The Impact of Real Options on Willingness to Pay for Infrastructure Safety Investments

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Abstract: Public investments are dynamic in nature, and decision making must account for the uncertainty, irreversibility and potential for future learning. In this paper we adapt the theory for investment under uncertainty for a public referendum setting and perform the first empirical test to show that estimates of the value of safety (VSL) from stated preference surveys are highly dependent on the inclusion of the option value. Our results indicate an option value of a major economic magnitude. This implies that previously reported VSL estimates, used in societal benefit-cost analysis of infrastructure investments, are exaggerated.

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1 Introduction

Public investments are generally irreversible by nature; once they are implemented they do not have to pass further market tests. Real option theory may be used to show how to take irreversibility of public projects into consideration in benefit-cost analysis. Using plausible parameter estimates it may be shown that the benefit-cost-ratio need to be higher than 3 (not 1!) for an investment to increase social welfare (Dixit and Pindyck, 1994). In addition, specific parameter estimates in benefit-cost analysis may be dependent on the option value. One important example is the value of a statistical life (VSL); in benefit-cost analysis of a typical road project in Sweden approximately 50 percent of the benefits consists of the value of increased road safety (Persson and Lindqvist, 2003).

Economists have used to two different approaches to estimate VSL, the revealed preference (RP) and stated preference (SP) approach. RP studies have most commonly been based on wage differentials between different risky jobs, for a review see Viscusi and Aldy (2003). SP studies, on the other hand, use surveys where respondents are asked about their willingness to pay (WTP) for a private or a public good leading to a mortality risk reduction. For an overview of up to 70 SP studies with a road safety context, see de Blaiej et al. (2003).

The RP and SP method both have their advantages and disadvantages. The RP method has the benefit of being based on actual behavior. However, it must rely on the assumption that respondents are aware of the objective risk reductions. SP studies on the other hand have the benefit of being able to tailor-make surveys and directly communicate the risk reductions to respondents. However, SP studies rely on survey responses, which may be plagued by hypothetical bias (Murphy et al., 2005; Harrison, 2006). In addition, there are major concerns that respondents have cognitive difficulties to have well behaved preferences for very small changes in probabilities of mortality risk (Andersson and Svensson, 2007).

Another potential limitation of RP studies is that they are based on ex-post analysis of observed behavior not considering the dynamic nature of the decision process. SP studies are also usually based on a static setting. This may cause problems, considering that consumers constantly can change their purchasing decisions given new information about market conditions, substitute goods and other relevant factors.

Zhao and Kling (2001; 2004) and Corrigan, Kling and Zhao (2002) have shown how to implement theories of dynamic behavior in the formation of WTP. As they state: *"In an explicitly dynamic setting characterized by uncertainty, irreversibility, and the potential for future learning, WTP for a good diverges from the standard variation measures"*. Zhao and Kling define the compensation an individual will demand when forcing to take a decision now (and losing the option) the *commitment cost*.

The concept of option value when making irreversible decisions under uncertainty was first developed as a quasi-option value in the context of environmental economics by Arrow and Fisher (1974), Henry (1974), and Fisher and Hanemann (1986). Later, a further concept of option value was developed for applications in dynamic business investment decisions by McDonalds and Siegel (1986), Dixit (1992), Pindyck (1991) and Dixit & Pindyck (1994).[3] During the same time, Hanemann (1989) integrated the concepts of Arrow and Fisher (1974) and of Henry (1974) into one unifying framework. Fisher (2000) claims that the concept of quasi-option value by Arrow, Fisher, Henry and Hanemann is equivalent to the option value by Dixit and Pindyck. However, Mensink and Requate (2005) rather argues that the option value by Dixit and Pindyck can be decomposed in two parts, one part measuring the value of new information, which is equivalent to the quasi option value and one part reflecting the pure value of delaying a decision irrespective of uncertainty.

[3] McDonalds and Siegel (1986) explicitly point out the use of option value in the context of cost benefit analysis and decisions under uncertainty by policy makers.

The intuition behind the above mentioned quasi option value is that in a situation when a respondent is uncertain about the utility she will derive from the good, there is a value of delaying the purchase decision until more information becomes available. Hence, if the respondent has to make a decision now, given the possibility for delay, she will want a compensation for this.

In this paper we set out the first empirical test of the real option theory for stated WTP for a public policy investment in road safety, reducing mortality risks. We do this using a CV survey in a Swedish city, where we ask respondents to vote yes or no to the implementation of a public policy program intended to increase road safety. This is a decision that shares the characteristics of an investment good where we can expect a real option value. It is irreversible, the outcomes are not certain (one cannot tell the exact magnitude of the actual risk reduction) and respondents may also be uncertain regarding their own utility from the safety improvement. The real option theory predicts that the current WTP will be lower, if there is opportunity for paying and implementing the public policy in the future. If there is an option value this may be important for how to design surveys eliciting VSL and how to interpret estimated values of safety for public policy decision making. If the option value is large enough it is important that the scenario description in stated preference studies mirrors the reality the policy maker actually faces. Also, it could further be problematic to use estimates based on observed behavior, as this necessarily is an ex-post analysis where it is impossible to capture the dynamic nature of the decision process.

The rest of the paper is structured as follows. The second section outlines the theoretical framework for the study, and explicitly states the hypothesis that is to be tested based on the real option theory. The third section describes the CV survey and shows descriptive statistics. The fourth section shows the results. The VSL estimate in the real-option sample is $3.55 million while in the non-real-option sample it is $6.21 million. Hence, respondents in the real-option sample places a considerable value to the real option of having the opportunity to wait and receive more information. It is also shown that the option value is higher when there is explicit uncertainty in the risk reduction, which is in line with theoretical expectations. In the last section we conclude with a brief discussion. The main point in the paper is that the result implies that we must question the estimates currently used in societal benefit-cost analysis of road investments, since they generally ignore the option value. Hence, it is important to explicitly design SP surveys such as the scenario mirrors the policy situation for which the estimates are to be used (dynamic or not), i.e. the option value is of such a considerable magnitude that a benefit-cost analysis cannot ignore it.

2 Theoretical Framework

A financial (call-) option is defined as the right but not the obligation to buy a certain asset at a certain time for a predetermined price. The real-option approach views an investment opportunity in real capital as an option: the right but not the obligation to invest a certain amount and thereby claim the future cash flows from the investment. One real option is the timing decision: we can, but we do not have to, invest immediately. The possibility of delaying the investment is a real option and the associated flexibility has a positive value if there is uncertainty about future cash flows.

However, it has not yet been considered in the literature that the commitment to a public policy measure in a referendum has the characteristics of a real option: voting against a proposed public policy, e.g. in the Swedish referenda on whether to change currency to the Euro may give the opportunity to vote yes for it later, when uncertainty may be (partly) resolved. Once the majority has voted yes, it is in practice an irreversible action (e.g. because of imperfections in second hand markets or political conventions), and has an impact on the household budget.

In this paper we focus on a public policy measure that has the characteristics of an investment: you pay an amount for an asset now, as a road safety investment, in order to get a return from it in the future, such as increased road safety. The derived utility from this public policy is uncertain for the individual and it will depend on future income and exposure to traffic. The commitment to a public policy in a referendum may therefore be seen as an uncertain investment. With some adaptations we can analyze such commitment to a public investment with a standard real option model for optimal timing (Dixit and Pindyck, 1994). Assume that the willingness to pay (u) derived from the public investment for the typical voter evolves over time as follows:

$$du = \alpha u dt + \sigma u dz \tag{1}$$

This equation implies that the consumer, given the present information, knows the actual value of the public project to her (that is, if we invest immediately), but that the future value is always uncertain. We want to derive a rule for optimal timing of the public investment and denote the value of the option to invest as $F(u)$:

$$F(u) = \max E\left[(u_T - p)e^{-\rho T}\right], \tag{2}$$

where T denotes the unknown future time of investment and ρ is the discount rate. For the existence of an optimum we must have that $\alpha < \rho$. In the following we denote the difference $\rho - \alpha$ with δ.

The problem we have to solve is to choose an optimal time for the investment in the public project, that is, to pay the price p for a public project giving the utility u to the typical voter. As u evolves stochastically we will not be able to find any optimal point of time, but a critical value u^* determining that it is optimal to invest as $u \geq u^*$.

In the continuation region, i.e. as long as it is not optimal to invest, the Bellman equation is:

$$\rho F dt = E(dF). \tag{3}$$

Equation (3) states that the return from the project should balance with the total return from holding the asset (here the increase in value from the project). The value of the investment opportunity is dependent on the evolution of the utility derived from the project. Since willingness to pay is assumed to be stochastic, the evolution of the value from the investment opportunity is also stochastic and we can use Ito's lemma to derive this process:

$$dF = F'(u)du + \tfrac{1}{2}F''(u)(du)^2. \tag{4}$$

We can now substitute for du in the equation (4) and get the expected value:

$$E[dF] = \alpha u F'(u)dt + \tfrac{1}{2}\sigma^2 u^2 F''(u)dt. \tag{5}$$

The Bellman-equation can then be written as:

$$\tfrac{1}{2}\sigma^2 u^2 F''(u) + \alpha u F'(u) - \rho F(u) = 0. \tag{6}$$

F(u) has to satisfy the following boundary conditions:

$$F(0) = 0 \tag{7}$$

$$F(u^*) = u^* - p. \tag{8}$$

$$F'(u^*) = 1 \tag{9}$$

Equation (7) is an implication from the stochastic process assumed for the evolvement of utility and states that if utility reaches zero it will remain there so that the option to invest becomes worthless. Equation (8) is the value matching condition, which states that when we invest we receive the net payoff $u^* - p$. Equation (9) is the so-called smooth pasting condition.

In order to satisfy equation (7) the solution has to take the following form:

$$F(u) = Au^b \tag{10}$$

Substituting (10) into (8) and (9), we receive the solution for the critical value u^*:

$$u^* = \frac{b}{b-1} p \, , \tag{11}$$

where b is a function of the parameters σ, ρ and δ. Since it can be shown that $b>1$, the critical level of willingness to pay u^* has to be larger than the price p one has to pay.

However, since we have a referendum, the voter cannot choose an optimal point of time, that is, to invest if $u \geq u^*$. Instead, given that the referendum is taken place at an exogenously determined time t, we have that the voter only votes yes if at that point of time we have that:

$$u_t \geq u^* \, ,$$

that is, the willingness to pay has to be equal or larger than the threshold value at the time the referendum is held. We define the difference between critical value of willingness to pay and p as the option value (OV):

$$u^* - p = OV > 0 \, , \tag{12}$$

or, the critical level of willingness to pay u^* is p plus the option value:

$$u^* = OV + p \, , \tag{13}$$

It is important to bear in mind that the option value OV is only present if the voter is given the option to defer the investment, that is, to wait for more information and to vote once again later. If this is her only opportunity to vote, she will vote yes if and only if:

$$u_t \geq p$$

Since it can be shown that the option value is strictly positive given uncertainty, the following relationship has to hold strictly:

$$u_t(option) \geq u_t^*(option) = p + OV > u_t^*(no\,option) = p$$

We assume further that the unknown voter willingness to pay u_t is uniformly distributed in the interval $[0, p^{max}]$ and hence the probability to vote yes (Pr) is monotonically decreasing with the threshold value:

$$\frac{\partial \Pr(u_t \geq u_t^*)}{\partial u^*} < 0$$

Thus, we arrive at the following empirically testable result:

$$\Pr(option) < \Pr(no\,option)$$

Hence, we expect that there is a lower probability to vote yes in the presence of a real option for the typical voter compared to the situation without such an option.

By differentiating equation (11) we can derive some comparative static properties of the solution. The volatility increases the option value since the future becomes more uncertain. In section 4.2 this hypothesis is also put to an empirical test. The effect of the discount rate is less clear: all things equal the option value will be less for a higher discount rate since the future becomes less important. However, we would also expect that the future growth rate of the utility derived from the project should increase so the net effect is uncertain. However, for financial call options the second effect dominates so that the option value increases with the discount rate. Similarly, the effect of an increase in risk aversion is ambivalent and depends on the net effect on ρ and α.

It could be argued that the real option approach leads to a postponement of investments, since instead of investing now we will wait and see and maybe invest in the future. However, even if some investments will be made later when considering the option value it is clearly optimal to do so. Considering the option value increases the threshold for investing immediately since we need compensation for the lost opportunity to wait for more information.

3 Method

3.1 The CV Survey

To test the real option theory in the formation of WTP for road safety improvements we conducted a mail survey in the spring of 2007 to 940 randomly selected residents in the city of Karlstad, Sweden. All respondents were described to a background of which there are on average 6 fatalities each year due to road accidents in Karlstad (mean between 1998 and 2005). Hence, we presented the fatalities in frequencies rather than in probabilities, which is easier for respondents to understand. Further, we use the community analogy to describe the scenario to increase the individuals' association to the proposed program (Kalman and Royston, 1997). The respondents were described to a local public program intended to reduce the number of fatalities by half. To test between the dynamic and the static scenario, one half of the respondents were given surveys where they were asked to decide on a proposition that included a real option.

Further, we included sub-samples that were described to a scenario with uncertainty regarding the risk reduction. The reason is that we wish to test if the option value is higher when there is uncertainty in the outcome as according to theoretical expectations, discussed in the previous section. In one sub-sample the uncertainty was described such that the annual fatalities will decrease from the baseline (six fatalities) to between two and four fatalities, with a reduction to three as the most likely outcome. In the other sub-sample the risk reduction was described to be from the baseline to between one and five fatalities, also here with a reduction to three fatalities as the most likely outcome. Hence, this corresponds to a triangular distribution of the risk reductions. The structure of the survey is shown in Figure 1.

[Insert Figure 1 here]

The sample without the real option was told that this was their "now or never" opportunity to decide on the issue. This was described as: *"…We also ask you to consider that the situation is such that the road safety program will be implemented either now or it will never be implemented. Consider the situation that this is your only opportunity to give your vote regarding the possible implementation of the traffic safety program"*. Whereas the respondents with the real option were told that even if the vote came to a no now, they would get another chance to give a final vote later when a new local referendum would be held. Benefits would then also be delayed. This was described in the following way: *"if the safety program is not implemented now, considerer that a new referendum will be held later where you will be asked the same question. At that point all new information regarding the safety program will be made available to you. For example, more time can be devoted to see which safety measures will be most efficient for the particular urban environment in Karlstad. You will also have time to consider your own valuation regarding the safety program."* Later in the survey it was explicitly stated that the possible later vote would be in one year.

After the description of the traffic safety program, the respondents were asked to vote yes or no to implement the public policy at a certain annual cost (5 different bid levels were used) and that it would be implemented at the stated cost if a majority supported the program. The survey also collected information on socio-demographics as well as some general risk preferences. A total of 465 respondents completed the survey, controlling for incorrect addresses, this gives a response rate of 55 percent.

3.2 Descriptive Statistics

Characteristics of the sample are shown in Table 1 below. There are slightly more females in the sample (54%) and the educational level is above average. We also see that on average 54% of the respondents vote in favor of the safety program. This is just a raw average, without controlling for e.g. the different bid levels.

[Insert Table 1 here]

In Figure 2 the proportion of respondents voting in favor of the safety program is shown in more detail and separated for the real-option and non-real-option sub-sample. We see that the share of respondents voting in favor of the program decreases as the stated cost increases. It is also evident that at all bid levels the share of respondents voting in favor are higher among those that do not have the real option, i.e. already here we see that respondents given an offer including a real option tend to place a value on the option.

[Insert Figure 2 here]

At the lowest stated cost (200 SEK) almost all of the respondents that were not offered the real option vote in favor of the program. For the two higher levels of stated cost the percentages of respondents voting in favor of the program is around 30%. In the next section we perform multivariate analyses estimating the real option value.

4 Estimations and Results

In this section multivariate analysis is performed such that in section 4.1 we test the hypothesis that respondents in the real-option sample are more likely to vote no the public safety program. Section 4.2 tests the hypothesis that the option value is higher when there is explicit uncertainty in the risk reduction, i.e. respondents in the real-option sample that were also in the sub-samples with uncertainty in the risk reduction are even more likely to vote no. Finally, section 4.3 concluded this section and estimates the value of a statistical life in the real-option and non-real-option sample.

4.1 Baseline Results

Table 2 shows the likelihood of voting in favor of the safety program, i.e. the dependent variable is a binary variable taking the value equal to one if the respondent voted yes to the public safety program. Results are shown for the full sample and for the the real-option and non-real-option sub-samples, respectively. Table 2 shows the marginal effects from the logit estimations.

[Insert Table 2 here]

The coefficient of the *Bid* variable is significant in all models, which may be seen as a validity test of the survey. The variable of most interest, *RO,* captures the real option effect and shows statistical and economic significance in both Model A and Model B. The negative coefficient implies that a respondent who faces the opportunity to wait and see (the real option sub-sample) is less likely to vote in favor of the safety program. Having the real option decreases the probability of voting in favor with 27 percent in Model A and with 26 percent in Model B. The effect is according to the theoretical expectations from the real option theory.

Regarding socio-economic covariates, gender is found to be associated with a higher likelihood of voting in favor of the safety program. This result is in line with results on gender-related risk behavior (Byrnes et al., 1999). In the full sample, being female increases the likelihood of voting yes with 10 (Model B) to 12 percent (Model A). Regarding age two different models are used, treating age as continuous and using different age-categories. In the model using age categories respondents below age of 30 are used as the reference group. The estimates indicates an inverted U-shape, where middle-aged respondents tend to be more likely to vote in favor of the program, but the difference is not statistically significant. Such a result has been reported in other studies estimating WTP for risk reductions, see e.g.

Johannesson et al. (1997). The coefficient of the variable *Own* is statistically significant, which shows that respondents that perceive that their baseline risk as higher than the average are more likely to support the safety program. In the non-real option sub-sample there are indications that respondents with a university education are more likely to vote yes, most other covariates are not statistically significant.

4.2 The impact of volatility on the option value

As outlined in the end of section 2 the partial derivative of the solution to the real option model with respect to volatility yields that higher volatility in future benefits σ increases the threshold value, i.e., the investment project is more likely to be deferred (for technical details see Dixit and Pindyck (1994)). This is in accordance with intuition, since the possibility of higher project values in the future increases, while the downside risk is unchanged. Hence option value of waiting increases with volatility.

To test whether higher volatility increases the real option value as predicted, we use the following empirical strategy. First, if we take the partial derivative of equation 11 we implicitly assume that the other coefficients in the model are constant. This assumption implies that respondents are risk neutral, otherwise increased volatility would change the subjective discount rate and the demanded return from the investment so that δ is affected. The net effect on real option value would therefore be unclear. Hence, in order to test for the impact of volatility, we consider only the answers of risk neutral respondents. We use a standard question for elicitation of respondents risk preferences as shown in Figure 3 (Daruvala, 2007).

[Insert Figure 3 here]

According to the expected utility model we define the respondents as risk neutral if their certainty equivalent C is equal to the expected payoff from the game (500 SEK). We thereafter estimate the following model for the risk neutral individuals, separately for the group with the real option and the group without real option.

$$Vote = \beta_0 + \beta_1 BID + \beta_2 VOL + \gamma \mathbf{x} + \varepsilon \tag{14}$$

The model contains socio-economic covariates ($\mathbf{x}$) and the bid level. Further, the dummy variable *VOL* is referring to a volatile scenario description where the risk reduction has the same expected outcome as the standard scenario but has a certain maximum and minimum outcome as described in section 3.1

Since the respondents are risk neutral we would expect that in the group that was not offered the real option there will be no effect on WTP in the sub-samples that were described to a volatile risk reduction. In contrast, in the group that was offered the real option we would expect that the option value of waiting is higher in the group with the volatile scenario description. The marginal effects from the logit estimation of equation 14 are reported in table 3 below.

[Insert Table 3 here]

As expected, the results show that there are no effects of volatility in the group without the real option. In comparison, volatility has a significant effect on the probability for voting yes in the real option group. The volatile scenario decreases the probability for voting yes with 23 percent, which correspondence to a considerable higher real option value. The results are robust with respect to the inclusion of control variables regarding the magnitude and statistical significance of the marginal effects.

4.3 VSL Estimates

To estimate the VSL, the probability of voting in favor of the program is estimated using a logistic model as in section 4.1. The mean WTP ($\overline{p}$) is defined as the area under the survivor function, shown in Figure 2, for positive WTP (p):

$$\overline{p} = \int_0^\infty 1/\left(1+e^{-\Delta v}\right) dp = -\frac{1}{\beta}\left[\ln\left(1+e^{\beta x}\right)\right], \tag{15}$$

where β_x is the constant term in the changed utility Δv. Using a bivariate model mean WTP can then be estimated as:

$$\overline{p} = \left(-1/\beta_{bid}\right) \cdot \log\left(1+\exp\left(\beta_{\text{constant}}\right)\right). \tag{16}$$

Using this we get the following estimates of the VSL with and without the real option shown in Table 4.

[Insert Table 4 here]

The results indicate that the VSL without the real option is about 42 million SEK ($6.21 million) and with the real option VSL today is around 24 million SEK ($3.55 million). These are considerable differences and they imply a real option value of almost 18 million SEK ($2.66 million). We compare the results with a standard[4] VSL study conducted in the city of Karlstad three months prior to the study reported in this paper (Svensson, 2007). The VSL estimate from the standard VSL study, using the same bid levels and risk reductions, was 50 million SEK ($7.3 million). This is not statistically significant from the estimate based on the scenario without the real option in this paper at 42 million SEK.

[4] By this we refer to not explicitly stating that it is a "now or never" or "now or laiter" decision. Hence, a design used by all previous studies in the VSL literature.

5 Policy Implications

Real option theory shows that the net-present-value criterion is not appropriate for public policy decision making if investments are irreversible. It has been shown that by including the option value to wait and see regarding irreversible investments, the benefit-cost ratio needs to be higher than 3, rather than only 1. Considering the option value increases the threshold for investing immediately since we need compensation for the lost opportunity to wait for more information. In this paper we have also shown that specific parameter estimates used in benefit-cost analysis can be heavily exaggerated if the irreversibility of investments is not taken into consideration. The results also indicated that the real option value depends positively on the degree of volatility. A large degree of uncertainty heightens the threshold for immediate investment. In the context of VSL, the benefits are even more exaggerated if there is a high degree of objective uncertainty or perceived subjective uncertainty. Policy has therefore to be concerned with reducing project risks by more elaborated techniques for planning and evaluation and managing the perceived risks from the voters through better provision of information.

It is important that the scenario description in stated preference studies mirror the reality the policy maker actually faces. If there is a possibility for delaying an irreversible investment with uncertain benefits for the average citizen where there will be arrival of new information over time, willingness to pay will be overestimated if this is not explicitly outlined in the survey. On the opposite, if we want to evaluate a measure that has to be taken “now or never”, not explicitly describing this in the scenario will underestimate the willingness to pay.

For public health investments such as traffic safety measures it seems that a “now or later” scenario description is usually most appropriate, since not making the safety measure now does not mean that the opportunity to implement the safety measure in the future is lost.

As most studies estimating the VSL do not have an explicit description whether it is a "now or never" or a "now or later" decision, the estimated VSL will depend on the implicit assumptions made by the respondents. Since these implicit assumptions could vary systematically with the different scenarios there is a likely bias in these estimates. Generally we believe that VSL estimates used in public policy decision making, based on SP studies, exaggerate the benefit of the investment. Considering the comparison mentioned section 4.3 with a standard VSL study performed approximately at the same time in the same city, it seems like respondents interpret standard VSL studies as a "now or never" decision.

Our result also has a more general implication. Clearly, a real option model can describe individual voting behavior and consumption with investment characteristics. It might e g provide an explanation for the observed status quo preservation in public referenda held in the EU during the last decade.

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Tables

Table 1. Descriptive statistics

Variable	Description	Mean	Std.Dev.	N
Age	Age of the respondent	45.73	24.03	435
Gender	=1 if woman	0.53	0.50	435
Income	Income in 1,000 SEK	37.58	19.45	435
University	=1 if university education	0.45	0.50	465
Vote	=1 if answered yes on the vote	0.56	0.50	431
Own				

Table 2. Marginal effects from Logit estimation, dependent variable: Vote

	Full sample		**Real Option Sample**		**Non-Real Option Sample**	
	Model A	*Model B*	*Model C*	*Model D*	*Model E*	*Model F*
Age	-1.11E-04	-	-1.00E-04	-	2.96E-04	-
Age 30-44	-	0.05	-	-0.02	-	0.11
Age 45-64	-	0.12	-	0.10	-	0.11
Age 65+	-	-1.39E-03	-	0.07	-	-0.16
Income	6.42E-07	6.47E-06	2.98E-04	1.25E-04	3.67E-04	-8.96E-04
Gender	0.12***	0.10*	0.05	0.04	0.14	0.12*
University	0.07	0.08	0.02	0.04	0.15*	0.14*
Kids	0.03	4.10E-03	-0.02	0.01	0.04	-4.98E-03
RO	-0.27***	-0.26***	-	-	-	-
VOL	0.01	0.02	-0.05	-0.04	0.08	0.11
Own	0.10***	0.10***	0.14***	0.15***	0.03	0.03
Bid	-1.11E-04***	-1.12E-04***	-1.10E-04***	1.05E-04***	-1.04E-04***	-1.02E-04***
N	423	423	221	221	202	202
Pseudo-R^2	0.12	0.13	0.08	0.08	0.15	0.16

Note: Two-tailed significance tests: *** 0.01 level, ** 0.05 level, * 0.10 level.

Table 3: Test of volatility on the option value

	Real Option Sample		**Non-Real Option Sample**	
	Model G	*Model H*	*Model I*	*Model J*
Age	-4.58E-03	-	5.00E-03	-
Income	1.54E-06	-	-2.85E-06	-
Gender	-0.02	-	0.20*	-
University	0.02	-	0.18	-
Kids	0.06	-	0.06	-
VOL	-0.23*	-.21*	-0.06	0.01
Own	0.11	-	0.01	-
Bid	-8.58E-05**	-6.86E-05**	-1.22E-04***	-1.11E-04***
N	88	88	94	94
Pseudo-R^2	0.08	0.04	0.14	0.14

Note: Two-tailed significance tests: *** 0.01 level, ** 0.05 level, * 0.10 level.

Table 4. VSL estimates in million SEK with and without real option (US million dollar in parenthesis)

	With real option	**Without real option**
VSL estimates	24.01 ($3.55 million)	42.00 ($6.21 million)
Option value	17.99 ($2.66 million)	

Figures

Figure 1. Structure of the survey

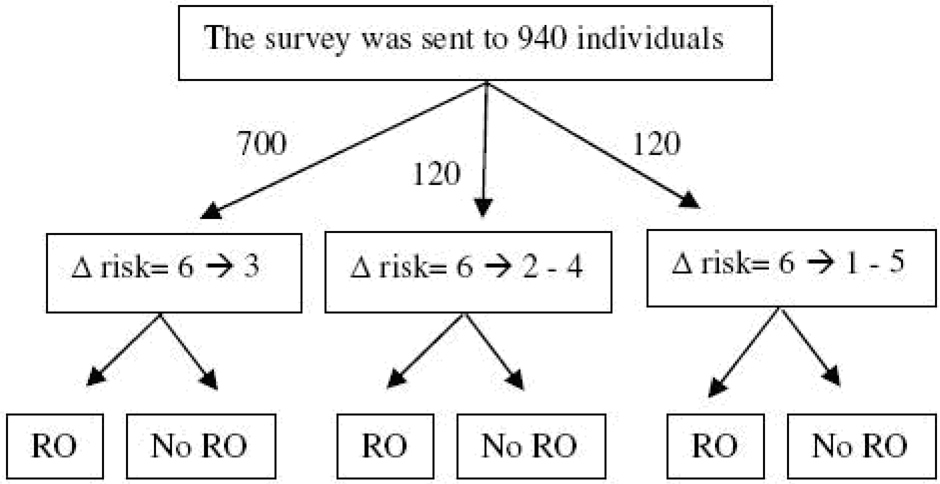

Figure 2. Proportion of "yes-votes" without and with the real option

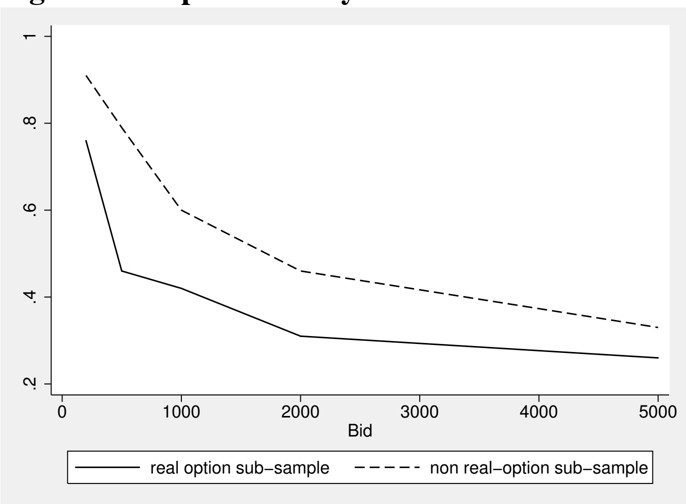

Figure 3. Question eliciting risk preferences

Question XX

You are presented with two alternatives below.

Alternative 1:

A die is thrown

In the case of an odd number you receive	0 SEK
In the case of an even number you receive	1000 SEK

Alternative 2:

You are unconditionally given	*C* SEK

For what value of C do you consider Alternative 1 to be *as good as* Alternative 2?

Answer: I like both alternatives *equally* when C = _______ SEK