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Risk-taking in entrepreneurial decision-making: A dynamic model of venture decision

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Abstract

On the basis of the seminal work of Kahneman and Tversky *Econometrica, 47*(2): 263–292 (1979), this research extends the boundaries of prospect theory in investigating determinants and temporal variation of risk-taking in entrepreneurial decisions, such as creating a new business organization or investing a risky business project. The two experimental studies (1) identify entrepreneurial risk-taking in the gain situation and find reversal of risk preference after a dynamic entrepreneurial learning process, indicating that the framing effect of prospect theory in explaining entrepreneurial risk-taking is conditional; (2) instead of weights, subjective judgment of the possibility of success of a risky project (subjective probability) consistently plays central moderating role in entrepreneurial decisions under uncertainty, and (3) the different effects of subjective probability in the two studies reveal that novice decision-makers are more value-driven, whereas experienced decision-makers, particularly under low probability conditions, tend to be more risk averse regardless of the value of a risky project perceived as long as they have a lack of confidence in eventual success.

Keywords Entrepreneurial decision · Dynamic learning · Risk-taking · Subjective probability · Subjective value · Asia-Pacific

What determines important entrepreneurial decisions such as new venture creation and the investment in risky projects? In addressing that key question, early research focused on identifying stable traits in entrepreneurs such as risk propensity, locus of control, and

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alertness that could distinguish them and their activities from non-entrepreneurs (Busenitz, 1996; Kaish & Gilad, 1991). After a number of years of study into traits-based characteristics, no distinctive demographic or personality characteristics have been found for entrepreneurs that exert any consistent and substantive effect on entrepreneurship (Brockhaus, 1980; Gartner, 1988; Shane, 2008). As such, the focus of recent studies has shifted from traits to more social (Birtch, Au, Chiang, & Hofman, 2018) and increasingly cognitive mechanisms of entrepreneurial decision-making such as perceptions of risk, rather than propensities (Mitchell et al., 2007; Norton & Moore, 2006; Palich & Bagby, 1995; Shaver & Scott, 1991).

Cognitive studies have documented that entrepreneurial decisions are likely to be affected by risk perception (Caliendo, Fossen, & Kritikos, 2009; Cramer, Hartog, Jonker, & Van Praag, 2002) and other cognitive heuristic biases (Simon, Houghton, & Aquino, 2000). The work of Dutton and Jackson (1987) suggested that decision framing influences entrepreneurs' perception of strengths versus weaknesses and opportunities versus threats, which influences entrepreneurial actions (Palich & Bagby, 1995) found that entrepreneurs are more likely to perceive a business venture as an opportunity rather than a threat, which manifests individual differences in perceiving venture opportunities. Moreover, Köllinger, Minniti, and Schade (2007) found that a start-up decision is highly dependent on subjective judgment. Entrepreneurs tend to present higher (biased) confidence in their success, which seems to be a pan-cultural phenomenon partly explaining the high failure rate of nascent entrepreneurs (Köllinger et al., 2007).

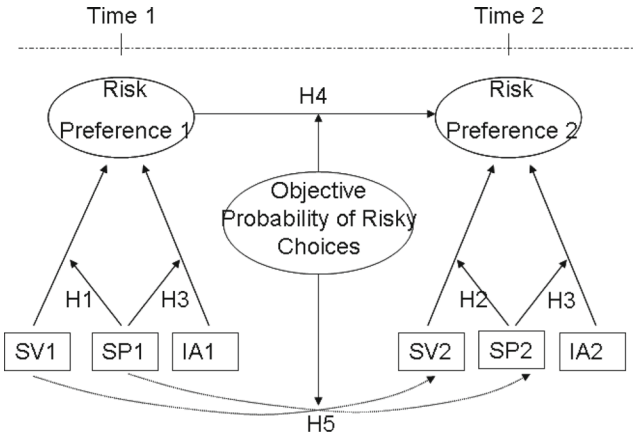
More recently, affective mechanisms (emotions) have also been found to be important in entrepreneurial decision-making and activities (Baron, 2008; Li, 2011; Shepherd, 2009). Drawing on the doctrine of the Austrian school of economics, entrepreneurship research has emphasized the importance of dynamism in entrepreneurial decision-making (Gifford, 2003) and entrepreneurial management (Bradley, Wiklund, & Shepherd, 2011). Baron and Ensley (2006) added that experience and learning from a dynamic process seemed to result in different decision-making styles between novice and experienced entrepreneurs. Entrepreneurship scholars have increasingly become aware that experimentally examining dynamics has become a sort of state of the art for moving entrepreneurship research forward (Schade & Burmeister, 2009). In this regard, the study of entrepreneurial decision-making needs a paradigm shift (Schade, 2009) – a paradigm that highlights its dynamic nature (Schumpeter, 1942) and sheds light on individual differences breaking the static-equilibrium (Solow, 1956, 1957) and administrative constraints toward growth (Bradley et al., 2011; Bruton, Ahlstrom, & Si, 2015) that can hinder important decision-making with respect to innovation (Ahlstrom, 2010).

Although a number of studies (most notably, Palich & Bagby, 1995; Baron, 1999) have alerted scholars to the rich insights that a cognition-based perspective can provide into the entrepreneurial decision process, few studies have sought to ground entrepreneurial decision making research in well established decision-making theories. Such an absence raises an important question: can the cognitive mechanisms observed in entrepreneurial decision-making anomalies (and unexplained by extant decision making theories), be integrated within them, while refining the findings and expanding the boundaries of these theories to account for entrepreneurial decision-making phenomena? Responses to this question lie at the

heart of theory development in this area, which will have important implications for entrepreneurs in terms of better assisting their decision-making and economic activities.

Correspondingly, in this study we contribute to theory on entrepreneurial decision making by utilizing prospect theory (PT) as a baseline model and including important affective mechanisms. By expanding PT's boundary conditions, we contribute to the empirical literature on entrepreneurship by reflecting individual differences and dynamic changes in decision-making under risk and uncertainty. To do so, we incorporate cognitive, emotional, and learning mechanisms into the entrepreneurial decision, namely a dynamic venture decision-making model (shown in Fig. 1). Moreover, we complement the conclusions of PT in two ways, insofar as they apply to entrepreneurial decision making. First, we replace the weighting function by the judgment of *subjective probability* to better represent uncertainty in entrepreneurial decision-making. Second, we incorporate *immediate anxiety* to reflect the impact of emotional reactions on risky and uncertain decision situations. The results of our experiments can also contribute to practice on entrepreneurship as we seek to further unpack the hows and whys of entrepreneurial decision making.

We support our model by two entrepreneurial decision-making experiments, which make casual linkages between entrepreneurial decision, psychological mechanisms, and risk-taking. In the first study, we recruited novice decision makers who did not have prior start-up experience to simulate a start-up decision. In so doing, we examine the novice decision maker's decision style in a static decision scenario, excluding the effect of experience or learning. This simulation heuristic method (Kahneman & Tversky, 1982) can come close to replicating a real decision making process and revealing the psychological linkages, avoiding retrospective and self-reporting biases. We provide evidence to show that the newly proposed decision-model presents incremental insights with respect to prospect theory in the context of entrepreneurial decision making. In the second study, following the paradigm of classic probability learning experiment (Estes, 1950), we examine risk learning effects in a dynamic process.



SV: Subjective Value SP: Subjective Probability IA: Immediate Anxiety

Fig. 1 The dynamic venture decision-making model

The paper is organized in four sections: (1) literature review, model development, and hypotheses; (2) Study 1: a test of the model in a static decision process using novice decision makers; (3) Study 2: a test of successive decisions with feedback on decision outcomes, to study the effect of learning and experience, as well as change in risk preference; and (4) discussion and implications for entrepreneurial decision making theory, and entrepreneurial practice.

Literature review and model development

Risk and uncertainty have a central place and a long history in entrepreneurship research (Knight, 1921; Schumpeter, 1942). Knight (1921) argued that risk refers to unknown outcomes which have known probabilities, while uncertainty means the probabilities are unknown. Thus risk may be perceived as the variation in possible outcomes while uncertainty is unpredictability and heretofore unexperienced events (March & Shapira, 1987; Taleb, 2010). As to choice behavior under risk and uncertainty, Simon's (1955) seminal work transforms decision-making theories from rational (Savage, 1954; Von Neumann & Morgenstern, 1944) into boundedly rational (Kahneman & Tversky, 1979) models. Other studies transform rational models into irrational ones (Bell, 1982; Loomes & Sugden, 1982; Mellers, Schwartz, Ho, & Ritov, 1997).

As a result of these and other studies on risk and uncertainty, it is well understood that people cannot make decisions completely rationally and maximize their utility purely based on calculations (Kahneman & Tversky, 1979). At the same time, studies have revealed that entrepreneurial decision-making is also not irrational or otherwise random (Shane, 2008). Entrepreneurs do a great deal of rational analysis before embarking on a new business or investing in a new project, such as seeking relevant business information, financial support, business partners, and positive institutional environments (Delmar & Shane, 2004; March, 2006). Therefore, a bounded rationality framework, rather than a purely rational (or irrational) model, should be more appropriate for understanding entrepreneurial decisions. However, discrepancy exists when employing the predominant bounded rationality theory, that is, PT (Kahneman & Tversky, 1979) to interpret the phenomenon of entrepreneurial decision making, in terms of the framing effect and weighting function.

Prospect theory and its boundaries, framing effect, weights

Prospect theory

Prospect theory (Kahneman & Tversky, 1979) points out that, rather than following given economic rules, people make decisions by subjectively judging possible outcomes or prospects of an uncertain choice, particularly the value and importance (weights). Moreover, whether to take a risk or not depends highly on the ways in which decision-makers cognitively edit and frame the choice. People take risks when the decision-making problems are framed as losses and avoid risks when they are

framed as gains, in terms of framing effects. PT expands the boundary of expected utility theory (Von Neumann & Morgenstern, 1944) on the belief that people are risk averse, which has significantly enhanced our understanding of risk-taking behavior and has been broadly utilized to interpret organizational risk-taking behavior (Bowman, 1980; Fiegenbaum & Thomas, 1988; Jawahar & McLaughlin, 2001; Jegers, 1991; Sinha, 1994; Wiseman & Catanach, 1997).

A number of researchers have noticed the disparity between prospect theory and risk-taking more as opportunity discovery, that is risk-taking in the gain domain (Busemeyer & Townsend, 1993; Chattopadhyay, Glick, & Huber, 2001; March & Shapira, 1987; Ocasio, 1995; Sitkin & Pablo, 1992; Sitkin & Weingart, 1995), in particular for entrepreneurs' activities in new venture creation (Shane, 2001), and strategy regarding organizational opportunities (Haynie, Shepherd, & McMullen, 2009; Ireland, Hit, & Sirmon, 2003). Kahneman and Lovallo (1993: 18) also added "the decision frame should be broadened to include these uncertainties: neglect of future risky opportunities will lead to decisions that are not optimal." These contentious points of view on the framing effect have highlighted the limitations and boundaries of prospect theory.

Framing effect

Framing in prospect theory is specifically defined as semantic statement of decision prospect. For example, the well-known Dread Disease problem is used to illustrate the effect of framing on the decision making (Kahneman & Tversky, 1984):

> Problem 1: Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:
>
> If Program A is adopted, 200 people will be saved.
> If Program B is adopted, there is a one-third probability that 600 people will be saved and a two-thirds probability that no people will be saved.

72% of the participants chose Program A when the choices were framed in this way, with the remaining 28% choosing Program B. In this decision scenario, both decision prospects, Program A and B, were framed in the positive situation (lives to be saved) and thus in the gain domain. They have same expected value ($200 \times 100\% = 600 \times 1/3$). Taking Program A, the certain choice, as the reference point, program B is thus seen as a risky choice.

Besides the narrowly defined concept, framing has broader meanings, referring to the internal cognitive judgment that is induced by the contextual features of a situation or individual factors (Kühberger, 1998). Changing the way a problem or decision choice is framed becomes a cognitive way of manipulating subjective judgment about decision tasks, as opposed to manipulating the decision tasks themselves. In this study, framing and the framing effect to which we refer, are consistent with prospect theory – the semantic control of gain or loss situations in decision tasks.

Boundaries of prospect theory

Indeed, unexplained risk-taking in the gain domain forms part of the inherent assumptions of prospect theory. We argue that PT needs to expand its boundaries for three reasons: to account for individual differences in risk preference, dynamism in the decision making process and having an appropriate variable for representing uncertainty instead of the weighting function. As Busemeyer and Townsend (1993) pointed out, prospect theory is static-deterministic. It is deterministic because it assumes that a binary choice has one preferable option absolutely better than its alternative. Further, it posits that the option with the majority can represent the whole population's judgment of utility. As a result, it is unable to interpret individual differences in risk preference. Indeed, even in the gain domain, some people selected the risky choice. For example, in the Dread Disease problem (Kahneman & Tversky, 1984), 72% of participants selected Project A (expected value = 200 × 100%), the certain choice, showing risk aversion; however, 28% selected Project B (expected value = 600 × 1/3 = 200), the riskier choice, which demonstrates risk-taking. The inability of PT to explain the choices of a significant minority (28% of decision makers) is a reflection of a problematic utility assumption and its biased statistical inference based on counting and categorizing data. These are the methodological limitations which results in its inability to describe individual differences in risk preference and to reveal the underlying psychological mechanism of choices.

Realizing the limitations of framing effects in the gain domain, Tversky and Kahneman (1992) proposed cumulative prospect theory, concluding that risk seeking can occur in the gain domain only under the condition that the objective probability of the risky choice is lower. This inference seems to make another deterministic conclusion in that risk seeking in the gain domain will be moderated by the levels of probability, that is, at higher levels of probability, people will still be risk averse. Similar to prospect theory, all of the inferences were made based on counting and categorizing data, an approach we contend is restricted in its ability to reflect the associations of multiple variables and the underlying psychological mechanisms in determining choices.

From the viewpoint of dynamism, PT assumes that risk aversion in the gain domain is invariant over time, which neglects the likely variation of framing effects in the temporal dimension and the dynamic nature of entrepreneurial decision-making (e.g. Gifford, 2003; Schade & Burmeister, 2009). Researchers have increasingly shown interest in how risk preference varies over time as a function of the learning processes to adapt to environmental variables (Denrell & March, 2001; Erev & Barron, 2005; Yechiam & Busemeyer, 2005). In this line of research, given a certain learning process, the framing effect in the gain domain could change, and even reverse, that is, people would prefer a risky choice over its certain alternatives.

As the understanding of decision making has progressed and empirical results using prospect theory have accumulated, the limits of the weighting function of PT have become more evident. According to Kahneman and Tversky's (1979) definition, "decision weights measure the impact of events on the desirability of prospects, and not merely the perceived likelihood of these events." From its semantic description, it seems that weights include the meaning of subjective probability, but there is less conceptual clarity about their relationship with uncertainty. At the same time, emphasizing desirability makes them seem more like valuation. Operationally, weights are

measured by the importance or salience of the objective probability (Shanteau & Ptacek, 1983; Van Schie & Van Der Pligt, 1995). Despite this ideally defined concept, weights are criticized as having inconsistent influences on choices (Arnold & Feldman, 1981; Barron, 1981; Hertwig, Barron, Weber, & Erev, 2004; Jia, Fischer, & Dyer, 1998; Murphy, 1982). As Pitz and Sachs (1984: 151) have noted, "such an account partly begs the question and is to some extent misleading." Based on this, we hypothesize:

Hypothesis 1 The weighting function will be a part of the function of valuation.

One crucial limitation of PT is the fact that it lacks a variable to denote uncertainty levels of choices (Ocasio, 1995), insofar as it replaces the *objective probability* of expected utility theory (Von Neumann & Morgenstern, 1944) or the *subjective probability* of subjective expected utility theory (Savage, 1954) by weights. In fact, Köllinger et al. (2007) found that an exaggerated view of one's ability to control the uncertainty of a venture opportunity results in a higher failure rate for start-up firms. Entrepreneurial decision making theorists also urge scholars to incorporate a variable representing the level of uncertainty (Mcmullen & Shepherd, 2006). Therefore, in place of weights, we utilize *subjective probability*, or the subjective belief in the likelihood of an event's occurrence, as a cognitive way of representing uncertainty levels in the newly developed decision model.

Uncertainty is also reflected in feelings (Damasio, 1994; Loewenstein, Weber, Hsee, & Welch, 2001; Slovic, Finucane, Peters, & MacGregor, 2002). Apart from cognitive estimation of the possibility, the pending outcome and its possible wide range can elicit visceral feelings such as fear or anxiety, in particular at the time when decision makers have to make the final decision and take responsiblity for its consequences. Loewenstein and Lerner (2003) defined such emotional reactions in the decision-making situation as immediate anxiety, and suggested that it be incorporated into decision-making models (Loewenstein, 2000). Use of this emotional construct in entrepreneurial studies is novel, since the often used positive and negative affect structure (Watson, Clark, & Tellegen, 1988) is not a sufficiently differentiated construct, and cannot connect one's emotional reaction with a specific event based on cognitive apprasials (Cropanzano, Weiss, Hale, & Reb, 2003; Li, Ashkanasy, & Ahlstrom, 2010). Here, immediate anxiety denotes overall feelings of having to bear the consequences of the decision, elicited by appraising the uncertainty of outcomes. It is kind of residuals of rational decision model (Li, Ashkanasy, & Ahlstrom, 2014). The newly added subjective probability (SP) and immediate anxiety (IA) should provide more variance after controlling for subjective value (SV) and weights, the original parameters in PT, in terms of incremental validity. Therefore, we hypothesize,

Hypothesis 2 The newly added SP and IA should provide incremental validity compared with PT as a baseline model.

With regard to the dynamic model, we will elucidate its cognitive, emotional, and learning mechanisms in two studies. In study 1, we investigate the cognitive and emotional mechanism at first in a static decision process and also compare its predictive validity with PT. Study 2 will examine the learning mechanism in a dynamic process.

Cognitive mechanisms: The interaction between subjective value and subjective probability

Expected utility theory (Von Neumann & Morgenstern, 1944) and subjective expected utility theory (Savage, 1954) are iconic normative rational models in decision sciences. Both theories suggest that entrepreneurs ought to follow decision-making rules, such as higher expected value (Von Neumann & Morgenstern, 1944) or higher subjective expected value (Savage, 1954) – the product of subjective value and subjective probability. Although a number of studies have demonstrated that the real process of decision-making violates the expected value rule (Kahneman & Tversky, 1979) and the subjective expected value rule (Camerer & Weber, 1992; Ellsberg, 1961; Fox & Tversky, 1995; Heath & Tversky, 1991; Wu & Gonzalez, 1999), both theories refined two important variables that deeply affect decision behavior under uncertainty. One is the *valuation of a choice* and another is the level of uncertainty represented by the *objective probability* or *subjective probability* of event occurrence. Yet, neither of these theories has described how valuation and subjective probability would interact in a real decision.

Subjective probability is fundamental to models of risky choice (Shapira, 1995). Its estimation varies, with either over or under estimation (Sieck, Merkle, & Zandt, 2007). The variation represents the extent of perceived capabilities in controlling uncertainty (Chattopadhyay et al., 2001). Moreover, valuation of a choice has evolved from referring to its absolute monetary amount (Von Neumann & Morgenstern, 1944) to judging its subjective value (Savage, 1954), that is the attractiveness and desire of the choice. Subjective value could be the relative monetary amount according to given reference points (Kahneman, 2003). In this sense, a US$10,000 project would not be attractive for a rich man such as Bill Gates, since his reference point is likely to be considerably higher. SV also could reflect multiple attributes of a choice (Currim & Sarin, 1984). A complex decision option, such as creating a new venture, contains many different values. It could be perceived as an opportunity for making a large profit (Shane, 2001), new combinations of knowledge or ways of learning, self-realization (Velamuri & Venkataraman, 2005) as well as creative destruction (Gibb, 2002), or as a perceived risk with significant monetary loss. Moreover, lower estimated opportunity cost also increases the perceived attractiveness of a new venture (Amit, Muller, & Cockburn, 1995). Finally, decision-makers' status quo bias is likely to prevent them from perceiving a more valuable venture opportunity (Burmeister & Schade, 2007).

Organizational researchers have explored opportunity identification from the function of the subjective value or subjective probability of success of a risky choice. For example, Tong, Reuer, and Peng (2008) studied the opportunity of firm growth from the value of entering into a new market via international joint venture. Choi and Shepherd (2004, b) found that entrepreneurs' decisions on opportunity exploration depend on the estimation of their capability to control uncertainty, perceived knowledge of customer demand, development of enabling technologies, the management team, and stakeholder support. Chattopadhyay, Glick, and Huber (2001) implied that organizational opportunity discovery relies on subjective judgment on both the value and probability of a risky decision.

Indeed, the famous Allais (1953) Paradox reflects the dilemma in balancing monetary amounts (value of an outcome) and probability of occurrence of the outcome. The latest research has shown divergences in focus on either value or probability functions. Bordley and LiCalzi (2000) suggest that people should make a choice to maximize the subjective probability, implying that people should prefer a choice with a higher subjective belief of success, neglecting the magnitude of value. In repeated decision tasks, researchers such as Erev and Barron (2005) and Yechiam and Busemeyer (2005) actually have found that rather than maximizing the payoff (value) of a risky choice, experienced decision-makers change their risk preferences to match the distribution of risky choices in terms of probability matching. In contrast, some decision makers are value focused. For example, Baron and Ensley (2006) found that novice decision-makers are likely attracted by perceived value of a venture, ignoring the likelihood of its success. These findings indicate that the focus on value or probability in decision is likely affected by decision-makers' experiences.

Novice decision-makers have not experienced much in terms of the pain of failure (Tetlock & Gardner, 2016). When they perceive higher value, they tend to be driven by the joy of possible successful outcomes, showing value maximizing behavior, even though the perceived likelihood of success of the risky choice such as creating a new venture is lower. Their likelihood of making a risky choice will increase with the increase in perceived value, and such a positive association will be strengthened when the subjective probability of success of the venture is estimated higher. This leads to the following hypotheses:

Hypothesis 3a For novice decision-makers, subjective probability moderates the positive association between perceived value and risk-taking.

Hypothesis 3b The positive association will be strengthened when subjective probability is higher.

Emotion: The interaction between immediate anxiety and subjective probability

Recent research into emotions has found that a decision does not completely rely on cognitive judgment of value and probability; emotions play an irreplaceable and indispensible role (Bechara, 2004; Damasio, 1994; Loewenstein, et al., 2001; Slovic, et al., 2002). Neurobiological evidence has shown that emotional deficiency does not influence judgments cognitively but the absence of feeling of decision problems significantly impacts decision performance (Damasio, 1994). Emotion is a functional part of reasoning and provides necessary information of decision that affects judgment of the value and probability (Dolan, 2002; Schwarz & Clore, 1996; Slovic, et al., 2002). It is also closely related to risk and uncertainty perception, which activates anxiety and fear (Loewenstein, Weber, Hsee, & Welch, 2001).

Despite the cognitively estimated uncertainty of success (SP), decision-makers are most likely to react emotionally at the time of making the final decision for fear of bearing unpredictable failures. Intensively elicited anxiety at the time of making a risky choice increases risk aversion (Lerner & Keltner, 2001; Loewenstein, et al.,

2001; Raghunathan & Pham, 1999). Even worse, the perceived possibility of success is also lower. The immediate anxiety will reduce willingness of taking risk, especially in people with weaker belief in the possible success. On the other hand, people also do not want to miss opportunities. A perceived greater likelihood of achieving a higher return will be dominant. Once it is perceived, the negative effects from immediate anxiety elicited by the decision situation will not influence the decision. Therefore we hypothesize:

Hypothesis 4 At lower levels of subjective probability, the intensity of immediate anxiety will be negatively associated with risk-taking.

Learning mechanism

Objective probability's influences on dynamic decision-making

The objective probability of the success of a risky choice, representing environmental influences, indicates the opportunity distribution of risky choices. A number of literatures have demonstrated that people would react with an adaptive strategy in a changing environment rather show invariant risk aversive behavior (Busemeyer and Townsend, 1993; Erev & Barron, 2005; Fiegenbaum, Hart, & Schendel, 1996; Yechiam, & Busemeyer, 2005). Minniti and Bygrave (2001) discussed how the variation of entrepreneurial decisions over time is affected by the prior successful and failed experiences. The changes are assumed to match objective probabilities, in terms of the probability-matching assumption (Erev & Barron, 2005; Estes, 1950; Shanks, Tunney, & McCarthy, 2002). Based on these research findings, the framing effect of risk preference is likely to reverse when the temporal parameter is taken into account, particularly when risk-taking has more chances of success, in terms of higher objective probability—more risk-taking behavior tends to appear in the gain situation to adapt to the circumstance. Thus we hypothesize:

Hypothesis 5 Under higher objective probability condition, the framing effect in the gain domain will reverse. Most people would prefer the risky choice over the certain choice in the gain domain.

Valuation functions and probability jjudgmens are adaptive and can be learned. Under the condition of a greater likelihood of the risky choice's success, more chances are provided for the risk-taker to be rewarded with the higher return from taking risks. This increases confidence of success in risk-taking and the perceived attractiveness of the risky choice. Thus, it is hypothesized:

Hypothesis 6a Under higher objective probability conditions, people tend to perceive a risky choice as more valuable.

Hypothesis 6b Under higher objective probability cconditios, people tend to estimate the subjective probability of the risky choice's success as higher.

The influences of experience on the interactive effect of SV and SP

Hertwig, Barron, Weber, and Erev (2004) have found that decision-making is likely to be influenced by past experience. Experience matters in influencing the strategy of making a decision, being driven either by perceived value, likelihood of success, or the interaction between the two. Novice risk-takers are inclined to be driven by perceived value. Given a favorable environment, the likelihood of receiving positive consequences from risk-taking is higher. The desire to achieve valuable higher returns from risk taking is encouraged. Therefore, there appears to be no reason to change the value-driven decision style under favorable environmental conditions. But once the environment becomes less favorable or hostile, the likelihood of success in starting a new venture decreases. More risk-taking is likely to result in more failures. Experienced pain from failures makes decision-makers more unwilling to take risks without assurance. They tend to make decisions by maximizing subjective probability and are reluctant to take risks at lower levels of subjective probability no matter how valuable the risky choice is. Only at the higher levels will the tendency of risk-taking increase with the increase of the subjective value of the risky choice; at the lower levels of subjective probability, decision-makers are unwilling to take the risk, regardless of how valuable the venture could be. In other words, the interaction between SV and SP in determining choice will be influenced by the experienced likelihood of success of the risky choice. That is the three way interaction; thus it is hypothesized:

Hypothesis 7a Experience will influence the interaction between subjective probability and subjective value in predicting risk-taking.

Hypothesis 7b In unfavorable environmental conditions with lower likelihood of success of risky choices, the positive association between risk-taking and subjective value will be significant only for higher levels of subjective probability.

In favorable environmental conditions with higher a likelihood of success of risky choice, value-driven decision making remains, just like novice decision makers who prefer the risky choice with the increase of perceived value.

Methods

Data description

In study 1217 undergraduate business students at a large university in the Asia-Pacific region with no start-up experience were recruited. After eliminating subjects with incomplete data and outliers with very high-expected income after graduation, we were left with 196 effective cases. The average age was just over twenty years (mean = 20.17, s.d. = 1.75) and 38% were female, and 62% male. They were asked to make a binary decision: either start a new business with a one-third probability to achieve US$90,000 net income or work in paid employment with a stable income US$30,000. It turned out that 61 participants (31.1%) decided to create a new venture—the risky

choice, with the remaining135 selecting the certain choice with stable income (68.9%). In addition to making this choice, participants were asked to rate the subjective value, weights, and subjective probability of the start-up opportunity, and to report their immediate anxiety at the time of making the binary choice. In order to control participants' trait anxiety and risk preference in a social event, participants reported their trait anxiety over the previous two weeks and made a dread disease decision (Kahneman & Tversky, 1984). In so doing, it was possible to control whether immediate anxiety is influenced by trait emotion and whether risk preference in new ventures is trait-type that cuts across start-up and social events.

Study 2 was designed to investigate the dynamic process of decision making. 206 participants were recruited from two large undergraduate business classes of a large university in the Asia-Pacific region. They were required to complete 20 binary project investment tasks–each comprising one risky and one certain project. All participants were randomly assigned to one of three objective probability conditions of risky choices winning (80%, 50%, and 20%). After the 20 tasks, they were then asked to make an additional binary decision. They also reported their subjective value, subjective probability of the additional risky project, and their immediate anxiety for making the decision. Trait anxiety was included as a control variable.

After deleting incomplete data and one outlier with extremely high-expected income after graduation, study 2 contained 174 effective respondents. The average age was 21 years, with 57% female and 43% male.

Study 1: A static decision scenario of start-up

Research design

We used the method of simulation heuristic (Kahneman & Tversky, 1982) to stimulate a start-up decision-making process. This method has been broadly used in the decision-making process of individuals (Sitkin & Weingart, 1995), organizations (Fredrickson, 1984), and entrepreneurial context (Choi and Shepherd, 2004; Shepherd, 1999). This method can simulate various mindsets in the real-time decision process, while overcoming the retrospective reporting bias, self-reporting bias, and difficulty in collecting contingent decision data.

In accordance with Kahneman and Tversky (1979)'s operational definition of risk-taking and risk aversion, the binary start-up choice was framed with the same expected value in the gain domain – continue working in a company with a stable $30,000 USD annual income (expected value = $1 \times 30{,}000$) or start a new business with one-third probability of success resulting in $90,000 USD in the first year (expected value $=1/3 \times 90{,}000$). If participants prefer the risky choice over the certain choice, they are risk-taking; if they do the opposite, risk averse. The decision scenario is close to a real venture situation. The annual income of US$30,000 in a stable job is very close to the median income of recent graduates from business schools in the local area. According to Timmons (1994), 66% of new ventures failed within six years, which is close to the 2/3 failure rate we used. A pilot study was conducted, showing that the decision scenario is clearly understood with acceptable face validity.

Measurements

All items in Study 1 were measured on a six-point Likert scale anchored by "not at all" (1) to "extremely" (6).

Independent variables

Subjective value The subjective value of the risky option is rated by three items including attractiveness, desirability, and intensity of preference (Murphy, 1982). The Cronbach's alpha was .86.

Immediate anxiety on decision-making (Shaver, Schwartz, Kirson, & Connor, 1987) Participants were informed, "You are now asked to make a choice from the two options, please rate your intensity of experienced anxiety, upset, and fear of making this decision." The Cronbach's alpha of these three items was .87.

Moderator variable

Subjective probability Subjective probability is the subjective belief in the likelihood or of an event's occurrence (Savage, 1954). Probability is a term too academic to be easily understood by laymen. It is represented by "possibility" in decision problem design (Kahneman and Tversky, 1979). This variable was measured by the question, "Please evaluate your possibility of operating the new venture creation successfully from 1 to 6." 1 represents no chance, 2 equals a 20% chance, 5 represents an 80% chance, and 6 equals a 100% chance. Its reliability was estimated in the second sample by adding one more item, "please rate your belief in your success of running this business opportunity." The Cronbach's alpha of the two items was .86.

Control variables

Weights Weights are the importance or influence of the outcome (Kahneman & Tversky, 1979). Participants were asked to rate: "How important is it to create the new venture for you?" The reliability of this single item variable was estimated in the second sample by adding one item, "how salient do you think this business opportunity is for you in comparison to the stable work option?" The Cronbach's alpha of the two items was .90.

Trait anxiety Trait anxiety was controlled to indicate whether immediate anxiety is influenced by trait anxiety. This is measured by the intensity of fear, upset, or anxiety that the participants experienced within the last two weeks. The Cronbach's alpha was .84.

Dread disease decision-making problem The dread disease decision-making problem (Kahneman & Tversky, 1984) is comprised of two choices in the gain domain: the certain choice (Project A) can save 200 people, and the risky choice (Project B) has a one-third probability of saving 600 people. This task was utilized to compare and control whether risk preference is a trait type attitude that cuts across new venture and social problems.

Results: Study 1

To test H1 that weighting function is not a good construct, we calculated the correlation between weights and SV shown in Table 1. We found that weights are too highly correlated ($r_{sample1} = .73$; $r_{sample2} = .86$) to be differentiated from SV. To further examine H1 and H2, H3a, H3b, and H4, logistic regression was conducted with the dummy coded dependent variable (whether or not to start up a new venture). The logistic regression is denoted as:

$$\text{Logit Y} = a + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_1 x_2 \ldots\ldots + \beta_n x_n \quad (1)$$

The probability of a decision (Y) is a nonlinear function of independent variables (x_n). But through transforming the probability Y into Logit Y, the relationship becomes linear. It ranges from $-\infty$ to $+\infty$. A larger logit Y indicates a higher probability that a participant will decide to create a new business. The interpretations for the relationship between logit Y and β_n, *a,* and the interaction term are the same as in OLS regression (Cohen, Cohen, West, & Aiken, 2003).

The results from the two samples are shown in Table 2. Except gender, all variables in the regression were standardized. Specification check did not find violation of normal distribution. Model 1 includes the control variables –gender and expected income after graduation, trait anxiety, and the weights for creating a new venture. Since the size of the second sample is small, we just input six variables in total. Weights were positively related to risk-taking ($\beta_{sample1} = 1.23$, $\beta_{sample2} = 1.68$, $p < .01$), but when Model 2 (prospect theory model) added SV into

Table 1 Experiment 1: Correlation matrix

Variables	Mean	s.d.	1	2	3	4	5	6	7	8	9
1.Age	20.08	1.75									
2Gender	.46	.98	−.03								
3.Expected Income	14,354	427	.08	−.03							
4. Trait Anxiety	3.37	1.21	.04	−.14*	.11	(.84)					
5.Weight	3.40	1.16	−.04	−.02	.01	−.08					
6.Choice1	.30	.46	−.04	−.05	.06	−.02	.44**				
7.Choice2	.41	.49	−.02	−.06	−.03	.01	.11	.13			
8.Subjective Value	3.43	1.00	−.06	−.12	.02	−.03	.73**	.54**	.12	(.86)	
9.Immediate Anxiety	3.86	1.18	−.05	−.20**	−.10	.41**	−.10	−.20**	−.04	−.12	(.87)
10.Subjective Probability	3.36	1.01	−.00	−.09	.09	−.22**	.53**	.42**	.12	.56**	−.24**

* $p < .05$ **$p < .01$ Sample size:

Choice 1: Decision on new venture creation (0—stable job; 1—start-up new venture)

Choice 2: Disease decision scenario (0—certain choice; 1—risky choice)

Table 2 Logistic regression of Study 1 in predicting the decision of creation a new venture

	DV: Logit of the probabilities of undertaking the new venture			
Variables	Model 1	Model 2	Model 3	Model 4
Constant	−1.08**	−1.29**	−1.37**	−1.47**
Control variables				
Expected Income	.39*	.48	.31	.28
Trait Anxiety	- .01	−.04	.26	.23
Weighting	1.24**	.45	.35	.37
Independent variables				
Subjective Value (SV)		1.45**	1.39**	1.36**
Immediate Anxiety (IA)			−.53*	−.59*
Subjective Probability (SP)			.48	.49
SV × SP				.60*
SP × IA				.46*
SV × IA				.01
Overall χ^2	49.7**	77.4**	88.2**	99.4**
df	3	4	6	9
Nagelkerke R^2	.32	.47	.52	.57
Percentage of correct prediction	78.1	81.3	82.8	84.4

Dependent variable is the logit of the probabilities of deciding to undertake a venture

↑ $p < .1$ * $p < .05$ **$p < .01$

the regression, the effect of weights became insignificant. The result was consistent across two samples, which supported H1—that weighting function is part of the valuation function. Its effect was explained by SV. In Model 3, SP and IA were entered. This model was significantly better than model 2 (PT model) with .05 Nagelkerke R^2 change, providing evidence that the newly added SP and IA have incremental validity in comparison with the PT model. Model 5 added the two-way interaction terms to test Hypotheses 3a, 3b, and 4. Compared to Model 2 - the baseline model of PT, the full model increased .10 Nagelkerke R^2, demonstrating that the new decision model is better than PT in predicting choices by inputting SP, IA, and their interactive effects.

The interaction term of SV and SP was significant ($\beta = .67$, $p < .05$) in predicting the logit of undertaking the venture. The interaction effect on the Logit Y was graphed as shown in Fig. 2. Consistent with H3a, the likelihood of starting a venture increased more in those confident in their success than those who lack confidence ($\text{Slope}_{\text{low}} = .76$, $t = 1.70$, $p < .05$; $\text{Slope}_{\text{high}} = 1.96$, $t = 4.39$, $p < .001$). Even for the lower SP, the likelihood of starting the venture still increased with the increase of the subjective value of the new venture, indicating value-driven risk preferences.

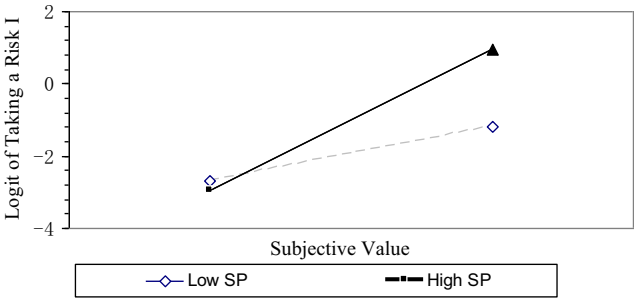


Fig. 2 The moderating effect of subjective probability on the relationship between subjective value and new venture creation in predicting the logit of probability

In support of H4, the significant interaction between SP and IA ($\beta = .59$, $p < .05$) is plotted as in Fig. 3. As expected, IA only influences risk-taking when people have less belief in their possibility of success. The results showed that when people lacked confidence in the success of a new venture, their experienced anxiety for the decision situation exacerbates their timidity towards undertaking the start-up ($Slope_{low} = -1.19$, $t = -2.67$, $p < .001$). Once their belief in the possibility of success is stronger, the experienced IA does not influence their willingness toward creating a new venture ($Slope_{high} = -.01$, $t = -.02$, *ns*).

In addition, we found that the correlation between choice 1 (new venture creation) and choice 2 (the Dread Disease problem, Kahneman & Tversky, 1984) proved insignificant. It supported contingent risk preference across decision scenarios (Payne, 1982). The distribution of SP does not violate the normal distribution, despite the informed one-third objective probability (OP), indicating that the informed OP did not influence the estimation of SP. This finding plus the positive relationship between value and risk-taking at higher SP levels reveal the weakness of CPT's claims about that risk-seeking behavior in the gain domain only occurs in the small probability. At first, people varied in estimating small probabilities. Second, even at the higher level of SP, risk-taking occurs over gain as long as the venture opportunity is valuable.

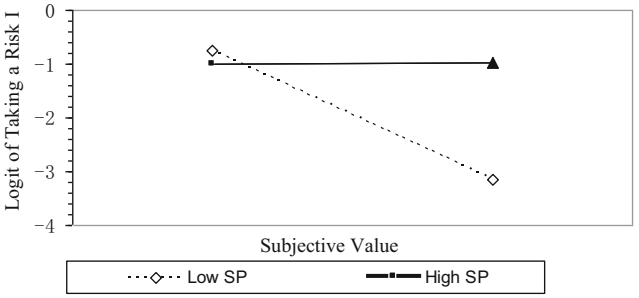


Fig. 3 The moderating effect of subjective probability on the relationship between immediate anxiety and new venture creation in predicting the logit of taking a risk

Discussion

This study empirically examined the constraints and suggested certain limitations of prospect theory regarding entrepreneurial decision making. We found that the weighting function is not a well defined construct in the decision making model, which is consistent with previous literature. By interpreting individual differences, the framing effect of risk preference is replaced by cognitive and emotional mechanisms. We also noted that the new model has incremental validity in comparison to PT in predicting choice. At the same time, SP moderates the effect of valuation and IA in predicting choices. Novice decision makers demonstrate more of a value-driven decision-making style, and are apt to undertake a desirable risky choice, thus ignoring perceived lower chances of success. Our findings also support the contingent theory of risk preferences. We found informed OP actually does not influence the judgment of SP.

Nonetheless, experiments based on decision scenarios frequently face questions over external validity across decision scenarios and samples, in spite of their strengths in countering retrospective bias and providing contingent data. To support the proposed decision-making model, Experiment 2 was conducted on a new decision-making task and with a different sample. Instead of the static design used in Experiment 1, Experiment 2 tested how learning and experience have an impact on risk-taking by designing a dynamic decision process.

Methods: Study 2, risk-taking in a dynamic process setting

Research design

The dynamic experiment is designed on the basis of the typical procedure of probability learning (Erev & Barron, 2005; Estes, 1950). Through immediate feedback from each decision, participants learn and change their risk preference, adapting to their circumstances, in terms of the objective probability of the risky project's success. The binary decision task involved choosing between a risky and a certain alternative. 175 students were required to complete 20 binary decision tasks. They are all novice decision-makers in entrepreneurial risky choices. These students were from a large university. Age from 17 to 37 (average age 21). Among them, 57.1% percent are female The risky project is denoted as "Project A: 2500K↔0," (K equal to one thousand) meaning that choosing project A can result in a profit of $2500 K if it succeeds, or nothing (0 profit) if it fails. The certain choice is denoted as "Project B: 500K," meaning a $500 K certain return if investing in project B. If a participant prefers Project A (the risky choice) over Project B (the certain choice), he or she is taking a risk, whereas choosing Project B represents risk aversion.

After each decision, the participants were informed of the monetary amount they earned and one of the outcomes of their decision (correct risk-taking: selecting the risky project but it turned out that the risky project won, correct risk-avoidance: selecting the certain project and the risky project failed, wrong risk-taking: selecting the risky project but it failed, and opportunity missed: selecting the certain project but the risky projects won). Both correct risk-taking and correct risk-avoidance are correct decisions. Such a method is originally derived from signal detection theory (Egan, 1975). We believe this design is being used for the first time in risk learning experiment.

The 20 investment decision-making tasks were designed under three objective probabilities of risky project success, 80% (Risky Group), 50% (Even Group), and 20% (Certain Group):

80% (Risky Group) – 16 of 20 risky projects succeed;
50% (Even Group) – 10 of 20 risky tasks succeed;
20% (Certain Group) – 4 of 20 risky tasks succeed.

The participants did not know the objective probability of their group. They therefore could not calculate expected value to assist them in each decision. After the 20 tasks, participants were required to complete an additional decision, denoted as "Project A: 6900K↔0; Project B: 2300K." The additional task has the same format as the previous 20 tasks, but the increased outcome variation in the risky project and the higher assured return in the certain alternative make this choice more risky and salient in comparison to the previous tasks. By increasing the difference in outcomes, we want to test whether the participants would transfer their learning from the previous 20 decision outcomes to the new task. After making the additional decision, participants were asked to rate their SP and SV of the risky project, the intensity of IA at the time of making the decision, and trait anxiety over the past two weeks as a control variable. All were measured using five-point Likert scales that ranged from "not at all" (1) to "extremely" (5). Although the five-point scale is different from the six-point scale used in study one, this variation will not influence the findings due to the fact that the focus is on the relationship between variables rather than on a comparison of means across studies. The Cronbach's alpha of SV, intensity of IA, and trait anxiety were .86, .74, and .88 respectively (shown in Table 3).

This experiment was conducted online. Every participant was randomly assigned into one of the three objective probability (OPs) conditions. After the experiment, each participant received a coffee voucher, worth US$4. The analysis of variance (ANOVA) indicated that participants across the three groups had no significant differences in age, gender, or expected income, showing demographical equivalence. They also did not

Table 3 Experiment 2: Correlation matrix

Variables	Mean	s.d.	1	2	3	4	5	6	7	8
1. Age	21.00	2.80								
2. Gender	.43	.50	−.03							
3. Expected Income	13,543	1831	−.05	.07						
4. Trait Anxiety	2.01	.98	.11	−.13	−.08	(.88)				
5. Group (dummy 1)	.31	.46	−.06	−.00	−.03	−.05				
6. Group (dummy 2)	.35	.48	.18*	−.04	−.09	.09	−.50**			
7. Subjective Value	3.11	.88	−.06	.02	.09	.11	−.07	−.24**	(.86)	
8. Immediate Anxiety	2.00	.78	.06	−.10	−.08	.47**	−.04	.06	.14	(.74)
9. Subjective Probability	3.26	.94	−.07	−.02	.03	.03	−.12	−.35**	.57**	.06

* $p < .05$ ** $p < .01$

show significant differences in the number of correct decisions, indicating that no trial is easier than other groups. The average number of correct decision making is 10.26 ranging from 4 to 16 over the 20 tasks.

Manipulation check

After the 20 decision-making tasks, participants were required to answer: "do you think the risky choices have many chances of success?" The results of ANOVA show that participants perceived the chances of the risky choice's success significantly different ($F(2,172) = 24.0$, $p < .01$) across the three OP groups. The mean for the risky group was 3.07 (*s.d.* = 1.22), which is significantly higher than even group (mean = 2.39, *s.d.* = 1.00), which in turn is significantly higher than the certain group (mean = 1.77, *s.d.* = .84). These results show that the experimental manipulation of the chances of the risky choice's success (80%, 50%, or 20%) was effective.

Results: Study 2

Reversed framing effect in the gain domain

As a baseline, risk preferences across groups did not show significant differences in the first decision-making task ($F(2, 172) = .14$, *ns.*). After performing 20 decision-making tasks, the three groups differ significantly in risk preferences for the additional decision ($F(2, 172) = 14.80$, $p < .01$). In support of H4, 78% of the risky group preferred the risky choice, showing a reversed framing effect in the gain domain. The certain group and even group also demonstrated adaptation to the objective opportunities of risky choices over time. Only 32% of the certain group selected the risky choice and 68% preferred the certain choice, appearing risk averse. The even group did not show apparent risk preferences, as 57% of them selected the risky choice and 43% preferred the certain choice. Figure 4 illustrated the changes between the initial decision and the additional decision. The results demonstrate that risk preference varied in adapting to the objective opportunities, rather than being invariant in risk aversion over time.

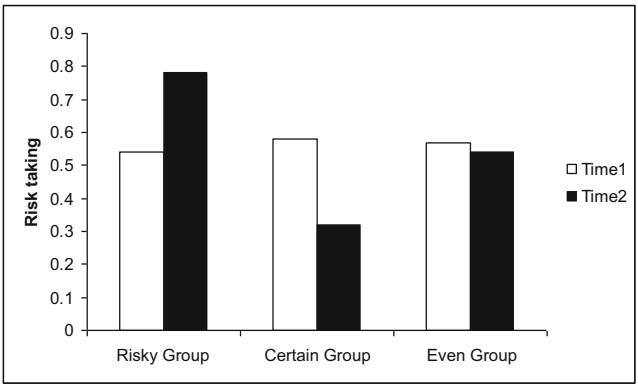


Fig. 4 Experiment 2: The change of risk-taking between time 2 and Time 1

Adapted judgment of subjective value and subjective probability of risky choice Consistent with Hypothesis 5a, the three groups showed significant differences in valuing the risky choice (SV) for the additional decision ($F(2, 172) = 9.75$, $p < .01$). Further t-testing finds that the High Success group perceived the highest value for the risky choice (mean = 3.49, *s.d.* = .73), which is significantly higher than the value given by the Low Success group (mean = 2.83, *s.d.* = .93) and the even group (mean = 3.02, *s.d.* = .85). In support of Hypothesis 5b, the subjective belief in the success of risky choice (SP) also varied for the additional decision across groups ($F(2, 172) = 27.0$, $p < .01$). The High Success group presented the highest SP (mean = 3.90, *s.d.* = .83), significantly higher than both the Low Success group (mean = 2.82, *s.d.* = .78) and the even group (mean = 3.09, *s.d.* = .88). These results provided evidence that valuation and confidence for risk-taking change over time to adapt to objective likelihood of the risky choice being successful.

Decision-making model in predicting additional decision after a dynamic process

The logistic regression was conducted as study 1 in predicting risk preference of the additional task. Table 4 reported the results. Specification check found immediate anxiety is skewed (*Mean* = 2.00, *s.d.* = .78), and therefore violated the normal distribution assumption. It was therefore excluded in the regression model. As expected, the lower mean implies that the additional decision-making task did not elicit intensive IA for most of participants after 20 repetitions. Model 1 includes the control variables such as gender and expected income after graduation. Model 2 adds two dummy variables for the three groups. It is significant ($p < .01$), indicating that the objective distribution of the risky choice's success does influence future risk preference. Model 3 adds SV and SP. Model 4 adds the two-way interaction terms. Model 5 adds the three-way interaction terms.

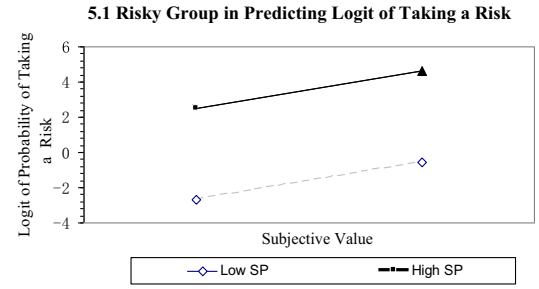
In support of H7a and 7b, we found significant three way interaction between SP × SV × Dummy Variable2 ($\beta = 2.19$, $p < .05$). Its marginal effect in predicting the probability of undertaking the risky choice is also significant (.48, $p < .05$), supporting H7a. Figure 5 graphed the interaction effect in the three groups. Consistent with Hypothesis 7b, decision-makers in rigid conditions without much chances of winning, such as in the even (50%) and certain (20%) groups, become cautious and are unwilling to take a risks without the confidence of winning. As shown in Figure 5.2 and 5.3, for both groups, their risk taking tendency was not influenced by SV at lower subjective probability levels ($Slope_{even} = .58$, $t = .89$, *ns*; $Slope_{certain} = .51$, $t = .42$, *ns*). At higher levels, the risk tendency of both groups significantly increases with the increase of Subjective Value but certain group ($Slope_{certain} = 4.69$, $t = 11.28$, $p < .001$) increased more than the even group ($Slope_{even} = .74$, $t = 1.78$, $p < .05$) with each additional unit increase of SV. As predicted, the risky group, with 80% percent chances of the risky choice successful, maintained a value driven decision style, shown in Fig. 5.1, whereas its risk taking tendency increases with the increase of SV even at higher level of SP ($Slope_{High\ Success} = .99$, $t = 2.38$, $p < .001$). Similarly, Fig. 5.1 5.2 and 5.3 are linear. They illustrated how subjective value at different levels of subjective probability influences the logit of undertaking a risky choice.

Table 4 Experiment 2: Logistic regression in predicting the additional decision-making

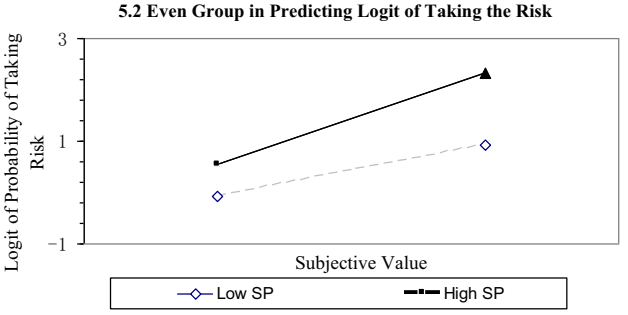
	Variables	Model 1 Beta	Model 2 Beta	Model 3 Beta	Model 4 Beta	Model 5 Beta
Constant		1.47	1.30	.75	.71	.73
Control variables	Gender	.14	.09	.31	.39	.30
	Expected Income	.03	−.02	.05	.07	.15
Independent variables	Groups Dummy 1 (DM1)		−.94*	−.06	−.11	−.04
	Groups Dummy 2 (DM2)		−1.98**	−1.32	−1.85*	−2.35**
Main Effect	Subjective Value (SV)			.83**	1.02	1.09
	Subjective Probability (SP)			1.45**	3.29**	2.64**
Two-way interaction	SV × SP				.89*	−.10
	SV × DM1				.03	−.43
	SV × DM2				.51	1.51
	SP × DM2				−2.76*	−2.37*
	SP× DM1				−1.66	−1.12
Three-way interaction	SV × SP × DM1					.18
	SV × SP × DM2					2.19*
	Overall χ^2 (df)	.3 (2)	26.1** (4)	93.1** (7)	103.1** (11)	109.1** (14)
	Nagelkerke R^2	.00	.19	.55	.60	.62
	Percentage of correct prediction	55.2	67.8	83.9	84.5	84.5

* $p < .05$ ** $p < .01$ Group 1: Risky Group (0,0) Group 2: Certain Group (0, 1) Group 3: Even Group (1,0) Putting the dummy variables into Model 5, we attained three regression equations respectively Risky Group: Logit Y = .73 + 1.09SV + 2.64SP -.10 SV × SP

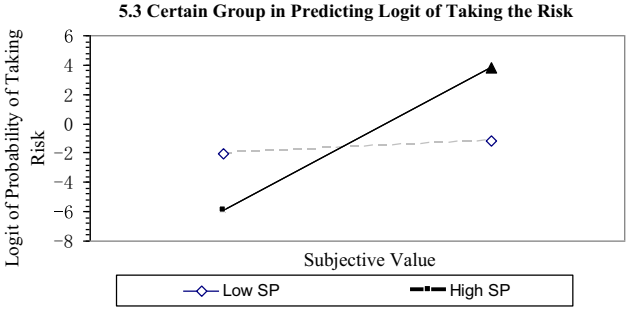
Certain Group: Logit Y = −1.52 + 2.60SV + .27SP + 2.09SV × SP Even Group: Logit Y = .69+ .66SV + 1.52SP + .08SP × SV



$Slope_{low}$=1.19, t = 1.83, p < .05 $Slope_{high}$= 0.99, t= 2.38, p < .05



$Slope_{low}$ = 0.58, t = 0.89, ns $Slope_{high}$= 0.74, t = 1.78, p < .05



$Slope_{low}$= 0.51, t = 0.42, ns $Slope_{high}$= 4.69, t = 11.28, p < .001

Fig. 5 The moderating effect of subjective probability on the association between subjective value and risk-taking in three groups

In comparison with study 1, the risky group maintained a value driven decision-making style just the same as novice decision makers. They undertake the risky choice with the increase in perceived value even when they lacked sufficient belief in winning; in contrast, at relatively lower OP conditions, such as in the certain and even groups, decision-makers exhibited SP maximizing decision strategy. Valuation did not function as long as the decision makers lacked confidence in success. At the same time, the dynamic model of venture decision showed higher correct prediction for the risky choice in Experiment 2 (81.3%) than it did in Experiment 1 (60%), which implied that the dynamic decision model can predict simple monetary tradeoff choices better than the complex decision, such as funding a new business that not only involves monetary

return but also leadership, network building and other capabilities (Li, Chun, Ashkanasy, & Ahlstrom, 2012; Timmons, 1994).

Discussion

Understanding entrepreneurial decision making calls for constructive and paradigmatic transformations is quite challenging (Schade, 2009), particularly given the high uncertainty and complexity involved in venture decisions, and the challenges of gathering (and making sense of) data on higher level decisions (Ahlstrom, Lamond, & Ding, 2009). From a dynamic perspective, this study studies the process of how value-driven novice decision makers become conservative subjective probability maximizing decision makers. It expands the static-determinant-descriptive paradigm that prospect theory and cumulative prospect theory (CPT) rely on to the dynamic model, shedding important light on the roles played by individual differences (Hayek, 1948), dynamism (Schumpeter, 1942), and psychological mechanisms (Simon, 1955; Kahneman & Tversky, 1979) in affecting the behavior of economic agents.

This research suggests that prospective entrepreneurs pursue a venture opportunity under uncertainty not because the decision situation is a gain or a loss situation (prospect theory) or because of the small probability of gains (cumulative prospect theory). Our two experiments have shown that subjective value, subjective probability, immediate anxiety, and their variation in the temporal dimension matter in determining individual differences of risk preference.

We found reversed framing effect in the gain domain and individual differences in risk preference. In spite of between-subject variation and within-subject differences over time, subjective value, subjective probability, and immediate anxiety consistently explain and predict risk preferences across samples and tasks in either a static or dynamic process, indicating that the dynamic model of venture decision is a generalizable decision-making model. These findings reveal important theoretical and practical implications for understanding entrepreneurial decisions.

Contributions

Regarding theory, this study shows that the framing effect is not a pre-condition for risk-taking. To a certain extent, framing a situation as a loss or a gain is part of the function of valuation, only partially accounting for risk-taking. At the same time, findings based on counting and categorizing data reduce their statistical inference power, which results in a constrained theoretical understanding of prospect theory and cumulative prospect theory in explaining entrepreneurial decision making. Instead, people decide to take a risk because they place a higher value on the risky choice (higher SV), have a greater belief in their success (higher subjective probability), and show less anxiety at the time of making the decision. They change their risk preference over time to adapt to their changing circumstances.

Second, objective probability is an important determinant in an uncertain choice, but its effects vary depending on the format in which it is presented. The normally distributed subjective probability in Study 1 shows that the hypothetical objective probability did not

affect subjective judgment in the likelihood of the success of a new venture. In contrast, when objective probability becomes parts of the external environment that represents the opportunity of risky choice winning, it significantly influences subjective judgment of the value and probability of a risky choice. Risk preference accordingly changes to adapt to objective probability. These findings further suggest that decision-making theory should incorporate probability in a more appropriate way (Ahlstrom & Wang, 2009; Tetlock & Gardner, 2016. Hypothetical reasoning based on informed objective probability may not influence decisions, as supported by the results of Experiment 1 and the insights from March and Shapira (1987: pp.1411) that, "individuals do not trust, do not understand, or simply do not much use precise probability estimates."

The two studies have consistently supported the importance of subjective probability in risk-taking. Of particular interest is the difference in its moderating effects between novice and experienced decision-makers. Novice decision makers tend to present a value-driven decision style; whereas experienced decision-makers show a subjective probability maximizing tendency. Baron and Ensley (2006) also have found that novice entrepreneurs are apt to neglect the factors that strongly affect the success of new ventures, but are attracted by the novelty and potential opportunity of new businesses or project investments. Mature entrepreneurs are inclined to ignore fancy new business ideas as long as they lack confidence in the new business to generate a financial return. Experience in rigid conditions therefore seems to become the dark side of entrepreneurship, leading to inertia in creation and innovation. This is also consistent with Burmeister and Schade's (2007) findings about the status quo bias of entrepreneurs. From this point of view, entrepreneurs and innovators thus may just belong to the domain of idealists and value driven risk-takers who dare to take a risk even when they are unsure of their possibility of success and the downsides (Dunbar & Ahlstrom, 1995; Tetlock & Gardner, 2016). Thus, future studies on entrepreneurship need dig more deeply about the nature and behavior of entrepreneurs and as well as how these may impact entrepreneurial performance, rather than simply comparing the differences between entrepreneurs and managers (Ahlstrom & Ding, 2014). Research should also be given to explore the ways in which prevent entrepreneurial failure. In addition, how risk perception (Palich & Bagby, 1995; Mitchell, et al., 2007) affects value and probability judgment or estimation should shed important lights on understanding entrepreneurial decision making. Our findings partly solved the Allais Paradox with a descriptive approach: value or probability, which one is more important in decision, is in fact closely related to personal experience. Novice decision-makers tend to use valuation strategy but experienced decision-makers utilize maximizing subjective probability strategy.

Third, this research provides further empirical evidence that risk preferences are task-specific. Some researchers are inclined to find the roots of risk preferences in stable properties of individuals such as personality and culture (Douglas & Wildavasky, 1982), achievement motivation (Deci, 1975; Kogan & Wallach, 1964; McClelland, 1961) locus of control (McInish, 1982) and recently in genetics (Gorodnichenko & Roland, 2017). Nevertheless, contingent decision theory (Payne, 1982) advocates that it is the adaptive mechanism that allows us to cope with a complex, dynamic environment (Hogarth, 1981), thus making decisions in accordance with the properties of decision tasks. The results of this study found no relationship between the decision of new venture creation and the social decision dilemma such as the dread disease problem (Kahneman & Tversky, 1984). It is evident from our results that entrepreneurial

decision making is contingent, relevant to the cognitive judgment of value and probability, emotional reaction to the decision situation, and learning over time.

Fourth, In Experiment 2, the distinctive risk preferences between the first and the additional task demonstrate adaptation to the experimental treatments. The results provide evidence that risk preferences evolve over time (cf. Tetlock & Gardner, 2016). Finally, the activation of immediate anxiety is conditional. In contrast to Experiment 1, participants present systematically lower ratings of immediate anxiety in Experiment 2. This implies that immediate anxiety reduces with the increase of familiarity to a given decision situation. At the same time, anxiety makes decision-makers reluctant to undertake a risk if their belief in its success is low, but does not influence risk-taking as long as they are highly confident in success, indicating that the motivation of grasping an opportunity overwhelms risk aversion.

In sum, this study contributes to theory by revealing the importance of experiences in risky choices, and provides additional empirical evidence for the nature and dynamics of risky decisions. Experience influence the tendency of risk avoidance or risk seeking and decision-makers' strategies in using value and probability in their risky choice decisions as well as anxiety toward decision situation.

In terms of practice, executives and entrepreneurs alike should be aware of the individual differences in perceiving an entrepreneurial activity as an upside opportunity or a downside risk, particularly at the time of making a decision based on the attitudes of a group (Ahlstrom, 2014; Christensen & Raynor, 2013). The individual differences towards a venture come from the variation of perceived attractiveness, belief in success, and anxiety when making the decision. Prior experiences should also be taken into account. Novice decision-makers tend to be attracted by the potential value of a risky choice, but overlook the likelihood of the risky choice's failure. This finding also suggests that managers and entrepreneurs should conduct more rational analyses on the probability of a risky choice's success and its downsides, particularly if the decision problem is new. Intuitive judgments should also be avoided for new businesses and investments. But for experienced decision makers, over-conservatism may lead to miss opportunities (Bradley et al., 2011). For certain levels, they may need to give the attractive venture more room in particular when they lack of confidence of its success.

At the same time, these findings suggest that the higher failure rate in new venture creation is partly due to novice entrepreneurs' incorrect assessment of their capability to run a new business successfully. They should therefore realize that in addition to being passionate about achieving the upside potential, the capabilities required to run a new business are critical and they should put efforts into learning and enhancing such capabilities. Immediate anxiety in the decision context is a good signal, reminding decision-makers of the unfamiliarity of the decision task. This emotional reaction should heighten their awareness for the need to analyze and execute the venture opportunity rigorously in order to manage the ambiguity that is typical of a new venture.

Limitations and future research

As for the limitations, our samples are undergraduate and graduate students and the decision scenarios are hypothetical without incentives. Given our research questions, such limitations are acceptable. For example, it is hard to design experiments with

rewards that large enough to elicit a so-called real decision of new venture creation without hypothetical reasoning bias (Schade & Burmeister, 2009). We counterbalance the potential negative effects of lack of real incentives by increasing the validity of the experiments, such as making the objective probability of a start-up and the annual income in stable work close to the reality as in Study 1. We manipulate three objective probability conditions, then compare the differences across groups in Study 2. As for the student samples, they are appropriate for Study 2 because we just want to examine the changes generated by a dynamic process. For Study 1, the findings were replicated even when applying the first study to a mature sample with more business experience.

With regard to future studies, the relatively lower correct prediction of starting up in Study 1 in comparison with Study 2 indicates that more determinants outside the current model need to be identified to reflect the multi-faceted properties of a complicated decision such as creating a new venture or strategic alliance. This conclusion supports Slovic (1995)'s claim that far more complex choice models rather than traditional decision models are required. In addition, to increase the studies' generalizability, future work should be conducted in different cultures outside of the Asia-Pacific region, and with experimental and where possible, archival data or using quasi-experimental conditions (DeRue, Nahrgang, Hollenbeck, Workman, 2012; Liu, Wang, Zhao, & Ahlstrom, 2013).

Conclusion

In summary, through reconciling the discrepancy between the interpretation of prospect theory of decision making under uncertainty, and the phenomenon of entrepreneurial decision making, we expand the boundaries of prospect theory and develop a dynamic model of venture decision by taking into account individual differences and its dynamic nature. This robust model elucidates the reasons for individual differences in risk preference by incorporating cognitive, emotional, and dynamic learning mechanisms. The dynamics of decision making successfully provide a descriptive solution to the Allais Paradox of value driven novice decision makers versus subjective probability maximizing experienced decision makers. Value-driven decisions are the most habitual entrepreneurship decision style. This study contributes to the literature by revealing the nature of venture decision under uncertainty and systematically examining the effects of probabilities in both a static and a dynamic decision-making process while continuing to unpack the factors that determine entrepreneurial decisions.

Given the salience of entrepreneurship in the commercial and public policy arenas (Ács, Audretsch, & Strom, 2009, Wang, Ahlstrom, Nair, & Hang, 2008), the importance of better understand entrepreneurial choices is clear, particularly for developing economies seeking to break out of the middle income trap and other growth cul-de-sacs (Agenor, 2017). This study, while contributing to decision making such as in the area of Prospect Theory, also suggests ways in which entrepreneurs can make better decisions. If this study could have one message in that regard, it would be that while it is good to be passionate about an idea and believe in its upside potential, it is certainly not the case that victory belongs to the one who believes in it the most, as Alec Baldwin's character proclaimed in the 2001 film *Pearl Harbor*. Immediate anxiety in the decision context is a good signal, pushing decision makers to think (and plan) in terms of what (reasonably speaking) can go

wrong, and how these problems can be overcome or at least mitigated (Ahlstrom & Wang, 2009; Rumelt, 2011). Emotion is a welcome addition to research on decision processes and its understanding will further unpack the challenging nature of decisions, particularly in the ambiguous and unstructured environment of the entrepreneur.

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Appendix 1: Experiment 1

Scenario: Here is a decision scenario about a start-up business. Please just make a decision based on your own judgment. Note that there is no correct or wrong decision.

Assuming that you are working in a company with a stable salary (US$ 30,000/year), you discover one business opportunity in your work. If you start a firm to realize this opportunity, you can gain US$ 90,000 at the first year if you execute it well and are successful; your gain will be zero if you fail. By your personal investigation, you know the possibility of start-up firm successfully is 33.3%, in other words, you will have one third possibility of success in executing this business opportunity; two third possibilities of failure. You are required to make a decision between the two choices:

- A: Start up a new firm (33.3% chance of earning US$ 90,000)
- B: Keep working at the company (certain income of US$ 30,000)___

Before you make the decision, please answer these questions on the below.

Subjective Value:

1. How attractive is this business opportunity for you?
2. How do you desire to realize this business opportunity?
3. What is your preference of this start-up opportunity in comparison to the stable work option?

Weights: 4. How important do you think this business opportunity is for you in comparison to the stable work option?

Subjective Probability:

5. Please estimate the possibility that you can execute this business opportunity successfully.

0 (not at all)	20%	40%	60%	80%	100%
○	○	○	○	○	○

You are now asked to make a choice from the two options, please rate your intensity of experienced anxiety, upset, and fear on making this decision.

	not at all	little	a little	bit	quite a bit	extremely
Fear	○	○	○	○	○	○
Anxiety	○	○	○	○	○	○
Upset	○	○	○	○	○	○

Now, please make a choice between A and B,

- A: Start up a new firm (33.3% chance of earning US$ 90,000)
- B: Keep working at the company (certain income of US$ 30,000)

Appendix 2: Experiment 2

Section 1: Introduction

You are a CEO of a company and you have to make 20 decisions on project investment. For each decision you have two choices. One is a certain return and one is a risky choice. A certain choice is denoted with one monetary return, e.g. **Project A: $100 K**, which means if you invest project A, you will be certain to get a $100 K return. A risky choice is denoted with a range of monetary returns, e.g. **Project B: $400 K↔0**, which means if you select Project B and it succeeds, you will get a $400 K return; but if this project fails, your gain will be zero.

After you choose between Project A or B, you will be informed whether the project succeeded and the amount of money you received from this investment.

As a CEO you have two goals: **(1) make as much money as possible**; and **(2) make correct decisions in your investments**. After the 20 decisions, you will have a break and answer 1 question; then you will make one additional investment decision-making task. Your performance in these decision-making tasks is not related with your ability. Just complete the series of decision-making tasks using your own judgment.

Section 2: Questionnaire (Manipulation Check)

Manipulation check

1. Do you think that the risky choice has many chance of winning?

very slightly or not at all ○ a little ○ moderately ○ quite a bit ○ extremely ○

Section 3: One Addition Decision Making Task

Please make one addition decision. The outcome of this task is very important. Please try your best to make a correct decision.

Please make a choice between:

Project A: 6900K↔0 ○
Project B: 2300K ○

Section 4: Questionnaires

Immediate Anxiety:

Please describe the intensity of your emotions on making this decision,

	not at all	a little	moderately	quite a bit	extremely
Fear	○	○	○	○	○
Anxiety	○	○	○	○	○
Upset	○	○	○	○	○

Subjective Value:

As for the risky choice (6900 K↔0), please answer these questions on the below.

1. How attractive is the risky choice for you?
2. How do you desire to choose the risky choice?
3. What is your preference of the risky choice in comparison to the sure return option?

Subjective Probability:

Please estimate the possibility that the risky choice (6900 K↔0) will win.

0 (not at all)	20%	40%	60%	80%	100%
○	○	○	○	○	○

Appendix 3

Table 5 Decision tasks in Study 2

Trail	Decision tasks	Designed results of whether risky choice win		
		Risky Group (80%)	Certain Group (20%)	Even group (50%)
1	Project A: 2500 K↔0 Project B: 500 K	√		
2	Project A: 800↔0 Project B: 100 K	√		
3	Project A: 2100 K↔0 Project B: 300 K		√	√
4	Project A: 3000 K↔0 Project B: 600 K	√		√
5	Project A: 2800 K↔0 Project B: 400 K	√		√
6	Project A: 2500 K↔0	√		√

Table 5 (continued)

Trail	Decision tasks	Designed results of whether risky choice win		
		Risky Group (80%)	Certain Group (20%)	Even group (50%)
	Project B: 250 K			
7	Project A: 3500 K↔0	√		√
	Project B: 500 K			
8	Project A: 4800 K↔0	√		√
	Project B: 1200 K			
9	Project A: 1080 K↔0		√	
	Project B: 360 K			
10	Project A: 1800 K↔0		√	
	Project B: 600 K			
11	Project A: 1920 K↔0	√		
	Project B: 480 K			
12	Project A: 360 K↔0	√		√
	Project B: 120 K			
13	Project A: 2100 K↔0	√		
	Project B: 700 K			
14	Project A: 1260 K↔0	√		
	Project B: 420 K			
15	Project A: 1000 K↔0	√		
	Project B: 330 K			
16	Project A: 2200 K↔0		√	√
	Project B: 550 K			
17	Project A: 1400 K↔0	√		
	Project B: 700 K			
18	Project A: 600 K↔0	√		√
	Project B: 200 K			
19	Project A: 6000 K↔0	√		
	Project B: 2000 K			
20	Project A: 2000 K↔0	√		√
	Project B: 900 K			
Additional decision task	Project A: 6900 K↔0			
	Project B: 2300 K			

√: means in that task, risky choice is designed as winning

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