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# NARROW FRAMING EFFECTS ON REAL OPTIONS: THE CASE OF IT APPLICATION PORTFOLIOS

*Research-in-Progress*

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## **Abstract**

*Real options theory has been advocated as a solution to IT investment problems with uncertainty around future outcomes and the inability of traditional financial measures to account for managerial flexibility. On the one hand, it is argued that real option analysis captures and formalizes managers' intuition, thus creating a disciplined decision making process. On the other hand, the intuitive valuation of the options is criticized due to the prevalent effects of various judgmental biases. Through this study, we try to capture one of the biases that can affect the real option value at exercise time in an IT application portfolio setting i.e. narrow framing. We also explore the impact of uncertainty around outcomes on real option exercise time. By conducting an online experiment using experimental choice analysis with IT managers as subjects, we try to see if they are prone to simplifying complicated real option exercise decisions by isolating them.*

**Keywords:** Narrow Framing, Real Options, Information Technology, IT Application Portfolios

## Introduction

A major challenge faced by managers handling information technology (IT) investment decisions in organizations is to make decisions in the face of uncertainty and with ill-structured information (Tiwana et al., 2007). Real options theory has been proposed as a way to handle such uncertainty by accounting for the embedded flexibility in IT projects, which allows managers to exploit future opportunities created by IT projects while curtailing the inherent risks in these projects (Benaroch, 2002; Bowman and Moskowitz, 2002). Several studies have focused on the application of real options theory in the context of IT investments, ranging from conceptualization of IT investments in real options contexts (Dos Santos, 1991; Kumar 1996) to valuation of the real options (Taudes, 1998; Benaroch and Kauffman, 1999; Keil and Flatto, 1999; Taudes et al., 2000; Benaroch, 2002) and intuitive recognition of real options, also known as real options thinking (Fitchman et al., 2005; Tiwana et al., 2006). Building on the intuitive recognition of real options by managers in IT projects, recent studies have tried to explore the presence and effects of various systematic biases in the case of real options (Table 1). These studies have focused on the effects of biases on real option valuation in the case of a single project and in the presence of single real option. This study augments the current stream of research in two ways. First, it further explores the presence of systematic biases in a different and more realistic setting, i.e. portfolio of projects with embedded options (IT application portfolio to be more specific). Secondly, it captures the effects of these biases on actual managerial decisions at option exercise time.

<b>Table 1: Literature on Intuitive Valuation of Real Options</b>			
<b>Reference</b>	<b>Theory Used</b>	<b>Hypotheses</b>	<b>Type of Subjects</b>
Busby and Pitts, 1997	Real Options Theory	How decision-makers in industry evaluate flexibility in capital investments.	Senior Finance Officers
Howell and Jäggle, 1997	Human Information Processing	How managers intuitively value real growth options.	Managers
Miller and Shapira, 2004	Prospect Theory and Framing Effects	How purchasers/sellers of call and put option price it relative to their payoffs/losses.	MBA Students
		Discount rates decrease with option duration, and the steepness of decline decreases with time.	
		Call/Put option sellers and buyers discount exercise price	
Tiwana et al., 2006	Escalation of Commitment	Presence of real options in a project increases the likelihood of warned continuation of an IT project with negative feedback.	Managers
	Prospect Theory and Framing Effects	Managers perceive strategic growth options embedded in an IT project as adding more value to the firm than operating options.	
Tiwana et al., 2007	Bounded Rationality	Under uncertainty, managers associate embedded options (growth, switch, stage, scale, defer, and abandon) with IT project value in case of a low NPV.	Managers
Lankton and Luft, 2008	Regret Theory	Under uncertainty, deferral options are intuitively valued more than growth options in IT projects.	MBA Students
		The presence of competition decreases the value of deferral options and increases the value of growth option.	

We draw on Tversky and Kahneman's (1981) idea of framing to suggest that managers will demonstrate systematic biases while making real option exercise decisions in an IT application portfolio setting. Specifically, we concentrate on narrow framing to capture the existence of biases in concurrent decisions situations such as in IT portfolios. We hypothesize that in an IT portfolio setting, managers' tendency of framing some options as gains (i.e. growth) and others as losses (i.e. abandon) (Millar and Shapira, 2004; Tiwana et al., 2006) with respect to the NPV of the project as a reference point, will lead them to make real option exercise decisions in isolation. This will lead to sub-optimal decisions from the point of view of net portfolio value.

The rest of the paper is structured as follows. Next, we briefly describe the theories supporting our research, followed by the hypotheses. Later we describe our research design and methodology before concluding.

## Theory and Hypotheses

### *Narrow Framing*

For strategic decisions involving high stakes, managers are expected to make decisions inclusively by considering all the alternatives and integrating variety of information (Bukszar and Connolly, 1988). In reality, as the task becomes cognitively challenging, managers arrive at their decisions by considering a broad range of facts and then by conducting a detailed examination of a subset of facts (Etzioni, 1989). While doing so, empirical studies have shown that they fall prey to the effects of narrow framing (e.g. Kahneman and Tversky, 1981; Kahneman, 2003).

Frames are cognitive shortcuts that people use to understand complex information and to simplify complicated phenomena into more easily understandable components (Liu et al. 2010). Tversky and Kahneman (1981) first described decision frames as the decision-makers conception of the alternatives and contingencies associated with the alternatives and outcomes. Through experimental evidence, they showed that the decision frames that a decision maker adopts rely on factors such as problem formulation, decision makers' norms, habits and personal characteristics.

Framing effects occur when willingness to undergo a risk depends on whether potential outcomes are positively or negatively framed. In "risky choice framing", Tversky and Kahneman (1981) showed preference reversal among people's risk preferences where they are willing to take higher risks with negatively framed outcomes than with positively framed outcomes. In their famous Asian disease problem, two groups were given the similar situation, but framed in two different ways i.e. gain (lives saved) save vs. loss (lives lost) frame. Both the options were mathematically equal i.e. with similar expected values. Majority of subjects showed preference reversal by showing *risk-averse behavior in the gain frame* and *risk seeking behavior in the loss frame*. In other words, they were risk-seeking when a "lives lost" frame was employed but under the "lives saved" frame, they were risk averse.

The formulation of frames is dependent on reference point to which decision maker become conveniently adapted. This leads them to start relying on narrow frames relative to that reference point (Kahneman and Tversky, 1984; Kahneman, 2003). For example, reference point in the previous example was lives saved (Tversky and Kahneman, 1981). Typically, reference points vary from situation to situation. For example, for managerial decision making, reference point is the organizational recourses at stake (Hogarth, 1987). In a trade situation, a reference point for a seller is found to be the amount received, whereas it is the amount paid for the buyers (Neale, Huber, and Northcraft, 1987), which leads to sellers being less risk- taking than buyers. In case of IT investment, a project's NPV is the reference point that managers conveniently adapt to (Fitchman et al., 2005), which guides their decision about the project. In other words, decision-makers perceptions become narrowly anchored on a reference point which they use to assess changes in wealth, rather than the final states of wealth (Kahneman and Tversky, 1984), therefore leading them to decision making in isolation (Tversky and Kahneman, 1981). The situation becomes more prevalent in case of decisions made intuitively rather than through effortful reasoning (Kahneman, 2003). Table 2 summarizes studies on narrow framing, along with the application area as well as major results.

### *IT Real Options*

An IT project possesses a real option when it offers management the opportunity, but not the obligation, to take some action in the future in response to endogenous (within the firm) or exogenous (in the business environment) events (Benaroch and Kauffman, 1999). Real options value goes beyond NPV to include the values of the options that are created when a series of repeated decisions can be made sequentially concerning an ongoing capital-investment stream. Thus, by allowing for managerial flexibility in decision making, real options allow a more accurate valuation of capital investments by curtailing the inherent risk (Benaroch and Kauffman, 1999; Tiwana et al. 2006).

IT real options literature focuses on applying financial options pricing models to value the embedded real options in IT projects. However, unlike financial options, the values of key parameters for the real options models are usually not available (e.g. option exercise price, option expiration time, underlying asset's value) (Table 3). Therefore, an

options heuristic is considered more practical in many investment scenarios (Bowman and Markowitz, 2001; Kogut and Kulatilaka, 2001; McGrath and MacMillan, 2000), but at the cost of rigor, and IT investment decisions are no exception (Fitchman, 2005; Lankton and Luft, 2008). Due to the differences highlighted above, the potential for incorrect exercise decisions is high for real options. In the face of persistent uncertainty around outcomes at exercise time and the absence of a hard time frame for exercising a real option on an IT asset, the exercise decision is left to the manager's discretion.

**Table 2: Summary of Narrow Framing Literature**

Reference	Area of Application	Results
Tversky and Kahneman (1981)	Psychology of decision making under risk	The formulation of frames is dependent on the reference point to which decision makers become conveniently adapted. It leads them to start relying on narrow frames relative to that reference point.
Kahneman and Lovallo (1993)	Psychology of decision making under risk	Narrow framers are liable to consider problems as unique. They isolate current choices from future opportunities and neglect the connection in terms of future choice opportunities, which results in isolation costs.
Thaler (1985)	Consumer behavior and evaluation of purchases	Consumers indulge in mental accounting while deciding on various aspects of their purchases.
Thaler (1999)	Mental accounting process	Risk attitude of loss-averse investors depends on the frequency with which they reset their reference point.
Barberis and Huang (2001)	Relation of narrow framing and loss aversion to the equity premium puzzle	Loss aversion due to narrow framing over financial wealth fluctuations in a dynamic equilibrium model captures a number of aggregate market phenomena.
Barberis, Huang, and Thaler (2006)	Investor behavior in stock market	Investors isolate their investment decisions in regards to their portfolio and do not take into account the degree of correlation between the portfolio components.
Barberis and Huang (2008)	Investors' utility function for asset allocation under narrow framing and loss aversion	Investors evaluate a gamble in isolation and are sensitive to losses.
Frazzini (2006)	Individual trading behavior in stock market	Investors evaluate a gamble in isolation and are indifferent to the correlation between their outcome and their total wealth.
Lim (2006)	Individual trading behavior in stock market	Individual traders exhibit mental accounting behavior in stock markets. They frame gains and losses separately, and are prone to executing trading decisions in order to sell more multiple losers on any given day versus selling winners.
Kumar and Lim (2008)	Individual trading behavior in stock market	Narrow framing traders exhibit the disposition effect more, and hold more undiversified portfolios in stock markets.
Baily et al. (2008)	Individual trading behavior in stock market	Investors who frame decision narrowly or prefer speculative securities poorly select mutual funds and trade excessively.
Magi (2009)	International portfolio choice	Narrow framing preferences in agents lead to home bias i.e. foreign assets seem less attractive than the one in the home country.
Liu et al. (2010)	Financial Options market	Traders in an options market show evidence of narrow framing by framing complicated investment decisions into simpler ones. Also, traders' professionalism, sophistication, and trading experience help to reduce investors' behavioral bias in the form of narrow framing.

Significant uncertainty persists at the option exercise time about the outcome in IT real options (Coff and Laverty, 2007). Two main sources of uncertainty surrounding exercise decision are technological changes i.e. unexpected problems in the hardware, system software, programming languages, and database technologies (Nidumolu, 1995; McGrath, 1997) and business environment changes i.e. unpredictable changes in a project's business priorities during its implementation (Nidumolu, 1995; Tiwana, Bharadwaj, and Sambamurthy, 2003). Therefore, at option exercise time, IT managers have to evaluate the situation with uncertain elements, and make a choice between exercising an option and letting it expire.

On one hand, it is argued that option analysis captures and formalizes the managers' intuition thus creates a disciplined decision making process (Amram and Kulatilaka, 1999). On the other hand, the intuitive valuation of the options is under fire due to the prevalence of various judgmental biases (Busby and Pitts, 1997; Millar and Shapira, 2004; Howell and Jäggle, 1997 etc). On top of that, irreversibility of investment in terms of development and implementation costs makes the timing of these option decisions very critical.

**Table 3: Comparison of Financial Call Options with Real Options on IT Asset**

Option Parameter	Financial Call Option	Real Option on IT Asset
Option Exercise Time (T)	Exercise date fixed when option is issued. A fixed date for European style options and flexibility in exercising before expiration for American style options	Unspecified date. Estimated based on experience with prior projects or managerial opinion (Kumar, 2002).
Strike / Exercise Price (K)	Exercise price is determined before option is issued, which does not change over the life of the option	Usually taken as the cost of IT project phase (Benaroch 2002, 2006; Kumar, 2002). It is uncertain at the time of option acquisition.
Uncertainty about full scale commitment ( $\sigma$ )	Calculated based on the price uncertainty of traded financial asset. It dissipates fully by the expiration date of option	Based on uncertainty in project cost/ benefits resulting from the IT project (Kumar 2002). Some uncertainty persists over time leading to downside risk at exercise time (Tiwana et al., 2006).
Benefits (S)	The market value of the financial asset	The benefits resulting from the IT project (Kumar, 2002) or the value of the underlying IT asset (Benaroch, 2002). This may be uncertain and could in turn be another option to invest in the next phase of the project.

### ***IT Application Portfolios***

Application portfolios constitute various applications that have a potential to add value to the firm. These applications typically compete for limited organizational resources (Ward, 1990). Various methods have been proposed for evaluating each project in such portfolios (Ward, 1990; Weil and Vitale, 1999). Each investment is profiled based on its risk and value characteristics over a period of time (Weil and Vitale, 1999). Investment decisions are then made based on these profiles of individual projects within the portfolio. This portfolio approach further translates into the overall value added by such investment to the firm's performance (Ward, 1990).

The overall objective of application portfolio management is to maximize the value of the portfolio by balancing the combined risk and value of projects. There can be several sources of risks within IT application portfolio, including, project size, experience with technology, project structure (McFarlan, 1981) and technical quality (Weil and Vitale, 1999) among others. These factors determine how volatile the benefits are from the investments. The value of the application is determined by the system's importance to a specific business unit, perceived management value of the system and the level of use of the system (Weil and Vitale, 1999). Based on that, the applications can have fourfold pattern of risk and value i.e. high risk-high value, high risk-low value, low risk-high value and low risk-low value.

There can be several embedded real options that add flexibility to these applications. They can have an embedded growth option where it may necessitate several platforms or enable implementation of value applications (Taudes et al., 2000). Examples include: (i) investments by firms in C-language-based projects, client-server applications, and graphical user interfaces providing them the knowledge to later exploit object-oriented programming innovations (Fichman and Kemerer, 1997), and (ii) investments in web-based technologies by utility firms provide them the software platform to exploit various e-services tailored to their customers (Bardhan et al., 2004). An application can also have embedded options to abandon where the application can be halted permanently before its completion, depending on the circumstances in the organization (Weil and Vitale, 1999). On the one hand, an option to abandon can be associated with a switch use option in IS literature (Benaroch, 2002). Such abandonment options become more valuable if the resources from the abandoned project can be put to another use. The value is generated by minimizing losses on overall investment through reducing resource waste. On the other hand, option to abandon and option to switch-use can be treated separately, where the value from the option to abandon is generated by the flexibility to curtail losses instead of minimizing losses across multiple investments. Although, in both cases, the option to abandon is valuable, empirical evidence shows several reasons for the abandonment option to be least

valuable for managers, even when it is appropriate to exercise the option (Busby and Pitts, 1997; Tiwana et al., 2006; Miller and Shapira, 2004). These reasons include political implications of cancellation the project, personal reputation of managers, negative impact on staff morale etc. (Keil, Mann and Rai, 2000).

In IT application portfolios, the key challenge is to allocate resources based on the risk-value profile of the portfolio. This, in turn, makes the investment decision dependent on the perception of real options embedded in projects and their exercise decisions. Sub-optimal decisions can impact the portfolio health in the form of sunk costs with early investments, lost opportunities and too much investment for too little value. In the absence of methods in place for portfolio evaluation, making optimal option exercise decisions is quite a challenge.

## ***Hypotheses***

Literature studying the fit between managerial intuitive valuation of real options and real options analysis confirms that managerial intuition does not always conform to real options analysis (e.g. Howell and Jäggle, 1997; Tiwana et al., 2007; Lankton and Luft, 2008). One interesting finding of this literature is the general managerial perception of these real options. With the use of prospect theory, Millar and Shapira (2004) showed that call options are framed as gains and put options are framed as losses, where option buyer and seller show risk-averse behavior for call options and risk seeking behavior for put options at option purchase. These effects are captured in the price and exercise price of real options. Tiwana et al., (2006) used the same reasoning to show that in an IT investment context, managers' value real growth options more than operational options because real growth options share the same structure as call options whereas the rest of the operational real options are like put options. Therefore, they perceive growth option being adding more value to the firm than operational options.

In this study, with the use of "narrow framing", we try to see if managerial intuition of IT managers falls prey to narrow framing, specifically at option exercise time, due to the growth options being framed as gains and abandonment options being framed as losses. As the theory implies, narrow framers make managerial decisions through selective simplification and engage in sub optimal decision making under risky situations (Tversky and Kahneman, 1981; Kahneman and Lovallo, 1993). The simplification process is executed by isolating each decision, formulating frames around each decision with a mutually exclusive reference point and then becoming conveniently adapted to it (Tversky and Kahneman, 1981). Especially in the investment portfolio setting, investors tend to isolate their decisions while ignoring the vital decision criteria such as correlation among portfolio components (Barberis, Huang and Santos, 2006) and connection between current choice and future opportunities (Kahneman and Lovallo, 1993).

We build our hypotheses around two real options i.e. real growth option and real option to abandon. As described earlier, the intuition is that IT managers' tendency to frame real growth options as gains and real operational options as losses (Miller and Shapira, 2004) may lead them to narrow framing. In case of IT real options, several operational options exist against one real growth option i.e. option to switch, stage, abandon, scale and defer. IT literature points that IT real option to abandon is least valued by the managers (Tiwana et al., 2006; Busby and Pitts, 1997), due to difficulty in exercising the option. A few contributors towards the difficulty in exercising the option to abandon include disruption in ongoing project operations, negative impact on team's morale and credibility, and the ability of the option to abandon to give no accomplishment as compared to other real options except curtailing losses (Tiwana et al., 2006).

Our motivation to capture narrow framing effects requires including options perceived as pure gains i.e. growth options and pure losses i.e. option to abandon. This makes the use of other real options such as switch option difficult in this study. MIS literature shows that switch options are more prevalent in IT applications than abandonment options, due to low costs involved in modifying the application from original plan and repurposing them (Tiwana et al., 2006). In this case, the application doesn't need to be discontinued entirely. Therefore, as mentioned before, abandonment options' concept is used interchangeably with switch-use options' concept (Benaroch, 2002). Based on that, we would like to clarify at this point that option to abandon involving pure losses only are considered in this study, and not the ones with underlying option to switch defined in IT literature.

In an IT application portfolio with multiple real options, where each option in the portfolio has a high risk and high return profile, managers will tend to perceive growth option associated with one project as gain and other as loss i.e. option to abandon. Therefore managers are likely to exhibit risk-averse behavior for growth option and risk seeking behavior for option to abandon. In theory, as a response to risk-averse behavior, given a choice, they would be likely to go for less but sure gains associated with growth option. As a risk seeker in losses, given a choice, they would

prefer to go with probable but higher losses than accepting the sure but fewer losses. Also, while doing that, they would isolate each real option exercise decision by ignoring the overall impact of their decision on the portfolio. Therefore, we hypothesize that:

*H1 a: Under high uncertainty, the tendency of IT managers to intuitively frame real growth options as gains and real options to abandon as losses will provoke risk averse behavior for growth options and risk seeking behavior for options to abandon therefore leading to narrow framing at option exercise time in an IT application portfolio setting.*

Narrow framing has costs associated with it. In case of IT real options, the isolation cost would be the suboptimal portfolio performance based on the option exercise decision. In other words, IT managers' risk-averse behavior for gains and risk seeking behavior for losses would lead them to ignore the overall impact of their exercise decision on portfolio. But, when the presentation of the same decisions is changed from the binary choice for each option in a portfolio to a single choice among potential portfolio outcomes, they would select the choice where portfolio value is optimal. This prediction is in alignment with Tversky and Kahneman (1981) finding where once the prospects are combined and dominance of the prospects are obvious, decision makers recognize the dominant prospect and select that. Therefore, we expect that:

*H1 b: Combining the option exercise decisions will reduce the narrow framing effects on real options exercise decisions in an IT project portfolio setting.*

Under uncertainty, the risk attitudes are not only confined to risk aversion to gains and risk seeking in losses (Tversky and Kahneman, 1992). The probability of outcome along with its magnitude plays a vital role in predicting the risk attitude. For moderate to high probability gains and losses with extreme outcomes, risk seeking is dominant for gain and risk-averse behavior rules the losses. The preferences reverse if the probabilities involved are low (Tversky and Kahneman, 1992) i.e. low risk involved in the outcome associated with the option. This leads to risk seeking behavior in gains and risk-averse behavior in losses. This implies, that growth as well as abandonment options would be valued more under low uncertainty where their potential of being exercised is more than in case of high uncertainty situation. Therefore we hypothesize:

*H2: Under low uncertainty, the IT managers will show risk seeking behavior for growth option and risk-averse behavior for option to abandon in an IT application portfolio setting.*

## Research Design and Methodology

The next step in this study is to test the hypotheses. The analyses will be performed at individual level with IT managers as subjects. By conducting a survey based online experiment using a stated choice model called as experimental choice analysis (ECA) (Louviere et al., 2000), we will be able to see if they are prone to simplify complicated real option exercise decisions by taking them into account in isolation. ECA integrates and applies theory and methods from conjoint analysis, probabilistic discrete choice theory and the design of discrete multivariate statistical experiments (Batsell and Louviere, 1991). Our motivation to use ECA is similar to previous IS studies using traditional conjoint analysis including controlling for social desirability bias via hypothetical decision scenarios, decomposing respondents' utilities for multi-attribute decision making (Tiwana et al., 2006), and suitability of the method for theory testing (Graham and Cable, 2001). Our intention is to capture the risk behavior of the respondents in a portfolio setting. This is only reflected in the choice of the respondent, therefore we use ECA instead of rating based conjoint analysis. In ECA, choice probabilities can be predicted directly (Moore, 2004), which will reflect the underlying risk behavior of the respondents under particular option exercise scenario.

The sample targeted for this research is the MIS directors and MIS executives in US firms selected randomly. We selected this sample because MIS directors and MIS executives are middle level management who are usually empowered to take resource decisions regarding the IT projects. Also, this sample description has been used in the IS literature before (Tiwana et al., 2006; 2007, Keil et al, 2007).

## Experiment Design and Measures

To test the effects of narrow framing in the portfolio setting, we have developed two different project profiles each consisting of two independent projects. The first portfolio contains high risk and high return projects, each with an embedded growth and an abandonment option. Each option has two outcomes: a risky outcome with some



uncertainty around it and a riskless one, with no uncertainty around outcome. The intention is to capture the narrow framing effects within a risky portfolio (H1a), based on the managerial perception of growth options as gains and abandonment options as losses (Miller and Shapira, 2004; Tiwana et al., 2006). The second portfolio is similar to the first one, except the projects are low risk low return. Only the uncertainty around the outcomes is different i.e. unlike first portfolio profile growth option payoffs are less uncertain and option to abandon's certain payoffs are more probable. This portfolio profile will help us in testing H2. To capture the narrow framing effects, we provide the respondent with a follow up question, following Tversky and Kahneman (1981), where two choices from both real options in the portfolios is combined to make the portfolio effect obvious. The first choice is the theoretically most probable choice and the second choice is the optimal choice. The narrow framing effects will be determined (H1b) if preference reversal is found among choices made in first portfolio and follow up question. A sample survey is shown in Appendix. We plan to conduct a pilot study before testing the hypotheses in a full scale experiment.

The testing of framing effects requires the experiments to be built around a reference point, to which decision maker become conveniently adapted, leading them to start relying on narrow frames relative to that reference point (Kahneman and Tversky, 1982; Kahneman, 2003). Following the MIS literature, the outcomes described in all the choices are net NPV values in each project (Fitchman et al., 2005; Keil et al., 2007). This acts as a reference point in our experiment. The reference point also serves as a boundary that distinguishes gains from losses (Tversky and Kahneman, 1992). Based on the reference point, the growth options in both portfolio profiles are presented as a prospect with possibility of minimum zero NPV and the abandonment options are presented as a prospect with possibility of maximum zero NPV.

### **Independent Variables**

The first Independent Variable (IV) is the *option type* (growth option and abandonment option). In growth option, the decision maker has a choice to further invest in an application that can add to the future IT capabilities of the firm or do not invest and let it work like that. In an option to abandon, the decision maker has a choice to abandon the application while it's still working, but has almost lost its value for the firm, or keep investing in it by not exercising the option to abandon and see if the value reduction is temporary. The second IV is the *uncertainty and payoffs* with each option type. The growth and abandonment options are varied in terms of uncertainty between the two portfolio profiles. In the first portfolio profile, both options are positioned as high risk, where probable gains are much higher for growth option as compared to certain gains, but with less probability. For option to abandon, the probability of the application to become valuable again for the firm is very less, with much higher chance of it not happening. We chose the probabilities on 25% - 75% based on the original experiments on narrow framing (Tversky and Kahneman, 1981). Further, cumulative prospect theory shows the threshold for risk behavior change is approximately 50%, where risk seeking behavior in gains and risk-averse behavior in losses are observed for outcomes with probability less than 50% and the reverse was observed for outcomes with probability more than 50% (Tversky and Kahneman, 1992). Based on the theory, we reversed the probabilities in second portfolio scenario making it look like a low risk. The payoffs are kept in figures comparable to an average IT application investment (Aberdeen Group, 2006) to simulate realistic IT investment decision scenarios.

### **Dependent Variables**

Our Dependent Variable (DV) is the *option exercise decision*. Decision making under risk can be and has been viewed as choice between prospects or gambles (Kahneman and Tversky, 1979). The closest approximation of capturing such a decision in an experiment is to treat it like a gamble (Kahneman and Lovallo, 1993). In our experiment, we present the real option exercise decision in each profile as a gamble. Real option exercise decisions are made in the face of uncertainty where future payoffs depend on the exercise decision and unveil over the period of time. Given uncertainty and dependency of payoffs on the decision are two major components of a gamble, we think it is the simplest way to represent a real option exercise decision in an artificially created scenario.

### **Control Variables**

We also include several control variables in our experiment, based on the MIS and Narrow Framing literature. They include, age, gender, work experience, experience with IT investments, decisions involving real options and IT portfolios, industry, and their personal risk preferences.

## Conclusion

Through this study, we are trying to capture one of the biases that can affect the real options value at exercise time in an IT application portfolio setting i.e. narrow framing. Additionally we want to see the impact of uncertainty around outcomes on real option exercise time. By conducting a survey based online experiment with IT managers as subjects, while simulating the real options' scenarios that occur in IT investments often, we will be able to see if they are prone to simplify complicated real option exercise decisions by taking them into account in isolation. Also, growth options and options to abandon are discussed the most in IT literature.

Our study contributes to the literature in several ways. First, it moves from the real option valuation problem into the real options exercise decision problem. IT real options exercise decisions are tricky due to prevalent uncertainty about commitment to the option, and managers are expected to take into account all the possible outcomes and future opportunities before making a decision. In case managers are involved in narrow framing, their bias of separating interconnected decisions may lead to isolation cost of sub optimal option exercise decision. Secondly, with this research, we are contributing to the literature of IT project portfolio. Most organizations today are adopting the idea for managing their IT investments in a portfolio form, especially for their applications. By knowing the potential pitfalls, IT managers can better equip themselves to avoid them. Third, we try to extend literature on behavioral decision making by studying the effects of narrow framing in a real options setting. Narrow framing has been studied extensively in the fields of psychology, consumer behavior, investment behavior and financial markets. Yet it has not been seen whether the phenomenon exists in real options setting, in an IT context.

## Appendix: Sample Survey Instrument

**Instructions:** You will be evaluating two project portfolios. Each project portfolio consists of two IT application projects. You need to make a decision about the future course of each project in the portfolio. You will be presented with two project scenarios for each portfolio in a table form. As a decision maker involved in IT application portfolio assessment, in both portfolios, please evaluate the project scenarios inclusively by indicating the options you prefer that appear with the scenarios. Assume that you were personally responsible for having approved or initiated all the projects. *Please select only 1 decision per scenario, by coloring into the circles.*

### About the projects:

- All the projects have spent 50% of their allocated budget and are only 50% complete.
- Considerable uncertainty exists for each project, and the estimated net present value (NPV i.e. discounted future cash flows of the project) for the project depends on your decision. Please note that none of the option exercise decisions can be deferred.

### IT Project Portfolio 1 of 2

<b>Project 1:</b> This project has option to <b>Grow</b> (The IT application involving new technology that can enhance the future IT capabilities). What would you choose to do?	
<u>Exercise the option</u> 25% chance of NPV to be \$ 1,500,000 <input type="radio"/> 75% chance of NPV to be \$ 0	<u>Do not exercise the option</u> 100% chance of NPV to be \$ 300,000 <input type="radio"/>
<b>Project 2:</b> This project has option to <b>Abandon</b> (The application has almost lost value and can be abandoned). What would you choose to do?	
<u>Exercise the option</u> 100% chance of NPV to be \$ -300,000 <input type="radio"/>	<u>Do not Exercise the option</u> 25% chance of NPV to be \$ 0 <input type="radio"/> 75% chance of NPV to be \$ -500,000

**Note:** Only one sample project portfolio is presented due to page limitation. This sample project portfolio will be used to test H1a. Sample portfolios for H2 and H1b are created in a similar pattern, but with different uncertainty and payoffs as discussed.

## References

- Aberdeen Group. 2006. "The Total Cost of ERP Ownership," *Aberdeen Group Enterprise Strategies*, <http://www.oracle.com/corporate/analyst/reports/corporate/cp/es101306.pdf>
- Amram, M., and Kulatilaka, N. 2008. "Disciplined Decisions: Aligning Strategy with the Financial Markets," *Harvard Business Review*, Vol. 77, January-February, 1999, pp. 95-104. Baily, W., Kumar, A., and Ng, D. Behavioral biases and mutual fund clientele (working paper), Cornell University.
- Barberis, N., and Huang, M. 2008. "Preferences with frames: A new utility specification that allows for the framing of risk" (working paper), University of Chicago.
- Barberis, N., and Huang, M. 2001. "Mental accounting, loss aversion and individual stock returns," *Journal of Finance* (56), pp.1247-1292.
- Barberis, N., Huang, M. and Thaler, R. 2006. "Individual Preferences, Monetary Gambles, and Stock Market Participation: A Case for Narrow Framing," *The American Economic Review*, pp. 1069-1090.
- Bardhan, I., Bagchi, S., and Sougstad, R. 2004. "Prioritizing a portfolio of information technology investment portfolios," *Journal of Management Information Systems*, (21:2), pp. 33-60.
- Benaroch, M. 2002. "Managing Investments in Information Technology Based on Real Options Theory," *Journal of MIS*, (19:2), pp. 43-84.
- Benaroch, M., and Kauffman, R. J. 1999. "A case for using real options pricing analysis to evaluate information technology project investments," *Information Systems Research*, 1999, pp.70-86.
- Bowman, E., and Moskowitz, G. "Real options analysis and strategic decision making," *Organizational Science*, (12:6), 2001, pp. 772-777.
- Bukszar, E., and Connolly, T. 1988. "Hindsight bias and strategic choice: Some problems in learning from experience," *Academy of Management Journal* (31), pp.628-641.
- Busby, J., and Pitts, C. 1997. "Real options in practice: An exploratory survey of how finance officers deal with flexibility in capital appraisal," *Management Accounting Research*, (8:2), pp. 169-187.
- Coff, R., and Laverty, K. 2007. "Real Options meet Organizational Theory: Coping with Path Dependencies, Agency Costs and Organizational Form," Eds. Reuer, Jeffrey and Tong, Tony. *Real Options Theory*, United Kingdom: JAI Press.
- Dos Santos, B. L. 1991. "Justifying Investment in New Information Technologies," *Journal of Management Information Systems* (7: 4), pp. 71- 89.
- Etzioni, A. 1989. "Humble decision making," *Harvard Business Review* (70:4), pp.122-126.
- Fitchman, R. G., Keil, M., and Tiwana, A. 2005. "Beyond Valuation: Options Thinking in IT Project Management," *California Management Review*, (47), pp. 74-96.
- Fichman, R. G., and Kemerer, C. 1997. "The assimilation of software process innovations: An organizational learning perspective," *Management Science*, (43:10), pp.1345-1363.
- Frazzini, A. 2006. "The disposition effect and under reaction to news," *Journal of Finance* (61), pp. 2017-2046.
- Graham, M., and Cable, D. M. 2001. "Consideration of the incomplete block design for policy capturing research," *Organizational Research Methods* (4:1), pp. 25-45.
- Hogarth, R. M. 1987. *Judgment and choice: The psychology of decision*, 2nd Ed. Oxford, England, John Wiley and Sons.
- Howell, S.D., and Jägle, A.J. 1997. "Laboratory evidence on how managers intuitively value real growth options," *Journal of Business Finance and Accounting* (24: 7), pp.915-935.

- Kahneman, D. 2003. "Maps of Bounded Rationality: Psychology for Behavioral Economics," *The American Economic Review* (93:5), pp. 1449-1475.
- Kahneman, D., and Lovallo, D. 1993. "Timid choices and bold forecasts: A cognitive perspective on risk taking," *Management Science* (39), pp.17-31.
- Kahneman, D., and Tversky, A. 1984. "Choices, values, and frames," *American Psychologist* (39), pp. 341-350.
- Keil, M., Depledge, G. and Rai, A. 2007. "Escalation: The Role of Problem Recognition and Cognitive Bias," *Decision Sciences* (28: 3), pp. 391-421.
- Keil, M., and Flatto, J. 1999. "Information systems project escalation: A reinterpretation," *Accounting, Management and Information* (9:2), pp. 115-139.
- Keil, M., Mann, J., and Rai, A. 2000. "Why software projects escalate: An empirical analysis and test of four theoretical models," *MIS Quarterly* (24:4), pp. 631- 664.
- Kogut, B., and Kulatilaka, N. 2001. "Capabilities as real options," *Organization Science* (12), pp. 744-758.
- Kumar, A., and Lim, S. 2008. "How do decision frames influence the stock investment choices of individual investors?," *Management Science* (54), pp.1052-1064.
- Kumar, R. L. 2002. "Managing Risks in IT Projects: An Options Perspective," *Information and Management*, (40), pp. 63-74.
- Kumar, R. L. 1996. "A Note on Project Risk and Option Values of Investments in Information Technologies," *Journal of Management Information Systems* (13:1), pp. 187-193.
- Lankton, N. and Luft, J. 2008. "Uncertainty and Industry Structure Effects on Managerial Intuition About Information Technology Real Options," *Journal of Management Information Systems* (25:2), pp. 203-240.
- Lim, S. S. 2006. "Do investors integrate losses and segregate gains? Mental accounting and investor trading decisions," *Journal of Business*, (79), pp. 2539-2573.
- Liu, Y., Wang, M., and Zhao, L. 2010. "Narrow Framing: Professions, Sophistication, and Experience," *Journal of Futures Markets* (30:3), pp. 203-229.
- Louviere, J., Hensher, D., and Swait, J. 2000. *Stated choice methods: Analysis and applications*. Cambridge, UK: Cambridge University Press.
- Magi, A. 2009. "Portfolio choice, behavioral preferences and equity home bias," *Quarterly Review of Economics and Finance*, Forthcoming.
- Margaret A., Neale, M. A., Huber, V.L. and Northcraft, G.B. 1987. "The framing of negotiations: Contextual versus task frames," *Organizational Behavior and Human Decision Processes* (39:2), pp. 228-241
- McFarlan, F. W. 1981. "Portfolio Approach to Information Systems," *Harvard Business Review* (59:5), pp. 142-150.
- McGrath, R. 1997. "A real options logic for initiating technology positioning investments," *Academy of Management Review* (22), pp.974-996.
- McGrath, R. G. and MacMillan, I. C. 2000. "Assessing Technology Projects Using Real Options Reasoning," *Research-Technology Management* (43:4), pp. 35-49.
- Miller, K. D., and Shapira, Z. 2004. "An empirical test of heuristics and biases affecting real option valuation," *Strategic Management Journal* (25:3), pp.269-284.
- Moore, W. L. 2004. "A cross-validity comparison of rating-based and choice-based conjoint analysis models," *International Journal of Research in Marketing*, (21), pp. 299-312.
- Nidumolu, S. 1995. "The effect of coordination and uncertainty on software project performance: Residual performance risk as an intervening variable," *Information Systems Research*, (6:3), pp. 191-219.
- Taudes, A. 1998. "Software growth options," *Journal of Management Information Systems*, (15:1), pp.165-185.

- Taudes, A., Feuerstein, M., and Mild, A. 2000. "Options analysis of software platform decisions," *MIS Quarterly*, (24:2), pp. 227–243.
- Thaler, R. 1985. "Mental accounting and consumer choice," *Marketing Science* (4), pp. 199–214.
- Tiwana, A., Bharadwaj, A., and Sambamurthy, V. 2003. "The antecedents of information systems development capability in firms: A knowledge integration perspective," *Proceedings of International Conference on Information Systems*, Seattle, WA, pp. 246–258.
- Tiwana, A., Keil, M., and Fichman, R.G. 2006. "Information systems project continuation in escalation situations: A real options model," *Decision Sciences* (37:3), pp. 357–391.
- Tiwana, A., Wang, J., Keil, M., and Ahluwalia, P. 2007. "The bounded rationality bias in managerial valuation of real options: Theory and evidence from IT projects," *Decision Sciences*, (38:1), pp. 157–181.
- Tversky, A., and Kahneman, D. 1992. "Advances in prospect theory: Cumulative representation of uncertainty," *Journal of Risk and Uncertainty* (5:4), pp. 297-323.
- Tversky, A., and Kahneman, D. 1981. "The Framing of Decisions and the Psychology of Choice," *Science* (211: 4481), pp. 453-458.
- Ward, J. M. 1990. "A Portfolio Approach to evaluating information systems investments and setting priorities," *Journal of Information Technology* (5), pp. 222-231.
- Weil, P., and Vitale, M. 1999. "Assessing the Health of an Information Systems Applications Portfolio: An Example from Process Manufacturing," *MIS Quarterly* (23: 4), pp. 601-624.