RISK ATTITUDE OF CHINESE CONTRACTORS IN BID/NO BID DECISION-MAKING OF INTERNATIONAL PROJECTS: A PRELIMINARY STUDY

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Decision-makers' attitude towards risk plays a critical role in the bid/no bid decision of international projects. As a descriptive model of decision making under uncertainty and risk, cumulative prospect theory (CPT) proposed a distinctive fourfold pattern of risk attitude. According to the CPT, the fundamental goal of this research is to explore the risk attitude of Chinese contractors in bid/no bid decision process of international projects. The research is also devoted to answer the question whether the risk attitude of Chinese decision-makers in international construction firms is consistent with the conclusions in CPT. An experiment based on Tversky and Kahneman's CPT research in 1992 was conducted. With limited source of Chinese contractors subjects, this research conducted a preliminary study on 48 post-graduates majoring in construction management in Tianjin University. Thirty five valid data were eventually obtained. Multivariate statistical analysis indicated that: 1) the risk attitude of Chinese contractors in bid/no bid decision-making of international projects accords with the fourfold pattern, the same in CPT; 2) all the parameters are less than 1, in accord with diminishing sensitivity in CPT; 3) when bidding international projects, the tendency of Chinese contractors to take high-risk projects for losses with moderate and high probabilities is higher than that to avoid risk for gains. The results show that the application of CPT should take different cultures and situations into consideration and this research also benefits contractors to make reasonable and proper bid/no bid strategies.

Keywords: bidding, contractor, cumulative prospect theory, international project, risk attitude.

INTRODUCTION

Globalization of international project market has provided tremendous opportunities for Chinese contractors to expand into the contracting markets. Chinese international project contracting has been increasing at a high speed in recent years, but that serious decision problems appeared in several international projects reveals the existing

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limitations of the decision-making of contracting enterprises. Appropriate bidding decision not only plays a critical role in the success of construction projects, but also has a direct bearing on the profit and development of enterprises. Generally bidding decision includes two major and interrelated decisions, bid/no bid decision and what bid price to use (Lin and Chen, 2004; Cheng et al., 2011). This research focuses on the bid/no bid decision-making, which is associated with uncertainty and complexity because of subjective considerations. Any decision involving risk and people's attitude toward risk differs (Hillson and Murray-Webster, 2007). Risk attitude of decision-maker will produce direct impact on one's choice (Harbaugh and Krause, 2010), so with the bid/no bid decision.

One of the major approaches to study risk attitude is derived from the traditional utility theory (Au and Chan, 2005). According to expected utility (EU) theory, risk attitude can be divided into three types, namely risk aversion, risk neutral and risk preference (Flanagan and Norman, 1993). Recognizing the limitations of the utility theory, Tversky and Kahneman (1979, 1992) proposed prospect theory and then cumulative prospect theory (CPT). Cattell et al (2011), considering that CPT serves to equate different return-risk alternatives to find one set of item prices which will provide the optimal outcome, introduced and applied CPT in the study of unbalanced bidding model. Therefore, CPT, as the descriptive model of decision making under uncertainty, is introduced in this research to investigate into the risk attitude of Chinese contractors when selecting international projects.

Han et al. (2005) put forward in his study that construction firms apt to display severe risk aversion which may bias consistent bid decisions in threat or opportunity situations. Meanwhile, cultural differences are considered to be one of the driving forces of different risk attitude. Weber and Hsee (1998) suggested that Chinese respondents were significantly less risk-averse in their pricing than Americans, which were associated primarily with cultural differences in the perception of the risk of the financial options. Therefore, the fundamental goal is to explore Chinese decision-makers' attitude towards risk in bid/no bid decision-making in international projects contracting domain based on CPT, as well as test and verify whether the risk attitude of decision-maker in China corresponds to the relative conclusions in CPT.

LITERATURE REVIEW

Relationship between risk attitude and bid/no bid decision-making

Risk attitude can be defined as a chosen response to an uncertainty that matters, influenced by perception (Hillson and Murray-Webster, 2007). Risk attitude is often seen as a stable personal trait, which will apply regardless of the context, the risk and consequences involved. Different people differ in the ways they resolve work-related or personal decisions which involve risk and uncertainty and decision-making behavior is often described or explained by risk attitude (Weber and Blais, 2002; Wang and Yuan, 2011). Both risk perception and risk attitude under uncertainty are well described determinants of risk decision-making behavior (Pennings and Smidts, 2000; Au and Chan, 2005). Limited by both the nature and competition for bid opportunities, bid/no bid decision as a critical activity for contractors is associated with uncertainty and complexity (Lin and Chen, 2004). Therefore, great academic attention should be paid to the risk attitude of bid/no bid decision-making.

Relationship between risk attitude and decision-making is studied in many domains including the construction management area (Au and Chan, 2005). Contractors

conduct different behaviours when dealing with small and large projects, and operating in good or bad years so that they tend to be most risk averse toward larger projects in lean years.(de Neufville er al., 1977). Han et al. (2005) emphasized the importance of risk attitude of international project contractor in decision-making and explored the relationship through questionnaire survey. According to Wang and Yuan (2011), decision-makers' attitudes towards risks play an important role in risk-based decision making, which is critical in successful construction project management. During the bidding decision-making process, the preference structure and the risk attitude of the decision maker should be taken into consideration, which reflect the bidder's subjective evaluation (Ahmad, 1990). Thus, this research focuses on the risk attitude from the perspective of decision-makers in bid/no bid decision in international project contracting context.

Cumulative Prospect Theory

CPT was derived from Expected Utility (EU) theory, the assumption of which is that all the decision-makers are completely rational. Due to the limitation of Expected Utility (EU)-based assessments of risk attitude, a developed model of choice, prospect (PT) (Kahneman and Tversky, 1979) and CPT (an extension of PT) (Tversky and Kahneman, 1992), explained the major violations of EU theory in choices between risky prospects with a small number of outcomes. CPT can help describe people's decision-making behaviour when faced with uncertain choices. A quantitative description of CPT is presented by value function (v) and weighing functions (w), fitted the following function functional form (Tversky and Kahneman, 1992):

$$v(x)=\begin{cases} x^{\alpha} & (x\geq 0) \\ -\lambda(-x)^{\beta} & (x<0) \end{cases} \quad \text{(value function)}$$

$$w^{+}=\frac{p^{\gamma}}{(p^{\gamma}+(1-p)^{\gamma})^{1/\gamma}} \qquad w^{-}=\frac{p^{\delta}}{(p^{\delta}+(1-p)^{\delta})^{1/\delta}} \quad \text{(weighing functions)}$$

(x represents for a set of consequences, like gains or losses; α and β are estimable coefficients determining the convexity or concavity of the function. p stands for the possibility level of outcome x; γ and δ are estimable parameters indicating the level of distortion in probability judgment)

According to CPT, risk aversion and risk seeking are determined jointly by the value and weighting functions. There are three main conclusions of CPT. 1) The most distinctive implication is a distinctive fourfold pattern of risk attitude: risk aversion for gains and risk seeking for losses of high probability; while risk seeking for gains and risk aversion for losses of low probability. 2) The second conclusion is that all the parameters (α, β, γ and δ) are less than 1, in accord with diminishing sensitivity: the impact of a change diminishes with the distance from the reference point. The functions are concave for gains, convex for losses, and steeper for losses than for gains. 3) The third conclusion of CPT revealed that for moderate and high probability, risk aversion for gains is more pronounced than risk seeking for losses.

Effect of Culture Difference

Cross-cultural difference in risk preference attributed difference in risky choices (Weber and Hsee 1998). As a dimension of culture variation identified by Hofstede (1980), collectivism-individualism is considered to be related to people's decision-making behaviors. Some previous studies have demonstrated that cultural differences

in interpersonal relationships between individualism and collectivism may impact the extent to which group members make risky decisions under conditions of uncertainty (Hofstede, 1981; Triandis, Bontempo, Villareal, Asai and Lucca, 1988).

A proposed cushion hypothesis proposed stated that members of socially-collectivist cultures, such as the Chinese culture, can afford to take greater financial risks because the social network insure against catastrophic outcomes (Hsee and Weber, 1999; Weber and Hsee, 2000). While in individualist cultures, a person making a risky decision will be expected to bear the consequences himself. Therefore, it can be supposed that the risk-taking tendency of Chinese people can be higher than that in individualist cultures.

Above all, considering the conclusions of CPT and the collectivism-individualism difference, the following hypotheses in this specific domain of international construction projects can be put forward:

- Chinese contractors display different risk attitude when making bid/no bid decision of international projects, according with the fourfold pattern presented in CPT.
- The parameters (α, β, γ and δ) estimated from the functions are all less than 1, indicating the diminishing sensitivity.
- When bidding international projects, the tendency of Chinese contractors to take high-risk projects for losses with moderate and high probabilities is higher than that to avoid risk for gains.

RESEARCH METHOD

Experiment is an efficient method to conduct research into individual risk attitude, which is widely adopted by many scholars (Harrison et al., 2007; Charness and Gneezy, 2010; Gloede et al., 2011). Given that there are so many factors affecting decision-making, an experimental research design would allow for manipulation of variables. Thus, experiment approach is chosen to investigate risk attitudes of contractors in choosing between projects with risky opportunity and sure payoff in the case of both gain and loss within the international construction environment. Based on the similar research of CPT by Tversky and Kahneman (1992), "Certainty Equivalent" (CE) research paradigm was adopted, which could qualitatively describe and quantitatively obtain the magnitude of risk aversion or risk seeking. A program in Java was designed on the computer to measure the magnitude of subjects' risk attitudes. Multivariate statistical analyses, mainly including correlation analysis, sign test and regression analysis, were performed by the application of the SPSS 19.0 software package.

RISK ATTITUDE EXPERIMENT

Subject selection

Experiment subjects are required to be equipped with certain professional knowledge and ability to make decisions. Due to the fact that it is difficult to invite Chinese contractors to participate in the experiments, post-graduates majoring in project management in Tianjin University were adopted to conduct a preliminary study. They have cognitive ability and theoretical foundation for international projects and bidding decisions. Eventually, 48 post-graduate students participated and each was rewarded 50 yuan for their contribution to the research.

With regard to the study of human decision activity, the adoption of student subjects is to some extent acceptable. The existing literature of experiment often chose college students as subjects for the reason that students are apt to understand experimental rules and learn new knowledge at a relatively rapid speed. Empirical evidence suggests that students are the appropriate and adequate surrogates for practitioners when the experiment refers to the basic human information processing and decision-making tasks (Ashton and Kramer, 1980, Liyanarachchi and Milne, 2005; Liyanarachchi, 2007). Therefore, post-graduates with a high level of construction bidding knowledge were enrolled in the risk attitude experiment.

Experiment design

"Certainty Equivalent" (CE) method is used to measure the subjects' risk attitude to examine its influence on bid/no bid decision-making. The experiment was carried out on the computer and programmed by JAVA, an application development language. This program was primary based on the experiment of Tversky and Kahneman (1992). Students major in computer technology were invited to join in the experiment team to help design the program. After the program was firstly designed, we had a pre-experiment on the post-graduates. With their suggestions, some minor errors were revised and the program was adjusted well.

Data collecting was derived from a serious of choices between a given prospect and several sure outcomes. The computer displayed a prospect and its expected value (EV) as Choice A. Choice B included a descending series of five sure outcomes linearly spaced between the extreme outcomes of the prospect (not including two extreme outcomes). For instance, computer screen exhibited the following trial to subjects. Then the subjects took a preference between the risky choices or each of the sure outcomes.

Assume that as the decision-maker of one international project contracting enterprise, you are about to make the bid/no bid decision between two overseas projects (A and B). From the perceptive of project return and ignoring other factors, please choose:

A. [p1] chance to win/loss a1 million yuan and [p2] chance to win/loss a2 million; EV as expected value;

B. Surely win/loss x million yuan.

To obtain a more refined estimate of CE, a new set of five sure outcomes was presented based on the first round, linearly spaced between the lowest amount accepted value and the highest amount rejected value. The CE value of prospect was derived from ten choices and estimated by the midpoint in the second set. The program could itself monitor the internal consistency of the responses to each prospect and reject errors. When subjects accepted a cash value lower than one previously rejected, warning appeared that "You have inconsistent choices, please choose again by pressing the enter button".

After choosing all the questions, subjects were told to write their response to this experiment. The value of a1 and a2 has 8 probabilities; while (p1, p2) has the following values (see Table 1). Therefore, 72 problems were formed from the combination and we finally chose 56 problems, 28 with positive prospect and 28 with negative. Besides, six random prospects appeared twice during the experiment program to check out the consistency of subjects choices. The experiment was finished in 30 minutes to one hour.

Experiment results

After experiment implementation, data of 35 subjects in total was aggregated. We firstly examined the consistency of repeated-twice six prospects and the correlations calculated, across subjects, averaged 0.53 over six different prospects. Each prospect is significantly related, which reveals that the choices of subjects to some degree are reliable. The experiment results are listed below, showing the median CE of prospects of 35 subjects (see Table 1).

FINDINGS

Risk attitude analysis

The decision-maker of international project enterprise is regarded as risk seeking when CE exceeds EV, and risk averse when CE is less than EV. According to the distinction, Table 2 displays the percentage of risk seeking of each subject within different probabilities. To simplify the table, only data of five subjects were listed.

Last line of Table 2 shows that 91.4% of subjects prefer to take risks for gains with low probability ($P2 \leqslant 0.1$) and 97.1% subjects are risk seeking for losses with high probability ($P2 \geqslant 0.5$). In addition, for high probability, all 35 subjects are predominantly risk averse for positive prospects (11.4%) and risk seeking for negative ones. Altogether, 29 subjects are in accord with the fourfold pattern of risk attitudes. In spite of the apparent overall pattern of risk attitude, the individual data undoubtedly involve noise and differences.

Table 1: Median CE (in millions)

									p2
	0.01	0.05	0.1	0.25	0.5	0.75	0.9	0.95	0.99
(0,50)			10.4		24.3		39.6		
(0,-50)			-10.4		-24.3		-39.6		
(0,100)		9.7		29.2	51.4	70.8		84.7	
(0,-100)		-9.7		-29.2	-40.3	-68.1		-81.9	
(0,200)	8.3		36.1		91.7		163.9		186.1
(0,-200)	-8.3		-30.6		-97.2		-152.8		-180.6
(0,400)	5.6								372.2
(0,-400)	-5.6								-372.2
(50,100)			64.6		75.7		85.4		
(-50,-100)			-60.4		-70.1		-79.9		
(50,150)		68.1		81.9	101.4	120.8		129.2	
(-50,-150)		-62.5		-73.6	-95.8	-112.5		-129.2	
(100,200)		120.8		134.7	151.4	165.3		179.2	
(-100,-200)		-115.3		-120.8	-140.4	-154.2		-179.2	

Table 2: Percentage of Risk Seeking Choices (CE＞EV)

No	Gender	Gain		Loss	
		P2≤0.1	P2≥0.5	P2≤0.1	P2≥0.5
1	F	75%	0%	37.5%	100%
2	F	100%	23.5%	12.5%	100%
3	M	87.5%	11.8%	0%	64.7%
4	M	62.5%	29.4%	25%	82.4%
...	...	...	...	...	...
Risk seeking		91.4%	11.4%	14.3%	97.1%

For prospect of the form (p1, 0; p2, a2), EV is equalled to p2*a2. Risk attitude can be defined by comparing p2 and CE/a2. Specifically speaking, subjects are risk seeking for gains if CE/a2 exceeds p2, while it is opposite for losses. Sign test is proceeded further to analyse the experimental results as follows (see Table 3). We can figure out that the majority of Sig. values are less than 0.05, except some with the probability between low and high probability, explaining the significant difference of number of people with different attitudes. Therefore, this further verifies the fourfold pattern of risk attitudes.

Table 3: Sign Test: p2 and CE/a2

p2	|a2|	Sig.(2-tailed)	
		Gain	Loss
0.01	200	0.000	0.000
0.01	400	0.000	0.000
0.05	100	0.001	0.018
0.10	50	0.002	0.007
0.10	200	0.007	0.499
0.25	100	0.043	0.735
0.50	50	0.499	0.018
0.50	100	0.735	0.176
0.50	200	0.091	0.018
0.75	100	0.176	0.007
0.90	50	0.000	0.002
0.90	200	0.043	0.001
0.95	100	0.000	0.000
0.99	200	0.000	0.000
0.99	400	0.000	0.000

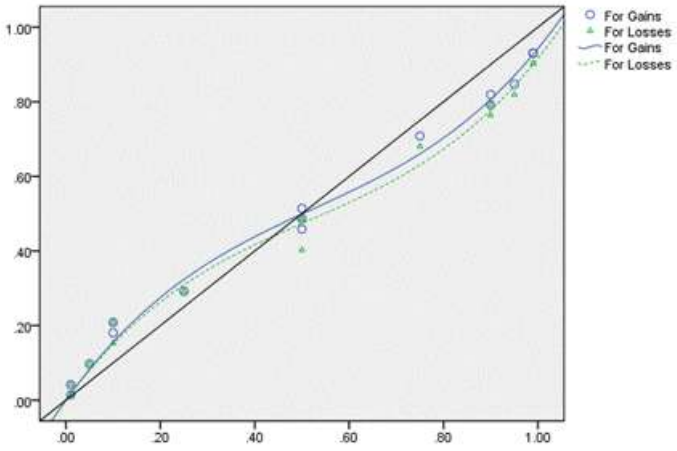

Figure 1: CE Values for Gains and Losses

Parameter analysis

In CPT, risk aversion and risk seeking are determined jointly by the value function and cumulative weighing functions. The principle of diminishing sensitivity reflected in both of the functions, giving rise to the value function which concave above the reference point and convex below the reference point, while the weighting function that is concave near 0 and convex near 1. All the parameters are less than 1, in accord with diminishing sensitivity. Nonlinear regression through the SPSS 19.0 was adopted to iterate and reach the value of parameters. The estimated values of α and γ were obtained as 0.697 and 0.506 after 10 times of iterations. The relatively low standard errors (0.024 and 0.017) indicated the reliability of the estimated value of parameters. The results of variance analysis and R squared (0.996) illustrates that the fitting model is quite effective. The values of β (0.648) and δ (0.648) were also obtained after 8 times of iterations. All the four parameters of them are less than 1, which reflects the diminishing sensitivity and keeps consistent with those in CPT experiment of Tversky and Kahneman (1992). Hence, hypothesis 2 is tested.

Analysis of magnitude

It was pointed out in CPT that the preference of risk aversion for gains is more significant than risk seeking for losses for moderate and high probabilities ($\gamma<\delta$). However, in this experiment, we obtained the opposite findings ($\gamma>\delta$) (see Figure 1). Figure 1 indicates that, for both positive and negative prospects, subjects overweigh low probabilities and under-weigh moderate and high probabilities, just as presented in CPT. Figure 1 also reveals that the weighting functions for gains and losses are quite close, but the latter is slightly curved than the former ($\gamma>\delta$). As a consequence, it can be inferred that contractors in international project enterprises are overwhelmingly tend to overweigh low probabilities and underestimate moderate and high probabilities

for both positive and negative prospects. Besides, the curve for losses is more crooked than that of gains, indicating that for moderate and high probabilities, tendency of subjects to be risk seeking for losses is more pronounced than that of subjects to be risk averse for gains. Thus, the third hypothesis is verified, assuming the risk-taking tendency of Chinese people can be higher.

CONCLUSIONS AND LIMITATIONS

Actually, there are various factors related to the bid/no bid decision-making of contractors, including the specific project, the uncertain environment, ability and conditions of the contracting firm, contractor's preference, and so on. As Chen et al. (2009) pointed out that cost competitiveness is the main factors for the success of the Chinese construction firms. But this paper mainly focuses on the perspective of the contractor's subjective preference and investigated the risk attitude of contractors. Through the experiment, we finally draw the following conclusions.

1) The risk attitude of Chinese contractors in bid/no bid decision of international projects accords with the fourfold pattern, the same in CPT. It refers to that decision-makers tend to be risk averse for gains and risk seeking for losses of high probability, while risk seeking for gains and risk averse for losses of low probability when making the bid/no bid decision of international projects; 2) All the parameters presented in the value function and weighting functions are lower than 1, indicating the diminishing sensitivity. The shape of the functions indicates risk aversion for gains and risk seeking for losses. 3) CPT indicates that risk aversion with moderate and high probabilities for gains is more pronounced than risk seeking for losses, but we obtained the opposite conclusion. In other words, when related to bid/no bid decision-making, tendency of Chinese contractors in international projects contracting enterprise to take high-risk projects for losses with moderate and high probabilities is higher than that to avoid risk for gains.

In the construction management field, risk-based decision making is in the core of risk management (He and Huang, 2007). This decision-making process is involved with human behaviour and related to decision maker's subjective perceptions. People's risk attitudes reflect their personal characteristics and experience. Just as Hillson and Mussray-Webster (2007) stated, different individuals can have various risk attitudes, and these play important roles in shaping decision makers' behaviour. Without a good understanding about the contractors' risk attitudes, it would be difficult to investigate or predict contractors' bid/no bid decision-making (Wang and Yuan, 2011).The findings of this research not only to some extent help scholars have better awareness and understanding of CPT theory and its application in China, but also benefit decision-makers to improve risk management in bid/no bid decision and make wise bid decision strategies.

However, Limitations are still included in this research. The first limit is the small sample size of subjects. The data of 35 subjects to some extent are not enough to conduct more comprehensive statistical analysis. A further existing problem is that all subjects participating in this experiment are post-graduates, rather than experienced workers in international construction domain. Though student subjects are widely adopted in experiment to substitute for managers, experience of decision-makers does play a non-ignorable role. This limitation resulted mainly from the high time-cost of this experiment and workers are not willing to spend that much time for the research. Therefore, further research may conduct experiment into experienced workers in international project contracting enterprises as well as enlarge the sample size, so as to

guarantee the internal and external validity. Encouraged by the experimental results that the conclusions of CPT cannot totally be available in international construction domain, we intend to focus future research on exploring the reasons, such as culture differences or situations, which lead to the different application of CPT.

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