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International Research Workshop on IT Project Management (IRWITPM)

12-14-2013

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Sarah S. Khan
National University of Sciences & Technology, Pakistan, sarah.khan@seecs.edu.pk

Ram L. Kumar
University of North Carolina, rlkumar@uncc.edu

Kexin Zhao
University of North Carolina, kzhao2@uncc.edu

Antonis Stylianou
University of North Carolina, astylian@uncc.edu

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Sarah S. Khan
National University of Sciences & Technology, Pakistan
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Ram L. Kumar
University of North Carolina
Charlotte, USA
rlkumar@uncc.edu

Kexin Zhao
University of North Carolina
Charlotte, USA
kzhao2@uncc.edu

Antonis Stylianou
University of North Carolina
Charlotte, USA
astylian@uncc.edu

ABSTRACT

To account for managerial decision flexibility in risky IT investments, Real Option Valuation (ROV) has been advocated. ROV formalizes managers' intuition, thus creating a disciplined decision making process. However, evidence suggests that ROV is usually utilized intuitively by professionals, in the form of "Real Option Thinking", and is subject to various judgmental biases. We focus on growth options for this study. Prior research has shown that, while valuing projects with real options, managers ascribe the greatest importance to projects with growth options. Similar results hold for IT projects, where IT managers perceive a growth option as adding more value to the project. This perception of growth options might suggest their vulnerability to the IT managers' risk preferences, through Prospect Theory. By conducting a survey-based experiment among 150 IT professionals, our results indicate that gender and experience impact biases in growth option exercise decisions significantly, depending on project size. However, we also observe some exceptions.

Keywords

Project management, real options, decision making/makers, gender differences, experience

INTRODUCTION

An IT project possesses a real option when it offers managerial flexibility to change the course of the project in response to endogenous or exogenous events (Benaroch and Kauffman, 1999). Such managerial flexibility in decision making allows more efficient capital investments while curtailing the unsystematic risk (Benaroch and Kauffman, 1999; Tiwana et al. 2006). In order to better account for decision-making flexibility and managerial risks, several studies (Clemons, 1991; Dos Santos, 1991; Kambil et al., 1993; Kumar, 1996; 2002) have used illustrative examples to propose using real options theory in IT investments. The IS literature primarily focuses on real options analysis for large and risky IT investments with known risks, under the assumption that some embedded real options already provide management with strategic and operational flexibility needed to manage risks (Benaroch et al., 2007).

Several types of real options may exist in an IT investment. These include the strategic growth option, the option to defer investment, the option to scale (up or down), and the option to terminate the investment. Benaroch et al., (2007) describe the types of real options identified in the IT context along with related risks. IT real options are further classified in two groups (Trigeorgis, 1993, Benaroch, 2002): growth and operational options[15]. From an options perspective, an IT investment project is seen as creating a base asset with some expected value, such as the baseline implementation of an enterprise resource planning (ERP) package (Tiwana et al., 2006). Growth options capture the possibility of building additional assets on top of the base asset if the initial project is to be completed.

[15] Some studies like Tiwana et al., (2006) view the option to defer as the growth option and not the operational option.

For example, a firm may have an opportunity to build a data warehouse to facilitate the analysis of data captured in an ERP system implemented earlier. Operational options relate to flexible actions that managers can make to reduce the potential for losses (usually) or increase the potential for gains (occasionally) on that base project. Operational options give managers the flexibility to change the features of a base project by modifying its timing, scale, or scope, while strategic growth options provide an opportunity to create one or more additional but related assets beyond the asset produced by the base project (Benaroch, 2002). It is important to note that in the case of operational options, there is only one asset under evaluation (i.e., the base system), while in the case of strategic growth options, there are multiple assets to consider (the base system, plus one or more future assets that build on the base system).

This classification of real options has been used in identification and recognition of real options (Benaroch, 2002), and valuation of IT investments with embedded real options in different scenarios (e.g. Dos Santos, 1991; Kumar, 2002; Benaroch and Kauffman, 1999; Su et al., 2009 etc.). Growth options are considered as having call option characteristics (right to buy an asset in the future), while operational options are considered as having put option characteristics (right to sell an asset in the future) (Benaroch, 2002).

Although the real options approach has been shown to be beneficial in managing the uncertainty in IT projects, this approach has been found to be utilized informally by managers in practice. Such informal use has been referred to as "Real Options Thinking" (Amram and Kulatilaka, 1999; Fichman et al., 2005).Unlike real option valuation, which is based on formal mathematical models, real options thinking refers to intuitive decision making after identifying real options embedded in an investment. Recent studies have shown that decision makers exhibit several systematic biases while utilizing this methodology (Goswami et al., 2008; Lankton and Luft, 2008; Tiwana et al., 2006; 2007). Previous research also illustrates that subjective frames impact the expected value of real options in general, as well as in the case of IT projects (Millar and Shapira, 2004; Tiwana et al., 2006).

Real options thinking and valuation are beneficial when their value is realized during the project management. However, real option value depends on the optimal timing of exercise (Dos Santos, 1991; Kumar, 1999). Real options are most beneficial when they are exercised optimally. Given the evidence that managers may be biased and hence not exercise options optimally, we examine the implications of such bias. We study option excerise decisions made by IT managers, who we view as bounded rational agents with preferences governed by Prospect Theory (Kahneman and Tversk, 1979). Prospect theory suggests that biased preferences exist independently of individual differences (Kahneman and Tversk, 1979). However, other studies suggest that individual characteristics, such as gender and experience, may guide risk taking behavior in individuals. We chose gender and experience for the following reasons. First, real option exercise decisions are considered risky decisions because of the prevailing uncertainty about the outcome at the point of the decision (Sullivan et al., 1999), and literature suggests that female decision makers tend to be more risk averse than male decision makers (Powel and Ansic, 1997). Two, literature also suggests that past experience contributes to increased familiarity in a given problem domain and can affect risk perceptions (Sitkin and Pablo, 1992).Our research intends to solve the conflicting points of view by exploring whether existence of managerial biases varies among different sub populations.

We focus on growth options for this research because they play a significant role in the economic justification of projects embedding them, by allowing decision makers to consider further investment opportunities as well as cash flows (Panayi and Trigeogis, 1998). Also, decisions involving growth options are often strategic in nature and biased decisions in the context of such options are an important research topic (Tiwana et al., 2006). In addition, prior research has shown that, while valuing projects with real options, managers ascribe greatest importance to projects with growth options (Busby and Pitts, 1997). Similar results hold for IT projects (Tiwana et al., 2006), where IT managers perceive a growth option as adding more value to the project than any other type of option. This perception of growth options as gains might suggest growth options' vulnerability to the risk preferences of IT managers once looked at through Prospect Theory. Hence we evaluate this research question by focusing on the growth option "exercise decision". Our results indicate that gender and experience do impact biases in growth option exercise decisions significantly. However, we also observe some exceptions.

The rest of the paper is structured as follows. Next, we briefly describe the relevant literature supporting our research, followed by the hypotheses. This is followed by research design, methodology, preliminary analysis and results, and conclusions.

LITERATURE REVIEW AND HYPOTHESES

Growth Options and Gender Differences

A substantial body of literature has studied gender differences in the context of risky decision making. Findings indicate that females are often more risk-averse than males (Powel and Ansic, 1997; Hudgens and Fatkin, 1985; Johnson and Powell, 1994; Sexton and Bowman-Upton, 1990; Levin et al., 1988). While there is significant evidence in favor of this, some studies also show circumstantial contradictions. One antecedent for this gender difference in risky decision making is related to the strong evidence that men, on average, are more overconfident than women (Barber and Odean, 2001; Beckmann and Menkhoff, 2008).

Lower preference for risk taking among females is one gender difference that is persistently found in the business literature as well as other studies (Powel and Ansic, 1997; Hudgens and Fatkin, 1985; Johnson and Powell, 1994; Sexton and Bowman-Upton, 1990; Levin et al., 1988). Eckel and Grossmann (2001) find significant gender differences in choices among several risky prospects, with females indicating a preference for the less risky prospect. Also women show lower risk propensity than men in their attitudes towards financial risks (Barsky et.al., 1997). Fellner and Maciejovsky (2007) find that females are more risk-averse than males, especially in binary lottery choices. Beckmann and Menkhoff (2008) show that female financial experts are more risk-averse than their male counterparts.

While studying risk propensity in financial decision making, Powell and Ansic (1997) show that females are less risk-seeking than males, irrespective of framing of decisions, familiarity with the scenario, and cost or ambiguity associated with the decision. However, Schubert et al., (1999) show that females are more risk-averse than males in gambles framed as gains. Although Schubert et.al. (1999) find gender differences in abstract gambling decisions, the differences disappeared with the introduction of an investment decision context. Kruse and Thompson (2002) also find no significant differences between men and women in low probability loss situations. Similarly, Schubert et al. (2000) find weak differences under two different formats of ambiguity but again no differences under risk.

Since growth options are like call options (Benaroch, 2002) and call options have been shown to be framed as gains (Miller and Shapira, 2004), based on the above studies we expect that females will be more risk-averse while exercising growth options. Hence, we hypothesize that:

Hypothesis 1: For growth option exercise decisions, female decision makers will take more suboptimal decisions than males.

Growth Options and Experience Differences

Experience is considered a primary way for decision makers to learn, and affects their response to similar as well as new situations (Levitt and March, 1988, Mintzberg et al., 1976). Learning occurs since decision makers tend to conceptualize a problem in terms of a most recognizable situation and try to solve it using familiar preexisting solutions (Cohen, March, & Olsen, 1972; Dearborn & Simon, 1958; Langer, 1978; March and Simon, 1958). Past experience is also shown to result in overconfidence among decision makers due to intentional ignorance of underlying risks (Lewin, 1989; Baird & Thomas, 1985; Langer, 1975; Lefcourt, 1973; Slovic et al., 1980) and illusion of control (Langer, 1975; Lefcourt, 1973). Slovic, Fischoff, and Lichtenstein (1980) argue that the prior experience of decision makers influences risk behavior by encouraging higher levels of confidence in extremely experienced individuals. However the lack of relevant experience is shown to lead the decision maker towards incorrect assumptions and diagnoses, even in the face of well-established operating procedures (Jemison & Sitkin, 1986). Decision makers with limited experience may be more likely to hold risk perceptions that are strongly influenced by available information, because either it is the only data point in that domain, it is recent, or it is obvious (Tversky & Kahneman, 1973), hence making them prone to biased decision making.

Experience has been studied to some extent in IS research (Keil et al., 2000) as well as real options studies (Liu et al., 2010). When decision makers are more experienced, they may be more willing to undertake risks than less experienced individuals (March & Shapira, 1987; Staw & Ross, 1987). Since exercising a growth option is a risky decision, we expect the experience of the IT managers to play a significant role in their decisions. Individuals tend to be risk-averse when a choice is presented as a gain (e.g., a growth option), and experience can help them overcome such tendency. Hence, we hypothesize that:

Hypothesis 2: For growth option exercise decisions, experienced managers will take less suboptimal decisions than inexperienced ones.

RESEARCH DESIGN AND METHODOLOGY

In this study, our motivation is to explore whether managers of a certain gender and work experience are able to fully extract the value of real options (Fichman et al., 2005). In Real Options theory, it is *assumed* that options are exercised optimally. Of course, a real option is most valuable when exercised optimally (Kumar, 2002). The optimal exercise of a real option is generally conceptualized as taking the exercise decision at a time period (before expiration) when the benefit from exercising the option is highest. However, we lack empirical evidence that options are indeed exercised optimally.

In order to capture gender and experience differences in growth options' exercise decisions, we conducted a survey among IT professionals by presenting the real option exercise decision for a project with a growth option as a gamble. We designed our survey based on Tversky and Kahneman's (1981) testing of the "framing of act"[16] because decision making under risk has been conceptualized as choices between prospects or gambles (Kahneman and Tversky, 1979). The closest approximation of capturing such decisions in organizations has been to treat them like a gamble (Kahneman and Lovallo, 1993). A gamble is characterized by uncertainty and the dependency of payoffs on a decision, like a real option exercise decision. The gambling design is a popular experiment design to capture risk preferences in various disciplines, including business, economics (Levin et al., 1998), real option valuation (Millar and Shapira, 2004), and dominates framing research (Kuhberger, 1998). Based on prior research, we believe that the gambling design is the simplest, yet most realistic way to represent a real option exercise decision.

The Project Profiles

The respondents were presented with two IT project profiles. For each project, information about the embedded growth option, the size of the project, and risk and return associated with real option exercise decisions were presented. The profiles only differed in terms of project size. For the growth option, the risky outcome was to exercise the option by investing further, with probable higher returns. We incorporated uncertainty by presenting the outcome with a probability. The corresponding riskless decision was set as letting the option expire, leading to a certain but lower outcome. We assumed gains for either outcome, since growth options are valued higher due to the potential for larger future benefits (Miller and Shapira, 2004; Tiwana et al., 2006). However, the future realized benefits are uncertain when exercising the option (Coff and Laverty, 2007). It can be argued that the outcome uncertainty can be reduced by deferring the investment. Our intention is to capture the investment behavior in the absence of such flexibility to delay the investment and to examine the risk behavior of IT managers under such situations. In reality, the flexibility to delay the investment is usually not utilized by firms operating in a competitive market, where growth is vital for their survival (Lankton and Luft, 2008).

Further, testing of risky decisions under Prospect Theory requires the scenarios to be built around a reference point (Kahneman and Tversky, 1982; Kahneman, 2003). For IT managers, the common criteria used to evaluate investment decisions is the project's NPV (Fitchman et al., 2005; Keil et al., 2007). Hence, we have used project NPV as a reference point. Based on the reference point, the growth options in both project profiles are presented as prospects with possibility of minimum zero NPV.

Uncertainty and Payoffs:

Consistent with reality, we modeled the real option exercise decision as a simple "exercise" vs. "do not exercise" decision. Growth option exercise decisions are usually high risk-high return decisions, where risk is contributed by the uncertainty around future outcomes. For example, exercising a growth option means investing in an ongoing project further with an aim for higher returns. In our survey, each real option decision scenario had a certain

[16] Framing of act experiment captured risky choice framing (Tversky and Kahneman, 1981, 1986; Kahneman and Tversky, 1979) with implications to Prospect Theory. The design itself is referred to as a gambling design, where respondents are asked to participate in risky decision making. The gambling design is a popular experiment design to capture risk preferences in various disciplines including business, economics (Levin et al., 1998),and real option valuation (Millar and Shapira, 2004), and dominates framing research (Kuhberger, 1998).

outcome and an uncertain outcome. For the growth option, the risky decision was the "exercise" decision, in order to capture the uncertainty associated with further investment in the project. The return from the growth option exercise decision was much higher but with a relatively low probability. Prospect Theory shows that the threshold for risk behavior change is approximately at 50%. Risk seeking behavior in gains is observed for better outcomes with probability less than 50% (Tversky and Kahneman, 1991). Therefore, we chose 25% as the probability that the better probable outcome would happen, in a manner similar to "framing of acts" experiment (Tversky and Kahneman, 1981). We kept the same uncertainty in all scenarios for simplicity and consistency.

We used payoffs data based on real ERP systems cost figures to make them realistic. ERP systems are a good example of IT projects due to their wide implementation. Also these investments are considered important due to the variety of applications that are enabled by the ERP systems. The average costs we found for ERP systems ranged from approximately $0.4 Million to $2.3 Million (Aberdeen Group Inc., 2007). We kept payoffs in all the profiles close to these figures. The details on the project sizes are given below.

Project Size:

To control for the projects' size, we chose $0.5 million for small projects and $2.0 Million for large projects. All projects were positioned as completed mid-way, where the project progress and resource investment was set at 50%. So the earned value[17] for small projects became $0.25 Million and $1.0 Million for the large projects. Earned value enabled us to create a suitable decision point in terms of planned value of the projects[18]. Respondents had to decide the future of the projects purely based on the embedded real option. Table 1 gives a breakdown of the payoffs and respective probabilities. Consistent with Prospect Theory, the net payoff difference between risky and riskless options was kept the same in small and large projects (equal to $200,000), to capture the size effects.

Small Projects	**Exercise**		**Do Not Exercise**	
	Pr.	***Payoff***	***Pr.***	***Payoff***
	25%	$1,800,000	100%	$250,000
Expected Value	$450,000		$ 250,000	
Difference	$200,000			
Large Projects	**Exercise**		**Do Not Exercise**	
	Pr.	***Payoff***	***Pr.***	***Payoff***
	25%	$4,800,000	100%	$1,000,000
Expected Value	$1,200,000		$1,000,000	
Difference	$ 200,000			

Table 5: Uncertainty and Payoffs used in the Scenarios

Gender:

The respondents were asked to disclose their gender in the survey.

Experience:

We captured the general work experience of the respondents in the survey on a scale of 1 to 5. To further refine the data, we also captured the experience related to IT investment as well as experience with real option decision making.

Control Variables:

We further controlled for the size of respondents' organization.

[17] The earned value of a project is the budgeted cost of project multiplied by its completion percentage (Anbari,2003)

[18] The planned value of the project is the value to be earned as a function of project work accomplishment up to a given point in time (Anbari, 2003)

Sample and Data

We pilot tested the decision scenarios using Dun and Bradstreet Executive's list 2010 (Tiwana et al., 2006; 2007) consisting of top and middle level management in US organizations involved in IT management. A total of 43 usable responses were generated to pre-test the decision scenarios among professionals. Based on the results, no major modifications to the survey were made. The finalized survey was sent out to IT management professionals in the US using Project Management Institute (PMI) US chapters and communities of practice. We received 150 useable responses. The sample size met the requirement based on our a-priori sample size estimation for the study given the effect size, error probability, and power for the parametric data analysis. Prior to running the analyses, all the variables were examined for accuracy of data entry, outliers, and missing values using SPSS v17. All the values for all variables were within acceptable ranges, suggesting that there were no data entry errors. Descriptive data analyses are given in Table 2. Work Experience scale included: 5=Above 20 years, 4=16-20, 3=11-15, 2= 6-10, 1=5 years or less. Firm size scale included: 4=More than $1 Billion, 3= $500 Million - $1Billion, 2=$ 1 Million - $ 500 Million, 1= Less than $1 Million.

		Minimum	Maximum	Mean	Std. Deviation
Scale of 0 and 1	Small Project	0	1	.45	.499
	Large Project	0	1	.33	.473
	Female	0	1	.66	.475
Scale of 1 to 4	Firm Size (in $s)	1	4	2.69	1.055
Scale of 1 to 5	Work Experience (in years)	2	5	4.33	1.014
	IT Investment Experience	1	5	3.42	1.276
	Real Options' Experience	1	5	3.49	1.140

Table 6: Descriptive Statistics (n=150)

RESULTS ANALYSIS

To examine the unique contribution of gender and experience on growth option decisions, logistic regression was performed using the following logit model:

$$\text{Option Exercise Decision} = \beta_0 + \beta_1(\text{Gender}) + \beta_2(\text{Work Experience}) + \beta_3(\text{IT Investment Experience}) + \beta_4(\text{Real Options Experience}) + \beta_5(\text{Firm Size}) + \varepsilon$$

Before running the data analyses, the data were coded in binary, i.e., 1 for the optimal project decision, and 0 for the suboptimal project decision. We ran a frequency analyses on project decisions to see the presence of rational and biased decisions. The test results were significant for both of the projects' choices under consideration. For the small project, we had 82 (54.7%) biased project decisions and 68 (45.3%) optimal decisions (t-value (149,150) = 11.12, $p < .001$). For large project, we had 100 (66.7%) biased project decisions and 50 (33.3%) optimal decisions (t-value (149,150) = 8.63, $p < .001$). This showed the presence of biased decisions at the real option exercise time for both projects.

We first ran the direct logistic regression analysis with small project decisions as a DV (dependent variable) with five predictors, i.e., gender, work experience, experience in IT investments, experience with real options decisions, and firm size. The test of the full model with all predictors against a constant-only model was not statistically reliable ($\chi^2(5, 150) = 1.303$, p=.254), indicating that the predictors did not reliably distinguished between optimal and biased real option choices. The variance in real option choice accounted for was not good, with Cox and Snell R^2 equal to .06 and Nagelkerke R^2 equal to .08. Predicted success was 76.8 % for the biased real option decisions and 41.2% for the optimal real option decisions, with an overall success rate of 60.0%. Table 3 shows the regression coefficients, Wald statistics, statistical significances, and odds ratios for each of the predictors and control variables for the small project. According to the Wald criteria, gender and IT Investment Experience reliably predicted the difference in growth option exercise decisions. The odds ratio indicated that for every growth option exercise time in a small project, females were 0.442 times more likely to fall prey to biased decision making (they showed risk-averse behavior). Similarly, the odds ratio for IT investment experience indicated that for every growth option exercise time in a small project, experienced people were 1.428 times less likely to fall prey to biased decision making. In other words, for every unit increase in IT investment decisions experience, people were 14.28% less likely to make biased decisions for growth option.

Variables	B	S.E.	Wald	df	Sig.	Odds Ratio
Gender	-.816	.386	4.475	1	.034**	.442
Work Experience	-.279	.180	2.412	1	.120	.756
IT Investment Experience	.356	.179	3.955	1	.047**	1.428
Real Options Experience	-.030	.195	.024	1	.877	.970
Firm Size	.109	.168	.419	1	.518	1.115
Constant	.142	.907	.025	1	.875	1.153

*** p< 0.001, ** p< 0.05, * p<0.01

Table 7: Logistic Regression results – Small Project

We further ran the direct logistic regression analysis with large project decisions as a DV with the same predictors. The test of the full model with all predictors against a constant-only model was statistically reliable, $\chi^2(5, 150)$ = 16.01, p<.001, indicating that the predictors reliably distinguished between optimal and biased real option choices. The variance in real option choice accounted for was also good, with Cox and Snell R^2 equal to .172 and Nagelkerke R^2 equal to .238. Predicted success was 87.0 % for the biased real option decisions and 48.0% for the optimal real option decisions, with an overall success rate of 74.0%. Table 4 shows the regression coefficients, Wald statistics, statistical significances, and odds ratios for each of the predictors and control variables. According to the Wald criteria, gender again reliably predicted the difference in growth option exercise decisions. The odds ratio indicated that, for every growth option exercise time in a large project, females were 0.194 times more likely to fall prey to biased decision making. Based on these results, H1 is supported irrespective of project size. However H2 is supported for only small projects.

Variables	B	S.E.	Wald	df	Sig.	Odds Ratio
Gender	-1.638	.409	16.018	1	.000***	.194
Work Experience	-.339	.193	3.087	1	.079	.712
IT Investment Experience	-.237	.187	1.599	1	.206	.789
Real Options Experience	.127	.212	.360	1	.548	1.136
Firm Size	.000	.191	.000	1	.998	1.000
Constant	2.104	1.021	4.246	1	.039**	8.200

*** p< 0.001, ** p< 0.05, * p<0.01

Table 8: Logistic Regression results – Large Project

Conclusion and Future Work

Through this study, we explore the relationship between gender and experience differences and the real growth options exercise decisions. By conducting a survey-based online experiment with IT managers as subjects, we simulated growth option scenarios that occur in IT investments. Our results indicate that gender and experience differences do impact growth option exercise decisions, and may help us predict decision makers' behavior. It turns out that, as expected, female decision makers exhibit risk-averse behavior, which may lead to suboptimal exercise decisions for growth options. This result held in our case for both small and large projects. We do intend to increase the sample size, to ensure better model fit.

Experience also played a significant role in predicting growth option exercise decisions. We found that IT investment experience was significant for small projects. We may conclude from this result that for small IT investments, specific experience relating to IT investments is required to minimize biased decision making. We need to further examine this effect by exploring the potential interaction effects. Firm size and real options experience did not play a significant role though.

Our study has several implications. First, it moves away from the real option valuation problem into the real options exercise decision problem, which is under-researched. IT real options exercise decisions are challenging due to prevalent uncertainty about commitment to the option. Also, managers are expected to make economically optimal decisions, while taking into account all possible outcomes and future opportunities. Our results provide another dimension to this expectation by illustrating that managers' personal characteristics, such as gender and experience, play a significant role in option exercise decisions. Moreover, project characteristics play a significant role as well. Greater experience might look like a logical facilitator for the risky economic decisions, however, we find contrary results. Second, we are contributing to the literature on IT project management. Organizations are considering the idea for managing their IT investments using real options. Our results indicate a need to consider gender and experienced-based decision maker differences while interpreting IT option exercise decisions. Third, we try to extend literature on IT investment behavior by studying the effects of gender and experience in a real options setting. Gender and experience differences have been studied in various areas including, but not limited to, general investment behavior, psychology, and financial markets. However, existence of these differences in the context of IT real options has not been studied.

APPENDIX – SAMPLE QUESTIONNAIRE

General Instructions

You will be evaluating four individual IT projects and three IT portfolios in order to determine their future direction.

- Each IT portfolio consists of two IT projects that may or may not be related.
- Each project (individual and in portfolios) that you will be evaluating in this survey, will have either an option to invest further in it for its future expansion (Option to Grow) or an option to kill it before it is completed (Option to Abandon).
- You will be given information regarding expected future payoffs from the project and the uncertainty around these payoffs.

Evaluation of Individual Projects

- All the projects are approximately mid-way in their life cycle i.e. they have spent 50% of their allocated budget and are only 50% complete.
- The estimated net present value (NPV) for each project depends on your decision. NPV of a project is the net future cash inflows of the project, adjusted for the time value of money.
- Based on the information given, please make a decision in terms of exercising the option (described below).

Sample question 1 (from the questionnaire)

IT Project Profile

<table>
<tr><td colspan="2">This Project has the option to Grow (Further investment in this IT project may enhance future revenues). Your choices are as follows.</td></tr>
<tr><td>Invest (Exercise the option)

25% chance of NPV being $1,800,000
75% chance of NPV being $0</td><td>Do not Invest (Do not exercise the option)

100% chance of NPV being $250,000</td></tr>
</table>

What would you choose to do for Project 1?

- ○ Invest (Exercise the option)
- ○ Do not Invest (Do not exercise the option)

REFERENCES

Aberdeen Group. 2006. The total cost of ERP Ownership, in *Aberdeen Group Enterprise Strategies: Insight and Advice for Enterprise Executive*, October 17 (2006).

Amram, M., and Kulatilaka, N. 1999. *Real Options: Managing Strategic Investment in an Uncertain World.* Boston: Harvard Business School Press.

Anbari. F. T. 2003 "Earned Value Project Management Method and Extensions," *Project Management Journal;* Dec. (34: 4), pp. 12-23.

Baird, I. S., and Thomas, H. 1985. "Toward a contingency model of strategic risk taking," *Academy of Management Review*, (10), pp. 230-243.

Barber B. and Odean, T. 2001, "Boys will be Boys: Gender, Overconfidence, and Common Stock Investment," *Quarterly Journal of Economics*, (116:1), pp 261-292.

Barsky, R., Juster, F. Kimball, M. and Shapiro, M. 1997. "Preference Parameters and Behavioral Heterogeneity: An Experimental approach in the Health and Retirement Study," *Quarterly Journal of Economics*, (112:2), pp. 537-579.

Beckmann D., and Menkhoff L. 2008. "Will women be women? Analyzing the gender difference among financial experts." *Kyklos*,)61), pp. 364–384.

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 technology project investments," *Information Systems Research, (*10:1), pp.70–86.

Benaroch, M., Jeffery, M., Kauffman, R.J. and Shah, S. 2007. "Option-Based Risk Management: A Field Study of Sequential Information Technology Investment Decisions," *Journal of MIS*, (24:2), pp.103-140.

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.

Clemons, E.K. 1991. "Evaluating Strategic Investments in Information Systems," *Communications of the ACM.(*34:1), pp.22-36.

Coff , R and Laverty K. 2007. "Real options meet organizational theory: coping with path dependencies, agency costs and organizational form," In *Real Options Theory* (REUER J and TONG T, Eds), JAI Press, United Kingdom.

Cohen, M. D., March, J. G., and Olsen, J. P. 1972. "A garbage can model of organizational choice," *Administrative Science Quarterly*, (17), pp. 1-25.

Dearborn, D. C., and. Simon, H. A. (1958) "Selective perception: A note on the departmental identification of executives," *Sociometry*, (21), pp. 140-144.

Dos Santos, B.L. 1991. "Justifying Investment in New Information Technologies," *Journal of MIS.(*7:4), pp. 71- 89.

Eckel C. and Grossman, P. 2001. "Sex Differences and Stereotyping in Attitudes towards Financial Risks," *Working Paper, Virginia Tech*, mimeo.

Fellner, G. and Maciejovsky, B. 2002. "Risk Attitude and Market Behavior: Evidence from Experimental Asset Markets," *Journal of Economic Psychology*, (28:3), pp. 338-350.

Fichman, R., Keil, M. and Tiwana, A. 2005. "Beyond valuation: real options thinking in IT project management," *California Management Review,* (47:2), pp.74– 96.

Goswami, S., Teo, H. H., and Chan, H. C. 2008. "Real Options from RFID Adoption: The Role of Institutions and managerial Mindfulness," *Proceedings Twenty ninth international Conference on Information Systems, Paris, France.*

Hudgens, G. A. and Fatkin, L.T. 1985. "Sex, Differences in risk Taking: Repeated Sessions on a computer-simulated Tasks," *The Journal of Psychology, (*119:3), pp. 197-206.

Jemison, D. B., and Sitkin, S. B. 1986. "Corporate acquisitions: A process perspective," *Academy of Management Review*, (11), pp. 145-163.

Johnson, J. E. V. and Powell, P. L. 1994. "Decision making, risk and gender: Are managers different?" *British Journal of Management,* (5), pp.123–138.

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. 1979. " Prospect Theory, An Analysis of Decision Under Risk," *Econometrica*, (47:2), pp.263-292.

Kahneman, D., and Tversky, A. 1982. "The psychology of preferences", *Scientific American*, (246:1), pp.160-173.

Kambil, A., Henderson, C.J., and Mohsenzadeh, H. 1993. "Strategic management of information technology: an options perspective," in: R.D. Banker, R.J. Kauffman, M.A. Mahmood (Eds.), *Strategic Information Technology Management: Perspectives on Organizational Growth and Competitive Advantage*, Idea Group Publishing, Middletown, PA, pp. 161–178.

Keil, M., Depledge, G. and Rai, A. 2007. "Esclation: The Role of Problem Recognition and Cognitive Bias," *Decision Sciences* (28: 3), pp. 391-421.

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.

Kruse, J. B. and Thompson, M. A. 2003. "Valuing Low Probability Risk: survey and experimental evidence," *Journal of Economic Behavior and Organization*, (50:4), pp. 495-505..

Kumar, R. L. 1999. "Understanding DSS Value: An Options Perspective," *Omega, (*27:30), pp. 295-304.

Kumar, R., L. 1996. "A note on project risk and option values of investments in information technologies," *Journal of MIS,(*13:1), pp.187-193.

Kumar, R., L. 2002. "Managing risks in IT projects: an options perspective," *Information and Management, (*40), pp.63-74.

Langer, E. J. 1975. "The illusion of control," *Journal of Personality and Social Psychology*, (32), pp. 311-328.

Langer, E. J. 1978. "Rethinking the role of thought in social interaction," In J. Harvey, W. Ickes, and R. F. Kidd (Eds.), New directions in attribution research, (2(, pp. 35-58. Hillsdale, NJ: Erlbaum.

Lankton, N.and Luft, J. 2008. "Uncertainty and Industry Structure Effects on Managerial Intuition About Information Technology Real Options", *Journal of MIS*, (25:2), pp.203–240.

Lefcourt, H. M. 1973. "The function of the illusion of control and freedom," *American Psychologist*, (28), pp. 417-425.

Levin, I. P., Snyder, M. A. and Chapman, D.P. 1988. "The Interaction of Experimental and Situational Factors and Gender in a Simulated risky Decision-making Task," *The Journal of Psychology,* (122:2), pp. 173-181.

Levin, I.P., Schneider, S.L., Gaeth, G.J. 1998. "All frames are not created equal: A typology and critical analysis of framing effects," *Organizational Behavior and Human Decision Processes*, (76), pp.149–188.

Levitt, B., and March, J. G. 1988. "Organizational learning," *Annual Review of Sociology*, (14), pp. 319-340.

Lewin, A. Y. 1989. "Organization design and auditing: An agenda for research," *Paper presented at the Audit Judgment Symposium, Newport Beach, CA*, February 20-21.

Liu, Y., Wang, M., and Zhao, L. 2010 "Narrow Framing: Professions, Sophistication, and Experience," *Journal of Futures Markets* (30:3), pp. 203–229.

March, J. G., and Shapira, Z. 1987. "Managerial perspectives on risk and risk taking," *Management Science*, (33), pp. 1404-1418.

March, J. G., and Simon, H. A. 1958. *Organizations*. New York: Wiley.

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.

Mintzberg, H., Raisinghani, D., and Theoret, A. 1976. "The structure o f unstructured decision processes," *Administrative Science Quarterly*, (25), pp.246-275.

Panayi, S., and Trigeorgis, L. 1998. "Multi-stage Real Options: The Cases of IT Infrastructure and International Bank Expansion," The *Quarterly Review of Economics and Finance* (38), pp.675-692.

Powell, M. and Ansic , D. 1997. "Gender Differences in Risk Behavior in Financial Decision-Making: An Experimental Analysis," *Journal of Economic Psychology*, (18:6),pp. 605-28.

Schubert, R., M. Gysler, B.M. and Brachinger, H. W. 1999. "Financial Decision-Making: Are Women Really More Risk-Averse?," *American Economic Review (Papers and Proceedings) (*89:2), pp.381-385.

Sexton, D., and Bowman-Upton, N. 1990. "Female and Male Entrepreneurs: Psychology characteristics and their role in gender related discrimination," *Journal of Business Venturing*, (5:1), pp. 29-36.

Sim B. Sitkin and Pablo, A. L. 1992. "Reconceptualizing the Determinants of Risk Behavior," *The Academy of Management Review*, (17:1) pp. 9-38.

Slovic, P., Fischhoff, B., and Lichtenstein, S. 1980. "Facts versus fears: Understanding perceived risk," In D. Kahneman, P. Slovic, & A. Tversky (Eds.), Judgment under uncertainty: Heu-ristics and biase, pp. 463-489. Cambridge: Cambridge University Press.

Staw, B. M., and Ross, J. 1987. "Behavior in escalation situations: Antecedents, prototypes, and solutions," In B. M. Staw & L. L. Cummings (Eds.), Research in organizational behavior, (9), pp. 39-78. Greenwich, CT: JAI Press.

Su, N., Akkiraju, R., Nayak, N. and Goodwin, R. 2009, "Shared Services Transformation: Conceptualization and Valuation from the Perspective of Real Options," *Decision Sciences*, (40:3), pp. 381-402.

Sullivan, K., Chalasani, P., Jha, S., and Sazawal, V. (1999) "Software design as an investment activity: A real options perspective" , In L. Trigeorgis (Ed.), *Real options and business strategy: Applications to decision making*. London: Risk Books.

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.

Trigeorgis, L. 1993. "The nature of option interactions and the valuation of investments with multiple real options," *Journal of Financial and Quantitative Analysis*, (28:1), pp.1–20.

Tversky, A. and Kahneman, D. 1986. "Rational choice and the framing of decisions," *The Journal of Business (*59:4), pp. 251-278.

Tversky, A. and Kahneman, D. 1991 "Loss aversion in riskless choice: a reference dependent model," Q*uarterly Journal of Economics (*106), pp. 1039–1061.

Tversky, A., and Kahneman, D. 1981. "The Framing of Decisions and the Psychology of Choice," *Science* (211: 4481), pp. 453-458.

Tversky, A., and Kahneman, D. (1981) "The Framing of Decisions and the Psychology of Choice," *Science* (211: 4481), pp. 453-458.