Barr et al., 2010; Grégoire, Shepherd et al., 2010; Podsakoff, MacKenzie, Lee & Podsakoff, 2003). An empirical study by Tumasjan and Braun (2012) examined entrepreneurial self-efficacy as a moderator for the relationship between promotion focus and opportunity recognition. The study reported negative moderation effects of entrepreneurial self-efficacy for both opportunity quantity and quality. Thus, despite conceptually knowing that self-efficacy is

important for opportunity recognition, our knowledge of the role of entrepreneurial self-efficacy on opportunity recognition remains a bit inconclusive and fragmented (Tumasjan & Braun, 2012).

In this study, I discuss what has been acknowledged in the entrepreneurship and management literature. First, that individuals with high entrepreneurial self-efficacy tend to interpret demands and problems as challenges rather than as hindrances (McGee et al., 2009). This interpretation could lead to a sense of well-being that can result in superior performance. Second, self-efficacious individuals are more likely to pay attention to their tasks at hand and exert greater effort. Third, when faced with hurdles, efficacious individuals will show tenacity and perseverance (Bandura, 1977). They will view challenging problems as tasks to be mastered with a commitment to the task at hand. Thus, these self-efficacious individuals focus on opportunities worth pursuing. In contrast, individuals with a weak sense of self-efficacy might avoid challenging tasks (e.g., identifying new opportunities) or believe that difficult tasks and situations are beyond their capabilities. This will lead them to accept premature defeat in the face of challenging tasks. Hence, I hypothesized what has already been formulated in other studies as,

> *H1a: Individuals with higher levels of entrepreneurial self-efficacy will recognize more opportunities.*
>
> *H1b: Individuals with higher levels of entrepreneurial self-efficacy will recognize higher quality opportunities.*

Tolerance of Uncertainty and Opportunity Recognition

Entrepreneurs decide and act under uncertainty (Packard et al., 2017; Shepherd et al., 2015), especially Knightian uncertainty (Knight, 1921; Sarasvathy, 2001). They must make judgments and decisions based on imagined outcomes of future possibilities (Shackle, 1979).

A startup is an organization dedicated to creating something new under conditions of extreme uncertainty (Ries, 2011). Uncertainty refers to the lack of information and unpredictability of the market. This uncertainty cannot be mitigated by data-gathering and analysis or search unlike risk (Tversky & Kahneman, 1975) or ambiguity (Packard et al., 2017). Recognizing business opportunities that involves radically new technologies represent true uncertainty (Packard et al., 2017). The set of input choices and the set of outcomes are open, and probability distributions are unknown. This is in contrast to ambiguity, which assumes an "ergodic stochastic context with a finite set of options and outcomes, but with unknown probability distributions of possible outcomes" (Packard et al., 2017: 5). Examples of ambiguous situations are insurance and gambling. There are differences between risk, ambiguity, and uncertainty depending on the context. A detailed discussion regarding the distinction among these three types is beyond the scope of this study (see Packard et al., 2017 for a review).

In summary, entrepreneurs face risk, ambiguity, and uncertainty depending on the stage in their entrepreneurship journey, and entrepreneurs need to have a tolerance for these. However, the constructs of either risk-taking or tolerance to ambiguity may not be a substitute for the construct of tolerance of uncertainty. Also, the concept of tolerance of uncertainty has not been explicitly mentioned by entrepreneurship scholars. In entrepreneurship, especially technology entrepreneurship, true uncertainty is present where probabilities are indeterminate. Accordingly, entrepreneurs high in tolerance for uncertainty could deal effectively (i.e., without psychological discomfort or threat), with uncertain situations (Packard et al., 2017; Schere, 1982). The higher the tolerance for uncertainty, the

more superior the performance outcomes (Miron-Spektor, Ingram, Keller, Smith & Lewis, 2017).

In the psychology (clinical, social, and personality) and healthcare literature, scholars have validated various measures of (in)tolerance of uncertainty and ambiguity (Budner, 1962; Buhr & Dugas, 2002; Carleton, Norton & Asmundson, 2007). Entrepreneurship scholars have measured tolerance of ambiguity as a discriminating variable between entrepreneurs and managers (Begley & Boyd, 1987; Schere, 1982). However, given that entrepreneurs face true uncertainty, especially at the pre-venture creation phase (Packard et al., 2017), tolerance for uncertainty seemed more appropriate for further analysis. Intolerance of uncertainty is the "notion that negative elements may occur and there is no definitive way of predicting such events" (Carleton et al., 2007: 106). It is also the inclination to "react negatively to an uncertain event or situation" (Ladouceur, Gosselin & Dugas, 2000: 934). Intolerance of uncertainty arises due to two types of anxiety (Carleton et al., 2007). The first one is inhibitory anxiety. This anxiety is related to action paralysis in the face of uncertainty and/or the inability to function well when faced with uncertainty (Carleton et al., 2007). Lack of information and unpredictability of the future trigger both these anxieties. The second one is prospective anxiety, which pertains to anxiety about uncertain future events. It arises out of the need for upfront planning and an aversion to any deviation from it, resulting in avoidance behavior (Carleton et al., 2007).

The vocational development literature adapted the intolerance of uncertainty scale. Researchers took the reverse scores for the said scale and named it as tolerance of uncertainty. The construct was then examined as a mediator between career identity and life satisfaction (Garrison, Lee & Ali, 2017). In another study, tolerance of uncertainty showed

positive moderating effects on the relationship between career decision and career satisfaction (Kim, Rhee, Ha, Yang & Lee, 2016). In a management study of entrepreneurial firms, tolerance of uncertainty was examined as a cultural trait at the national level (Steensma, Marino, Weaver & Dickson, 2000), that influenced the dynamics of technology alliance formation.

So far, entrepreneurship studies have not yet directly used nor measured the construct of tolerance of uncertainty. Neither has any study provided empirical evidence to support the theoretical notion that the willingness to bear uncertainty or possession of stress tolerance (Frese & Gielnik, 2014) results in superior outcomes. Entrepreneurs tackle and manage uncertainty in the following ways (Packard et al., 2017). They make selections from their belief systems. They also draw from their prior experience and knowledge. They might use their capability (e.g., tolerance of uncertainty) to counter any environmental uncertainty. Hence, tolerance of uncertainty is an important individual attribute that can benefit entrepreneurs in the various stages. To address the gap, I examined the impact of tolerance of uncertainty on opportunity recognition in this study.

Hypothesis development linking tolerance of uncertainty and opportunity recognition. Individuals differ in the way they view and respond to uncertainty. Some individuals view uncertainty as desirable while others see it as threatening or as a hindrance (LePine, Podsakoff & LePine, 2005; Ventura, Salanova, & Llorens, 2015). Those who view uncertainty as threatening might feel that uncertainty is paralyzing (e.g., "when it's time to act, uncertainty paralyzes me"). They might feel that uncertainty compromises individual functioning (e.g., "when I am uncertain I can't function very well"). And finally, uncertainty in these individuals will lead to action inhibition (e.g., "the smallest doubt can stop me from

acting") (Carleton, Collimore, & Asmundson, 2010). These responses are due to inhibitory anxiety that inhibits normal functioning in individuals. In short, intolerance to uncertainty mitigates an individual's capacity to perform tasks.

On the other hand, individuals with high tolerance of uncertainty remain calm and composed in any situation. This releases their brain-bandwidth (mental resources) to effectively deal with an imminent task. Their resilience would not be compromised, and they could move forward in their lives (Einstein, 2014). So, rather than lamenting the negative aspects of a situation (Miron-Spektor et al., 2017), tolerant individuals would fully engage with the task. Hence, for individuals who have overcome their inhibitory anxiety, I hypothesized as follows:

> *H2a: Individuals with high tolerance of uncertainty (lower levels of inhibitory anxiety) will recognize more opportunities.*
>
> *H2b: Individuals with high tolerance of uncertainty (lower levels of inhibitory anxiety) will recognize higher quality opportunities.*

Those individuals who view uncertainty as threatening show a preference for certainty when engaging in problem solving tasks (Einstein, 2014). These individuals tend to get upset by unforeseen events. They always want to look ahead to avoid surprises, and they want to know what the future has in store for them (Carleton et al., 2007). The preference for certainty results in prospective anxiety in individuals when they face uncertain situations. This anxiety suggests that unexpected events spoil everything and prevent an individual from being prepared (Einstein, 2014). Hence, it can prevent an individual from taking decisions when complete information is not available (Einstein, 2014).

On the other hand, individuals with high tolerance for uncertainty (with respect to lower prospective anxiety) are empowered with certain internal features. They are not

frustrated by uncertain situations (Carleton et al., 2007), nor do they have the need for predictability (Einstein, 2014). They can overcome their doubts and accept that the future is unknown and unpredictable (Carleton et al., 2010). They also realize that they cannot plan or organize everything in advance (Carleton et al., 2007). They can adapt to the situational demands and accept things which are not controllable (Budner, 1962; Carleton et al., 2007, 2010).

Individuals might develop uncertainty tolerance either by choosing (consciously or unconsciously) to ignore uncertainty, or by attempting to solve unsolvable problems. Over time, individuals who practice solving unsolvable problems may be habituated to view uncertainty as a challenge. They will not be frustrated or upset when dealing with uncertainty. Another way that individuals might enhance tolerance of uncertainty is being mindful of the present (Bird & West, 1998). Being mindful allows individuals to make sense and handle the task at hand without questioning. Thus, I hypothesized the following relationships between tolerance of uncertainty (with respect to lower prospective anxiety) and opportunity recognition as:

> *H2c: Individuals with high tolerance of uncertainty (lower levels of prospective anxiety) will recognize more opportunities.*
>
> *H2d: Individuals with high tolerance of uncertainty (lower levels of prospective anxiety) will recognize higher quality opportunities.*

Prior Experience and Opportunity Recognition

Prior work experience is a form of human capital. It contributes to the development of competences, abilities, and skills in individuals (Hmieleski et al., 2015; Wright, Hmieleski, Siegel & Ensley, 2007). The competences, in turn, can drive and incentivize entrepreneurial actions (Davidsson & Honig, 2003). Experience is underpinned by knowledge, which is a

cognitive antecedent of opportunity recognition (Frese & Gielnik, 2014; Shane 2000). The literature identified two types of work experience: industry experience and startup experience (Gimeno, Folta, Cooper, & Woo, 1997; Shane, 2003).

Industry experience. Industry experience is a part of human capital. It has been extensively studied in the entrepreneurship (Hmieleski et al., 2015), and management literature (Hambrick & Quigley, 2014). Individuals with industry experience are acknowledged to comprehend the competitive nature of business (Kor, 2003). Industry-specific knowledge has been useful in identifying entrepreneurial opportunities (Delmar & Shane, 2006; Jin, Madison, Kraiczy, Kellermanns, Crook & Xi, 2017). It also helped in pursuing growth opportunities (Alvarez & Busenitz, 2001) in existing industries and markets (Hmieleski et al., 2015). Prior industry experience was shown to be an important indicator of venture success in the case of medical devices (Chatterji, 2009), Silicon Valley law firms (Phillips, 2002), and in laser-industry startups (Klepper & Sleeper, 2005). Cao and Im (2018) found that same-industry experience positively related to the research and development search intensity of new technology ventures. So, industry experience shaped industry-specific learning, which was translated to the new venture *provided they are both in the same industry* (Eggers & Song, 2015).

If the entrepreneur switches industry (i.e., start venturing in an industry different than his/her previous employment), there might be adverse effects of changing industries (Eggers & Song, 2015). They would be disadvantaged from abandoning their previous industry experience. The knowledge that the individual gained was industry-specific human capital, which had limited or no applicability to other industry contexts (Campbell, Coff, & Kryscynski, 2012). For example, an individual with previous manufacturing experience

(through employment) might be at a disadvantage, compared to others, if he/she wants to start a venture in the hotel or retail or financial industry. The longer the previous industry experience, the less the relevance in a new industry, and the more difficult is the industry switch. Expertise can decay because of the industry switching (Eggers & Song, 2015). Further, some industries (e.g., technology) might require more specialized knowledge than others. These suggest that entrepreneurs are penalized for switching industries (Eggers & Song, 2015) and that industry change can be the costliest for subsequent venture performance.

In my study, I focused on opportunity recognition emerging from two new technologies: soft robot and virtual reality. These technologies are yet to be proven in the market. They do not arise from existing industries or markets (Hmieleski et al., 2015). An experienced individual who starts venturing in any of these technologies would most likely be switching industries. Their possibility of having worked in either the soft robot or the virtual reality industry is small given the newness of both technologies. Moreover, industry-specific competence has not shown any positive effect on pre-venturing activities (e.g., opportunity recognition) (Chatterji, 2009). When asked to identify opportunities emerging from new technology, experienced individuals would tend to draw from their existing experience to interpret the issues at hand, then process the information given, before generating opportunities (Finkelstein, Hambrick, & Cannella, 2009). Prior and extensive industry experience might prove counter-productive to innovative thinking about new technology. Further, individuals with extensive industry experience might be prone to reduced cognitive flexibility with lessened willingness to adapt to change (Denrell & March, 2001). This can result in their inability to effectively navigate the uncertainty associated with

identifying opportunities arising from a new technology (Hmieleski et al., 2015). This logic leads me to the following hypothesis:

> *H3a*: *Individuals with prior industry experience will recognize fewer number of opportunities.*
>
> *H3b: Individuals with prior industry experience will recognize lower quality opportunities.*

Startup experience. Existing research shows mixed results for the relationship between startup experience and entrepreneurial performance (Delmar & Shane, 2006; Jin et al., 2017; Unger, Rauch, Frese & Rosenbusch, 2011). Nonetheless, individuals with prior startup or entrepreneurial experience identified new opportunities and subsequently grew a new business (Dimov, 2010). Irrespective of prior venture success or failure, the startup experience positively influenced identification of entrepreneurial opportunities, intentions and subsequent successes (Ucbasaran, Westhead, Wright & Flores, 2010; Ucbasaran, Wright, Westhead & Busenitz, 2003). Alvarez, Barney and Anderson (2013: 9-10) argued that "actors who have already gone through this process may not be concerned with the uncertainty of outcomes, or the trial-and-error decision-making process through experimentation." In the same vein, Dimov (2011) stated that individuals with entrepreneurial experience are more likely to demonstrate higher tolerance for decision uncertainty, having "honed their ability to act in the context of missing information or lack of feedback" (Hmieleski et al., 2015: 294).

Additionally, prior startup experience can enhance an aspiring founder's ability to detect and assimilate valuable new information and thereby mitigate uncertainty (Haynie, Shepherd & McMullen 2009). Following this logic, I argued that individuals with prior startup experience will show superior performance in opportunity recognition tasks. Generalizing:

H3c: *Individuals with prior startup experience will recognize more opportunities.*

H3d: Individuals with prior startup experience will recognize higher quality opportunities.

TIME PRESSURE – FIRST SITUATIONAL CONTINGENCY

Time pressure is the "perception that there is a scarcity of time available to complete the task, or set of tasks, relative to the demands of the task(s) at hand" (Maruping, Venkatesh, Thatcher, & Patel, 2015: 1315). (Also see Cooper, Dewe & O'Driscoll, 2001; McGrath & Kelly, 1986). Time pressure relates to the objective clock time (Kunisch, Bartunek, Mueller & Huy, 2017) and is an evaluation of the task environment; i.e., it is a situational contingency (Maruping et al., 2015). Contingencies of time pressure implies resource scarcity. This gives rise to tensions which, in turn, affects individual behavior and performance (Miron-Spektor et al., 2017). Time pressure has been shown to stifle employee creativity (Byron, Khazanchi & Nazarian, 2010; Hsu & Fan, 2010) because individuals handled time pressure by blanking out some information, or by adopting simpler cognitive strategies, or by using heuristics to complete their tasks (Miron-Spektor et al., 2017), which can result in inferior task "quality." On the other hand, vocational behavior studies portrayed time pressure as an ambivalent challenge stressor. That is, time pressure affected both positive and negative well-being of individuals (Widmer, Semmer, Kälin, Jacobshagen & Meier, 2012).

Management research has emphasized the positive effects of time pressure. Smith (2014) found that time pressure to develop innovation quickly in software resulted in a lower quality product, no doubt, but it allowed the software firm to emerge as a legitimate competitor. Widmer et al. (2012) conceptualized time pressure as a challenge stressor that enhanced productivity. Time pressure resulted in enhanced motivation (LePine et al., 2005),

positive affect, feelings of enjoyment, and even euphoria (Boswell, Olson-Buchanan & LePine, 2004). On the other hand, time pressure showed negative outcomes on the well-being (e.g., by inducing strain and stress) of employees (Byron et al., 2010).

The entrepreneurship literature has not yet examined the concept of time pressure as an ambivalent challenge stressor. Entrepreneurship involves high time pressure, work demands, and accountability in magnitudes greater than those borne by employees and managers of organizations (Busenitz & Barney, 1997; Shepherd et al., 2015). Time pressure enters the entrepreneurship equation at many points (Bird & West, 1998). Changes in the environment (Smith, 2014) such as a radically different technology may demand rapid competitive response to identifying opportunities to market the new technology (Bird & West, 1998). "Effectively capturing opportunities requires rapid decision making" (Bakker & Shepherd, 2017: 130). Opportunities are inherently fleeting (Short, Ketchen, Shook & Ireland, 2010), which, if not recognized, will be lost. Given the importance of time pressure in entrepreneurship and the dearth of studies investigating the same, I considered time pressure as a moderator in my framework. The following paragraphs build on the moderating effects on the individual attributes-opportunity recognition relationships.

INDIVIDUAL ATTRIBUTES, TIME PRESSURE, AND OPPORTUNITY RECOGNITION

How time pressure is perceived depends on an individual's ability. Studies on the moderated effects of time pressure have yielded equivocal findings (Miron-Spektor et al., 2017). On one hand, time pressure has been shown to reduce the epistemic motivation that is critical for creativity (Amabile, Hadley & Kramer, 2002). Low time pressure resulted in generation of higher quantity and quality of new ideas in the healthcare industry (Lindskog,

Hemphälä & Eriksson, 2017). In contrast, research posited time pressure to be invigorating and performance enhancing. Time pressure enhanced the performance of National Aeronautics and Space Administration (NASA) scientists and engineers (Andrews & Farris, 1972). Moderate levels of time pressure inspired increased task engagement and innovation (Mehta & Zhu, 2015; Miron-Spektor et al., 2017). Hence, time pressure interacts differently with different individuals to influence performance (Hsu & Fan, 2010). Whether the time pressure is perceived as positive or negative would depend on the individual's attributes. This relates to the popular saying: *The problem is not the problem; the problem is the way we think about the problem* (Watzlawick, Weakland & Fisch, 2011). The following paragraphs build on how each individual attribute varies with time pressure and influences opportunity recognition.

Entrepreneurial Self-efficacy, Time Pressure, and Opportunity Recognition

Under time pressure, do self-efficacious individuals generate more and higher quality opportunities? Entrepreneurial self-efficacy has been theoretically and empirically proven to positively affect opportunity quantity and quality (Tumasjan & Braun, 2012). Research suggests that individuals high in entrepreneurial self-efficacy perform better in task-specific goals (Chen et al.,1998). When faced with a task, self-efficacious individuals feel as if they are on a "mission" (Amabile et al., 2002). Arguing in the same line of logic, highly efficacious individuals would believe in their capability to generate business opportunities when engaging in opportunity recognition tasks.

However, how entrepreneurial self-efficacy varies with the contingencies of time pressure during opportunity recognition tasks is not yet known. Studies on opportunity recognition centered around new technologies (Grégoire, Barr et al., 2010; Shane, 2000) did

not examine individuals' performance under time constraints. The few management studies that examined the interaction of self-efficacy and role stressors found that self-efficacy in task-specific abilities mitigates the stress and/or strain caused by role stressors (Brown, Jones & Leigh, 2005). Self-efficacious individuals are less likely to be tensed or distressed (Hmieleski & Corbett, 2008) during task performance (Miron-Spektor et al., 2017).

On the other hand, few studies revealed that self-efficacy further negated the negative effects of role stressors such as time constraints on work satisfaction (Hmieleski & Corbett, 2008). This is because entrepreneurial self-efficacy has to do with the individual's ability to identify new business opportunities (Zhao et al., 2005). It might have little or nothing to do with a characteristic of the external stressor (e.g., time constraints) that is associated with the activating event (e.g., opportunity recognition task) (Amabile, Conti, Coon, Lazenby, & Herron, 1996; Amabile et al., 2002). The duration and intensity of the stressor (time pressure) would mitigate entrepreneurial self-efficacy (Hmieleski & Corbett, 2008).

Let us consider an opportunity recognition task where individuals would identify as many opportunities as possible emerging from recently invented technologies. When self-efficacious individuals were presented with the task, they would invoke their innate ability that "reside" in them to respond. But, when an additional external stressor (i.e., time pressure) is introduced, the stress resulting from it might have little or nothing to do with entrepreneurial self-efficacy. Thus, individuals high in entrepreneurial self-efficacy would no longer perceive time pressure as invigorating. Rather, they might view the pressure as a tension, and might not be able to counter the tension. Or they could not become comfortable with the anxiety and disquiet the tension provokes (Miron-Spektor et al., 2017). This would disrupt the individual's ability by introducing factors to his or her mental resources that

might be unrelated to the task at hand (Eysenck & Calvo, 1992; Garrison & Schmeichel, 2018). They might not be able to sustain their efficacy-levels (Hmieleski & Corbett, 2008). As a result, self-efficacious individuals would be threatened by the tensions associated with the time pressure and end up doing poorly for both opportunity quantity and quality. Generalizing,

> *H4a: Time Pressure negatively moderates the relationship between entrepreneurial self-efficacy and opportunity recognition such that the positive relationship between entrepreneurial self-efficacy and the number of opportunities recognized will be weaker under high time pressure than under low time pressure.*
>
> *H4b: Time Pressure negatively moderates the relationship between entrepreneurial self-efficacy and opportunity recognition such that the positive relationship between entrepreneurial self-efficacy and the quality of opportunities recognized will be weaker under high time pressure than under low time pressure.*

Tolerance of Uncertainty, Time Pressure, and Opportunity Recognition

Under time pressure, do individuals with high tolerance of uncertainty generate higher count and higher quality opportunities? Tolerance of uncertainty is one of several kinds of psychological capital of entrepreneurs (McClelland, 1967; McKelvie et al., 2011). It is caused by various internal notions and attitudes of individuals in accepting and countering uncertain situations (Carleton et al., 2007). Organizational studies show that individuals with high tolerance for uncertainty embrace tensions well. They do not resist or avoid tensions. They accept or even value these tensions as persistent puzzles (Smith, 2014). They have a "greater propensity to proactively confront tensions and become comfortable with the disquiet they provoke" (Miron-Spektor et al., 2017: 30). The acceptance allows them to immerse themselves in tensions. They can allocate their mental resources to effectively address the task at hand even under pressure (Miron-Spektor & Beenen, 2015). They might question existing assumptions but come up with more effective and innovative solutions

(Miron-Spektor et al., 2017). So, instead of trying to avoid or eliminate the tensions, highly tolerant individuals work around the time given for task completion.

In contrast, an individual with low tolerance of uncertainty will not be able to manage the time. Intolerant individuals will not judiciously allocate their mental resources to the task at hand to begin with. They might worry about the task and seek more details. This, in turn, could result in fear of the unknown, and an inability to move forward (Carleton et al., 2007). Fear of the unknown could disrupt an individual's ability by introducing factors to his or her mental resources that are unrelated to the task at hand (Eysenck & Calvo, 1992; Garrison & Schmeichel, 2018). Additionally, if time pressure is introduced, individuals low in tolerance of uncertainty would waste precious time as they deal with their fear of the unknown and the resulting anxiety within. This would hinder their normal functioning and inhibit action, resulting in poor performance in the task (Carleton et al., 2007). Moreover, research has shown that attempts to eliminate tensions can be emotionally depleting (Vince & Broussine, 1996).

Thus, when individuals accept and even value tensions, they draw energy from them and increase their overall psychological resources for performing their task (Miron-Spektor et al., 2017). In psychology, the personal tendency to accept uncertainties and contradictions is identified as an important coping mechanism in life (Lomranz & Benyamini, 2016). Even under time pressure, individuals with high tolerance of uncertainty are capable of fully capturing ambiguous and complex configurations of reality. Thus, these individuals can contribute to innovation (Miron-Spektor et al., 2017). The time pressure can enhance their performance by stimulating new understandings. Doing so enables these individuals to generate more possible solutions and better solutions, rather than settling on suboptimal

strategies (Rothman & Melwani, 2017). In contrast, individuals with low levels of tolerance of uncertainty will not be able to manage the time limits and end up with fewer and mediocre-quality opportunities. Hypothesizing,

> *H5a: Time Pressure positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of inhibitory anxiety) and the number of opportunities recognized will be stronger under high time pressure than under low time pressure.*
>
> *H5b: Time Pressure positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of inhibitory anxiety) and the quality of opportunities recognized will be stronger under high time pressure than under low time pressure.*
>
> *H5c: Time Pressure positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of prospective anxiety) and the number of opportunities recognized will be stronger under high time pressure than under low time pressure.*
>
> *H5d: Time Pressure positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of prospective anxiety) and the quality of opportunities recognized will be stronger under high time pressure than under low time pressure.*

Prior Experience, Time Pressure, and Opportunity Recognition

Industry experience and time pressure. Entrepreneurship research extensively examined the main effects of prior work experience on entrepreneurial actions. However, how prior experience varies with the situational contingency of time pressure has not yet been examined. In an earlier section, I theorized about the role of prior industry experience and its downside on opportunity quantity and quality in the context of new technology. The negative effect of prior industry experience will be more prominent under time pressure. The following paragraphs explain why.

When faced with an opportunity recognition task that requires an individual to think and decide or act spontaneously, individuals might recollect the past, perceive the present, or anticipate the future (Shipp, Edwards & Lambert, 2009). Experienced individuals are more likely to adopt the past focus. The past focus associates with reflection of the past and repeated use of past memories in decision-making (Kunisch et al., 2017). Individuals recall previous work experiences to apply any relevant lessons in the present decision-making context. They might tend to repeat their past behaviors to build on their experience and to ensure that they do not make a mistake in identifying the right opportunities. They would take care not to look stupid by making a bad or wrong decision. Hence, they would be more careful and conscientious in a decision-making context. But, for a task centered around new technology, past recollection and lessons may be futile and irrelevant. Additionally, when the external stressor of time pressure is introduced, experienced individuals might perform worse. This is because they might waste precious time recalling their past experiences and knowledge to identify any relevance or analogy with the present task. They might not be open-minded enough to resort to on-the-feet thinking. As a result, individuals with industry experience may be less flexible and less adaptable to the new unproven technology (Kunisch et al., 2017).

On the other hand, individuals who have less or no industry experience will have no past observations or work-related memories to recall, analyze, and then apply to the current task. This will give them a strong present focus with a “here and now” orientation (Shipp et al., 2009) and a jumpstart on the task at hand. Further, this orientation will emphasize the current time frame in decision-making. So, individuals with less or no work experience will be more mindful of their current task and situation (Kunisch et al., 2017). Moreover, less

experienced individuals may tend to have a future focus. This focus implies thinking primarily about what the future holds and about future events (Kunisch et al., 2017). Thus, they will be more flexible and open to new experiences that can result in quicker task completion. Following this logic, I generalized:

> *P6a*: *Time Pressure negatively moderates the relationship between prior industry experience and opportunity recognition such that the negative relationship between prior industry experience and number of opportunities recognized will be more negative under high time pressure than under low time pressure.*
>
> *P6b: Time Pressure negatively moderates the relationship between prior industry experience and opportunity recognition such that the negative relationship between prior industry experience and quality of opportunities recognized will be more negative under high time pressure than under low time pressure.*

Startup experience and time pressure. Individuals with startup experience show superior entrepreneurial outcomes (Alvarez et al., 2013; Dimov, 2010, 2011). While detecting entrepreneurial opportunities emerging from new technology, entrepreneurs are entering unchartered waters in which reliable information is not readily available to guide their actions or decisions (Nambisan, 2017; Hmieleski et al., 2015). The individuals have very little to rely on and have to draw from their personal resources available at the time of decision-making (Hmieleski et al., 2015; Shackle, 1979). When the external stressor (time pressure) is introduced, the problem worsens (Hmieleski et al., 2015) as they now must effectively utilize the time given.

Prior entrepreneurs do not give up so easily as they have already undergone the process (Hmieleski et al., 2015). They would be able to draw more heavily from their psychological inclinations. They would have greater cognitive flexibility to complete their tasks successfully in the set time (Denrell & March, 2001). Further, individuals with startup experience are more likely to have viewed the world through different lenses in their prior

startups. This might have modified their existing framework or even added new categories over time. In this way, the experienced entrepreneurs can absorb and integrate more new information. Most importantly, they can do so quickly and make sense of the information and the current task.

Entrepreneurs gain from their prior startups whether they were successes or failures and can easily cope with external shocks or situations (Shepherd, 2003). They are aware that they would face unique problems or situations, with no existing heuristics or pre-composed plans to guide them. In their previous startup, they might have experienced demand conditions in the market where "passage of time" was critical. Additionally, prior entrepreneurs are more present-orientated and are hence, mindful of the time available (Bird & West, 1998). As a result, such experienced individuals might perceive the time pressure as a challenge which motivates and energizes them to perform better in the task at hand.

In contrast, non-entrepreneurs might not possess the stock of entrepreneurial knowledge. They may not comprehend the importance of time as they have not yet experienced the turbulence of a startup and the lessons learned therein. Also, they might not be used to making quick and impromptu decisions. As a result, they might simply ignore the task or half-heartedly engage their mental faculties and efforts. This would lead to inferior outcomes. So, non-entrepreneurs are more likely to end up recognizing the wrong opportunities or not being able to recognize any new opportunity. Following this logic, it can be argued that individuals with startup experience are more likely to recognize opportunities compared to those with less or no startup experience (Shane, 2000). Generalizing,

> *P6c: Time Pressure positively moderates the relationship between prior startup experience and opportunity recognition such that the positive relationship between*

prior startup experience and the number of opportunities recognized will be stronger under high time pressure than under low time pressure.

P6d: Time Pressure positively moderates the relationship between prior startup experience and opportunity recognition such that the positive relationship between prior startup experience and the quality of opportunities recognized will be stronger under high time pressure than under low time pressure.

UNCERTAINTY – SECOND SITUATIONAL CONTINGENCY

Uncertainty is "a conceptual cornerstone for most theories of the entrepreneur" (McMullen & Shepherd, 2006: 133). Uncertainty arises because of new information or changes in the environment (Packard et al., 2017) where distributions are unknown (Packard et al., 2017). In most economics and behavioral studies, researchers examine risky and ambiguous situations. However, both risk and ambiguity are potentially measurable as probabilities exist (Packard et al., 2017; Tversky & Kahneman, 1975). In the case of entrepreneurship, even the information needed to anticipate the outcomes themselves is frequently unavailable (Alvarez & Barney, 2007; Knight, 1921; McMullen & Shepherd, 2006), giving rise to the concept of environmental or external uncertainty (Milliken, 1987; Sarasvathy, 2001). Environmental uncertainty is the situation where the set of input choices is closed but the set of outcomes is open. This gives decision-makers an indefinite number of possibilities to consider – an infinite set of imagined outcomes and possibilities (Packard et al., 2017). In the case of commercialization of radically new technology, consequence of any course of action cannot be fully predicted as the market for the technology is unknown (Packard et al., 2017). In this study, I considered "true" or objective uncertainty (Knight, 1921) as the situational contingency. It is not the individuals' perception of the uncertainty. Hence, I did not hypothesize the main effects of uncertainty on opportunity recognition. I

hypothesized the moderating effects of uncertainty on the individual attributes-opportunity recognition relationships in the following paragraphs.

INDIVIDUAL ATTRIBUTES, UNCERTAINTY, AND OPPORTUNITY RECOGNITION

Uncertainty primarily implies lack of knowledge about the following: (1) the alternatives or response options available, (2) the states of nature or outcomes likely to be connected with each, and (3) the values or utility associated with each alternative-state-of-nature pair (Milliken, 1987). This is Knightian uncertainty, which refers to the innate uniqueness of any situation that prohibits the assignment of Bayesian probabilities (Packard et al., 2017). The psychology literature defines uncertainty as situations which cannot be adequately structured nor categorized by an individual because of lack of sufficient cues (Budner, 1962).

Uncertainty is inevitable in business (Knight, 1921), but different individuals perceive uncertainty in different ways. This makes uncertainty an important situational contingency to entrepreneurs (McMullen & Shepherd, 2006; Sarasvathy, 2001; Shepherd et al., 2015). In organization research, Milliken (1987) proposed three types of perceived uncertainty: state, effect, and response. State uncertainty refers to the inability to predict how the components of the environment are changing. Effect uncertainty is the inability to predict how the change in the environment will affect the firm or the entrepreneur. Response uncertainty is the unknowability of competitors' responses to any chosen course of action (McKelvie et al., 2011; Packard et al., 2017). The following paragraphs develop the hypotheses and propositions for the moderating effects of uncertainty on individual attributes.

Entrepreneurial Self-efficacy, Uncertainty, and Opportunity Recognition

Research suggests that entrepreneurial self-efficacy reduced psychological strain (Brown et al., 2005; Hmieleski & Corbett, 2008) experienced by entrepreneurs under uncertainty. The authors found a positive moderating effect of entrepreneurial self-efficacy on the relationship between improvisational behavior and venture performance. It has been theoretically established that individuals high in self-efficacy are initially driven by a belief in their own ability to successfully achieve a task (Chen et al., 1998; McGee et al., 2009; Zhao et al., 2005) even in the face of uncertainty (Sarasvathy, 2001). This is because entrepreneurial self-efficacy has to do with the individual's ability to identify new business opportunities (Zhao et al., 2005) where uncertainty is inherent. When environmental uncertainty is introduced, it acts as an external stressor that is associated with the activating event (e.g., opportunity recognition task) (Amabile et al., 1996; Amabile et al., 2002) and which enhances the uncertainty.

Research shows that entrepreneurial self-efficacy acts as an intrinsic resource that aids entrepreneurs to transform increasing perceptions of uncertainty into opportunity identification (Schmitt, Rosing, Zhang & Leatherbee, 2017). In other words, responding effectively to an uncertain situation (e.g., identifying opportunities emerging from newly invented technology) is inherent in the construct of entrepreneurial self-efficacy. Hence, individuals high in entrepreneurial self-efficacy would solidify their beliefs in their ability to directly shape the environment (Engel, Dimitrova, Khapova & Elfring, 2014). They would believe in their ability to respond to the task even under high uncertainty. This belief would propel self-efficacious individuals to initially have an ambitious goal (Engel et al., 2014) in the face of uncertainty. For example, let us consider an opportunity recognition task in which

individuals identified as many opportunities as possible based on a certain new technology (e.g., soft robot). Each identified opportunity had to be worded so that it conveyed a meaningful concept. This task emphasizes both the count and quality of opportunities generated. Studies on the interaction effects of entrepreneurial self-efficacy and uncertainty have shown that entrepreneurs high in self-efficacy more likely to achieve higher identification of opportunities (Schmitt et al., 2017). In contrast, entrepreneurs lower in entrepreneurial self-efficacy might tend to develop a pessimistic or fearful approach (Schmitt et al., 2017). This might hamper their identification of several opportunities during the task. Generalizing,

> *H7a: Uncertainty positively moderates the relationship between entrepreneurial self-efficacy and opportunity recognition such that the positive relationship between entrepreneurial self-efficacy and the number of opportunities recognized will be stronger under high uncertainty than under low uncertainty.*

On one hand, uncertainty may provide an optimal starting point in identifying business opportunities (Schmitt et al., 2017; Shane & Venkataraman, 2000). On the other hand, uncertainty may induce a state of psychological entropy in which individuals experience conflicts within (Schmitt et al., 2017). The two conflicting mechanisms under uncertainty might be more obvious in a task that involves multiple goals. I argue that uncertainty could moderate entrepreneurial self-efficacy levels in individuals from one goal to the other during opportunity recognition. As a result, these individuals might not be able to sustain their self-efficacy levels (Hmileski & Corbett, 2008) uniformly in a task that embeds two goals (quantity and quality). The performance of self-efficacious individuals would vary. For example, entrepreneurs high in entrepreneurial self-efficacy will identify more opportunities, but they might not be able to sustain their self-efficacy levels during the

secondary goal. That is, they may not be able to detail out and meaningfully convey each opportunity they identified, as their overarching goal would be to generate a higher count of opportunities. This would push them to identify the next opportunity and so on till they generate a sufficiently high number of opportunities. As a result, most of their efforts would be exhausted in generating a higher count of opportunities.

In other words, high self-efficacy motivates individuals to adopt initial ambitious goals (e.g., higher opportunity count). This is based on their belief system that those goals are achievable (Bandura, 1997; Schmitt et al., 2017). However, high self-efficacy may reduce motivation within a goal level (Hechavarria, Renko & Matthews, 2012). Hence, high entrepreneurial self-efficacy does not necessarily mean uniform ability to embrace or overcome uncertainty for both the goals (e.g., quantity and quality). So, while writing down each opportunity, the efficacious individuals might experience heightened tensions and anxiety levels owing to the lack of information. This would hurt the quality of their identified opportunities. The poor quality will be exacerbated by uncertainty (Miron-Spektor et al., 2017). The highly self-efficacious individuals may not acknowledge this. When they are unable to cope with situational contingencies, they are likely to attribute their failure to the external cause (e.g., uncertainty) (Hmieleski & Corbett, 2008). Generalizing,

> *H7b: Uncertainty negatively moderates the relationship between entrepreneurial self-efficacy and opportunity recognition such that the positive relationship between entrepreneurial self-efficacy and the quality of opportunities recognized will be weaker under high uncertainty than under low uncertainty.*

Tolerance of Uncertainty, Uncertainty, and Opportunity Recognition

Under environmental uncertainty, do individuals with high tolerance for uncertainty perform better in opportunity quantity and quality? Entrepreneurship literature has investigated two streams related to uncertainty (Nambisan, 2017). One deals with the

environmental uncertainty that is objectively present in the environment (Packard et al., 2017); for example, market uncertainty surrounding the commercialization of a radically new technology. The second stream deals with the psychological ability of individuals to tolerate or bear uncertainty and take actions and decisions under uncertainty (Nambisan, 2017). The main effects of both environmental uncertainty and tolerance of uncertainty are more or less theoretically established. However, little is known about the moderating effects of environmental uncertainty on the link between tolerance of uncertainty and opportunity recognition (Nambisan, 2017). The interaction effect deserves investigation as new technologies have transformed the external uncertainty associated with the change, as well as the ways of dealing with uncertainty (Nambisan, 2017).

Let us consider the importance of considering both the constructs. Say, there is a new technology (e.g., soft robot) invented by an American university. No information is available about its market demand. Neither do we know about potential competitors' strategies or the usage of this new technology. These unknowns represent environmental uncertainty. Uncertainty could potentially shape the appeal and accessibility of the business opportunities arising out of the new technology (Nambisan, 2017). On the other hand, an individual's tolerance for uncertainty will determine how much of the external uncertainty the individual could bear or absorb and move forward in identifying new opportunities using the soft robot.

When the levels of external uncertainty are high (little to no information and high unpredictability), individuals high in tolerance for uncertainty will perform better than individuals who are less tolerant. The clinical psychology field shows that tolerance for uncertainty leads to greater acceptance of uncertain situations (Carleton et al., 2007). The acceptance makes the tolerant individual mindful of the present. The present-orientation, in

turn, helps the individual to focus on the task at hand. This facilitates task completion with the given information rather than wasting personal resources searching for more information that does not exist (Bird & West, 1998).

Additionally, individuals with high tolerance for uncertainty will have sufficient slack in their mental resources (Carleton et al., 2007; Carleton et al., 2010). This allows them to focus on "how" to deal with the situation at hand, rather than engaging precious mental resources in figuring out the why (Watzlawick et al., 2011). This tolerant attitude allows the individual unhindered focus on the task with the use of his or her full mental resources. As a result, individuals high in tolerance of uncertainty overcome inhibitory anxiety. They would not be paralyzed by any fear of the unknown. They could continue to function and act normally and effectively. Similarly, individuals high in tolerance of uncertainty would overcome their prospective anxiety when faced with external stressors such as environmental uncertainty. They would not feel the need to know and organize everything in advance, or fear that any surprise would spoil everything. Instead, they would embrace the unknown. They would rise to the demanding situation and respond in an effective way in the face of uncertainty. Generalizing,

> *H8a: Uncertainty positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of inhibitory anxiety) and the number of opportunities recognized will be stronger under high uncertainty than under low uncertainty.*
>
> *H8b: Uncertainty positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of inhibitory anxiety) and the quality of opportunities recognized will be stronger under high uncertainty than under low uncertainty.*

H8c: Uncertainty positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of prospective anxiety) and the number of opportunities recognized will be stronger under high uncertainty than under low uncertainty.

H8d: Uncertainty positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of prospective anxiety) and the quality of opportunities recognized will be stronger under high uncertainty than under low uncertainty.

Prior Experience, Uncertainty, and Opportunity Recognition

Industry experience and uncertainty. *Under uncertainty, do individuals with prior industry experience excel in opportunity quantity and quality?* Research supports the notion that individuals with prior industry experience will perform poorly in opportunity recognition. But how industry experience varies under uncertainty has not yet been examined. Hence, in this study, I investigated the moderating effects of uncertainty on prior industry experience and opportunity recognition. I proposed that uncertainty would further weaken the negative relationship between industry experience and both opportunity quantity and quality. The following paragraphs explain why.

It is established that entrepreneurs need to decide and act under uncertainty (Alvarez & Barney, 2007; McMullen & Shepherd, 2006; Sarasvathy & Kotha, 2001; Schmitt et al., 2017). Under uncertainty, the information needed to anticipate the outcomes of tasks is unavailable (Alvarez & Barney, 2007; Knight, 1921; McMullen & Shepherd, 2006). Entrepreneurial action under uncertainty is like chasing an invisible moving target (Engel, Kaandorp & Elfring, 2017). But given identical situations, different individuals may experience uncertainty differently (Engel et al., 2017; McKelvie et al., 2011) depending on entrepreneurial agency (Alvarez et al., 2013). This agency is different for individuals with

prior industry experience compared to those who have lesser or no experience. Individuals with industry experience are inclined to draw from their previous knowledge and experience. This can hinder their cognitive flexibility, which can prevent them from adapting to a new situation, and navigating the uncertainty therein (Denrell & March, 2001).

Further, individuals with previous industry experience might choose the predictive approach (Hmileski et al., 2015) by recalling and analyzing their past experiences. They might do this to find relevance for tackling the current task. But, for identifying opportunities emerging from new technologies, past recall may not work. This is because information is limited or even non-existent under high uncertainty. Additionally, their knowledge derived from prior industry experiences is unlikely to be relevant to the new technologies. As a result, experienced individuals may have a hard time adapting to the limited information about the new technology and its potential utilization. In contrast, individuals with less or no industry experience have little or nothing to recall. This can free their mental resources for tackling the task at hand. They might display greater cognitive flexibility, open-mindedness, and a willingness to explore new territory (Denrell & March, 2001). Generalizing,

> *P9a*: *Uncertainty negatively moderates the relationship between prior industry experience and opportunity recognition such that the negative relationship between prior industry experience and number of opportunities recognized will be weaker under high uncertainty than under low uncertainty.*
>
> *P9b*: *Uncertainty negatively moderates the relationship between prior industry experience and opportunity recognition such that the negative relationship between prior industry experience and quality of opportunities recognized will be weaker under high uncertainty than under low uncertainty.*

Startup experience and uncertainty. *Under uncertainty, do individuals with prior startup experience excel at opportunity quantity and quality?* Research has established the positive influence of prior startup experience on opportunity recognition. But how startup

experience varies under uncertainty is not yet examined. Accordingly, in the following paragraphs, I examine how uncertainty can further strengthen the positive relationship between startup experience and opportunity recognition.

Uncertainty means that there is limited or no information available about the product demand, usage of the new technology, or market. So, while detecting opportunities under uncertainty, entrepreneurs are entering unchartered waters in which reliable information is not readily available to guide their actions or decisions (Hmieleski et al., 2015). However, given past startup experiences, individuals might be able to draw more heavily from their psychological inclinations, rather than from outside information (Hmieleski et al., 2015; Shepherd et al., 2015). They are more likely to display greater cognitive flexibility in adapting and responding to a new task under uncertainty (Denrell & March, 2001). Additionally, prior entrepreneurs have experienced the world through varied lenses in their previous startups. Different experiences can induce the skill of learnability in individuals, which results in quicker adaptation to new situations (Hmieleski et al., 2015) and being more comfortable with uncertainty.

In this way, experienced entrepreneurs can absorb and integrate more new information, however limited the information might be. They can make sense of an uncertain situation. In contrast, non-entrepreneurs lack this experience of facing and tackling uncertainty. Nor do they have the stock of entrepreneurial knowledge. These shortcomings might result in them developing a pessimistic approach or mentally disengaging from the task. So, non-entrepreneurs are more likely to end up recognizing the wrong opportunities, or not being able to recognize any new opportunity. Following this logic, it can be argued that

individuals with startup experience are more likely to recognize opportunities compared to those with less or no startup experience (Shane, 2000). Generalizing,

> *P9c: Uncertainty positively moderates the relationship between prior startup experience and opportunity recognition such that the positive relationship between prior startup experience and the number of opportunities recognized will be stronger under high uncertainty than under low uncertainty.*

> *P9d: Uncertainty positively moderates the relationship between prior startup experience and opportunity recognition such that the positive relationship between prior startup experience and the quality of opportunities recognized will be stronger under high uncertainty than under low uncertainty.*

CHAPTER 3

RESEARCH METHODOLOGY

Opportunity recognition studies measure the construct through post-hoc recollection methods such as surveys (Tumasjan & Braun, 2012), which have various methodological challenges. These are retrospective bias (Corbett, 2007; Goodwin, 2009; Kier & McMullen, 2018), attribution bias (Fiske & Taylor, 1991), and self-reporting bias (Sandberg & Hofer, 1987). To overcome these shortcomings, entrepreneurship scholars have recommended the use of experimental studies (Hsu, Simmons & Wieland, 2017; McMullen, Wood, & Kier, 2016; Shepherd et al., 2015). In this study I heeded the calls for more experiments in entrepreneurship by conducting an on-line experiment to test my framework. I adapted an established research design from Kier and McMullen (2018), Tumasjan and Braun (2012), and Shepherd and DeTienne (2005) to shape my experiment. The research design to assess opportunity recognition acknowledges the fact that opportunity recognition happens unpredictably and can in principle occur anywhere any time (Tumasjan & Braun, 2012).

RESEARCH SETTING AND MATERIAL

I designed the experiment in Qualtrics. The three independent variables and controls were self-reported measures. The independent variables are entrepreneurial self-efficacy, tolerance of uncertainty, and prior experience. The first two are psychological constructs. As such, their manipulation would mean deceiving the participants. Although prior experience is an observable variable, it is underpinned by tacit knowledge, which is a cognitive element, and as such, difficult to manipulate. Accordingly, in my study, I manipulated the two moderators – time pressure and uncertainty – as experimental conditions (Breugst & Shepherd, 2017). Moderators are independent variables in a model. In this study, I did not

test for the main effects of the two moderators. I tested only their moderating effects. Both time pressure and uncertainty are theorized as situational contingencies that influence individual behavior. The outcomes – opportunity quantity and quality – could vary in the experiment. I obtained due approval from the IRB (Institutional Review Board) before conducting my study (see Appendix A).

The experiment focused on two scenarios/studies showcasing new technologies: soft robot and virtual reality, both of which are yet to be commercialized in the market. The reason for using new real-life technology is to ensure that external validity of the task and material can be augmented (Grégoire, Barr et al., 2010). Scenario #1 described the emerging soft robot technology in a brief write-up followed by a short video (see Appendix B2). Soft robots are very different from the existing robots made of hard materials (https://biodesign.seas.harvard.edu/soft-robotics). Hard robots have been successfully used in various industries up until now. The radical "soft" robots are small and made of malleable materials. They offer greater flexibility in their movement and in the number and kind of uses than ever imagined possible. The invention of the soft robot has opened vast avenues for newer opportunities both in the commercial and social sectors. However, soft robot venturing could be difficult and uncertain as with any new technology. The uncertainties pertain to unknown market demands or competitors' strategy or the use of the new technology. Soft robot venturing might encounter other difficulties arising from Intellectual Property rights or regulations. Hence, the soft robot technology with the potential of new markets and industries offers a useful context for examining decision-making under uncertainty.

The second scenario is about virtual reality. (Note: I refer to the virtual reality scenario as scenario #2 only for the sake of simplicity. During the experiment, this was not

shown after the soft robot scenario. Instead, the two scenarios were presented in random order while ensuring that the participants completed both the studies.) Virtual reality is a relatively new technology that provides an immersive experience to its users. In my study, I have showcased one way of applying this technology to the market – a beauty brand which utilizes virtual reality technology to give its customers an innovative virtual bike-ride in their stores (https://www.vertexvr.nl/case-study-korean-beauty-brand-innisfree-using-vr-take-customer-journey/). The participants were then asked to generate business opportunities using virtual reality, other than the one shown on the video.

The virtual reality technology is not too recent. But, the technology has not yet diffused to a desirable extent. New areas of applications using virtual reality are emerging at a rapid pace. Although virtual reality applications tend to be highly priced, there is no dearth of such opportunities in various industries and markets. Hence, a virtual reality venture represents suitable uncertainty levels to allow testing for decision-making under uncertainty. Another reason for choosing the virtual reality technology for which opportunities have already been exploited is to ensure that external validity of the task and material can be augmented (Grégoire, Barr et al., 2010).

SAMPLE

Pilot

I carried out an on-line pilot before administering the actual experiment. The first iteration of my pilot study was used to test model validity and assess the effect of my manipulations. This was done to confirm the relevance of the two technology scenarios to test my theoretical framework and to ensure that respondents were able to understand the task instructions and generate multiple business opportunities using each of the new technologies.

The pilot helped me to ascertain the understanding of the key constructs. Most importantly, it helped in refining the manipulations of both time pressure and uncertainty so that they were realistic and achieved the intended effects. The pilot sample consisted of five Ph.D. students and 15 practicing entrepreneurs. They provided constructive feedback regarding the scenario settings and overall content. The feedback can be categorized into the following main themes.

First, the pilot study and follow-up questions made it clear that I needed to keep the videos about the two technologies short (not exceeding 1.5 minutes). Second, I needed to keep the description about the technologies brief and concise. The first two points were to ensure that the attention span of the participants was not exceeded so that the participants would not suffer from information overload and they would continue to be engaged with the task. Third, the feedback about the uncertainty manipulation was very helpful. Following prior literature and building upon the pilot study, I manipulated three types of environmental uncertainty. These were uncertainty in product demand, use of the technology, and potential competition. Incorporating the feedback from the pilot, I streamlined the uncertainty content into bullet points and kept the sentences short and precise (see Appendices B3 and B4 for details). Fourth, the feedback about the font size, and color themes within the Qualtrics design was thoughtful. I duly incorporated the requisite feedback and conducted a revised pilot to ensure that the experiment was satisfactory.

Undergraduate Students Registered with Bloch's REP Pool

Following the pilot for my study, I administered the on-line experiment to undergraduate students registered with the Research Engagement Pool (REP) of UMKC's Bloch School. Students were recruited from the REP of the university's business school so

that the task of opportunity recognition (see earlier description) was comprehensible to them. The students were offered one extra credit hour to participate in the experiment. The experiment, designed in Qualtrics, was administered via the Sona System (http://www.sona-systems.com/about.aspx). The Sona System is an experiment management system that enables universities to manage research and recruit participants in a cloud-based environment. The students registered via the Sona System, signed up for my study, and took the on-line experiment from any place. Their responses were available at Qualtrics. A total of 246 respondents participated in the study. Out of the 246 respondents, 234 wrote down opportunities for the soft robot scenario. Out of these 234 respondents, 227 wrote down opportunities for both the soft robot and virtual reality scenarios. There were seven respondents who generated opportunities for the soft robot but left their task space blank for the virtual reality scenario although they were presented with this scenario. To maintain uniformity, in my data analysis, I considered the 227 participants who generated opportunities for both the scenarios.

PROCEDURE AND FLOW OF THE EXPERIMENT

Respondents first signed and submitted the consent form which certified that they were 18 years of age and above, and that they understood the task at hand and associated benefits. In my on-line experiment, I had two technology scenarios/studies: soft robot and virtual reality. The respondents had to take both the scenarios. The order of the presentation of the scenarios and the study's independent variables were randomized to mitigate sequence bias (Kirk, 2013). Each of the scenarios was randomly assigned to the respondents under four experimental conditions. The conditions were: (low time pressure, low uncertainty), (low

time pressure, high uncertainty), (high time pressure, low uncertainty), and (high time pressure, high uncertainty).

The experiment for scenario #1 – soft robot is reproduced in Appendix B1 to B7. Depending on the uncertainty condition, the content of the task description was varied to manipulate the level of uncertainty (Breugst & Shepherd, 2017; McKelvie et al., 2011). See B3 for low uncertainty manipulation. For the low uncertainty group, sufficient information about current market trends, future demand forecasts, potential competition and so forth were provided. In contrast, this information was withheld for the high uncertainty group. Additionally, the high uncertainty group was told that soft robot venturing could be difficult and uncertain as with any new technology. These difficulties might pertain to Intellectual Property rights and government regulations. See B4 for high uncertainty manipulation.

High time pressure was introduced by explicitly mentioning that only two minutes would be allowed to write down all business opportunities. I emphasized the time pressure by having a timer counting down prominently on the screen. For the low time pressure condition, there was no explicit mention of two minutes' time for the task completion. Neither was a timer displayed on the screen while the respondents were completing the tasks. Once the participants were presented with the scenario in either of these experimental conditions, they read a brief write-up followed by watching a short 1.5-minute video on the new technology. Then I had the respondents generate by writing down as many business opportunities as possible using the new technology. I measured opportunity recognition by assessing both opportunity quantity and quality.

STUDY MEASURES

Dependent Variables

Studies related to opportunity recognition acknowledge that assessment of both opportunity quantity and quality are important (Kier & McMullen, 2018). Generating multiple opportunities is important so that there are fallback options if one opportunity does not work out (Kier & McMullen, 2018; Reinig & Briggs, 2006; Shane, 2000; Shepherd & DeTienne, 2005; Tumasjan & Braun, 2012). Accordingly, in my study, I had two dependent variables, which had been assessed by two independent raters. One rater was a Ph.D. student in the entrepreneurship department with an engineering background and with one year of work experience. The second rater was a part-time entrepreneur, with a full-time job that the rater had held for more than five years, and with an engineering background.

Quantity (soft robot scenario). This is the number of business opportunities generated and written down by each respondent for the soft robot scenario. The two raters independently scored the quantity (number) of opportunities generated by each respondent. The inter-rater reliability between the raters using a Pearson bivariate correlation was .95 ($p<.001$). After an independent discussion with each of the raters, full agreement was reached.

Quality (soft robot scenario). The second dependent variable was the quality of the opportunities generated. The raters independently assessed the quality of each opportunity generated by each respondent on a 1 to 5-point scale (see Appendix C) ranging from "very poor" to "excellent." A total of approximately 3,000 ideas were assessed by the two raters. The inter-rater reliability using a Pearson bivariate correlation was .90 ($p<.05$). and a Spearman coefficient of .85 ($p<.01$). In addition, for the quality outcome, I did a two-level

hierarchical linear modeling as each respondent generated several ideas which were scored by the two raters. To test the nesting effect, I specified the dependent variable as Rater 1's score and the independent variable as Rater 2's score with the respondents' ID as the subject grouping. The regression coefficient was positive and significant (β=.773, $p<.0001$). The strong correlation suggested that there was strong agreement between the raters and that the raters' assessment did not differ from person to person. The average of the highest quality score for each respondent by the raters was selected and used in the analysis (Reinig & Briggs, 2006; Reinig, Briggs & Nunamaker, 2007).

Quantity (virtual reality scenario). This is the number of business opportunities generated by each respondent for the virtual reality scenario. The two raters independently scored the quantity (number) of opportunities identified by each respondent. The inter-rater reliability between the raters using a Pearson bivariate correlation was 1.0 ($p<.001$).

Quality (virtual reality scenario). The second dependent variable was the opportunity quality. The raters assessed the quality of each of the idea generated by each respondent on a 1 to 5-point scale (see Appendix D) ranging from "very poor" to "excellent." The inter-rater reliability using a Pearson bivariate correlation was .89 ($p<.05$) and with a Spearman coefficient of .84 ($p<.01$). Approximately, 2,800 opportunities were independently assessed and scored by the raters for this scenario. I did a two-level hierarchical linear modeling as each respondent generated several ideas which were scored by the two raters. To test the nesting effect, I specified the dependent variable as Rater 1's score and the independent variable as Rater 2's score with the respondents' ID as the subject grouping. The regression coefficient was positive and significant (β=.81, $p<.0001$). The strong correlation suggested that there was strong agreement between the raters and that the raters' assessment did not

differ from person to person. The average of the highest quality score for each respondent by the raters was selected and used in the analysis (Reinig & Briggs, 2006; Reinig et al., 2007).

Independent Variables (Common for Both Scenarios)

Entrepreneurial self-efficacy. I used Zhao et al. (2005)'s scale to measure individuals' confidence in their ability and skills to "identify new business opportunities" on a 1- to 5-point scale. I did not use the item measure "thinking creatively," because both the technology scenarios in my experiment specified the new technology around which entrepreneurial opportunities were to be identified. The technology scenarios were like self-contained judgment tasks that facilitated opportunity alternatives. These were not exactly open-ended creativity exercises (Grégoire, Shepherd et al., 2010).and implied that an opportunistic situation does undoubtedly exist (i.e. the potential for arbitrage) (Shepherd & McMullen, 2006). In other words, the creativity had been constrained because a decision scenario was forced on the decision maker. In contrast, the item measure "thinking creatively" is suitable for identifying opportunities that are not constrained by a context (e.g., technology).

Cronbach's alpha calculated for this study's construct of entrepreneurial self-efficacy was .73. The latent construct from the item measures was estimated and generated using the GSEM (Generalized Structural Equation Modeling) command in Stata 14.2 (StataCorp, 2016, http://www.cair.org/wp-content/uploads/sites/474/2015/07/HuberC-SEMWorkshop.pdf: 55-56). I used this procedure to generate a composite score from the observed variables which were not equal contributors to the main factor; i.e. they did not have equal weights. However, a simple average of the observed indicators was also

calculated and used in regression analysis as robustness checks. Measurement components results for the GSEM are provided in Appendix E.

Tolerance of uncertainty. For my study, I adapted the 12-item scale of Carleton et al. (2007)'s intolerance of uncertainty. This scale consists of two distinct subscales: inhibitory anxiety comprising five items, and prospective anxiety consisting of seven item measures. The item measures for inhibitory anxiety included "Uncertainty keeps me from living a full life" and were measured on a 1- to 5-point scale. The measures for prospective anxiety included "I always want to know what the future has in store for me" and were measured on a 1- to 5-point scale. For the same reason as for entrepreneurial self-efficacy above, composite scores were calculated from the observed variables for both the sub-scales using the GSEM. The Cronbach alphas for this study were .81 and .70 respectively. Measurement components results for the GSEM are provided in Appendix E. The items were reverse-coded and used in this study to measure tolerance of uncertainty. I created additional variables by calculating the average scores for each of these two latent constructs and used these in regression analyses as robustness checks for both the scenarios (see Tables 7 and 12).

Prior experience. Prior experience comprised two components: prior industrial experience and prior startup experience. Industry experience is prior work experience measured by the number of years worked. Prior startup experience is founding experience: "yes" if the respondent has started his/her own business, and "no" otherwise.

Moderators for the Soft Robot Scenario (Experimental Manipulations)

Time pressure. Time pressure was manipulated, and respondents were randomly exposed to a low or high time pressure condition. Consistent with the organization literature (Hsu & Fan, 2010; Widmer et al., 2012), I operationalized high time pressure by explicitly

mentioning in the task that only two minutes would be allowed to write down as many business opportunities as possible based on the soft robot:

> Question: You will have ONLY 2 minutes to write down as many new business opportunities that you can identify using this new soft robot technology. Briefly describe each business opportunity in few words to convey a meaningful concept.

To emphasize the time pressure, I added a timer counting down the two minutes, which was displayed on the screen during the task. On the other hand, for the low time pressure condition, there was no explicit mention of the two minutes' time for task completion, and neither was a timer shown on the screen for this group. Time pressure was entered as a dummy variable in the analysis: 0 for low time pressure and 1 for high time pressure.

Uncertainty. Uncertainty was manipulated, and respondents were randomly exposed to either a high or low uncertainty condition. Consistent with the management and entrepreneurship literature, I operationalized high levels of environmental uncertainty through the content of the task description (Breugst & Shepherd, 2017; McKelvie et al., 2011). First, respondents under the *high levels of uncertainty* were told that the product demand for soft robots was unknown. This implied unpredictability of the environment regarding the future market for soft robots (Green, Covin & Slevin, 2008). Second, the respondents were told that the actions of competitors were generally not easy to predict, which ties back to environmental uncertainty (Green et al., 2008; Milliken, 1987). Finally, respondents were told that technological uncertainty exists. This uncertainty refers to the perceived complexity and instability of the technology (Bstieler, 2005). To emphasize the uncertainty of the environment, the respondents were further told that it was difficult to predict how long their product would enjoy advantages before a competitive response eroded

profits. On the other hand, the respondents in the *low uncertainty condition* were told that soft robot has a variety of future applications with its "demand" increasing. If they were to start their own soft robot venture, it would be able to sustain viability in the market. Further, the respondents were given current sales trends in the general robotic industry which indirectly implied a market for the new soft robot. Uncertainty was entered as a dummy variable in the analysis: 0 for low uncertainty and 1 for high uncertainty.

Moderators for the Virtual Reality Scenario (Experimental Manipulations)

Time pressure. Time pressure was manipulated, and respondents were randomly exposed to either a low or high time pressure condition. Consistent with the organization literature (Hsu & Fan, 2010; Widmer et al., 2012), I operationalized high time pressure by explicitly mentioning in the task that only two minutes would be allowed to write down as many business opportunities as possible using the virtual reality technology:

> Question: You will have ONLY 2 minutes to write down as many new business opportunities that you can identify using this new virtual reality technology. Briefly describe each business opportunity in few words to convey a meaningful concept.

To emphasize the time pressure, I added a timer counting down the two minutes which was being shown on the screen during the task. On the other hand, for the low time pressure group, there was no explicit mention of the two minutes' time for task completion, and neither was a timer displayed on the screen for the low time pressure group. Time pressure was entered as a dummy variable in the analysis: 0 for low time pressure and 1 for high time pressure.

Uncertainty. Uncertainty was manipulated, and respondents were randomly exposed to either a high or low uncertainty condition. Consistent with the management and entrepreneurship literature, I operationalized high levels of environmental uncertainty

through the content of the task description (Breugst & Shepherd, 2017; McKelvie et al., 2011). First, respondents under the *high levels of uncertainty* were told that the demand for products using virtual reality is unknown. This implies unpredictability of the environment regarding the future market for virtual reality (Green et al., 2008). Second, the respondents were told that the actions of competitors were generally not easy to predict, which ties back to environmental uncertainty (Green et al., 2008; Milliken, 1987). Finally, respondents were told that technological uncertainty exists. This uncertainty refers to the perceived complexity and instability of the technology (Bstieler, 2005). To emphasize the uncertainty of the environment, the respondents were further told that it was difficult to predict how long their product would enjoy advantages before a competitive response eroded profits. On the other hand, the respondents in the *low uncertainty condition* were told that virtual reality has a variety of future applications with its "demand" increasing. If they were to start their virtual reality venture, it would be able to sustain viability in the market. Further, the respondents were given current increasing sales trends with the possibility of growth in the near future. Uncertainty was entered as a dummy variable in the analysis: 0 for low uncertainty and 1 for high uncertainty.

Control Variables

Familiarity with the soft robot technology was used as a control variable with the question "before you watched the video, how familiar were you with the soft robot technology?" to account for superior outcomes for those respondents who were already familiar with the new technology. Familiarity with the virtual reality technology was used as a control variable with the question "before you watched the video, how familiar were you with the virtual reality technology?" to account for superior outcomes for those respondents

who were already familiar with the new technology. Age and major were not considered in the analyses, as the undergraduate business students were a homogenous sample.

CHAPTER 4

ANALYSIS AND RESULTS FOR SOFT ROBOT SCENARIO

MANIPULATION CHECKS

Manipulation Checks for Time Pressure

To determine if the manipulation was successful, I asked participants about their perceived time pressure while working on their tasks in the post-experiment questionnaire. The wording of the question was "How much time pressure did you feel while identifying business opportunities using the soft robot?" Out of the 227 participants considered in my analysis, 113 respondents were in the low time pressure condition (including both low and high uncertainty). Thirty-five responded with "very little pressure," 43 responded with "little pressure," 27 responded with "neither too little nor too much pressure," 7 responded with "much pressure," and one responded to "too much pressure." With only eight respondents (7.2%) feeling high pressure, the time pressure manipulation indicated success.

There were 114 respondents in the high time pressure condition (including low and high uncertainty). Out of the 114 respondents, 10 responded with "little pressure," 22 responded with "neither too little nor too much pressure," 67 responded with "much pressure' and 15 responded with "too much pressure." Thus, there were 10 respondents (8.8%) in the high time pressure group who responded as feeling low time pressure. A t-test comparing the two conditions (high and low time pressure) revealed significant differences between the members in low and high time pressure conditions, $t(225) = -22.5$ ($p < .001$), Cohen's $d = 2.87$. For the low time pressure group, S.D.= 0.26, and Mean = 0.07. For the high time pressure group, S.D. = 0.31, and Mean = 0.89. Hence, the manipulation was successful.

Manipulation Checks for Uncertainty

To determine if the manipulation of uncertainty was successful, in the post-experiment questionnaire, I asked respondents about their perceived uncertainty. I used the three item measures pertaining to product demand, competition, and technology. The item measures were respectively "product demand is very easy to forecast versus very hard to forecast," "actions of competitors are quite easy to predict," and "simplicity of the technology: simple technology versus very complex technology." The respondents responded on a 1- to 5-point scale from 1=very easy to 5=very hard. I did not combine these three item measures into a single scale because of the greatly varying nature of what each was measuring.

The responses to the "product demand" uncertainty question showed that out of the 113 respondents in the low uncertainty condition, 105 responded with "demand is very easy to forecast (=1)" with "demand is neither too easy nor very hard to forecast" (=3), and 8 responded with "hard to forecast" and "very hard to forecast." With only 8 respondents (7.1%) perceiving high uncertainty with respect to product demand in the environment, the uncertainty manipulation indicated success.

Out of the 114 respondents in the high uncertainty condition, 42 responded with "very hard to forecast," 43 responded with "hard to forecast," 18 responded with "demand is neither too easy nor very hard to forecast," and the remaining 11 responded with either "very easy" or "easy to forecast." Thus, there were 11 respondents (9.6%) in the high uncertainty group who responded as perceiving low uncertainty. Further, a t-test comparing the two groups (high and low uncertainty) with unequal variances revealed significant differences between the them, $t(225) = -12.89$ ($p < .001$). Cohen's $d = 1.64$. For the low uncertainty group,

S.D. = 0.96, and Mean = 2.36. For the high uncertainty group, S.D. = 1.03, and Mean = 4.0. Hence, the manipulation was successful.

ANALYTICAL STRATEGY

Analytical Strategy for the Count Variable (Quantity)

Given that opportunity quantity is a count variable, I tested to see if I could use a Poisson or a Negative Binomial (NB) Regression. The three tests that I conducted are as follows for each model with quantity as the dependent variable (Hilbe, 2011; UCLA website: https://stats.idre.ucla.edu/stata/faq/how-can-i-analyze-count-data-in-stata/). All the analyses were carried out in Stata 14.2.

First, I ran the negative binomial regressions without the robust option. I checked the likelihood ratio test displayed at the bottom of the analysis. This is a test of the over-dispersion parameter alpha (UCLA website: https://stats.idre.ucla.edu/stata/faq/how-can-i-analyze-count-data-in-stata/) which compares this model to a Poisson model. The probability of the associated chi-squared value is significant at the 1% level for the models. This seems to imply that alpha is significantly different from zero and rejects the null hypothesis that the errors do not exhibit over-dispersion (over-dispersion is the case where the variance is larger than the mean) in the dependent variable. Thus, the Poisson distribution may not be appropriate in this case.

Second, I checked the goodness of fit test after running the Poisson model. The goodness of test fit was significant at the 1% level for the different models. This means that the model does not fit the data and a negative binomial is preferred. Third, I ran GLMs (Generalized Linear Models) with a negative binomial distribution and a log link function. The Pearson chi-squared was greater than 1.00, which implies that the data are over-

dispersed, and a negative binomial regression is preferred (http://data.princeton.edu/wws509/stata/overdispersion.html). Fourth, I checked the conditional mean and variance for the quantity variable. The variance is larger than the mean. The ratio of the variance to the mean of the dependent variables was 1.5. This suggests that the distribution of the "quantity" variable is displaying signs of over-dispersion, that is, greater variance than might be expected in a Poisson distribution (UCLA website).

Diagnostics

After running the GLM, I ran the diagnostics for each of the seven regression models to check the normality of the residuals through the deviance (Hilbe, 2011). An example of the normal probability (see Figure 2) and the normal quantile plot (see Figure 3) are shown for one of the negative binomial models. The normal probability plot is sensitive to the non-normality in the middle range of the data. On the other hand, the normal quantile plot is sensitive to non-normality near the tails (Stata Manual).

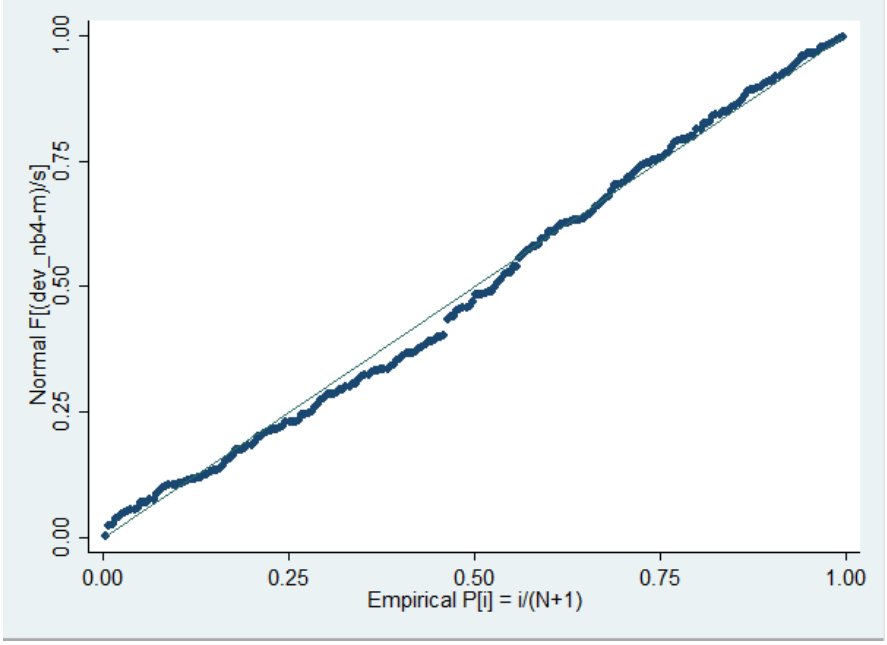

Figure 2. Normal Probability Plot (Soft Robot)

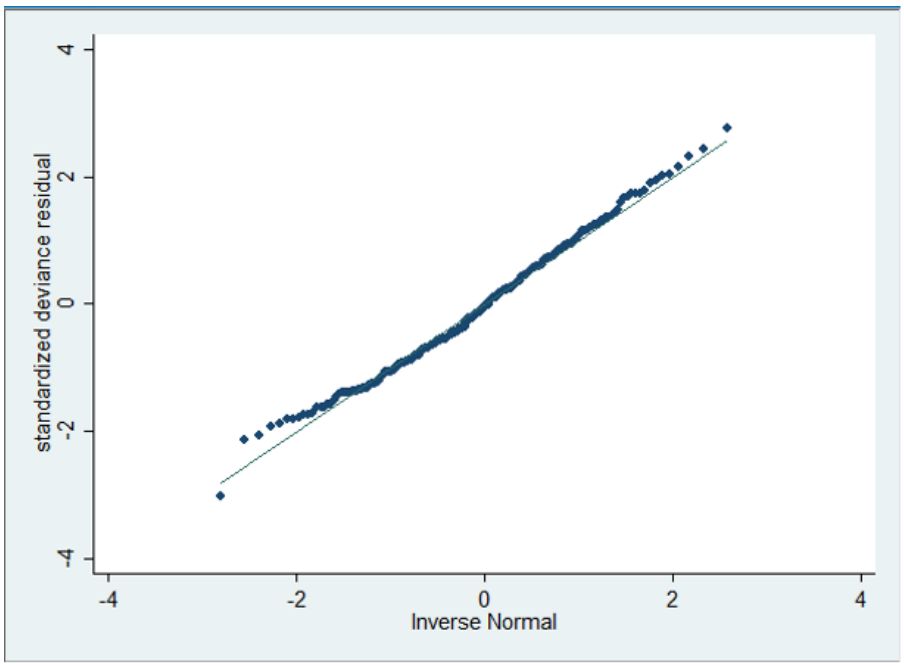

Figure 3. Quantile for Normal Distribution Plot (Soft Robot)

In view of the results of the above tests, I have retained the negative binomial model, which will give the same results as the Poisson if the Poisson model had been a good fit for the data. The important assumptions for a negative binomial model is that the dependent variable is a count variable, and that it is over-dispersed. So, the only time the negative binomial model will not work is if the data are under-dispersed. If the data are under-dispersed, the negative binomial model would not converge, and I would not have obtained any results. Hence, I used negative binomial regression with robust errors in Stata 14.2 as the statistical technique to analyze individuals' variance in the quantity (count) of opportunities recognized. I used robust errors to take care of unequal variances or heteroskedasticity in the data (Cameron & Trivedi, 2005).

For the second dependent variable, namely quality, linear regression with robust errors was used to explain variance in opportunity quality. I used robust errors to take care of unequal variances or heteroskedasticity in the data (Cameron & Trivedi, 2005). Descriptive

statistics are reported in Table 3. The mean level of entrepreneurial self-efficacy across the sample is -.01(s.d.=2.29), the mean level of tolerance of uncertainty (related to inhibitory anxiety) is .001 (s.d. =1.57), and that related to prospective anxiety is -.001 (s.d. = 1.37).

The mean total number of opportunities recognized is 4.31 (s.d.= 2.42), and the mean quality of these opportunities is 3.64 (s.d.=.87). As seen in Table 3, the two dependent variables, quantity and quality are different and are not strongly correlated. Hence, these were analyzed separately. Collinearity diagnostics indicate that the VIFs were below ten, which suggest that multicollinearity is unlikely to have confounded the results. The Pearson correlations may not be appropriate for the multiplicative model – negative binomial for the count data.

DV: QUANTITY OF OPPORTUNITIES RECOGNIZED (1ST DV)

Table 4 reports the results of the negative binomial regression analyses. The Incidence Rate Ratios (IRRs) are shown for the Models 1-7 in Table 4. Model 1 shows that if a respondent were to increase his/her entrepreneurial self-efficacy score by one point, his/her rate for "quantity" of opportunities identified would be expected to increase by a factor of 1.05 (IRR=1.05, $p<.001$) or 5%, while holding all other variables in the model constant. In the same model, we can see that for a one-unit increase in tolerance of uncertainty (with regard to lower levels of inhibitory anxiety), it is expected to have a rate 1.06 times greater (IRR=1.06, $p<.01$) or a 6% increase for the outcome "quantity." The finding support for H1a and H2a.

Table 3: Means, Standard Deviations, and Correlations (Soft Robot)

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1.Quantity	4.31	2.42	1.00									
2.Quality	3.64	.87	.22*	1.00								
3.Efficay	-.01	2.29	.22*	.03	1.00							
4.TU (inhibitory)	.001	1.57	.15*	.24*	.095	1.00						
5.TU (prospective)	-.001	1.37	.05	.07	.05	.19*	1.00					
6.Work experience	4.93	4.83	-.02	.06	.03	.02	.02	1.00				
7.Startup experience	.13	.34	.07	.002	.18*	.004	-.05	.15*	1.00			
8.Time pressure	.48	.5	.10*	.14*	.04	.03	-.05	-.009	-.08	1.00		
9.Uncertainty	.5	.5	.02	.16*	-.09	-.07	.08	.06	-.04	-.01	1.00	
10.Familiarity w/ SR tech.	1.45	.76	.05	-.14*	.16*	-.16*	.03	.04	.03	.04	-.05	1.00

*specifies correlation coefficients significant at the 5% level or better. N=227

Model 2 shows that the interaction of time pressure and entrepreneurial self-efficacy is significant. When time pressure is high, the rate of entrepreneurial self-efficacy (1.08) decreases by a factor of 0.93 (IRR=.93, p<.01) or 15% for the quantity outcome. To interpret the nature of the interaction, the relationship was plotted on a y-axis of the number of opportunities recognized and an x-axis of entrepreneurial self-efficacy. The nature of the interaction is illustrated in Figure 4.

As can be seen from the interaction plot (see Figure 4), the rate of increase in the number of opportunities recognized with increasing entrepreneurial self-efficacy is significantly higher when time pressure is low than when time pressure is high. This indicates that when time pressure is high, the relationship between entrepreneurial self-efficacy and quantity is weaker than that under low time pressure. This finding supports hypothesis 4a, which stated that individuals with higher entrepreneurial self-efficacy will perform poorer under time pressure compared to individuals with lower levels of entrepreneurial self-efficacy.

Model 4 in Table 4 shows that the interaction of time pressure and tolerance of uncertainty (lower levels of prospective anxiety) is positive and significant at the 7% level (IRR=1.11, p<.1). When time pressure is high, the rate of tolerance of uncertainty-prospective anxiety (.98) increases by a factor of 1.11 or by 13% for "quantity." Although the significance level was above 5%, I reported this interaction effect as partial support for the following reasons. First, the confidence intervals for the interaction term did not show a zero when tested for the 95% interval. As a result, we cannot reject the null hypothesis, which specifies that there is no effect. The p-value was .07. Second, this finding involving tolerance of uncertainty might be of importance in future studies. Third, prior

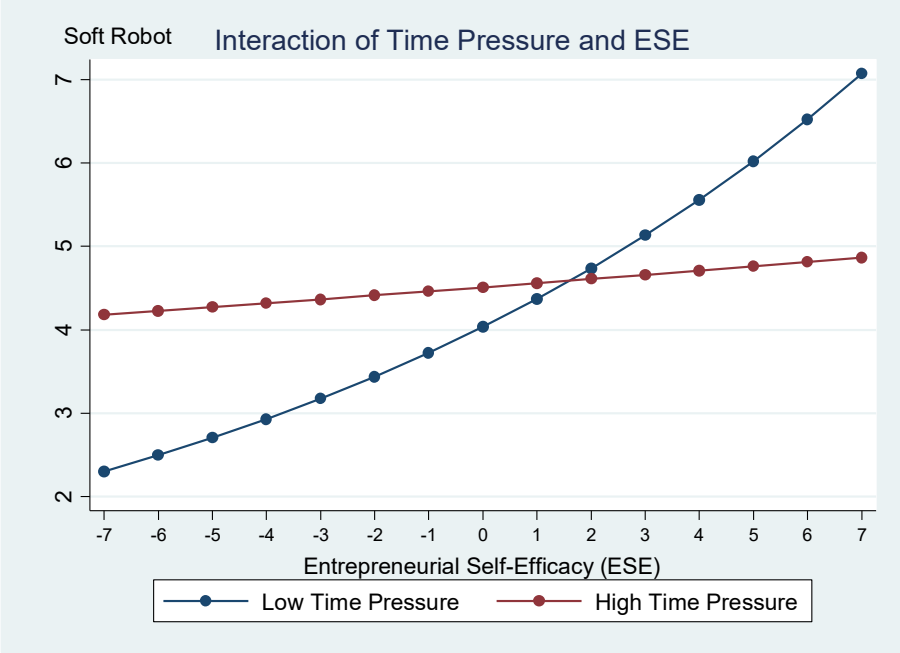

Figure 4. Interaction of Time Pressure and Entrepreneurial Self-efficacy (Quantity for Soft Robot)

entrepreneurhsip studies including those published in top-tier journals such as *Academy of Management Journal* (Eggers & Song, 2015), *Journal of Business Ventruing* (Stephan & Pathak, 2016) and *Journal of International Business Studies* (Autio, Pathak & Wennberg, 2013) have reported regression coefficients significant at <.10 level as partial support.

To interpret the nature of the interaction, the relationship was plotted on a y-axis of the number of opportunities recognized and an x-axis of tolerance of uncertainty. The nature of the interaction is illustrated in Figure 5. As can be seen from the interaction plot (see Figure 5), the rate of increase in the number of opportunities recognized with increasing tolerance of uncertainty is higher when time pressure is high than when time pressure is low. This indicates that when time pressure is high, the relationship between tolerance of

uncertainty and quantity is stronger than it is under low time pressure. The finding supports H5c.

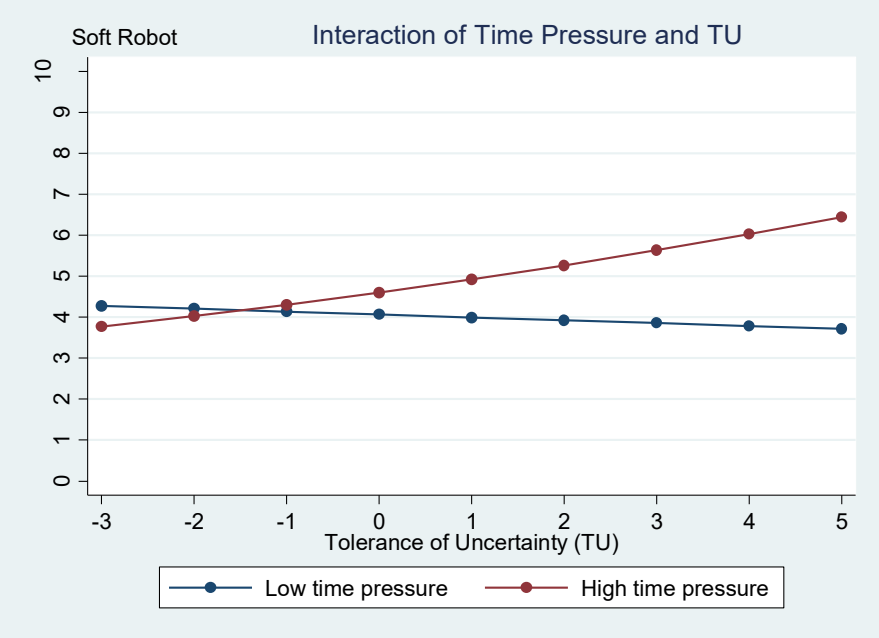

Figure 5. Interaction of Time Pressure and Tolerance of Uncertainty (Quantity for Soft Robot)

Model 5 shows that the interaction of uncertainty and entrepreneurial self-efficacy is positive and significant. An IRR=1.14, $p<.05$ means that when external uncertainty is high (=1), then the rate of entrepreneurial self-efficacy (1.05) increases by a factor of 1.14 or increases by 9%. To interpret the nature of the interaction, the relationship was plotted on a y-axis of the number of opportunities recognized and an x-axis of tolerance of uncertainty. The nature of the interaction is illustrated in Figure 6.

As can be seen from the interaction plot (see Figure 6), the rate of increase in the number of opportunities recognized with increasing entrepreneurial self-efficacy is higher when uncertainty is high than when uncertainty is low. This indicates that when uncertainty

is high, the relationship between entrepreneurial self-efficacy and quantity is stronger than it is under low uncertainty. The finding provides support for H7a.

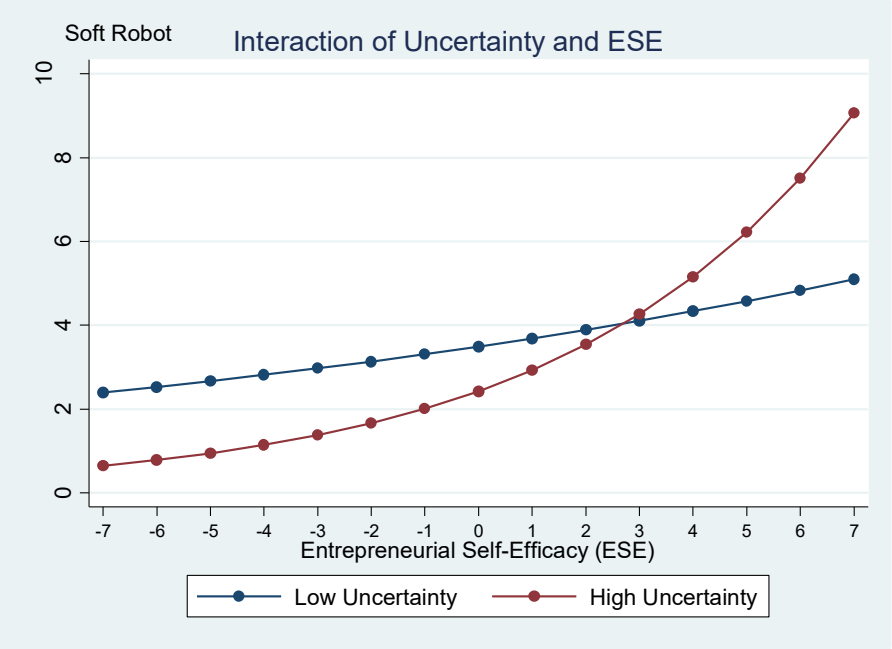

Figure 6. Interaction of Uncertainty and Entrepreneurial Self-efficacy (Quantity for Soft Robot)

Model 7 shows that the interaction of uncertainty and tolerance of uncertainty (prospective) is positive and significant. An IRR=1.15, p<.05 means that when external uncertainty is high (=1), then the rate of tolerance of uncertainty-prospective anxiety (.91) increases by a factor of 1.15 or increases by 24%. To interpret the nature of the interaction, the relationship was plotted on a y-axis of the number of opportunities recognized and an x-axis of tolerance of uncertainty. The nature of the interaction is illustrated in Figure 7. As can be seen from the interaction plot (see Figure 7), the rate of increase in the number of opportunities recognized with increasing tolerance of uncertainty is higher when uncertainty

is high than it is when uncertainty is low. This indicates that when uncertainty is high, the relationship between tolerance of uncertainty and quantity is stronger than it is under low uncertainty. The finding provides support for H8c.

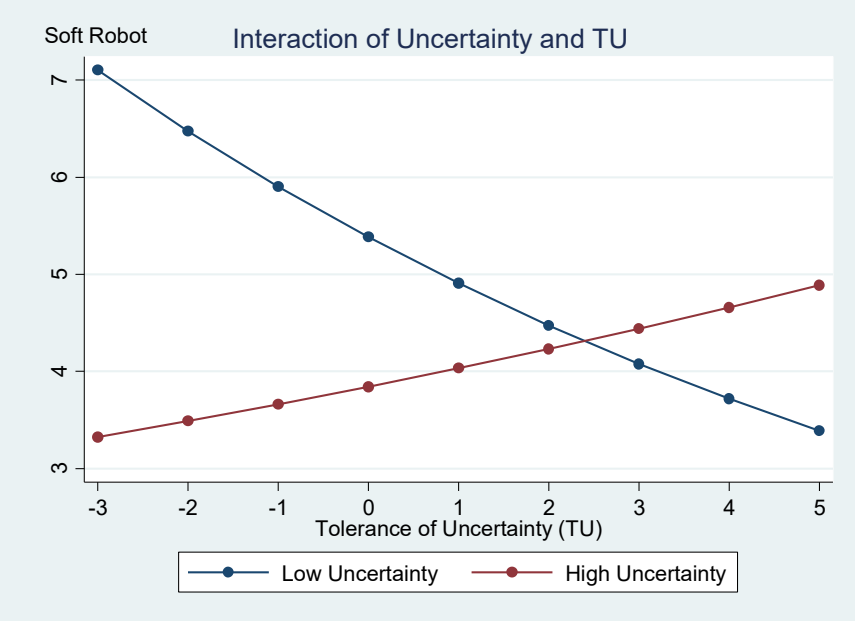

Figure 7. Interaction of Uncertainty and Tolerance of Uncertainty (Quantity for Soft Robot)

Table 4: Negative Binomial Regression Results for Quantity (Soft Robot)

DV=Quantity (SR) VARIABLES	Model 1 IRRs	Model 2 IRRs	Model 3 IRRs	Model 4 IRRs	Model 5 IRRs	Model 6 IRRs	Model 7 IRRs
Efficacy	1.05*** (0.016)	1.08*** (0.02)	1.05*** (0.01)	1.06*** (0.017)	1.05 (0.056)	1.05*** (0.01)	1.05** (0.016)
TU (inhibitory anxiety)	1.06** (0.025)	1.06* (0.025)	1.07* (0.03)	1.05* (0.024)	1.07** (0.025)	1.08* (0.03)	1.06* (0.025)
TU (prospective anxiety)	1.00 (0.026)	0.99 (0.026)	1.00 (0.03)	0.98 (0.032)	1.01 (0.026)	1.00 (0.02)	0.91* (0.032)
Work experience	1.0 (0.008)	1.0 (0.007)	0.99 (0.01)	0.99 (0.009)	0.99 (0.007)	0.99 (0.01)	0.99 (0.008)
Startup experience	1.09 (0.12)	1.08 (0.128)	1.1 (0.12)	1.11 (0.132)	1.11 (0.123)	1.09 (0.12)	1.07 (0.125)
Moderators							
Time Pressure	1.11 (0.07)	1.12† (0.077)	1.11 (0.07)	1.13† (0.08)	1.12 (0.078)	1.10 (0.07)	1.1 (0.076)
Uncertainty	1.07 (0.078)	1.08 (0.078)	1.08 (0.08)	1.04 (0.074)	0.70† (0.10)	1.08 (0.08)	0.71† (0.14)
Familiarity (SR)	1.02 (0.043)	1.02 (0.043)	1.02 (0.04)	1.01 (0.042)	1.02 (0.043)	1.02 (0.04)	1.02 (0.043)
Moderating effects							
Time Pressure * Efficacy		0.93** (0.025)					
Time Pressure * TU (inhibitory)			0.98 (0.04)				
Time Pressure * TU (prospective)				1.11† (0.052)			

Uncertainty * Efficacy					1.14* (0.073)		
Uncertainty * TU (inhibitory)						0.96 (0.03)	
Uncertainty * TU (prospective)							1.15* (0.04)
Constant	3.8*** (0.373)	3.8*** (0.371)	3.8*** (0.37)	4.0*** (0.705)	3.2.7*** (0.60)	3.79*** (0.37)	4.98*** (0.84)
Observations	227	227	227	227	227	227	227
AIC	1046.16	1043.73	1047.96	1002.25	1043.92	1047.4	998.84
BIC	1080.71	1081.74	1085.96	1043.24	1081.93	1085.42	1039.84
Pseudo Loglikelihood	-513.08	-504.87	-512.9	-489.12	-510.96	-512.73	-487.42

Robust standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05, † p<.1

DV: QUALITY OF OPPORTUNITIES (2ND DV)

Table 5 reports the results of the linear regression analyses for opportunity quality. The base model (Model 1) for quality that includes the main effects of all the focal variables and moderators explains a moderate but significant portion of the variance ($R2 = .12$, $p<.01$). The sign and significance of the regression coefficients show that tolerance of uncertainty (with regard to lower levels of inhibitory anxiety) is positively related to the quality of opportunities ($\beta=.126$, $p<.001$), though the effect is small. The finding provides support for H2b. Model 4 shows that the interaction of time pressure and tolerance of uncertainty (lower levels of prospective anxiety) is positive and significant ($\beta=.221$, $p<.01$). The slope of quality and tolerance of uncertainty is significantly positive when time pressure is high compared to the slope when time pressure is low (see Figure 8). The finding provides support for H5d.

Table 5: Regression Results for Quality (Soft Robot)

DV= Quality (SR) VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Efficacy	0.013	-0.035	-0.004	0.007	0.026	-0.00	0.001
	(0.028)	(0.032)	(0.03)	(0.03)	(0.04)	(0.02)	(0.026)
TU (inhibitory anxiety)	0.126***	0.113**	0.11*	0.106**	0.10*	0.09*	0.105**
	(0.038)	(0.037)	(0.05)	(0.036)	(0.036)	(0.05)	(0.04)
TU (prospective anxiety)	0.015	0.022	0.01	0.072	0.08†	0.07	0.051
	(0.044)	(0.045)	(0.04)	(0.059)	(0.048)	(0.05)	(0.061)
Work experience	0.008	-0.004	-0.003	-0.001	-0.002	0.01	0.008
	(0.017)	(0.019)	(0.01)	(0.018)	(0.019)	(0.01)	(0.018)
Startup experience	0.027	0.02	0.002	0.008	-0.087	-0.01	-0.023
	(0.164)	(0.165)	(0.16)	(0.168)	(0.171)	(0.10)	(0.155)
Time Pressure	0.240*	0.25*	0.25*	0.246*	0.225*	0.21*	0.215*
	(0.108)	(0.109)	(0.11)	(0.108)	(0.107)	(0.10)	(0.110)
Uncertainty	0.291**	0.286**	0.30**	0.297**	0.285**	0.30**	0.281*
	(0.110)	(0.111)	(0.11)	(0.11)	(0.11)	(0.11)	(0.110)
Familiarity (SR)	-0.122	-0.132†	-0.14†	-0.136†	-0.143*	-0.137	-0.152
	(0.077)	(0.081)	(0.08)	(0.079)	(0.079)	(0.08)	(0.076)
Moderating effects							
Time Pressure * Efficacy		0.091					
		(0.059)					
Time Pressure * TU (inhibitory)			0.01				
			(0.07)				

Time Pressure * TU (prospective)				0.221** (0.082)			
Uncertainty * Efficacy					-0.12† (0.054)		
Uncertainty * TU (inhibitory)						0.06 (0.07)	
Uncertainty * TU (prospective)							0.150* (0.088)
Constant	3.51*** (0.164)	3.34*** (0.317)	3.34*** (0.32)	3.41*** (0.309)	3.61*** (0.381)	3.72*** (0.21)	3.80*** (0.205)
Observations	227	227	227	227	227	227	227
R-squared	0.120	0.130	0.114	0.141	0.160	.135	0.149

Robust standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05, † p<.1

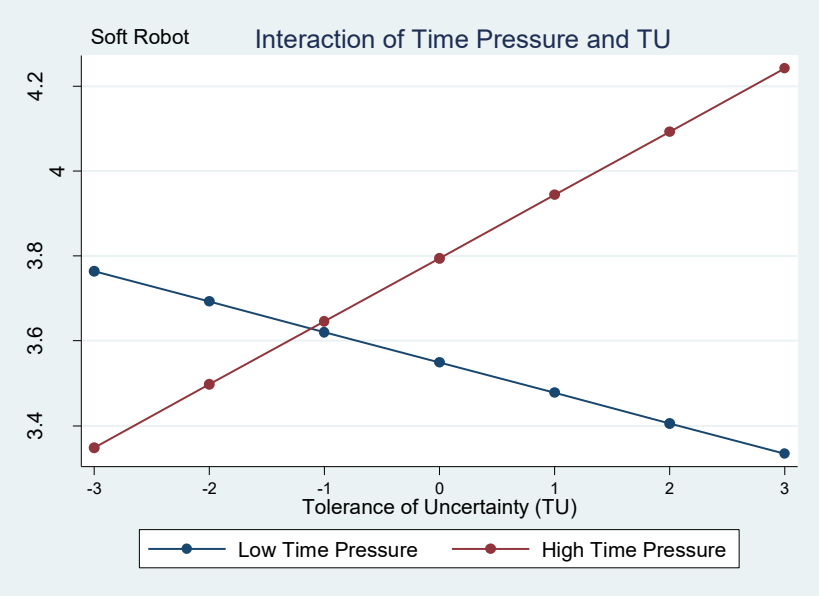

Figure 8. Interaction of Time Pressure and Tolerance of Uncertainty (Quality for Soft Robot)

Model 5 shows that the interaction of uncertainty and entrepreneurial self-efficacy is negative and significant at the 10% level (β=-.12, p=.07). Although the significance level was above 5%, I reported this interaction effect as partial support for the following reasons. First, the confidence intervals for the interaction term did not show a zero when tested for the 95% interval. As a result, we cannot reject the null hypothesis, which specifies that there is no effect. The p-value was .07. Second, this finding involving entrepreneurial self-efficacy might be of some importance in future studies. Third, prior entrepreneurhsip studies including those published in top-tier journals such as *Academy of Management Journal* (Eggers & Song, 2015), *Journal of Business Venturing* (Stephan & Pathak, 2016) and *Journal of International Business Studies* (Autio et al., 2013) have reported regression coefficients significant at <.10 level as partial support. As Figure 9 shows, the slope of entrepreneurial self-efficacy is significantly different when uncertainty is high when

compared to the slope of entrepreneurial self-efficacy when uncertainty is low. The finding provides support for H7a.

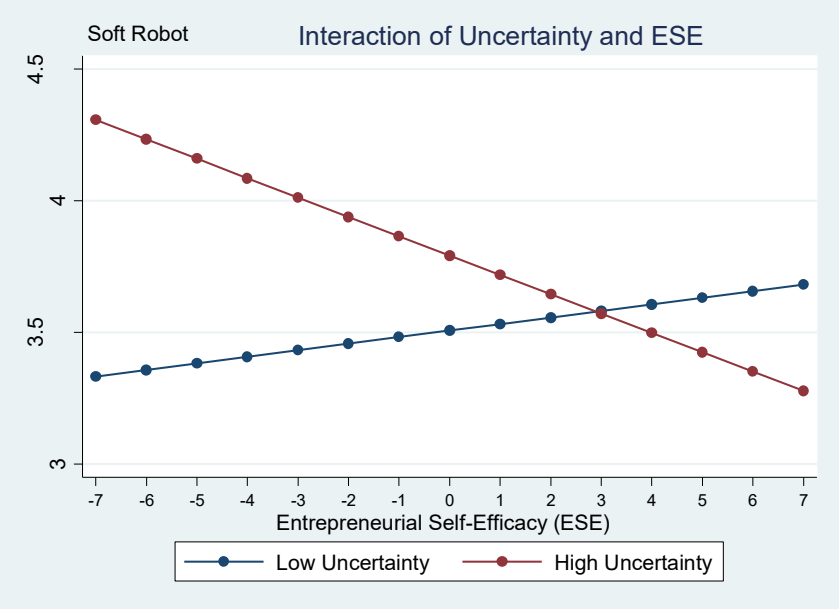

Figure 9. Interaction of Uncertainty and Entrepreneurial Self-efficacy (Quality for Soft Robot)

Model 7 shows that the interaction of uncertainty and tolerance of uncertainty (with regard to prospective anxiety) is positive and significant (β=.15, $p<.05$). The slope of tolerance of uncertainty is significantly different when uncertainty is high when compared to the slope of tolerance of uncertainty when uncertainty is low (as in Figure 10). The finding provides support for H8b.

POST-HOC ANALYSES

As post-hoc analysis, I created an additional dependent variable for opportunity quality. I calculated the average quality score for each respondent by the two raters. The inter-rater reliability between the raters using a Pearson bivariate correlation was .80

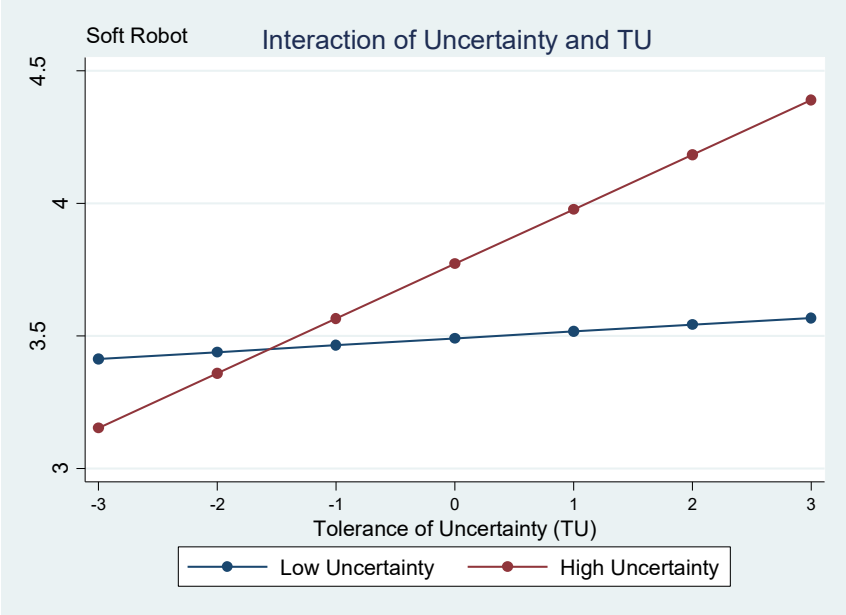

Figure 10. Interaction of Uncertainty and Tolerance of Uncertainty (Quality for Soft Robot)

($p<.001$). The regression results are shown in Table 6. As can be seen from model 1, the main effect of entrepreneurial self-efficacy is insignificant. This finding still does not support H1b. A positive and significant beta of 0.088 ($p<.001$) for tolerance of uncertainty on the average quality score provides support for H2b. Surprisingly, I found a positive and significant moderating effect of time pressure on the entrepreneurial self-efficacy and quality relationship. This is counter to what I have argued and hypothesized in H4b. Further, time pressure positively moderated tolerance of uncertainty ($\beta=.112$, $p<.05$) thereby supporting H5b. On the other hand, I did not find any support for the moderating effect of uncertainty on either entrepreneurial self-efficacy or tolerance of uncertainty. Hence, H7b and H8b were not supported in this post-hoc analysis.

Table 6: Results of Post-hoc Analyses (Soft Robot)

DV = Average quality score (SR) VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Efficacy	-0.006	-0.059**	-0.02	-0.018	-0.015	-0.01	-0.018
	(0.024)	(0.028)	(0.02)	(0.024)	(0.033)	(0.02)	(0.023)
TU (inhibitory anxiety)	0.088***	0.074**	0.073*	0.069**	0.071**	0.08**	0.078**
	(0.031)	(0.028)	(0.04)	(0.027)	(0.029)	(0.04)	(0.033)
TU (prospective anxiety)	0.011	0.016	0.005	-0.037	0.0054	0.01	0.005
	(0.037)	(0.036)	(0.03)	(0.048)	(0.035)	(0.03)	(0.054)
Work experience	0.006	-0.005	-0.004	-0.003	-0.004	0.006	0.005
	(0.014)	(0.016)	(0.06)	(0.016)	(0.016)	(0.01)	(0.015)
Startup experience	0.11	0.120	0.10	0.104	0.099	0.11	0.083
	(0.137)	(0.136)	(0.13)	(0.139)	(0.139)	(0.13)	(0.133)
Time Pressure	0.220**	0.232**	0.230*	0.228**	0.230**	0.22**	0.195**
	(0.092)	(0.092)	(0.09)	(0.092)	(0.092)	(0.09)	(0.092)
Uncertainty	0.257***	0.267***	0.28***	0.278***	0.277***	0.26***	0.269***
	(0.093)	(0.092)	(0.09)	(0.093)	(0.094)	(0.09)	(0.093)
Familiarity (SR)	-0.132*	-0.132*	-0.14*	-0.137**	-0.140**	-0.13*	-0.133*
	(0.068)	(0.069)	(0.06)	(0.068)	(0.069)	(0.06)	(0.068)
Time Pressure * Efficacy		0.093**					
		(0.046)					
Time Pressure * TU (inhibitory)			0.004				
			(0.06)				
Time Pressure * TU (prospective)				0.112*			
				(0.068)			

Uncertainty * Efficacy					-0.02		
					(0.004)		
Uncertainty * TU (inhibitory)						0.01	
						(0.06)	
Uncertainty * TU (prospective)							0.098
							(0.075)
Constant	3.139***	2.999***	3.0***	3.033***	3.000***	3.14***	3.244***
	(0.134)	(0.265)	(0.268)	(0.264)	(0.269)	(0.13)	(0.181)
Observations	227	227	227	227	227	227	227
R-squared	0.117	0.138	0.121	0.137	0.136	0.12	0.135

Robust standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05, † p<.10

ROBUSTNESS CHECKS

Additionally, as robustness checks, I created three additional independent variables. I calculated the average score for entrepreneurial self-efficacy, tolerance of uncertainty (inhibitory anxiety), and tolerance of uncertainty (prospective anxiety). I replicated the analyses for both the outcome variables of quantity and quality by using these three independent variables. I observed no loss of generalizability in my findings. The results of the robustness checks are shown for the quality outcome in Table 7.

Table 7: Results of Robustness Checks for Quality (Soft Robot)

DV = Quality (SR) VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Efficacy	0.019	-0.044	0.017	0.004	0.072	0.001	-0.003
	(0.082)	(0.119)	(0.08)	(0.087)	(0.122)	(0.08)	(0.078)
TU (inhibitory anxiety)	0.25***	0.250***	0.28***	0.202***	0.248***	0.227***	0.255***
	(0.065)	(0.063)	(0.10)	(0.061)	(0.068)	(0.087)	(0.067)
TU (prospective anxiety)	-0.041	-0.029	-0.02	-0.149	-0.234*	-0.10	-0.290*
	(0.097)	(0.098)	(0.07)	(0.103)	(0.110)	(0.09)	(0.141)
Work experience	0.008	0.007	0.008	-0.001	-0.004	0.01	0.007
	(0.017)	(0.016)	(0.017)	(0.017)	(0.019)	(0.017)	(0.017)
Startup experience	0.017	0.026	0.024	0.012	-0.088	0.022	0.016
	(0.161)	(0.159)	(0.163)	(0.168)	(0.168)	(0.158)	(0.158)
Time Pressure	0.240**	-0.249	0.47	0.289*	0.242**	0.23**	0.247**
	(0.108)	(0.108)	(0.50)	(0.118)	(0.109)	(0.11)	(0.107)
Uncertainty	0.297***	0.294***	0.30***	0.301***	1.192**	-0.014	-0.872*
	(0.110)	(0.110)	(0.11)	(0.109)	(0.560)	(0.50)	(0.515)
Familiarity (SR)	-0.093	-0.086	-0.098	-0.114	-0.175*	-0.113	-0.094
	(0.075)	(0.077)	(0.076)	(0.077)	(0.084)	(0.083)	(0.079)
Time Pressure * Efficacy		0.147					
		(0.165)					
Time Pressure * TU (inhibitory)			0.07				
			(0.10)				
Time Pressure * TU (prospective)				0.375*			
				(0.148)			
Uncertainty * Efficacy					-0.276*		
					(0.166)		

Uncertainty * TU (inhibitory)						0.092 (0.133)	
Uncertainty * TU (prospective)							0.434** (0.189)
Constant	2.646*** (0.449)	2.815*** (0.528)	2.46*** (0.520)	3.076*** (0.500)	2.913*** (0.560)	2.71*** (0.482)	3.221*** (0.490)
Observations	227	227	227	227	227	227	227
R-squared	0.134	0.138	0.135	0.149	0.135	0.135	0.154

Robust standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05, † p<.10

SUMMARY OF FINDINGS FOR SCENARIO #1 – SOFT ROBOT

Quantity Outcome

Main effects. Entrepreneurial self-efficacy showed a positive association with the quantity of opportunities generated. Tolerance of uncertainty (lower levels of inhibitory anxiety) showed positive and significant main effects on opportunity quantity. I did not find any significant main effects of tolerance of uncertainty (lower levels of prospective anxiety) on opportunity quantity. Prior experience (industry and startup) did not show significant effects on quantity.

Moderating effects of time pressure. As hypothesized, time pressure negatively moderated the relationship between entrepreneurial self-efficacy and quantity. Also, as theorized, time pressure positively moderated the relationship between tolerance of uncertainty (lower levels of prospective anxiety) and quantity. Time pressure did not show any significant moderating effects for the other factor of tolerance of uncertainty, namely, having lower levels of inhibitory anxiety, and quantity. Also, time pressure did not yield any significant moderating effects for the industry experience-quantity relationship or the startup experience-quantity relationship.

Moderating effects of uncertainty. As hypothesized, uncertainty positively moderated the relationship between entrepreneurial self-efficacy and quantity. And as theorized, uncertainty positively moderated the relationship between tolerance of uncertainty (lower levels of prospective anxiety) and quantity. Uncertainty did not show any significant moderating effects for the other factor of tolerance of uncertainty, namely, having lower levels of inhibitory anxiety, and quantity. Further, uncertainty did not show any significant

moderating effects on either the prior industry experience-quantity relationship or the prior startup experience-quantity relationship.

Quality Outcome

Main effects. I did not find any significant main effect of entrepreneurial self-efficacy on the quality of opportunities generated. Tolerance of uncertainty (lower levels of inhibitory anxiety) showed positive and significant main effect on opportunity quality. Prior experience (industry and startup) did not show any significant main effects on quality.

Moderating effects of time pressure. I did not find significant moderating effects of time pressure on the relationship between entrepreneurial self-efficacy and quality. However, as theorized, time pressure positively moderated the relationship between tolerance of uncertainty (lower levels of prospective anxiety) and quality. Once again, time pressure did not show any significant moderating effects for the prior experience (industry, startup) and quality relationships.

Moderating effects of uncertainty. As hypothesized, uncertainty negatively moderated the relationship between entrepreneurial self-efficacy and opportunity quality. And as theorized, uncertainty positively moderated the relationship between tolerance of uncertainty (lower levels of prospective anxiety) and quality. Uncertainty did not show any significant moderating effects for the other factor of tolerance of uncertainty, namely, having lower levels of inhibitory anxiety, and quality. Further, uncertainty did not show any significant moderating effects on either the prior industry experience-quality relationship or the prior startup experience-quality relationship.

CHAPTER 5

ANALYSIS AND RESULTS FOR VIRTUAL REALITY SCENARIO

MANIPULATION CHECKS

Manipulation Checks for Time Pressure

To determine if the manipulation was successful, in the post-experiment questionnaire, I asked participants about their perceived time pressure while working on their task. The wording of the question was "How much time pressure did you feel while identifying business opportunities using virtual reality technology?" Out of the 227 final respondents, 113 respondents were in the low time pressure condition. The responses to the manipulation check question showed that 24 responded with "very little pressure," 56 responded with "little pressure," 23 responded with "neither too little nor too much pressure," 8 responded with "much pressure" and 2 responded with "too much pressure." With 10 respondents (8.8%) feeling high pressure, the time pressure manipulation indicated success.

Out of the 114 respondents in the high time pressure, 5 responded with "very little pressure," 8 responded with "little pressure," 22 responded with "neither too little nor too much pressure," 50 responded with "much pressure' and 29 responded with "too much pressure." Thus, there were 13 respondents (11.4%) in the high time pressure group who responded to as feeling low time pressure. A t-test comparing the two groups (high and low time pressure) revealed significant differences between the two, $t(225) = -11.03$ ($p < .001$), Cohen's $d = 1.4$. For the low time pressure group, S.D. = 1.01, and Mean = 2.31. For the high time pressure group, S.D. = 1.05, and Mean = 3.76. Hence, the manipulation was successful.

Manipulation Checks for Uncertainty

To determine if this manipulation was successful, in the post-experiment questionnaire, I asked respondents about the perceived uncertainty presented by their task context. The three item measures pertaining to demand, competition, and technology were respectively "product demand is very easy to forecast versus very hard to forecast," "actions of competitors are quite easy to predict" and "simplicity of the technology: simple technology versus very complex technology," The respondents responded on a 1- to 5-point scale from 1=very easy to 5=very hard. I did not combine these three item measures into a single scale because of the greatly varying nature of what each was measuring.

In the low uncertainty group, the responses to the "product demand" uncertainty question showed that out of the 113 respondents, 94 responded with "demand is very easy to forecast" (=1) to "demand is neither too easy nor very hard to forecast" (=3), and 19 responded to "hard to forecast" and "very hard to forecast." With 19 respondents (16.8%) perceiving high uncertainty with respect to product demand in the environment when the manipulated condition was supposed to have been low uncertainty, the uncertainty manipulation indicated success.

Out of the 114 respondents in the high uncertainty condition, 45 responded with "very hard to forecast," 34 responded with "hard to forecast," 23 responded with "demand is neither too easy nor very hard to forecast," and the remaining 12 responded with either "very easy" or "easy to forecast." Thus, there were 12 respondents (10.5%) in the high uncertainty group who responded as perceiving low uncertainty. Further, a t-test comparing the two groups (high and low uncertainty) revealed significant differences between the two, $t(225) = -9.98$ ($p<.001$), Cohen's $d=1.27$. For the low uncertainty group, S.D. = 1.09, and Mean =

2.43. For the high uncertainty group, S.D. = 1.17, and Mean = 3.88. Hence, the manipulation was successful.

ANALYTICAL STRATEGY

Analytical Strategy for the Count Variable (Quantity)

Like scenario #1 covered in chapter 4, I checked the assumptions before deciding on the analytical strategy. Given that opportunity quantity is a count variable, I tested to see if I could use a Poisson or a Negative Binomial (NB) Regression. I conducted the following three tests for each model with quantity as the dependent variable in Stata 14.2 (Hilbe, 2011; UCLA website: https://stats.idre.ucla.edu/stata/faq/how-can-i-analyze-count-data-in-stata/).

First, I ran the negative binomial regressions without the robust option. I checked the likelihood ratio test at the bottom of the analysis. This is a test of the over dispersion parameter alpha (UCLA website https://stats.idre.ucla.edu/stata/faq/how-can-i-analyze-count-data-in-stata/) and compared this model to a Poisson model. The probability of the associated chi-squared value is significant at the 1% level for the models. This implied that alpha is significantly different from zero, and rejects the null hypothesis that the errors do not exhibit over-dispersion (when variance is larger than the mean) in the dependent variable. Thus, the Poisson distribution may not be appropriate in this case.

Second, I checked the goodness of fit test after running the Poisson model. The goodness of test fit was significant at the 1% level for the different models. This means that the model does not fit the data and a negative binomial is preferred. Third, I ran GLMs (Generalized Linear Models) with a negative binomial distribution and a log link function. The Pearson chi-squared was greater than 1.00, which implies that the data is over-dispersed, and a negative binomial regression is preferred

(http://data.princeton.edu/wws509/stata/overdispersion.html). Fourth, I checked the conditional mean and variance for the quantity variable. The variance is larger than the mean. The ratio of the variance to the mean of the dependent variables was 2.0. This suggested that the distribution of the "quantity" variable is displaying signs of over dispersion, that is, greater variance than might be expected in a Poisson distribution (UCLA website).

Diagnostics

After running the GLM, I ran the diagnostics for each of the seven regression models to check the normality of the residuals through the deviance (Hilbe, 2011). An example of the normal probability plot (see Figure 11) and the quantile for normal distribution plot (see Figure 12) are shown for one of the negative binomial models. The normal probability plot is sensitive to the non-normality in the middle range of the data. On the other hand, the normal quantile plot is sensitive to non-normality near the tails (Stata Manual).

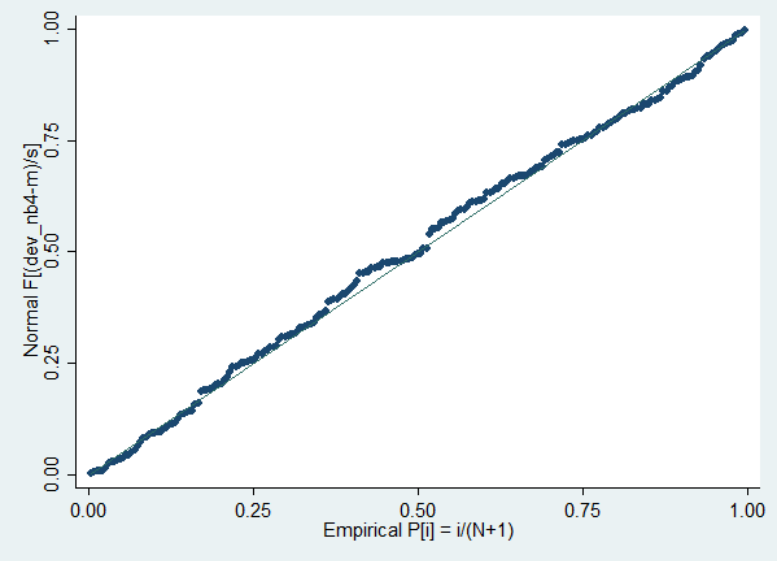

Figure 11. Normal Probability Plot (Virtual Reality)

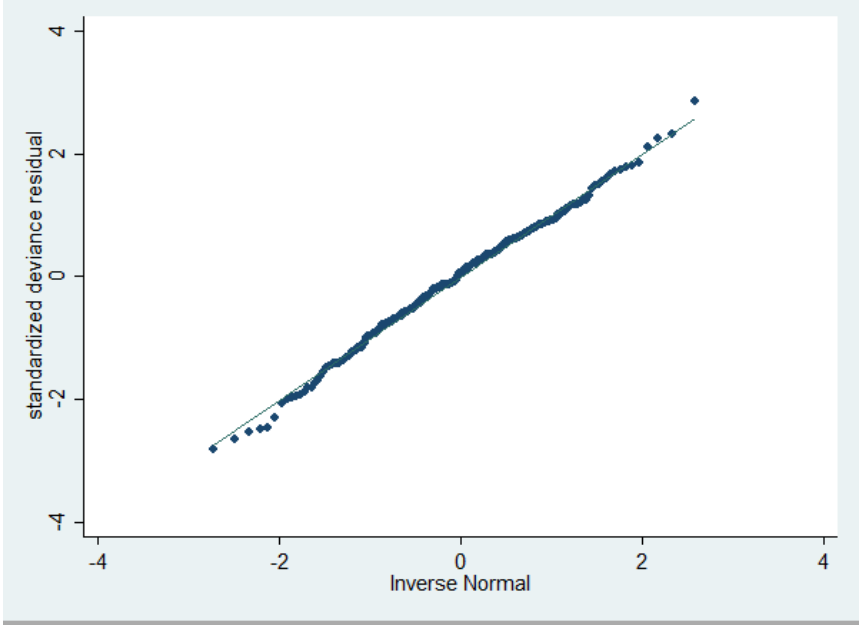

Figure 12. Quantile for Normal Distribution Plot (Virtual Reality)

In view of the results of the above tests, I retained the negative binomial model which would give the same results if the Poisson model was a good fit for the data. The important assumptions for an negative binomial model is that the dependent variable is a count variable, and that it is over-dispersed. So, the only time the negative binomial model would not work is if the data was under-dispersed. If the data was under-dispersed, the negative binomial model would not converge, and I would not have obtained any results.

I used negative binomial regression with robust standard errors in Stata 14.2 as the statistical technique to analyze individuals' variance in the quantity (count) of opportunities recognized. I used robust errors to take care of unequal variances or heteroskedasticity in the data (Cameron & Trivedi, 2005). For the second dependent variable, namely quality, linear regression with robust errors has been used to explain variance in individuals' quality of opportunity recognition. I used robust errors to take care of unequal variances or heteroskedasticity in the data (Cameron & Trivedi, 2005). Descriptive statistics are reported

in Table 8. The mean level of entrepreneurial self-efficacy across the sample is -.01(s.d.=2.29), and the mean level of tolerance of uncertainty (related to inhibitory anxiety) is .001 (s.d. =1.57) and that related to prospective anxiety is -.001 (s.d. = 1.37).

The mean total number of opportunities recognized is 5.37 (s.d.= 2.42), and the mean quality of these opportunities is 3.63 (s.d.=.70). As seen in Table 8, the two dependent variables, quantity and quality are different and are not strongly correlated. Hence, these were analyzed separately. Collinearity diagnostics indicate that the VIFs were below ten, which suggest that multicollinearity is unlikely to have confounded the results. The Pearson correlations may not be appropriate for the negative binomial, because it is a multiplicative model and not an additive model.

Table 8: Means, Standard Deviations, and Correlations (Virtual Reality)

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10
1.Quantity	5.37	2.42	1.00									
2.Quality	3.63	.70	.22*	1.00								
3.Efficacy	-.01	2.29	.18*	-.11*	1.00							
4.TU (inhibitory)	.001	1.57	.16*	.20*	.05	1.00						
5.TU (prospective)	-.001	1.37	.11*	-.02	.00	.19*	1.00					
6.Work experience	4.93	4.83	.03	-.09	-.003	.03	-.01	1.00				
7.Startup experience	.13	.34	.07	.01	.16*	-.01	-.06	.14*	1.00			
8.Time pressure	.48	.5	-.03	-.02	-.02	-.08	-.01	-.08	-.03	1.00		
9.Uncertainty	.5	.5	-.01	.11*	.09	-.07	.009	-.10	-.04	-.004	1.00	
10.Familiarity w/ VR tech.	2.89	1.02	.28*	.03	.10	.03	-.04	.03	.10	.03	-.08	1.00

*specifies correlation coefficients significant at the 5% level or better. N=227.

DV: QUANTITY OF OPPORTUNITIES RECOGNIZED (1ST DV)

Table 9 reports the results of the negative binomial regression analyses for virtual reality. The Incidence Rate Ratios (IRRs) are shown for Models 1-7 in Table 9. Model 1 shows that if a respondent were to increase his/her entrepreneurial self-efficacy score by one point, his/her rate for "quantity" would be expected to increase by a factor of 1.03 (IRR=1.03, $p<.01$) or 3%, while holding all other variables in the model constant. In the same model, we can see that for a one-unit increase in tolerance of uncertainty (with regard to inhibitory anxiety) it is expected to have a rate 1.04 times greater (IRR=1.04, $p<.01$) for the outcome "quantity." The finding provides support for H1a and H2a.

Model 2 shows that the interaction of time pressure and entrepreneurial self-efficacy is negative and significant. When time pressure is high (=1), the rate of entrepreneurial self-efficacy (1.12) decrease by a factor of 0.87 (IRR=.87, $p<.01$). To interpret the nature of the interaction, the relationship was plotted on a y-axis of the number of opportunities recognized and an x-axis of entrepreneurial self-efficacy. The nature of the interaction is illustrated in Figure 13. As can be seen from the interaction plot (see Figure 13), the rate of increase in the number of opportunities recognized with increasing entrepreneurial self-efficacy is significantly higher when time pressure is low than when time pressure is high. This indicates that the relationship between entrepreneurial self-efficacy and quantity weakens under high time pressure more than under low time pressure. This finding supports hypothesis 4a.

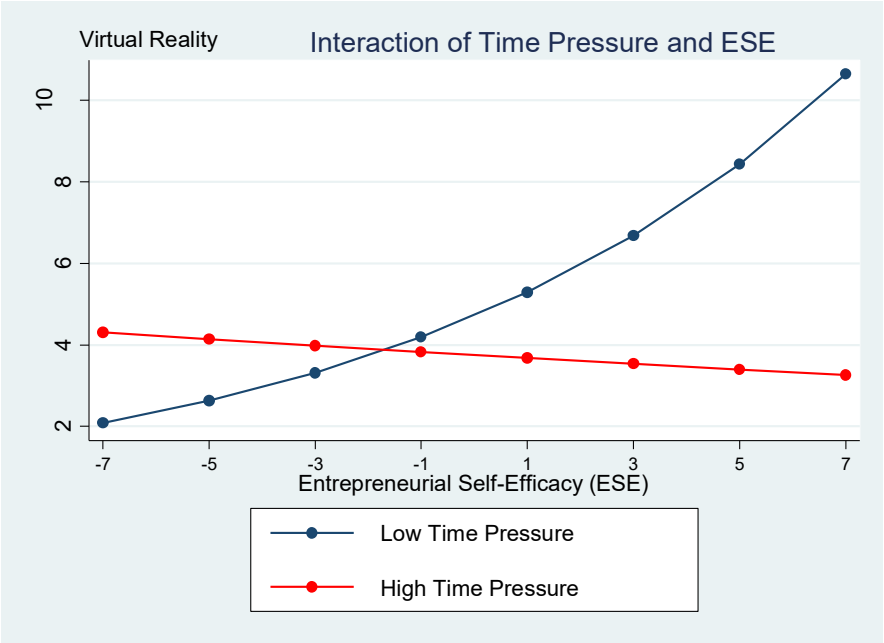

Figure 13. Interaction of Time Pressure and Entrepreneurial Self-efficacy (Quantity for Virtual Reality)

Model 4 in Table 9 shows that the interaction of time pressure and tolerance of uncertainty (prospective) with regard to prospective anxiety is positive and significant (IRR=1.43, p<.001). When time pressure is high, the rate of tolerance of uncertainty-prospective anxiety (0.97) increases by a factor of 1.43 or by 46%. To interpret the nature of the interaction, the relationship was plotted on a y-axis of the number of opportunities recognized and an x-axis of tolerance of uncertainty. The nature of the interaction is illustrated in Figure 14. As can be seen from the interaction plot (see Figure 14), the rate of increase in the number of opportunities recognized with increasing tolerance of uncertainty is higher when time pressure is high than when time pressure is low. This indicates that when time pressure is high, the relationship between tolerance of uncertainty and quantity is stronger than that under low time pressure. The finding supports H5c.

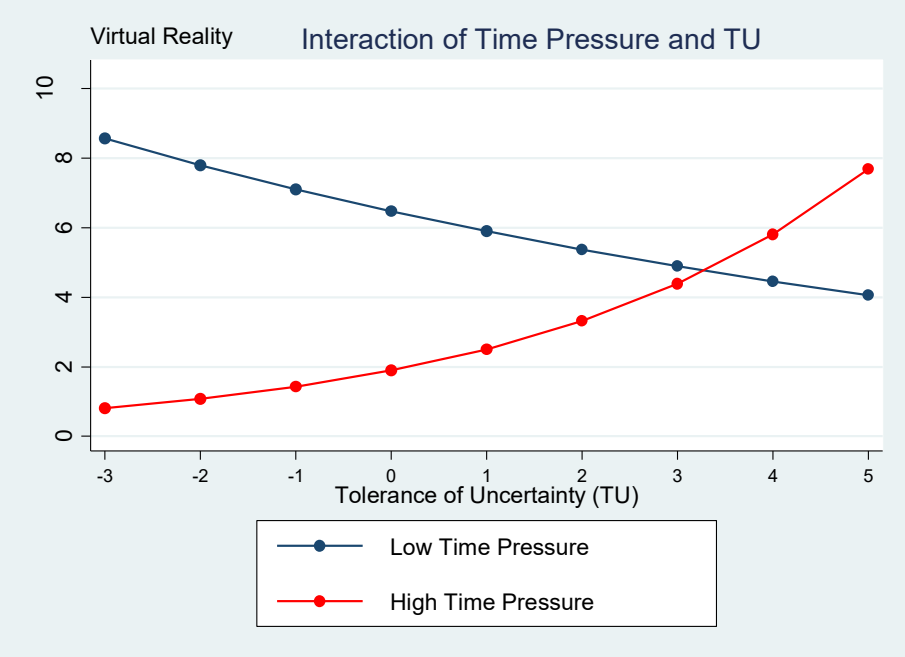

Figure 14. Interaction of Time Pressure and Tolerance of Uncertainty (Quantity for Virtual Reality)

Model 5 shows that the interaction of uncertainty and entrepreneurial self-efficacy is positive and significant. An IRR=1.05, $p<.05$ implies that when external uncertainty is high (=1), the rate of entrepreneurial self-efficacy (1.0) increases by a factor of 1.05 or 5%. To interpret the nature of the interaction, the relationship was plotted on a y-axis of the number of opportunities recognized and an x-axis of tolerance of uncertainty. The nature of the interaction is illustrated in Figure 15. As can be seen from the interaction plot (see Figure 15), the rate of increase in the number of opportunities recognized with increasing entrepreneurial self-efficacy is higher when uncertainty is high than when uncertainty is low. This indicates that when uncertainty is high, the relationship between entrepreneurial self-efficacy and quantity is stronger than it is under low uncertainty. The finding provides support for H7a.

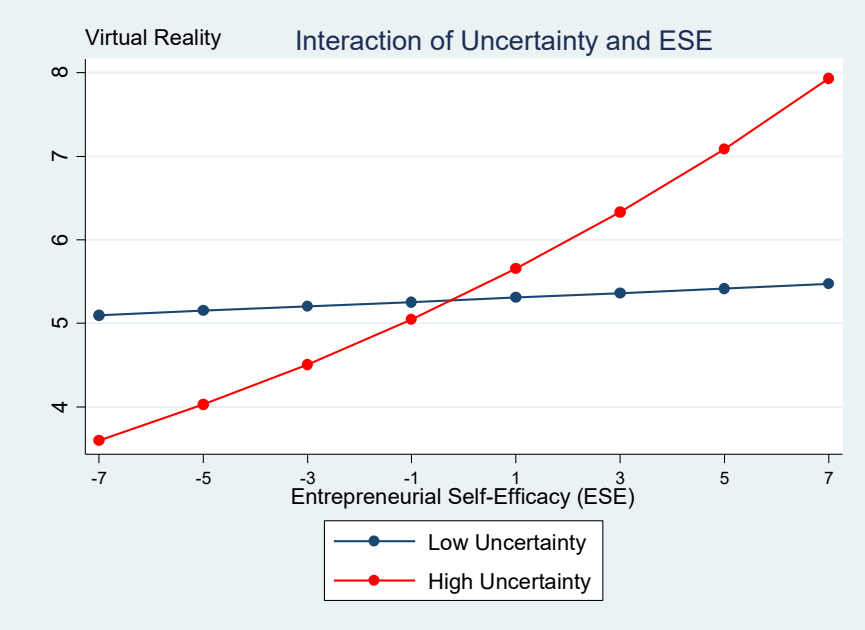

Figure 15. Interaction of Uncertainty and Entrepreneurial Self-efficacy (Quantity for Virtual Reality)

Model 7 shows that the interaction of uncertainty and tolerance of uncertainty (with regard to lower levels of prospective anxiety) is positive and significant. An IRR=1.08, $p<.05$ means that when external uncertainty is high (=1), the rate of tolerance of uncertainty - prospective anxiety (1.03) increases by a factor of 1.08 or 5%. To interpret the nature of the interaction, the relationship was plotted on a y-axis of the number of opportunities recognized and an x-axis of tolerance of uncertainty. The nature of the interaction is illustrated in Figure 16. As can be seen from the interaction plot (see Figure 16), the rate of increase in the number of opportunities recognized with increasing tolerance of uncertainty is higher when uncertainty is high than when uncertainty is low. This indicates that when uncertainty is high, the relationship between tolerance of uncertainty and quantity is stronger than it is under low uncertainty. The finding provides support for H8c.

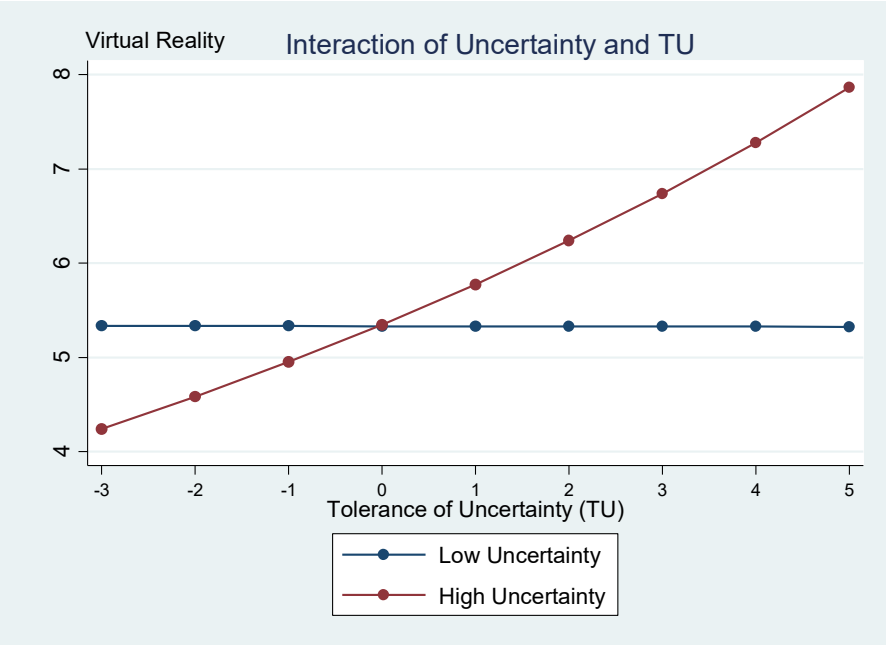

Figure 16. Interaction of Uncertainty and Tolerance of Uncertainty (Quantity for Virtual Reality)

Table 9: Negative Binomial Regression Results for Quantity (Virtual Reality)

DV=Quantity (VR) VARIABLES	Model 1 IRRs	Model 2 IRRs	Model 3	Model 4 IRRs	Model 5 IRRs	Model 6	Model 7 IRRs
Efficacy	1.03**	1.12***	1.03*	1.03**	1.00	1.03*	1.03*
	(0.014)	(0.03)	(0.013)	(0.012)	(0.01)	(0.015)	(0.014)
TU (inhibitory anxiety)	1.04**	1.03*	1.16***	1.04*	1.04*	1.04*	1.0
	(0.02)	(0.02)	(0.046)	(0.02)	(0.02)	(0.02)	(0.02)
TU (prospective anxiety)	1.03	1.05**	0.987	0.97	1.03†	1.03	1.04†
	(0.02)	(0.02)	(0.026)	(0.07)	(0.019)	(0.029)	(0.021)
Work experience	1.0	1.0	0.99	1.0	1.0	1.01	1.0
	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.01)	(0.01)
Startup experience	1.06	1.05	1.03	1.05	1.09	1.07	1.07
	(0.074)	(0.075)	(0.072)	(0.07)	(0.08)	(0.07)	(0.08)
Moderators							
Time Pressure	0.98	.80†	0.76†	0.52**	0.75**	0.97	0.97
	(0.056)	(0.1)	(0.117)	(0.102)	(0.05)	(0.057)	(0.055)
Uncertainty	0.99	1.06	1.02	1.04	1.01	1.013	1.0
	(0.056)	(0.06)	(0.06)	(0.06)	(0.02)	(0.058)	(0.057)
Familiarity (VR)	1.11***	1.10***	1.11***	1.10***	1.10***	1.11***	1.11***
	(0.03)	(0.029)	(0.029)	(0.03)	(0.03)	(0.031)	(0.03)
Moderating effects							
Time Pressure * Efficacy		0.87**					
		(0.038)					
Time Pressure * TU (inhibitory)			0.865				
			(0.089)				
Time Pressure * TU (prospective)				1.43***			
				(0.154)			

Uncertainty * Efficacy					1.05* (0.027)		
Uncertainty * TU (inhibitory)						1.01 (0.04)	
Uncertainty * TU (prospective)							1.08* (0.04)
Constant	5.3*** (0.315)	3.4*** (0.46)	3.79*** (0.61)	4.7*** (1.01)	5.7*** (0.28)	4.97*** (0.971)	4.94*** (0.94)
Observations	227	227	227	227	227	227	227
AIC	1042.81	1017.73	1021.40	1019.68	1022.18	1000.63	996.53
BIC	1073.63	1075.9	1079.63	1077.9	1056.43	1037.97	1033.86
Pseudo Loglikelihood	-512.4	-491.86	-493.70	-492.84	-501.10	-489.32	-487.26

Robust standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05, † p<.10

DV: QUALITY OF OPPORTUNITIES (2ND DV)

Table 10 reports the results of the linear regression analyses for the quality outcome of the opportunities recognized. The first model, Model 1,which includes the main effects of all the focal variables and moderators, explains a small but significant portion of the variance (R2 = .09). The sign and significance of the regression coefficients show that tolerance of uncertainty pertaining to inhibitory anxiety is positively related to opportunity quality (β=.103, $p<.01$), though the effect is small. The finding provides support for H2b. On the other hand, the coefficient of entrepreneurial self-efficacy (ESE) shows that every one-unit increase in the ESE score decreases the quality score by -.05 ($p<.05$). The result is not what I had expected as the main effect of entrepreneurial self-efficacy has been associated with success in entrepreneurial tasks.

Model 2 shows that the interaction of time pressure and entrepreneurial self-efficacy is significant in the negative direction (β=-.084, $p<.05$). As the interaction graph in Figure 17 shows, the rate of change of the slope for quality with regard to entrepreneurial self-efficacy decreases faster when time pressure is high than when time pressure is low. This finding supports hypothesis H4b.

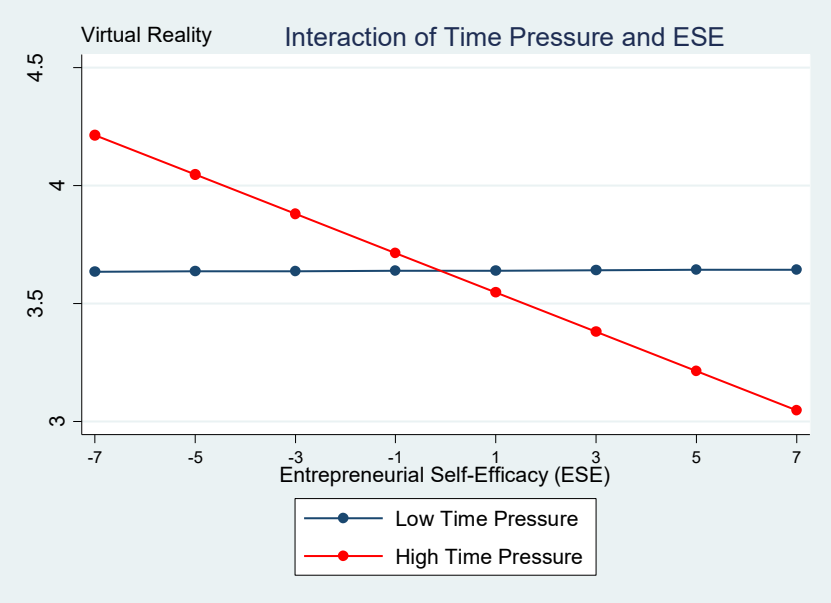

Figure 17. Interaction of Time Pressure and Entrepreneurial Self-efficacy (Quality for Virtual Reality)

Model 4 shows that the interaction of time pressure and tolerance of uncertainty (pertaining to prospective anxiety) is positive and significant (β=.273, $p<.05$). The slope of tolerance of uncertainty is significantly positive when time pressure is high when compared to the slope of tolerance of uncertainty when time pressure is low (as shown in Figure 18). The finding provides support for H5d.

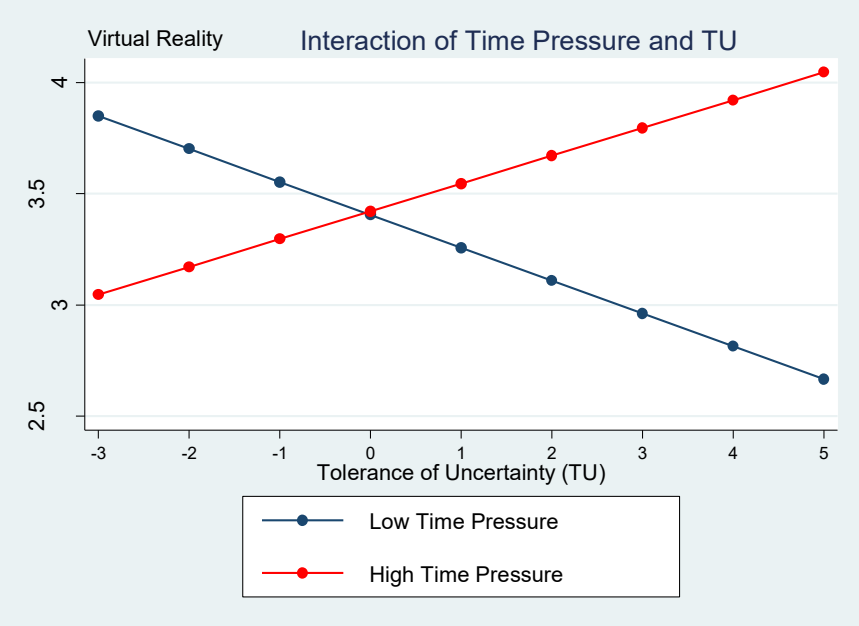

Figure 18. Interaction of Time Pressure and Tolerance of Uncertainty (Quality for Virtual Reality)

Model 5 shows that the interaction of uncertainty and entrepreneurial self-efficacy is significant in the negative direction (β=-.236, $p<.05$). The slope of quality and entrepreneurial self-efficacy decreases at a faster rate when time pressure is high compared to the slope when time pressure is low (as in Figure 19). The finding provides support for H7b.

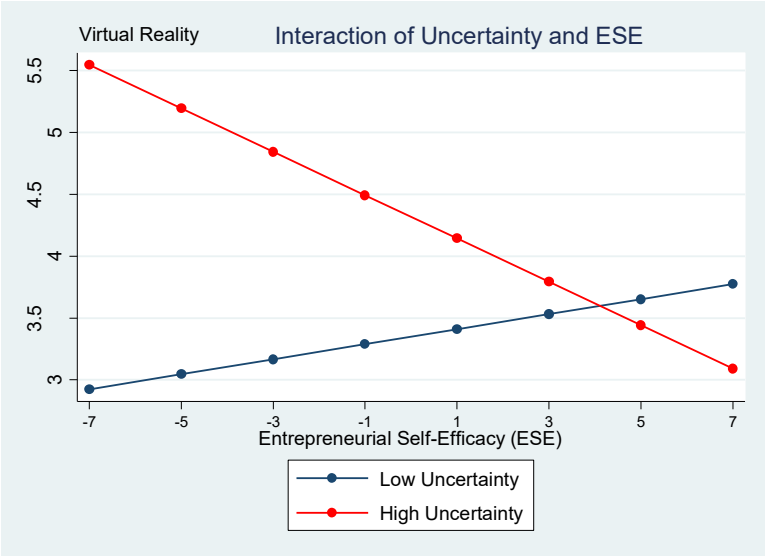

Figure 19. Interaction of Uncertainty and Entrepreneurial Self-efficacy (Quality for Virtual Reality)

Table 10: Regression Results for Quality (Virtual Reality)

DV=Quality (VR) VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Efficacy	-0.05*	0.001	-0.04*	-0.05*	0.06	-.045*	-0.045*
	(0.02)	(0.03)	(0.02)	(0.02)	(0.083)	(0.02)	(0.02)
TU (inhibitory anxiety)	0.103**	0.104**	0.191*	0.103**	0.105**	0.122**	0.101**
	(0.034)	(0.034)	(0.11)	(0.033)	(0.035)	(0.045)	(0.035)
TU (prospective anxiety)	-0.033	-0.035	-0.033	-0.14	-0.033	-0.034	-0.01
	(0.035)	(0.034)	(0.036)	(0.12)	(0.036)	(0.035)	(0.046)
Work experience	-0.015	-0.015	-0.015	-0.014	-0.011	-0.014	-0.014
	(0.016)	(0.015)	(0.014)	(0.01)	(0.018)	(0.015)	(0.016)
Startup experience	0.105	0.073	0.104	0.106	0.117	0.112	0.108
	(0.116)	(0.118)	(0.115)	(0.115)	(0.118)	(0.117)	(0.116)
Time Pressure	-0.015	-0.01	-0.073	0.016	0.01	-0.016	-0.031
	(0.09)	(0.089)	(0.178)	(0.199)	(0.045)	(0.09)	(0.092)
Uncertainty (expt. Condition)	0.188*	0.202*	0.187*	0.198*	0.969*	0.189*	0.187*
	(0.09)	(0.092)	(0.096)	(0.095)	(0.412)	(0.089)	(0.09)
Familiarity (VR)	0.027	0.032	0.036	0.041	0.05	0.025	0.03
	(0.045)	(0.045)	(0.047)	(0.047)	(0.047)	(0.044)	(0.04)
Moderating effects							
Time Pressure * Efficacy		-0.084*					
		(0.041)					
Time Pressure * TU (inhibitory)			0.156				
			(0.178)				
Time Pressure * TU (prospective)				0.273*			
				(0.156)			
Uncertainty * Efficacy					-0.236*		

					(0.116)		
Uncertainty * TU (inhibitory)						-0.042 (0.06)	
Uncertainty * TU (prospective)							-0.062 (0.069)
Constant	3.52*** (0.176)	3.51*** (0.176)	3.25*** (0.253)	3.19*** (0.263)	3.65*** (0.50)	3.53*** (0.175)	3.52*** (0.175)
Observations	227	227	227	227	227	227	227
R-squared	0.089	0.11	0.11	0.121	0.100	0.090	0.092

Robust standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05, † p<.10

POST-HOC ANALYSES

As post-hoc analysis, I created an additional dependent variable. I calculated the average quality score for each respondent by the two raters. The inter-rater reliability between the raters using a Pearson bivariate correlation was .87 ($p<.001$). The regression results are shown in Table 11. Model 1 shows that the main effect of entrepreneurial self-efficacy is insignificant. This finding does not support H1b. A positive and significant beta of 0.08 ($p<.001$) for tolerance of uncertainty (inhibitory anxiety) on the average quality score provides support for H2b.

For the interaction effects, time pressure negatively moderated the main effect of entrepreneurial self-efficacy on quality ($\beta=-.051$, $p<.05$). This finding supports H4b. As hypothesized, time pressure positively moderated tolerance of uncertainty-prospective anxiety ($\beta=.171$, $p<.05$), thereby supporting H5b. For the moderating effects of environmental uncertainty, I found that uncertainty negatively moderated the entrepreneurial self-efficacy-quality relationship ($\beta=-.131$, $p<.05$). This finding supports H7b. On the other hand, I did not find any support for the moderating effect of environmental uncertainty on tolerance of uncertainty. Hence, H8b did not find support in this post-hoc analysis.

Table 11: Results of Post-hoc Analyses (Virtual Reality)

DV = Average quality score (VR) VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Efficacy	-0.024	0.004	-0.019	-0.024	-0.024	-0.024†	-0.023
	(0.015)	(0.022)	(0.015)	(0.015)	(0.014)	(0.015)	(0.015)
TU (inhibitory anxiety)	0.080***	0.081***	0.142*	0.084***	0.076***	0.106**	0.078***
	(0.024)	(0.023)	(0.084)	(0.026)	(0.027)	(0.034)	(0.02)
TU (prospective anxiety)	-0.019	-0.02	-0.017	-0.122	-0.020	-0.021	0.006
	(0.028)	(0.027)	(0.02)	(0.104)	(0.029)	(0.028)	(0.038)
Work experience	-0.017	-0.017	-0.016	-0.017	-0.018	-0.016	-0.016
	(0.011)	(0.011)	(0.011)	(0.013)	(0.014)	(0.011)	(0.012)
Startup experience	0.072	0.054	0.075	0.073	0.072	0.081	0.075
	(0.099)	(0.101)	(0.10)	(0.097)	(0.101)	(0.100)	(0.098)
Time Pressure	-0.099	-0.095	0.025	0.075	-0.108	-0.10	-0.115
	(0.071)	(0.071)	(0.051)	(0.157)	(0.076)	(0.071)	(0.075)
Uncertainty	0.046	0.054	0.046	0.049	0.487	0.048	0.044
	(0.072)	(0.073)	(0.076)	(0.078)	(0.310)	(0.072)	(0.072)
Familiarity (VR)	-0.035	-0.033	-0.03	-0.029	-0.034	-0.039	-0.030
	(0.033)	(0.034)	(0.035)	(0.035)	(0.035)	(0.033)	(0.032)
Time Pressure * Efficacy		-0.051*					
		(0.030)					
Time Pressure * TU (inhibitory)			-0.19				
			(0.145)				
Time Pressure * TU (prospective)				0.171*			
				(0.10)			
Uncertainty * Efficacy					-0.131*		
					(0.0847)		

Uncertainty * TU (inhibitory)						-0.057 (0.04)	
Uncertainty * TU (prospective)							-0.06 (0.055)
Constant	3.218*** (0.141)	3.206*** (0.142)	2.99*** (0.20)	2.950*** (0.211)	2.988*** (0.400)	3.22*** (0.140)	3.216*** (0.140)
Observations	227	227	227	227	227	227	227
R-squared	0.086	0.095	0.115	0.106	0.108	0.092	0.105

Robust standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05, † p<.10

ROBUSTNESS CHECKS

For robustness checks, I created three additional independent variables. I calculated the average scores for entrepreneurial self-efficacy, tolerance of uncertainty (inhibitory anxiety), and tolerance of uncertainty (prospective anxiety). I replicated the analyses for both the outcome variables of quantity and quality by using these three independent variables. I observed no loss of generalizability in my findings. The results of the robustness checks are shown in Table 12 for the quality outcome.

Table 12: Results of Robustness Checks for Quality (Virtual Reality)

DV = Quality (VR) VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Efficacy	-0.132**	-0.016	-0.04*	-0.052**	0.052	-0.133*	-0.130**
	(0.062)	(0.09)	(0.02)	(0.021)	(0.082)	(0.061)	(0.062)
TU (inhibitory anxiety)	0.177***	0.178***	0.318*	0.098***	0.177***	0.238**	0.174***
	(0.059)	(0.059)	(0.19)	(0.024)	(0.06)	(0.077)	(0.06)
TU (prospective anxiety)	-0.061	-0.064	-0.072	-0.230	-0.061	-0.067	-0.019
	(0.066)	(0.065)	(0.064)	(0.182)	(0.068)	(0.066)	(0.085)
Work experience	-0.014	-0.014	-0.012	-0.013	-0.01	-0.014	-0.013
	(0.015)	(0.015)	(0.011)	(0.012)	(0.017)	(0.015)	(0.015)
Startup experience	0.089	0.061	0.059	0.052	0.110	0.105	0.093
	(0.117)	(0.119)	(0.117)	(0.119)	(0.118)	(0.118)	(0.117)
Time Pressure	-0.002	0.721*	0.95	-1.277	-0.001	-0.003	-0.016
	(0.089)	(0.428)	(0.82)	(0.853)	(0.095)	(0.089)	(0.092)
Uncertainty	0.179**	0.192**	0.155	0.170*	0.949*	0.623	0.427
	(0.09)	(0.092)	(0.096)	(0.091)	(0.419)	(0.423)	(0.37)
Familiarity (VR)	0.032	0.036	0.028	0.025	0.012	0.027	0.033
	(0.045)	(0.045)	(0.046)	(0.045)	(0.047)	(0.043)	(0.044)
Time Pressure * Efficacy		-0.215*					
		(0.124)					
Time Pressure * TU (inhibitory)			-0.26				
			(0.293)				
Time Pressure * TU (prospective)				0.454*			
				(0.281)			
Uncertainty * Efficacy					-0.232*		
					(0.117)		
Uncertainty * TU (inhibitory)						-0.128	
						(0.11)	

Uncertainty * TU (prospective)							-0.09
							(0.128)
Constant	3.509***	3.108***	2.48***	4.007***	3.172***	3.32***	3.398***
	(0.367)	(0.456)	(0.735)	(0.560)	(0.543)	(0.412)	(0.384)
Observations	227	227	227	227	227	227	227
R-squared	0.092	0.104	0.114	0.112	0.098	0.099	0.094

Robust standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05, † p<.10

SUMMARY OF FINDINGS FOR SCENARIO #2 – VIRTUAL REALITY

Quantity Outcome

Main effects. Entrepreneurial self-efficacy showed a positive main effect on opportunity quantity. Tolerance of uncertainty (lower levels of inhibitory anxiety) showed positive and significant main effect on quantity. The results did not yield any significant main effect for the other factor for tolerance of uncertainty-lower levels of prospective anxiety on quantity. Prior experience (industry and startup) did not show any significant main effects on quantity.

Moderating effects of time pressure. As hypothesized, time pressure negatively moderated the relationship between entrepreneurial self-efficacy and quantity. And as theorized, time pressure positively moderated the relationship between tolerance of uncertainty (lower levels of prospective anxiety) and quantity. Time pressure did not show any significant moderating effects for the other factor of tolerance of uncertainty-lower levels of inhibitory anxiety, and quantity. Time pressure did not show any significant moderating effects for the prior industry experience-quantity relationship or the prior startup experience-quantity relationship.

Moderating effects of uncertainty. As hypothesized, uncertainty positively moderated the relationship between entrepreneurial self-efficacy and quantity. And as theorized, uncertainty positively moderated the relationship between tolerance of uncertainty (lower levels of prospective anxiety) and quantity. Uncertainty did not show any significant moderating effects for the other factor of tolerance of uncertainty-lower levels of inhibitory anxiety and quantity. Further, uncertainty did not show any significant moderating effects for

the prior industry experience-quantity relationship or the prior startup experience-quantity relationship.

Quality Outcome

Main effects. I found a surprising reverse main effect of entrepreneurial self-efficacy on opportunity quality. Tolerance of uncertainty (lower levels of inhibitory anxiety) showed positive and significant association with quality. The second factor for tolerance of uncertainty (lower levels of prospective anxiety), prior experience (industry and startup) did not show any significant main effects on opportunity quality.

Moderating effects of time pressure. As hypothesized, time pressure negatively moderated the relationship between entrepreneurial self-efficacy and opportunity quality. And as theorized, time pressure positively moderated the relationship between tolerance of uncertainty (lower levels of prospective anxiety) and quality. Time pressure did not show any significant moderating effects for the other factor of tolerance of uncertainty-lower levels of inhibitory anxiety, and quality. Once again, time pressure did not show any significant moderating effects for either the prior industry experience-quality or the prior startup experience-quality relationships.

Moderating effects of uncertainty. As hypothesized, uncertainty negatively moderated the relationship between entrepreneurial self-efficacy and quality. As theorized, uncertainty positively moderated the relationship between tolerance of uncertainty (lower levels of prospective anxiety) and quality. Uncertainty did not show any significant moderating effects for the other factor of tolerance of uncertainty-lower levels of inhibitory anxiety and quality. Further, uncertainty did not show any significant moderating effects for

either the prior industry experience-quality or the prior startup experience-quality relationships.

CHAPTER 6

DISCUSSION AND CONCLUSION

This chapter begins by showing the overall hypotheses support summary for opportunity quantity and quality for both the scenarios (see Tables 13 and 14). This is followed by a broader discussion of the findings for the main effects across scenarios. Thereafter follows a discussion of the moderating effects of time pressure and uncertainty on each individual attribute-opportunity recognition relationship. The next section highlights several theoretical and practical implications of the study. A discussion of the study's limitations follows, laying the groundwork for future research avenues related to entrepreneurial tasks and behaviors.

Table 13: Hypotheses Support for Quantity (Both Scenarios)

H#	Hypotheses	SOFT ROBOT		VIRTUAL REALITY	
		S	NS	NS	NS
1a	Individual with higher levels of entrepreneurial self-efficacy will recognize more opportunities.	Y	-	Y	-
2a	Individuals with higher levels of tolerance of uncertainty (lower levels of inhibitory anxiety) will recognize more opportunities.	Y	-	Y	-
2c	Individuals with higher levels of tolerance of uncertainty (lower levels of prospective anxiety) will recognize more opportunities.	-	NS	-	NS
3a	Individuals with prior industry experience will recognize fewer number of opportunities.	-	NS	-	NS
3c	Individuals with prior startup experience will recognize more opportunities.	-	NS	-	NS
4a	Time Pressure negatively moderates the relationship between entrepreneurial self-efficacy and opportunity recognition such that the positive relationship between entrepreneurial self-efficacy and the number of opportunities recognized will be weaker under high time pressure than under low time pressure.	Y	-	Y	-
5a	Time Pressure positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of inhibitory anxiety) and the number of opportunities recognized will be stronger under high time pressure than under low time pressure.	-	NS	-	NS
5c	Time Pressure positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of prospective anxiety) and the number of opportunities recognized will be stronger under high time pressure than under low time pressure.	Y	-	Y	-

H#	Hypotheses	SOFT ROBOT		VIRTUAL REALITY	
		S	NS	NS	NS
7a	Uncertainty positively moderates the relationship between entrepreneurial self-efficacy and opportunity recognition such that the positive relationship between entrepreneurial self-efficacy and the number of opportunities recognized will be stronger under high uncertainty than under low uncertainty.	Y	-	Y	-
8a	Uncertainty positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of inhibitory anxiety) and the number of opportunities recognized will be stronger under high uncertainty than under low uncertainty.	-	NS	-	NS
8c	Uncertainty positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of prospective anxiety) and the number of opportunities recognized will be stronger under high uncertainty than under low uncertainty.	Y	-	Y	-

Table 14: Hypotheses Support for Quality (Both Scenarios)

H#	Hypotheses	SOFT ROBOT		VIRTUAL REALITY	
		S	NS	S	NS
1b	Individual with higher levels of entrepreneurial self-efficacy will recognize higher quality opportunities.	-	NS	Y (-ve direction)	-
2b	Individuals with higher levels of tolerance of uncertainty (lower levels of inhibitory anxiety) will recognize higher quality opportunities.	Y	-	Y	-
2d	Individuals with higher levels of tolerance of uncertainty (lower levels of prospective anxiety) will recognize higher quality opportunities.	-	NS	-	NS
3b	Individuals with prior industry experience will recognize lower quality opportunities.	-	NS	-	NS
3d	Individuals with prior startup experience will recognize higher quality opportunities.	-	NS	-	NS
4b	Time Pressure negatively moderates the relationship between entrepreneurial self-efficacy and opportunity recognition such that the positive relationship between entrepreneurial self-efficacy and the quality of opportunities recognized will be weaker under high time pressure than under low time pressure.	-	NS	Y	-
5b	Time Pressure positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of inhibitory anxiety) and the quality of opportunities recognized will be stronger under high time pressure than under low time pressure.	-	NS	-	NS

H#	Hypotheses	SOFT ROBOT		VIRTUAL REALITY	
		S	NS	S	NS
5d	Time Pressure positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of prospective anxiety) and the quality of opportunities recognized will be stronger under high time pressure than under low time pressure.	Y	-	Y	-
7b	Uncertainty negatively moderates the relationship between entrepreneurial self-efficacy and opportunity recognition such that the positive relationship between entrepreneurial self-efficacy and the quality of opportunities recognized will be weaker under high uncertainty than under low uncertainty.	Y	-	Y	-
8b	Uncertainty positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of inhibitory anxiety) and the quality of opportunities recognized will be stronger under high uncertainty than under low uncertainty.	-	NS	-	NS
8d	Uncertainty positively moderates the relationship between tolerance of uncertainty and opportunity recognition such that the positive relationship between tolerance of uncertainty (lower levels of prospective anxiety) and the quality of opportunities recognized will be stronger under high uncertainty than under low uncertainty.	Y	-	-	NS

DISCUSSION OF FINDINGS

Extensive research has been done in understanding opportunity discovery, evaluation, and exploitation (Shane & Venkataraman, 2000), but extant literature has fallen short on theoretically and empirically in understanding the precursor of these opportunities: opportunity recognition (Davidsson, 2015; Kier & McMullen, 2018). Opportunity recognition does involve subjective efforts to comprehend one's environment and imagine the "to-be" (e.g., how to introduce a new technology) (Grégoire, Shepherd et al., 2010). By examining opportunity quantity and quality, I sought to gain a better understanding of the critical starting point of entrepreneurship. I did so by taking a cognitive perspective (Baron, 2004; Grégoire, Corbett & McMullen, 2011; Mitchell et al., 2007). I sought to unpack how the individual attributes (cognitive variables) interact with situational contingencies (e.g., time pressure) to manifest as individual behavior in opportunity recognition.

I integrated literature from entrepreneurship (Shane & Venkataraman, 2000; Shepherd, 2015); creativity (Amabile et al., 2002; Amabile, 2012, 2017); cognitive psychology perspective in entrepreneurship (Baron, 2004; Grégoire et al., 2011); and psychology (Carleton et al., 2007; Carleton et al., 2010) to analyze individual behavior and decision-making during opportunity recognition. Our understanding of how individual attributes influence opportunity recognition has been limited. Accordingly, I have developed a framework to clarify how and why each of the individual attributes (entrepreneurial self-efficacy, tolerance of uncertainty, and prior experience) is integral to opportunity quantity and quality. Although the main effects of the said individual attributes were assumed to be important during opportunity recognition, empirical evidence of the main effects of tolerance of uncertainty is scarce. Hence, in this dissertation, I adapted the scale for intolerance of

uncertainty from the psychology literature (Carleton et al., 2007). I reverse scored the item measures to name it as tolerance of uncertainty and tested whether it affects opportunity recognition.

How individuals think and how they act under contingencies of time pressure (Shepherd et al., 2015) and uncertainty (McKelvie et al., 2011; Sarasvathy, 2001) are increasingly recognized as critical factors during opportunity recognition and subsequent entrepreneurial actions. Yet, time pressure and uncertainty are rarely tested empirically for their contingency effects on individuals' performance in opportunity recognition. Accordingly, I introduced time pressure and environmental uncertainty as manipulations in an experiment to observe the real-time behavior of individuals while recognizing opportunities based on new technologies. The study findings demonstrated that certain individuals could leverage tensions arising out of situational contingencies of time pressure and environmental uncertainty. These individuals were more entrepreneurial in recognizing opportunities emerging from new technologies (Sarasvathy & Kotha, 2001) compared to others. For example, under high time pressure, individuals with high tolerance of uncertainty excelled both in opportunity quantity and quality. In the following paragraphs, I discuss each independent variable's (individual attribute) main and moderating effects on opportunity quantity and quality.

ENTREPRENEURIAL SELF-EFFICACY

Entrepreneurial Self-efficacy and Quantity

As expected and established in the entrepreneurship literature, entrepreneurial self-efficacy showed a positive main effect on the opportunity quantity for both the scenarios.

Entrepreneurial Self-efficacy and Quality

Surprisingly, entrepreneurial self-efficacy showed reverse main effects for opportunity quality in the virtual reality scenario. It did not show a significant main effect for the soft robot scenario. This finding might deny a commonly held assumption that efficacious individuals perform better in all entrepreneurial tasks. However, as seen above, this assumption was supported for the quantity outcome. The results might help us to delve deeper into the delineation of the role of entrepreneurial self-efficacy in achieving an ambitious primary goal (quantity) and then their performance levels (quality) within the goals. The assessment of quantity and quality of opportunities might have been perceived as competing demands by the self-efficacious individuals, and they could not sustain their high efficacy levels equally for achieving both the goals. This resulted in these individuals excelling in one at the cost of the other (Hmieleski & Corbett, 2008).

Moderating Effects of Time Pressure on Entrepreneurial Self-efficacy and Quantity

Creativity research demonstrated that time pressure shaped the creativity and productivity of employees in large organizations (Amabile, 2012). Entrepreneurship literature has theoretically established that entrepreneurs work against time pressure while taking entrepreneurial decisions and actions (McMullen & Shepherd, 2006; Shepherd et al., 2015). However, possessing high entrepreneurial self-efficacy does not necessarily imply better management and handling of time pressure during opportunity recognition or other entrepreneurial tasks. Time pressure is perceived the same by individuals irrespective of their entrepreneurial self-efficacy levels. Dealing effectively with time pressure is not necessarily an inbuilt feature of entrepreneurial self-efficacy. Given this argument for my hypothesis, it

was not surprising when I observed that time pressure had a negative moderating effect on the link between entrepreneurial self-efficacy and opportunity quantity for both the scenarios.

Moderating Effects of Time Pressure on Entrepreneurial Self-efficacy and Quality

A similar argument applies to the moderating effects of time pressure on entrepreneurial self-efficacy and opportunity quality. The results showed a negative moderating effect of time pressure on the link between entrepreneurial self-efficacy and quality for the virtual reality scenario, while there was no significant effect for the soft robot.

Moderating Effects of Uncertainty on Entrepreneurial Self-efficacy and Quantity

In line with the reasoning that self-efficacious individuals aim at ambitious goals, the individuals high in entrepreneurial self-efficacy were successful in achieving the primary goal – opportunity quantity under uncertainty. Individuals high in entrepreneurial self-efficacy could embrace uncertainty while engaging in entrepreneurial tasks. Hence, self-efficacious individuals perceived less tension arising out of environmental uncertainty compared to others. The results showed a positive moderating effect of uncertainty on the link between entrepreneurial self-efficacy and quantity for both the scenarios.

Moderating Effects of Uncertainty on Entrepreneurial Self-efficacy and Quality

On the other hand, environmental uncertainty had a negative moderating effect on the relationship between entrepreneurial self-efficacy and opportunity quality. This supports the argument that highly self-efficacious individuals will focus more on the primary goal of generating more opportunities rather than the secondary goal of achieving higher quality for each of the opportunities identified.

Tolerance of Uncertainty and Quantity

Entrepreneurship literature portrays entrepreneurs as individuals who have the willingness to bear uncertainty, and take risks (McClelland, 1967). However, the literature falls short in empirically establishing the assumptions. Accordingly, I adapted the (in)tolerance of uncertainty scale from psychology (Carleton et al., 2007). The scale has two subscales – inhibitory anxiety and prospective anxiety. I reverse scored the item measures for both the subscales to measure individuals' tolerance for uncertainty and their influence on opportunity recognition. My findings supported the theoretically established notion that individuals with high tolerance for uncertainty (lower levels of inhibitory anxiety) excelled at opportunity quantity for both the scenarios.

Tolerance of Uncertainty and Quality

I found similar empirical support for the quality outcome. Individuals with higher tolerance for uncertainty (lower levels of inhibitory anxiety) showed a positive main effect on opportunity quality for both the scenarios. The second factor related to prospective anxiety did not shown any main effect on quality.

Moderating Effects of Time Pressure on Tolerance of Uncertainty and Quantity

I tested for the moderating effects of time pressure on both the factors of tolerance of uncertainty (inhibitory anxiety and prospective anxiety) on opportunity quantity. I found positive and significant interaction effects of time pressure on the tolerance of uncertainty (prospective anxiety) and quantity for both the scenarios.

Moderating Effects of Time Pressure on Tolerance of Uncertainty and Quality

Similarly, I tested for the moderating effects of time pressure on both the factors of tolerance of uncertainty (inhibitory anxiety and prospective anxiety) for the quality outcome. I found positive and significant interaction effects of time pressure on the tolerance of uncertainty (prospective anxiety) and quality for both the scenarios.

Moderating Effects of Uncertainty (Environmental) on Tolerance of Uncertainty and Quantity

I tested the moderating effects of environmental uncertainty on both the factors of tolerance of uncertainty (inhibitory anxiety and prospective anxiety) on the quantity outcome. I found positive and significant interaction effects of environmental uncertainty on the tolerance of uncertainty (prospective anxiety) and quantity for both the scenarios.

Moderating Effects of Uncertainty (Environmental) on Tolerance of Uncertainty and Quality

I tested the moderating effects of environmental uncertainty on both the factors of tolerance of uncertainty (inhibitory anxiety and prospective anxiety) on the quality outcome. I found positive and significant interaction effects of environmental uncertainty on the tolerance of uncertainty (prospective anxiety) and the opportunity quality across the two scenarios. Overall, coping with time pressure and uncertainty was detrimental for individuals with lower levels of tolerance for uncertainty.

PRIOR WORK EXPERIENCE

I did not find any significant main effects of either prior industry or prior startup experience on opportunity quantity or quality. This could be due to the undergraduate student sample who took both the scenarios. Most respondents had neither industry nor startup

experience. As such, the moderating effects of time pressure and uncertainty were not tested in this study for prior experience. However, the propositions have been developed.

BRIEF RECAP

The results demonstrate different main effects of entrepreneurial self-efficacy on opportunity quantity and quality. Tolerance of uncertainty, as hypothesized, enhanced both opportunity quantity and quality. For the moderating hypotheses, the findings do support competing theoretical arguments that time pressure and uncertainty serve a dual role. For some individuals, these situational contingencies act as negative stressors inhibiting decision-making and action. For example, time pressure mitigated entrepreneurial self-efficacy, whereas for other individuals, time pressure and uncertainty acted as energizers. Individuals who were high in tolerance of uncertainty successfully leveraged the tensions arising out of time pressure and environmental uncertainty. This answers the question why some individuals could leverage tensions and uncertainty to their benefit, while others do not.

IMPLICATIONS

My dissertation contributes to literature and practice in six primary ways. First, my research adopts a contingency framework to understand opportunity recognition. The situational contingencies of time pressure and environmental uncertainty are real problems that can prevent aspiring entrepreneurs from birthing new ventures. My study sought to contribute to the opportunity recognition literature by theorizing the contingency effects of time pressure and uncertainty on cognitive variables. The study provided empirical evidence through an experiment to validate the major hypotheses. Entrepreneurship studies seldom hypothesize and empirically test the moderating effects of time pressure and uncertainty, although both time pressure and uncertainty have been widely acknowledged as critical and

unique factors that entrepreneurs face (McMullen & Shepherd, 2005; Sarasvathy, 2001). Taken together, my study complements the interactionist perspective which has greater explanatory power for an opportunity recognition model. The experimental setting allowed the use of research tasks that showcased the real-time efforts of individuals to recognize opportunities. Doing so helped in alleviating issues of retrospective and recall bias (Grégoire, Shepherd et al., 2010), thereby overcoming the threats of depending on self-reported measures of opportunity recognition. In the process, I believe my efforts contribute to the literature on opportunity recognition as a cognitive process model and contribute to empirical advancement in entrepreneurship and opportunity recognition.

Second, to complement the cognitive literature on opportunity recognition (Baron, 2006, 2008; Dimov, 2011; Grégoire, Barr et al., 2010; Haynie & Shepherd, 2009; Shepherd et al., 2017), my study adopted an interdisciplinary approach. My study integrated the little-explored construct of tolerance of uncertainty within entrepreneurship. I have theoretically and empirically laid the foundation that tolerance of uncertainty is an important individual attribute that is integral to opportunity recognition. Existing research theoretically assumed that willingness to bear uncertainty or stress tolerance is fundamental for success in entrepreneurial actions (Frese & Geinik, 2014; Sarasvathy, 2001; Shepherd & McMullen, 2006). However, the theoretical notion was not yet supported by empirical evidence. On the practical side, my study findings reiterate the importance of cultivating tolerance of uncertainty in students and practicing entrepreneurs. This is because individuals high in tolerance of uncertainty leveraged tensions arising out of time pressure and environmental uncertainty to their benefit compared to others. In summary, these individuals coped and performed better in high pressure business situations.

Third, my study reinforces that high time pressure or uncertainty levels need not be stressors that deplete individual performance. Time pressure and uncertainty are performance enhancers to certain individuals. Both these variables showed positive moderating effects on the links between tolerance of uncertainty and opportunity recognition. This finding is crucial if an entrepreneur wants to be a first-mover in the market using new technology. Whenever a technology radically changes or a new technology is invented, each entrepreneurial opportunity emerging from the new technology has a limited time for market entry (Bstieler, 2005). If this time frame is not utilized, the opportunity of applying the new technology to a new market passes away or is captured by another individual (McCaffrey, 2014). The rate of technology change can introduce time pressure even during venture operation. For example, the frequency of technological change is so rapid that as a new software application is being developed and readied for upload and use, a newer version hits the market (Bstieler, 2005).

Fourth, my study extends Shane's (2000) finding that a new technology invention does not generate obvious business opportunities that every entrepreneur can see. The inventor who created the new technology does not necessarily recognized an opportunity. The opportunity is about applying the new technology to a market (Grégoire, Shepherd et al., 2010). Recognizing a good quality opportunity depends on the individual and his/her beliefs. The challenge deepens during commercialization of a new technology. A new technology involves uncertainty owing to lack of information and unpredictability of its use. Entrepreneurs do not gain much through formal planning, market analysis, or information search. Information about the market or use of the new technology does not yet exist. My study could point toward a way of birthing new ventures which does not require a formal

search. Rather it depended on how an individual viewed the problem and handled the tensions at the point of decision-making (Packard et al., 2017).

Fifth, my study uses an on-line experiment to test the research hypotheses. Existing studies on opportunity recognition have used post-hoc recollection methods such as surveys. These methods depend on memory recall and can present various methodological challenges such as retrospective bias (Goodwin, 2009; Shepherd & DeTienne, 2005), attribution bias (Fiske & Taylor, 1991), and self-reporting bias (Sandberg & Hofer, 1987). To overcome the methodological shortcomings, entrepreneurship scholars have advocated for more experimental work (Hsu et al., 2017; McMullen et al., 2016; Shepherd et al., 2015). An experimental setting allows researchers to control for extraneous variables and focus on the outcome (e.g., opportunity quantity and quality). I answered this call by employing an experimental approach similar to Breugst and Shepherd (2017), Tumasjan and Braun (2012), and Shepherd and DeTienne (2005) in which participants were randomly assigned to high-pressure and low-pressure groups. The participants then generated opportunities based on new technologies and completed survey measures of my variables. I heeded the suggestions of Grégoire, Barr et al. (2010) and Grégoire, Shepherd et al. (2010) for manipulating situational contingencies such as time pressure and uncertainty to simulate real-time behavior of individuals and their efforts in opportunity recognition tasks.

Sixth, I contribute to practice in the following way. Universities can encourage or incentivize business students to engage in opportunity recognition and potential commercialization based on the new scientific and technology invention by their STEM (Science, Technology, Engineering, Mathematics) counterparts. A tighter collaboration between the entrepreneurship department and the STEM disciplines can result in

entrepreneurial growth of the region surrounding the university. Moreover, universities normally upload their scientific and technology inventions on their website with a call to entrepreneurs to commercialize their inventions. This involves transfer of the technology along with the patent. Being able to act speedily in detecting opportunities based on the new technology is important to beat the competition and commercialize the invention first.

My experiment revealed that uncertainty surrounding a new technology does not necessarily deter the student entrepreneurs from identifying novel opportunities both for commercial and social purposes. While examining their responses, I found that many respondents came up with novel ways of using the two technologies (soft robot and virtual reality) to address social problems and needs and the possibility of new venturing with a social goal. Overall, my theoretical framework has implications for research in high-tech entrepreneurial opportunity recognition and for policies designed to increase entrepreneurial behaviors.

LIMITATIONS

Despite its contributions, this study has limitations that could be addressed in future research. First, my research sample comprised students for both the technology studies. The students were mainly undergraduates with business majors. There have been conflicting views on using student populations in behavioral studies in entrepreneurship (Robinson, Huefner & Hunt, 1991; Shepherd & DeTienne, 2005). On the positive side, the student sample allowed me as a researcher to gather a much broader and diverse sample than would otherwise be possible (McGee et al., 2009). Entrepreneurship research questions on the pre-launch stage of a new business (i.e., opportunity recognition) are well-suited for business

students. Moreover, I studied opportunity recognition emerging from new technology. This context centered around commercializing new technology is relevant to university settings.

Second, I adopted the perspective that the new technologies (e.g., soft robot) have already been created by the inventors and therefore objectively exist as artifacts (Nambisan, 2017). The inventor(s), by creating the new technologies, might have developed a new means of supply (Grégoire, Shepherd et al., 2010: 120). The inventor(s) did not necessarily recognize an opportunity. The opportunity is about applying the new technology to a market. In this sense, the basis for opportunities (e.g., soft robot, virtual reality) exist objectively in the environment. However, individuals form subjective beliefs that an opportunity (of using the new technology) exists for the willing and able. Hence, the aspiring entrepreneur had to identify alternatives of using the invented technology, and not create a new technology per se. To ensure that the findings are robust and generalizable across all new technologies, I focused on a single context approach – new technology. I designed the research material so that it controlled for the characteristics of different opportunities and contexts (Grégoire, Shepherd et al., 2010). Thus, a single-context approach can allow researchers to model the complexities and idiosyncrasies that characterize the reality faced by aspiring entrepreneurs in a particular context without the slippage that could result from including other contexts and populations into the model. Accordingly, I did not opt for a multi-context approach in studying opportunity recognition. Examples of other opportunity recognition contexts could be geopolitical changes, demographic shifts to urban areas, rapidly growing aging population, and climate-centric solutions for ecological problems.

Third, my study focused on individual-level efforts and behavior in opportunity recognition as a precursor to starting a new business. However, according to the

entrepreneurship literature, teams, not individuals, found the majority of new ventures (Klotz, Hmieleski, Bradley & Busenitz, 2014; Powell & Baker, 2017). Additionally, new technologies and new types of digital infrastructures (e.g., social media) have led to more collective ways of pursuing entrepreneurship (Aldrich, 2014). Accordingly, future research exploring how, say, tolerance of uncertainty of individuals mix or combine to form team-level tolerance of uncertainty may increase our understanding of opportunity recognition. Additionally, the contingencies of high time pressure or uncertainty will perhaps have different moderating effects at the team level. An individual team member would face not only his/her tensions and pressures but also those pressures perceived by the team. The multiple sources of pressures might impact outcomes differently. Hence, in a team setting, the efforts and behavior displayed by an individual might be different.

Fourth, entrepreneurial self-efficacy showed different main effects on quantity and quality. The results are interesting and provide an avenue for future research.

Fifth, partial support was found for the moderating effects of time pressure on entrepreneurial self-efficacy, and for the moderating effect of uncertainty on tolerance of uncertainty. Ideally, the study's theoretical framework should work across both the technology studies. Finding empirical support for the above mentioned two hypotheses for one technology scenario and not for the other might be due to differences in technology attributes of the soft robot and virtual reality. Examining the differences in the two technologies that could have explained the above partial support is beyond the scope of this study and calls for future research.

Sixth, although my experiment was randomized, I cannot claim to have established causality. It would be closer to a quasi-experiment (Corbett, 2007; Kier & McMullen, 2018).

I did introduce time pressure and uncertainty as two manipulations in the experiment. However, I did not study the main effects of either time pressure or uncertainty. I theorized both time pressure and uncertainty as situational contingencies that influence individual attributes. Accordingly, I focused on their moderating effects. However, moderators are independent variables.

Seventh, my study considered opportunity recognition, which is an initial belief that an opportunity exists. I did not consider evaluation or exploitation of the opportunities. Opportunity recognition is but one initial phase in the entrepreneurship process. Entrepreneurs continuously need to mobilize resources, build efficient operations, distribute their product or service or app, adapt to a changing business environment (Kier & McMullen, 2018), and engage in planning and organizing (Frese & Geinik, 2014). Individual capabilities and situational contingencies such as time pressure and uncertainty would continue to play a role in the subsequent phases of entrepreneurship. Moreover, practicing entrepreneurs juggle multiple decision tasks with varying degrees of time pressure. How these entrepreneurs prioritize and expend their energy while multi-tasking over a period will provide different insights. Longitudinal studies, as opposed to cross-sectional ones, that examine decision-making under time pressure might provide additional information if individuals learn to be better over time at dealing with such pressures. These insights, in turn, could be applied to pedagogical (or andragogic) approaches through effective discourse that teach students the inevitability of time pressure and uncertainty and how best to utilize such pressures to their advantage in entrepreneurship.

AVENUES FOR FUTURE RESEARCH

My study used a homogeneous sample comprising of undergraduate business student (Grégoire, Shepherd et al., 2010). A future research sample of engineering and technology students might provide a basis for comparison between the two groups. The findings could provide further insight into whether a closer collaboration between entrepreneurship and STEM disciplines in a university could be fruitful for entrepreneurial development. Second, a heterogeneous sample could be useful (e.g., using Amazon's Mechanical Turk) to enhance the generalizability/boundary conditions of the theory and results. Third, testing the theoretical framework in contexts other than technology can provide additional insights. As discussed in the limitations section, my study used two technology-centric scenarios for opportunity recognition, but opportunities can emerge from contexts other than new technology. Examples of this would be identification of climate-based solutions to solve problems related to ecological changes or ensuring quick and efficient delivery of services and amenities to a rapidly migrating population to urban centers.

Fourth, future research can conduct the study experiment to test the theory which duly acknowledges that entrepreneurship is a team effort. The study experiment could be conducted for 2- or 3-member teams which are homogeneous or heterogeneous. Fifth, my study yielded different main effects of entrepreneurial self-efficacy on opportunity quantity and quality. Future research can investigate further the main effects of entrepreneurial self-efficacy on opportunity quantity and quality. Sixth, as pointed out in the limitations above, I incorporated two technology scenarios in my study to overcome the limitations of a single study and to ensure that the findings are generalizable across all new technologies. My study's theoretical framework was expected to yield similar results for both the technology

studies. For two moderating hypotheses, I found partial support. That is, I found support for the two hypotheses in one technology scenario, but not for the other. For example, the moderating effects of time pressure on the link between entrepreneurial self-efficacy and quality was supported for the soft robot scenario but not for the virtual reality scenario. Future research can investigate whether differences in characteristics of the two technologies could have contributed to the partial support. This could be done by theorizing the role of specific aspects of the technologies in shaping entrepreneurial opportunities, decisions, actions, and outcomes (Nambisan, 2017); for example, what characteristics of new technology artifacts shape entrepreneurs' (individual or collective) tolerance of uncertainty and perceived uncertainty and thereby their performance in opportunity recognition. Seventh, the theoretical framework could be extended to measure different outcomes such as opportunity evaluation, opportunity implementation, and venture exit.

CONCLUSION

Dealing with tensions arising out of contingencies such as high time pressure or uncertainty is fundamental in entrepreneurship. Yet we have a limited understanding of how these situational contingencies differently affect individuals' real-time efforts and behavior during opportunity recognition and the role that certain individual attributes (e.g., tolerance of uncertainty) play in this process. The cognitive theory for opportunity recognition acknowledges that entrepreneurs make decisions and take actions based on their individual cognitive ability (Baron, 2006, 2008; Dimov, 2011; Grégoire, Barr et al., 2010; Haynie & Shepherd, 2009; Shepherd et al., 2017), but how this cognitive ability interacts with situational contingencies to influence opportunity recognition is not fully understood. To help fill this gap, I sought to provide a theoretically grounded contingency framework to explain

opportunity recognition. I addressed the following questions. What are the main effects of individual attributes (e.g., entrepreneurial self-efficacy) on opportunity recognition? How do these attributes vary under contingencies of time pressure and uncertainty? Which individual attribute better leveraged the situational contingencies of time pressure and uncertainty? My research is but a small step in the arduous journey of entrepreneurship. It is my hope that this dissertation advances the conversation on the role that situational contingencies play during opportunity recognition and provide an avenue for future research on individual attributes both for their main effects and contingency effects on other entrepreneurial outcomes in experimental settings.

APPENDIX A

IRB APPROVAL

The following email was received from Bloch Research Engagement Program dated 8/23/2017:

This is an email notification to inform you that the study "Opportunity Recognition," which has you as a researcher, has been approved. Protocol ID: 17-030.

For more information, please log on to the site at https://umkc-bloch.sona-systems.com

APPENDIX B

EXPERIMENT

1. **Sign Consent Form. By clicking " >>" I indicate that I am at least 18 years old and agree to participate in this research.**

2. **Scenario #1 – Soft Robot: 3D Printed Robot is Agile Even on Sand and Rocks**

In the video (1.5 minutes duration) that you will watch next, a 3D-printed, four-legged 'soft' robot climbs over obstacles and walks on different terrains, just like a real animal would. Its four legs, positioned in an "X" shape, can alternate between walking, climbing and crawling or even make a motion that resembles swimming. The robot can move forward and backward and can rotate and move sideways without needing any sensors to "see" the environment. Its speed, however, is rather modest —about 0.8 inches (20 millimeters) per second.

Please watch the video for more information. The video has audio, so, please turn on your speakers. You will be able to advance to the next page (>> button) only after 60 seconds; so, please click on the video and watch it.

3. **Low Uncertainty Manipulation**

<u>Please read through the following points:</u> (you will be asked few questions based on the following information in the next page)

Recent research shows that:

- The soft robot has a **variety of future applications**.
- The **demand for robots is promising and increasing.**
- If you start your own soft robot venture, it will be able to **sustain viability in this product market.**
- If you act now, your **product will enjoy competitive advantages long enough to realize entrepreneurial returns** although you may not be able to fully predict the speed or nature of action of your potential competitors.
- In 2014, **robot sales improved** by 29% to 229,261 units, which is the highest level recorded for one year. Sales of developed robots to all industries increased over the span of a year.
- Assume that you are **not constrained by capital** to start this new soft robot venture**.**

4. High Uncertainty Manipulation

Please read through the following points: (you will be asked few questions based on the following information in the next page).

Recent research shows that:

- The **market demand** for the soft robots **is unknown**.
- It is **not possible to foresee** the ability of a new venture based on soft robot technology to sustain viability in this product market.
- Even if you or others were to start a new venture, you have **no insights as to how your potential competitors will react** in response to your product introduction.
- There may be concerns related to Intellectual Property Rights and government regulations.
- You **cannot predict how long your product will enjoy advantages** before a competitive response erodes profits.
- Assume that you are not constrained by capital to start this new soft robot venture.

5. Low Time Pressure Manipulation

Question: Despite the fact that market demand and future use of the soft robots is unknown, write down as many business opportunities that you can think of using soft robots. **Briefly describe each business opportunity in few words to convey a meaningful concept.**

6. High Time Pressure Manipulation

Question: Despite the fact that market demand and future use of the soft robots is unknown, write down as many business opportunities that you can think of using soft robots. **Briefly describe each business opportunity in few words to convey a meaningful concept.** You will have ONLY 2 minutes to write down.

7. Questions for the respondents

Q1. Please indicate your level of ***confidence*** for the following statements. There is not a right or a wrong answer. The options are ***Very Little = 1, Little = 2, Neutral = 3, Much = 4, and Very Much = 5.***

S.N.	Item measures	(1)	(2)	(3)	(4)	(5)
	How much confidence do you have in your ability to ……...?					
1	Identify new business opportunities	○	○	○	○	○
2	Create new products	○	○	○	○	○
3	Commercialize an idea or new development	○	○	○	○	○

Adapted from 'Entrepreneurial Self-Efficacy' scale: Zhao et al. (2005)

Q2. Please indicate your level of agreement with the following statements. The options are ***Strongly Agree (SA) = 1, Agree (A) = 2, Neither Agree nor Disagree (N) = 3, Disagree (D) = 4, and Strongly Disagree (SD) = 5***.

S.N.	Item measures	SA (1)	A (2)	N (3)	D (4)	SD (5)
	Inhibitory Anxiety					
1	Uncertainty keeps me from living a full life	❍	❍	❍	❍	❍
2	When it's time to act, uncertainty paralyzes me	❍	❍	❍	❍	❍
3	When I am uncertain I can't function very well	❍	❍	❍	❍	❍
4	The smallest doubt can stop me from acting	❍	❍	❍	❍	❍
5	I must get away from all uncertain situations	❍	❍	❍	❍	❍
	Prospective Anxiety					
6	Unforeseen events upset me greatly	❍	❍	❍	❍	❍
7	It frustrates me not having all the information I need	❍	❍	❍	❍	❍
8	One should always look ahead so as to avoid surprises	❍	❍	❍	❍	❍
9	A small, unforeseen event can spoil everything, even with the best of planning	❍	❍	❍	❍	❍
10	I always want to know what the future has in store for me	❍	❍	❍	❍	❍
11	I cannot stand being taken by surprise	❍	❍	❍	❍	❍
12	I should be able to organize everything in advance	❍	❍	❍	❍	❍

Adapted from the 'Intolerance of Uncertainty' scale: Carleton, Norton & Asmundson (2007)

Q3. How many years of overall work experience do you have (put a 0 for none)?

Post experiment questions - Q4 and Q5 are manipulation checks

Q4. How much time pressure did you feel while identifying business opportunities using soft robot?

1. Very Little Pressure
2. Little Pressure
3. Neither too Little nor too Much Pressure
4. Much Pressure
5. Too Much Pressure

Q5. How much time pressure did you feel while identifying business opportunities using virtual reality?

1. Very Little Pressure
2. Little Pressure
3. Neither too Little nor too Much Pressure
4. Much Pressure
5. Too Much Pressure

Q6. **Manipulation checks for uncertainty (external)**

S.N.	Item measures	(1)	(2)	(3)	(4)	(5)
1	Actions of competitors are quite easy to predict (1 = very easy TO 5 = very hard to predict).	○	○	○	○	○
2	Simplicity of the technology: simple VERSUS very complex technology (1 = very simple TO 5 = very complex).	○	○	○	○	○
3	Product demand: easy to forecast VERSUS very hard to forecast (1 = demand is very easy to forecast TO 5 = demand is very hard to forecast).	○	○	○	○	○

Item measure #1 and 3 are taken from Green, Covin & Slevin (2008); while #2 was taken from Bstieler, L. (2005).

Q7 and Q8 are about familiarity with the two new technologies

Q7. Before you watched the video, how familiar you were with the soft robot technology?

1. Not at all Familiar
2. Slightly Familiar
3. Moderately Familiar
4. Very Familiar
5. Completely Familiar

Q8. Before you watched the video, how familiar you were with the virtual reality technology?

1. Not at all Familiar
2. Slightly Familiar
3. Moderately Familiar
4. Very Familiar
5. Completely Familiar

APPENDIX C

QUALITY SCORING SCALE FOR RATERS: SOFT ROBOT

(to assess the quality of the soft robot opportunities)

Q. What do you think of the quality of the following opportunity using soft robots?

1	2	3	4	5
Very Poor	Below Average	Average	Above Average	Excellent

Legend for the above 1 to 5-point scale:

(1) Very Poor: Words that do not make any sense or where instructions have not been followed. For e.g. "xxx" or "abcd" or "I am a ball." etc.

(2) Below Average: Words that make sense but are mostly single words like "education" or "entertainment." However, "toys" might be more specific and make more sense and hence, maybe categorized as 'Average.'

(3) Average: A product or service identical to an existing product/service, but now using soft robot technology (i.e., a new application for an existing product/service). E.g. toys for children which is an existing product, but here the toys are made using the soft robot.

(4) Above Average (Good): A product or service that is offered to a new or an underserved market (e.g. the soft robot can be used to go down rabbit holes to help zoologists who want to study their behavior). OR A significant improvement to an existing product/service that offers additional features and benefits (e.g. robots have already been used for cleaning homes, but with the soft robot it can now be done more effectively, by reaching all the nooks and crannies that are difficult to reach).

(5) Excellent: A new-to-the world product/service (i.e., a product or service which did not yet exist). For example, using the soft robot to inspect hazardous materials, or use in the military as a weapon that could move over sand and rocks, or as a tool to help the disabled people etc.
(adopted from DeTienne & Chandler, 2004)

APPENDIX D

QUALITY SCORING SCALE FOR RATERS: VIRTUAL REALITY

(to assess the quality of the virtual reality opportunities)

Q. What do you think of the quality of the following opportunity using virtual reality technology?

1	2	3	4	5
Very Poor	Below Average	Average	Above Average	Excellent

Legend for the above 1 to 5-point scale:

(1) Very Poor: Words that do not make any sense or where instructions have not been followed. For e.g. "xxx" or "abcd" or "I am a ball." etc.

(2) Below Average: Words that make sense but are mostly single words like "education" or "entertainment." However, "learning" might be more specific and make more sense and hence, maybe categorized as 'Average.'

(3) Average: A product or service identical to an existing product/service. E.g. live streaming of music or games.

(4) Above Average (Good): A product or service that is offered to a new or an underserved market (e.g. using VR technology for real-estate tours etc.). Or a significant improvement to an existing product/service that offers additional features and benefits (e.g. virtual reality technology being used for fire training).

(5) Excellent: A new-to-the world product/service (i.e., a product or service which did not yet exist). For example, Using VR to show different countries realistically showing areas there which need social improvement projects, or where one could potentially set up manufacturing plants and factories.
(adopted from DeTienne & Chandler, 2004)

APPENDIX E

MEASUREMENT COMPONENTS RESULTS

(USING GSEM: FAMILY ORDINAL, LINK LOGIT)

https://www.stata.com/manuals/semexample27g.pdf
https://www.researchgate.net/.../GSEM_in_Stata.../GSEM+in+stata+introduction.pdf: 10-12
https://www.stata.com/meeting/italy13/abstracts/materials/it13_huber.pdf : 66-68

1. Entrepreneurial Self-Efficacy

Observed Variables	Coefficients	S.E.
Identify new business opportunities	1 (constrained)	
Create new products	0.66***	0.17
Commercialize an idea or new development	0.68***	0.19
AIC	1853.66	
BIC	1906.24	

***p<.000

2. Tolerance of Uncertainty (Inhibitory Anxiety)

Observed Variables	Coefficients	S.E.
Uncertainty keeps me from living a full life	1 (constrained)	
When it's time to act, uncertainty paralyzes me	1.96***	0.32
When I am uncertain I can't function very well	1.76***	0.28
The smallest doubt can stop me from acting	1.39***	0.22
I must get away from all uncertain situations	1.41***	0.21
AIC	3018.42	
BIC	3106.10	

***p<.000

3. Tolerance of Uncertainty (Prospective Anxiety)

Observed Variables	Coefficients	S.E.
Unforeseen events upset me greatly	1 (constrained)	
It frustrates me not having all the information I need	1.33***	0.23
One should always look ahead so as to avoid surprises	1.07***	0.22
A small, unforeseen event can spoil everything, even with the best of planning	0.59***	0.14
I always want to know what the future has in store for me	1.01***	0.21
I cannot stand being taken by surprise	1.10***	0.22
I should be able to organize everything in advance	0.86***	0.18
AIC	4503.64	
BIC	4626.33	

***p<.000

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VITA

Sumita Sarma originally hails from India. She has lived, studied and worked in three countries. Sumita did her Bachelor of Engineering (Electronics and Telecommunications) from Assam Engineering College, Gauhati University in India (University Topper and Gold Medalist), Master of Science in Project and Program Management and Business Development from Skema Business School (earlier ESC Lille) in France, and Ph.D. in Entrepreneurship and Innovation from the University of Missouri-Kansas City in the United States.

Sumita worked in each of these three countries where she was fortunate to get the opportunity to work co-locationally as well as virtually with teams across several geographies. After graduation from UMKC, Sumita plans to work as an Assistant Professor at the California State University-Bakersfield.

Sumita's current research addresses questions at the micro-, macro-, and multi-level. At the micro-level, Sumita's interests include opportunity recognition at the individual-level, and business model innovation at the firm-level. At the macro-level, Sumita's interests are situated in entrepreneurial ecosystems. Her research has been published in the *Asia Pacific Journal of Management* and *Business Horizons*. Two of her research papers are currently under review at the *Journal of Business Ethics* and *European Journal of Marketing*.