Impact of Risk and Uncertainty in the Provision of Local and Global Environmental Goods: An Experimental Analysis[♣]

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Abstract

Uncertainties and risk in the decision making process are abundant in the area of environmental economics, irrespective of whether the problems being discussed are local or global. This paper uses laboratory evidence from public goods games to examine how in payoff equivalent situations, decision makers contribute towards local or global environmental goods, in the presence of risk and uncertainties in the provision of these goods. We use a within subject design that allows for comparisons across seven different treatments in which subjects are exposed to internal (strategic) and external (environmental) risk and uncertainty. Our results show that the location of the risk and uncertainty matters, with subjects moving away from the external uncertainty in favor of internal uncertainty, when that uncertainty is associated with the local environmental good. When it relates to the global environmental good, subjects face both external and internal uncertainty on the same good leading to a significant drop in contributions. We find that in the presence of risk and uncertainty subjects use feedback from other members of their group when deciding about future contributions. The reward for research and development and innovation is captured in the experimental design by the increased probability of obtaining the desired outcome in the endogenous probability treatment. Subjects seem to understand this incentive and contribute more towards global goods in this treatment.

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1. **Introduction**

All environmental problems, whether global or local, commonly involve scientific uncertainties. In addition, the process of environmental policy making involves further uncertainties regarding the decisions and actions taken by the parties involved. In this paper we explore, using laboratory experiments, how the two kinds of uncertainties influence decisions in the context of global and local environmental problems.

Since Knight (1921) introduced the dichotomy of known and unknown probabilities, the economics literature applies the term "uncertainty" to describe situations when the probabilities of possible future events are unknown. The term "risk" is used to describe situations when the probabilities of future events are known.

Climate change is a classic example of global environmental problems. While there is scientific evidence that atmospheric concentrations of greenhouse gases are increasing as a result of human activities, the resulting changes in world climates and the costs and benefits of proposed strategies for responding to possible global warming are not at all certain. Another well known global environmental problem is the depletion of the ozone layer caused by chlorofluorocarbons (CFCs). The two global environmental problems, however, differ in the degree of knowledge about the environmental uncertainties. While climate change is undoubtedly a case of "uncertainty" since no precise probability estimates exist, the ozone layer depletion is more characterized as "risk" since detailed scientific knowledge and predictions exists about the impact of the depletion of the ozone layer and its impact on human health (eg. melanoma, cataracts).

Examples of local environmental risks and uncertainty are also abundant. Kerr (1992) gives an example of geysers in northern California which are used for their geothermal power. From the beginning of their use in the 1960s, great uncertainties surrounded the underground structure and the availability of the feeding groundwater. Decisions made in uncertainty lead to exploitation beyond safe yield and the destruction of the resource. Wills (1997) gives an example of the risk involved in different timber management regimes on the survival of the Leadbeater's possums. There is no experience and no reliable estimates about the depletion of geysers thus decision makers are facing "uncertainty". There is, however, some experience with timber management and its impact on habitat and the survival probabilities of forest-dependent species. Thus decision makers in the second case are facing "risk".

In this context, research may be viewed as a means of decreasing the uncertainty by improving the reliability of estimates and, therefore, converting uncertain decision situations into risky situations. Furthermore, adaptation strategies may be viewed as ones that increase (decrease) the probability of occurrence of the desirable (undesirable) outcome.

Environmental problems have often been modelled in a laboratory using the framework of public goods and common pool resource dilemma games. In the standard non-cooperative experimental setting there is always uncertainty about the ultimate size of the public good or resource request as subjects do not know how other group members will behave. Messick et al. (1988) refers to this uncertainty as "strategic uncertainty". The role of strategic uncertainty has been extensively modelled in the laboratory. Several factors including groups size (Buchanan, 1968; Marwell and Ames, 1979; Isaac and Walker, 1988; Isaac et al., 1990 and Loehman et al., 1996) the information structure inherent in the experimental design (Budescu et al., 1995a; Suleiman et al., 1996), the incentives or contribution mechanism employed (Green and Laffont, 1979; Groves and

Ledyard, 1977, 1980 and Loehman et al., 1996), existence and the level of provision point (Schelling, 1960; Schmidtz, 1987; Isaac et al., 1989 and Marks and Croson, 1998), incentives for the public good relative to the private good (Isaac et al., 1984; Isaac and Walker, 1988 and Zelmer, 2003) have been shown to have significant impact on the contribution levels.[1]

An implicit assumption underlying these public goods and common pool resource dilemma games is that the optimal size of the public good or the carrying capacity of the commons is known and that there is no uncertainty associated with the benefits of the public or private goods. However, in many environmental problems that bear a resemblance to the public good games, such as climate change, the decision maker does not know with certainty the optimal level of carbon-dioxide emissions abatement, nor the costs and benefits of proposed mitigation strategies. Similarly, in many environmental problems that share the destructive characteristics of the common pool resource dilemmas (e.g., energy shortage, deforestation, over-fishing) the carrying capacity of the resource is not known with certainty. Messick et al. (1988) introduced the terminology "environmental uncertainty" to distinguish this factor from strategic uncertainty: "Environmental uncertainty refers to environmental variables that determine which group action is best, while [strategic] uncertainty centres on how other group members will respond….The problem that is raised by the environmental uncertainty is the problem of optimality or efficiency, while the problem raised by [strategic] uncertainty is (…) coordination." (Messick et al. 1988; p. 678-679). Messick et al. (1988) incorporated a

[1] For a survey about treatment variables that have been shown to affect contribution levels in public goods games, see Ledyard (1995) and for a meta-analysis of several of these factors see Zelmer (2003).

probabilistic destruction of the resource when the safe yield was surpassed and showed that even when strategic uncertainty was absent (i.e., there was only one participant) the random size of the resource led to sub-optimal outcome.

Several researchers have used mean preserving spreads to model uncertainty. Rapoport *et al.* (1992) used uniform distributions of resource with the same expected value (mean) but different levels of variances (ranges) representing increasing environmental uncertainty. In the five-person group experiment it appeared that subjects dealt with the strategic uncertainty by requesting roughly one-fifth of the mean amount available. As the environmental uncertainty (range) increased, however, subjects requested more than an equal share from the resource. Associated with the observed over-exploitation of the common resources, subjects' estimates of the resource size also increased. Similarly, Suleiman *et al.* (1996) also found that the subjects' mean estimates of the random resource size increased as the resource uncertainty increased. One of the explanations provided by Rapoport et al. (1992) is that when people are asked to provide their best estimate of an unknown resource, their estimate will be biased by what they hope for. Such tendency have been labeled in the literature "optimism", "outcome desirability bias", or simply "wishful thinking" (Hogarth, 1987).

In the experiment by Wit and Wilke (1998), the provision point was randomly determined. The authors also manipulated strategic uncertainty by giving bogus feedback about the variance of the contribution levels of the fellow subjects. Low and high variance of contribution levels represented low and high strategic uncertainty, respectively. Wit and Wilke (1998) found lower actual contributions under high environmental uncertainty than under low environmental uncertainty with the most dramatic drop in the contribution levels when high environmental uncertainty was coupled with high strategic uncertainty.

In the public goods domain, Dickinson (1998) reported the results of an experimental study where the provision of the public good was conditional on the aggregate contribution level (Incentives treatment). The results showed that the increase in probability of provision as a function of contribution levels, *per se*, did not significantly affect contribution levels either but the changing marginal incentives did.

Loewenstein et al. (1989) found evidence that people's *attitudes* towards risk and the *decision process* involving risk and uncertainty may be very different in social and nonsocial domains owing to the differences between social and nonsocial preferences. This provides further validity for our research and the distinction between social or "strategic" and "environmental" uncertainty.[2]

The main focus of the current research is to investigate how individuals perceive risk and uncertainties when making decisions about local and global environmental policies. Using the framework of public goods games we study whether - in payoff equivalent situations - decision makers contribute more or less towards local or global environmental problems when different forms of risks and uncertainties regarding the decision outcome are involved. In this paper, money spent on private goods is interpreted as contributions to local environmental problems, while contributions to public goods are thought of as contributions towards global environmental problems. From the viewpoint of a single region, state or country, global problems involve strategic uncertainty, that is

[2] For further discussion of the different kinds of environmental and strategic risk and uncertainty studied in the literature, in various experimental settings, refer to Nemes (2005).

outcomes can depend on the strategies adopted by other countries. Hence a country's individual effort to mitigate global environmental problems are comparable to voluntary contributions to provide a public good, while efforts to resolve local environmental problems are not complicated by the presence of strategic uncertainty, making it similar to a private good.

While several papers have examined the different aspects of risk and uncertainty in isolation, this paper attempts to employ three different kinds of treatments (Risk, Uncertainty and Incentives) in a common framework. Also, the above mentioned decision scenarios are placed into a standard public goods game context. Furthermore, the treatments considered allow us to isolate strategic uncertainty from several forms of environmental risk and uncertainty (using Bernoulli, uniform and endogenous probabilities). In the baseline treatment no environmental uncertainty exists, only strategic uncertainty influences the outcome. Throughout the rest of the treatments, strategic uncertainty (e.g., group size, communication, marginal incentives to contribute) is kept constant and environmental risk and uncertainty is introduced in both local and global environmental problem settings. Implementing multiple-shot games and within-subject analysis allows us to combine these areas of research in a systematic and rigorous way and to gain further insights into several aspects of decision making in the field of environmental policy.

As we explain our results in the context of environmental policy making, in order to avoid confusion, in the present paper we introduce the term *internal* uncertainty to describe strategic uncertainty and the term *external* uncertainty to describe environmental uncertainty.[3] *Internal* uncertainty therefore describes the uncertain nature of the decision making process due to unknown information about the decision of others. *External* risk and uncertainty arises from the limited scientific understanding of the environmental systems (whether probabilities are known or unknown).

2. Experimental Design

2.1 Experimental Procedure

The laboratory experiment was implemented in ten sessions each involving five subjects and fifteen decision making periods for each of the seven treatments.[4] We used a within-subject design; all 50 subjects participated in the seven treatments, which allows for powerful comparisons across treatments. At the beginning of each experimental session participants were told that they would be participating in an economic experiment in which they would make investment decisions.[5] A group of five participants faced the same investment dilemma and made simultaneous decisions.

In order to control for risk aversion at the individual level, prior to the computerized experiment, we asked the subjects to participate in a hand run lottery game. Participants had to indicate their preferences between two options: a safe option that

[3] Another way to look at the distinction between the environmental and strategic uncertainty is to note that while environmental uncertainty is exogenous to the decision maker, strategic uncertainty is endogenous. However, in some of the treatments in this paper, research influences environmental uncertainty and thus the decision to undertake research and development can make environmental uncertainty endogenous in those treatments. Hence we avoid using the terms exogenous and endogenous to indicate strategic and environmental uncertainty respectively and prefer internal and external uncertainty. External uncertainty in our paper includes treatments where the uncertainty is exogenous to the decision maker and some treatments where it is endogenous.

[4] The experiment was programmed and conducted with the software z-Tree (Fischbacher 1999).

[5] In order to avoid framing bias in the decisions, the subjects were given instructions where a neutral language was used. Instead of making decisions about environmental problems, subjects were making investment decisions into a "private" and a "group" account. Even the term "contribution" was avoided and the more neutral term "investment" was used instead.

yielded \$7.00 with certainty or a risky option with the probability of winning \$12 changing in 10% increments from 10% on the first lottery to 100% on the 10th lottery (Holt and Laury 2002). One of the games on the sheet was played at the end of each session. Conducting the lottery game helped in measuring the risk preference of the subjects which we can then compare with their behaviour in the public goods experiments where they face risk and uncertainty in the group context.[6] Furthermore, qualitative and quantitative information were also collected in the form of questionnaires from the participants. These questionnaires were completed by the participants after treatment 4 and 5 and also at the end of the session. (The instructions and questionnaires are in the Appendix.)

The experiments were conducted using subjects drawn from a population of undergraduate and graduate students at The University of Melbourne. Subjects made an average of 33 cents per decision period and a total of \$37 on average. Furthermore, subjects received an additional \$2, \$7 or \$12, depending on their choice and the outcome of the lottery game. In order to control for wealth effects, their income from the lottery game was only revealed to the subjects at the end of the session, after the public goods experiment.

2.2 Decision Process

At the start of each period, each subject was given the same number of tokens or experimental dollars (E\$), ω_i. The subjects had to divide these tokens between contributing to a "private account" (x_i) and a "group account" (g_i). Investment into the

[6] While the risk attitude survey was an important part of the current research and we use the risk estimates in the multivariate estimations presented in the results section, the results are further discussed in detail in Nemes (2005).

private account earned α experimental dollars with probability p_x to the individual only. Contributions to the group account earned $\beta \frac{G}{n}$ experimental dollars to each participant with probability p_g, where $G = \sum_{i=1}^{n} g$, β is the "efficiency factor" of the group account and n is the number of participants in the group. Contributions to the group account yielded the same return to all participants, irrespective of their contributions. Therefore, the group account exhibited the public goods' non-excludible and non-rival characteristics. At the end of each period, subjects learnt the aggregate level of contribution to the public good and their return from the private as well as the group account.

2.3 Formulation of the Social Dilemma

Individual i 's expected payoff is given by $E(u_i) = p_x \alpha x_i + p_g \beta \frac{G}{n}$. The subjects must maximize this payoff function, subject to a budget constraint ($\omega_i = x_i + g_i$), a public goods identity ($G = \sum_{i=1}^{n} g_i$), and a non-negativity constraint ($g_i \geq 0$).

Let's define M as the marginal per capita return (MPCR) – the amount that is generated for each member of the group when one individual contributes a token to the public good. It can also be seen as the marginal rate of substitution of the private good for the public good or as a measure of the incentives to contribute to the public good.[7] EM is the expected value of the marginal per capita return.

$$EM = E(M) = E\left(- \frac{\partial u_i / \partial G}{\partial u_i / \partial g_i} \right) = \frac{\beta p_g}{n \alpha p_x}$$

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[7] The MPCR was introduced by Isaac et al (1984).

In the baseline treatment, where $p_x = p_g = 1$, $EM = M$. The value of α and β may change from one treatment to the other but remain constant throughout each treatment.

The social dilemma arises if the parameters satisfy the inequality:

$$0 < \frac{\beta p_g}{n} < \alpha p_x < \beta p_g$$

In this case, a unit investment into the private account provides a subject with more payoff than a unit investment into the group account. On the other hand, taking from every participant a unit of the private investment and contributing it to the group account makes each participant better off. Thus, the unique dominant strategy is to free ride (i.e., zero contribution $g_i = 0$ for $\forall i$) while the socially optimal Pareto efficient solution requires every participant to contribute all their tokens to the group account (i.e., $g_i = \omega_i$ and $g_i \in I$ for $\forall i$).

2.4. Treatments

We examine 7 treatments in this paper. We controlled for order effects by switching the order in which subjects experienced the treatments. Using the terminology introduced by Knight (1921), treatments 2 and 3 replicate decision making with risk (known probabilities) involved whereas treatments 6 and 7 present decision making with uncertainty (unknown probabilities). Furthermore, treatments 4 and 5 replicate a situation when initially decision makers face uncertainty but can learn the exact probabilities and thereby reduce uncertainty to risk (endogenous probabilities).

2.4.1. Baseline (Treatment 1)

The baseline treatment (treatment 1) is a standard public goods game; there is no risk regarding return from the private or the group account. All parameters, (α , β , p_x and p_g) are known with certainty to the participants and $p_x = p_g = 1$, $\alpha = 1, \beta = 1.5$. There is no external uncertainty and the only uncertainty that is present in the game is internal uncertainty, which is kept constant throughout the following treatments. The expected marginal per capita ratio is $EM = M = 0.3$. The group payoff in case of Pareto efficient outcome would be 1.5 Experimental dollars for each group member for each period while the free riding Nash equilibrium would yield each subject 1 Experimental dollar per period. The parameters for $n = 5$ and $\omega_i = 100$ are summarized in Table 1.

2.4.2. Risk (Treatments 2 and 3)

In the risk treatments, the probability of obtaining the return from the private account (treatment 2) or the group account (treatment 3) is altered, while keeping everything else constant (including the marginal incentives to contribute). Participants will no longer be guaranteed the return from their investments. In treatment 2 the probability of return from the private account is reduced to $p_x = 0.5$ but it is held constant throughout the treatment and its value is known to all participants. For each period, the computer generated a random number, $r \in [0,1]$. If $r \le p_x$ then the investment multiplied by the efficiency factor on the private account (αx_i) was returned. Otherwise the investment into the private account was lost for the participants. The investment into the group account was returned with certainty $p_g = 1$ and the efficiency factor on the group account remained unchanged at $\beta = 1.5$. Similarly, in treatment 3 the return from the group account is no longer guaranteed but its probability is held constant and is known to all participants, $p_g = 0.5$. In order to preserve the value of $EM = 0.3$ and maintain the single-period dominant strategy of zero contributions and the Pareto efficient outcome at 100 percent contribution, the efficiency factor on the private and the group account was modified to $\alpha = 2$ and $\beta = 3$ in treatment 2 and 3, respectively. The parameters of the group account were held at the values of the baseline treatment, $p_x = 1$ and $\alpha = 1$. Similar to treatment 2, the return from the group account was determined by random number generation.

The external risk treatments model decisions where, based on past events and statistical analysis, decision makers can estimate the possible outcomes and the probability of occurrence of these outcomes. For example, several studies have been undertaken to estimate the costs, health related benefits and associated probabilities of certain automobile emissions standards (e.g. clean fuels, banning lead additives, reduction of carbon monoxide and volatile organic compounds). Decisions in such case are usually based on known probabilities, i.e. in the face of "risk".

2.4.3. External Uncertainty (Treatments 4 and 5)

In treatments 4 and 5, the probability of receiving the return from the investment is drawn from a uniform distribution in each period and is not displayed to participants. Therefore, there is uncertainty regarding the return from the investment into the private (treatment 4) and the group (treatment 5) accounts. To learn the exact probability of return, participants must pay a fee of $f = 20$ from their endowments. When participants choose to do so, the information regarding the probability of return from the private (p_x) and group (p_g) accounts is displayed on the computer screen in treatments 4 and 5, respectively. This information remains the private information of those participants that paid the fee for the information and they remain with $\omega_i - f = 80$ tokens to invest in the period.

These treatments allow us to divide the participants into two distinct groups: those who know the exact value of the probability (facing risk) and those who do not (facing uncertainty). At the end of treatments 4 and 5 a questionnaire was filled out by the participants to assess their "willingness-to-pay" for the information regarding the probability of return from the private and the group account, respectively.

Treatments 4 and 5 simulate scenarios when the probabilities of the environmental policy outcome are initially uncertain. Decision makers may invest into research in order to get estimates about the probabilities. For example, scientists may use paleoclimate data to analyze the relationship between world average surface temperatures and atmospheric carbon dioxide concentration. This analysis may be used to develop a probability that increased atmospheric carbon dioxide concentration will raise earth's future temperature. Research, however is costly, and will leave decision makers with less money to invest into mitigating the environmental problem itself.

2.4.4. Incentives (Treatments 6 and 7)

In treatments 6 and 7, participants have the opportunity to increase the probability of return from the private and the group accounts, respectively. In treatment 6, participants face an uncertainty regarding the probability of return from the private account. Similarly to the previous treatments, the probability initially is drawn from a uniform distribution. Participants, however, due to their individual investments into the private account, could increase the probability of return from the private account. Similarly, in treatment 7 a higher level of aggregate investment into the group account may lead to the increase of the initial probability of return from the group account.

The probability of return in each round is determined by the sum of a random number drawn from a uniform probability distribution and an increment due to the investment into the private (treatment 6) or the group account (treatment 7) in that round. That is, $p_{xi} = r\left(1+\frac{x_i}{2\omega}\right)$ and $p_g = r\left(1+\frac{G}{2n\omega}\right)$, respectively.

In treatment 6, therefore, depending on the individual investments, the participants may face differing levels of probabilities. Both the initial random number and the probability increment remain unknown to the participants until the end of the period. At the end of each period the computer displays the initial probability and the increase in probability of return from the private and the group account in treatment 6 and 7, respectively.

The incentives treatments mainly reflects cases when technological advancement increases the probability of obtaining the benefits from the environmental project. For example, the problem of stratospheric ozone depletion caused by CFCs has been addressed effectively, in part, because of the development of substitute chemicals in response to the change in the regulations. A key to successful innovation is harnessing human ingenuity by international cooperation for the collective good. Treatment 7 models cases where innovations that have an impact on a global scale are involved. The reward for innovation and research and development in this paper is increased probability of obtaining the desired environmental outcome.

In summary, in treatments 2 to 7 we vary external risk and uncertainty on the private and the group accounts while keeping the internal uncertainty and the expected payoff (together with the marginal incentives to contribute) equivalent to that in the Baseline treatment.

2.5. Hypotheses to be Tested

Hypothesis 1: In payoff equivalent situations, subjects contribute less to the global good (group account) when risk or uncertainty is associated with the global good than when risk or uncertainty is associated with the local good (comparing treatment 2 with 3; and treatment 4 with 5)

Hypothesis 2: In payoff equivalent situations, subjects contribute less to the global good (group account) when they face endogenous probability of provision of the global good than when they face endogenous probability of provision of the local good (private account) (comparing treatment 6 with 7)

Hypothesis 3: In payoff equivalent situations, subjects' contribution level to the local good (private account) is lower when facing uncertainty than when facing risk (comparing treatments 2 and 4)

Hypothesis 4: In payoff equivalent situations, subjects contribution level to the global good (group account) is lower when facing uncertainty than when facing risk (comparing treatments 3 and 5)

Hypothesis 5: In payoff equivalent situations, when probabilities are endogenous, i.e. subjects can increase the probability of provision of the local good (return from private account) subjects' contribution to the local good will be higher than that when facing risk or uncertainty (comparing treatment 6 with 2 and 4)

Hypothesis 6: In payoff equivalent situations, when probabilities are endogenous, i.e. subjects can increase the probability of provision of the global good (return from group account) subjects' contribution to the global good will be higher than when facing risk or uncertainty (comparing treatment 7 with 3 and 5).

3. Results

We start with an overview of the data collected from the experiments, then report results from econometric tests which examine the impact of risk, uncertainty and incentives on individual behaviour.

3.1. Overview

Table 2 and Figure 1 present the average proportional contributions to the local and the global goods as a percentage of their endowments, for all treatments.[8] The dark parts of the column illustrate the proportion of the endowment contributed to the global good. In all treatments except 2 and 4 the contribution to the global good is approximately 20 percent. In treatments 2 and 4, where there is risk or uncertainty associated with the local good, the average contribution towards the global good reaches approximately 50 percent. Subjects seem to move away from the risky or uncertain local good and contribute more towards the global good.

Figure 2 tracks the average contributions to the global good over the 15 periods in each treatment and confirms the much higher contributions in treatments 2 and 4. Contributions start at a higher point and gradually taper down by the end of the session. Figure 3 depicts the deviation from the Baseline treatment. Since the baseline treatment (treatment 1) is a pure internal uncertainty treatment (there is no external uncertainty) and

[8] In the Uncertainty treatments (treatments 4 and 5), subjects may choose to pay a fee of 20 experimental dollars from their endowment to reveal the probability associated with the local and the global good respectively. The proportional contribution takes account of the fact that in these two treatments some subjects have only 80 experimental dollars to place in the local and global account.

the internal uncertainty is kept constant throughout treatments 2-7, the deviation from the Baseline treatment could be considered to be solely the affect of the external risk and uncertainty. Except in treatment 2 and 4, when the risk and the uncertainty is related to the return from the local good, the contribution levels are below that in the Baseline treatment.

Figures 4 and 5 show the decisions made by subjects under risk (i.e., known probability) versus uncertainty (i.e., unknown probability). The probability was revealed to those subjects who chose to pay a fee for it and thus they no longer face “uncertainty” but “risk”. Both Figures 4 and 5 show a difference in the pattern of the contribution levels to the global good when the probability of return from the local (treatment 4) and global goods (treatment 5) is known (subjects facing “risk”, marked by diamond shape) or unknown (subjects facing “uncertainty”, marked by rectangular shape). Subjects who face risk have a slope-like pattern in their decisions: when the probability of return on the local good is high the contributions to the global good are low. In contrast, those who make decisions in the face of uncertainty, tend not to have any pattern in their behavior. The contributions levels seem to be randomly distributed. Similar to Figure 4, Figure 5 shows the average contributions for treatment 5, separated for risk and uncertainty. Comparing Figures 4 and 5, it is clear that the contributions to the global good are systematically lower in treatment 5. It is interesting to observe that there are a few subjects who were willing to pay for the information about the probability of return from the local or the global good in treatment 4 and 5, respectively but the information did not seem to play a role in their decisions. The investments displayed in the lower left (Figure 4) and the lower right (Figure 5) corners represent subjects who were willing to pay 20 experimental dollars for the information about the probability of return from the local or global good, respectively. However, even when the probability of return from the local good was very low $(0 \leq p_x \leq .3)$ or the probability of return from the global good was very high $(.7 \leq p_g \leq 1)$ these subjects invested either all or a substantial part of their remaining tokens into the local good. The interesting thing is not their investment decision, *per se*, but the fact that they were willing to pay for the information about the probabilities despite the fact this information did not seem to play a role in their decisions. Both cases may also be understood as a high aversion from the internal uncertainty. So even when external probabilities are unfavorable, they are still more attractive than internal uncertainty (i.e., contribution to the global good).

3.2. Econometric Tests

To examine whether our data support the six hypotheses outlined above, we present results from very conservative pairwise t-tests and non-parametric Wilcoxon rank-sum tests. These statistical tests use one observation per treatment per session. The non-parametric tests are particularly valuable as they require a minimum of statistical assumptions. In addition we also report results from multivariate regression models. These models evaluate the contribution of the (potential) impact of multiple influences on the decisions of subjects. These panel regressions employ a random effects error structure, with the subject representing the random effect. We present results from random effects generalized least squares regression where the dependent variable is the individual contributions made to the global good as a proportion of the total endowment. We also present estimates from a random effects tobit model, as the dependent variable, being a proportion is censored and takes values between 0 and 1. Apart from the treatment dummy the other regressors included are: inverse of time period $(invperiod)$ to capture the dynamic elements of the data $(1/t)$, whether the random outcome was such that it resulted in the provision of the global good in the previous period: a binary variable $(lout)$, the difference between the amount contributed to the global good by an individual in the previous period and the group contribution in the previous period $(ldeviation)$, the increase in probability achieved in the previous period by the investments in treatment 6 and 7 $(lprobincr)$, the expected marginal per capita ratio (EM) and individual specific characteristics. The individual characteristics are age, gender and their attitudes towards risk as captured by the lottery game conducted before the experiment. From the results obtained from the lottery game, subjects could be classified into three categories: risk averse, risk neutral and risk lovers. This is an individual specific risk measure and allows us to control for their risk attitudes. We define dummies for risk averse and for risk neutral subjects and include these in the regression.[9] [10]

Tables 4, 5A and 5B report results from pairwise regressions and Table 6 presents results from pooled regressions where we include the data for all the treatments and introduce treatment dummies (T2 to T7), with treatment 1 as the baseline dummy to examine how subjects behave in the different treatments. In Table 6 we show results from

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[9]The explanatory variables used to understand behavior vary depending on the treatments being considered. For example, $lprobincr$ is used only when comparing treatments 6 and 7, EM is used only in regressions comparing treatments 2 and 4 and treatments 3 and 5, in regressions where we separate the data for subjects who want to know the probability they face.

[10] Since subjects participated in the seven treatments in different order we conducted statistical tests to determine if the order in which they participated had an impact on contribution levels in the different treatments and found that the order had no behavioral implications.

different model specifications which are reported to indicate the robustness of the results.[11] The pooled results are consistent with the pairwise regressions reported.

Results relating to the first two hypotheses are reported in Tables 3 and 4. These hypotheses examine the impact of the location of the risk and uncertainty, ie whether it is associated with the local or the global good. Both the statistical tests (t-tests and the Wilcoxon tests) and the regression results provide strong support for Hypothesis 1. The dummy for treatment 3 and for treatment 5 are negative and statistically significant.[12]

Hypothesis 2 relating to the incentives treatments is not supported by the data. The point estimates show that the average contributions to the global good are higher in treatment 7 than in treatment 6, although the difference is not statistically significant. The regression results however show that the contributions to the global good are significantly higher in treatment 7. This is the only treatment in which even though subjects face uncertainty in the global good, they contribute about the same as they do when they face uncertainty in the local good (treatment 6). The subjects in this treatment perhaps think that they can make a difference by contributing more to the global good and increasing the probability of return. They think that they have some control over the uncertainty. Hence when there is an opportunity to benefit from common international innovations and technology improvement, it could act as an incentive to deal with global

[11] Model 1 in Table 6 includes only time and the treatment dummies, Model 2 adds lagged variables (*lout*, *ldeviation*) and Model 3 adds the individual specific characteristics. The results are robust to these additions. We also conducted these robustness tests for the pairwise regressions reported in Tables 4 and 5A and 5B, but do not present them in the paper to conserve space. Again the results are robust to different model specifications.

[12] In additional regressions we only include the subjects who paid a fee to reveal the probability they were facing in treatments 4 and 5, since subjects who learnt the probabilities associated with the local (treatment 4) and the global good (treatment 5) behave systematically different from those who are unaware of such information. The results for these are presented in Table 6 (Model 4). The dummy for treatment 5 is negative though not significant in this sub sample.

environmental problems like climate change. So the fact that the international cooperation will bring amplified benefit to the participants could increase the willingness to contribute to the solution of the global environmental problem.

Results associated with Hypotheses 3-6, which examine whether individuals behave differently when they face risk, uncertainty or can change the probability they face, are presented in Tables 3, 5A and 5B . Hypothesis 3 is not supported by the tests and the regression results (dummy for treatment 4 is negative and significant and not positive as the hypothesis would suggest.). This could be evidence of positive optimism or wishful thinking. In treatment 2 subjects know that they have only 50% chance of obtaining the good. In treatment 4 subjects face uncertainty and in this case they could weight the high end of the distribution more. Subjects seem to interpret uncertainty in a way to justify their deceased level of contribution to the global good. These results also corroborate with Rapoport *et al.* (1992) and Suleiman *et al*. (1996) who showed in a common pool resource game context that with increased level of environmental uncertainty the resource request from the common pool resource increased. It seems that when subjects estimate the probabilities, they have the tendency to over or under estimate it depending on what they hope for.[13]

The regression results support Hypothesis 4. The dummy for treatment 5 is negative and significant, indicating the contributions to the global good are lower when subjects face uncertainty as compared to risk. The point estimates for the statistical tests also support this hypothesis however the difference is not statistically significant. Here as

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[13] In Table 5A we also present results from regressions where we include only individuals who pay to know the probability in treatment 4 and compare to behavior in treatment 2. The dummy for treatment 4 retains its negative and significant pattern.

the uncertainty is associated with the global good, subjects perhaps perceive the probabilities differently, expecting it to be near the low end of the distribution. Separating the data for subjects who want to know in treatment 5 (Table 5A columns 6 and 7), we find that for subjects who choose to convert uncertainty into risk, the contributions are not lower in treatment 5. These subjects paid a fee to know the probability so they are perhaps the subjects who would be more aware about contributions to the global good relative to those who did not even pay the fee. This may explain the statistically significant increase in contribution levels relative to treatment 3 (according to the GLS estimate). Essentially, however, for subjects who chose to know the probability, treatments 3 and 5 are the same so the contribution levels for these subjects should be the same (and this is confirmed by the tobit estimates). This gives additional support for hypothesis 4, as it indicates that it is uncertainty that is driving contributions to be lower in treatment 5 as compared to treatment 3.

We obtain strong support for Hypothesis 5. Both the statistical tests and the regressions (Table 5B) show that contributions to the global good in treatment 6 are significantly lower than in treatments 2 or 4. In treatment 6 subjects can increase the probability of return they face if they invest more in the local good. This incentive crowds out the contribution to the global good.

Hypothesis 6 is supported by the regression results (Table 5B), which show that contributions in treatment 7 are significantly higher than contributions in treatments 3 and 5. The point estimates confirm this however the differences in contributions are not statistically significant using the t-tests and wilcoxon tests.

Other Regressors: The results from the multivariate regressions show that the time variable is positive and highly significant implying that contributions to the global good decay over time.[14] The variable which measures whether the good was provided in the previous period (*lout*) is positive and significant in some regressions, indicating that a provision of the good in the previous period increases the contribution to the global good in the current period.[15] Deviation (*ldeviation*) which captures the difference between the individual and group contribution in the previous period is very substantial in explaining contributions, with a higher level of deviation leading to higher contributions in this period. This result is appealing intuitively since it suggests that people use feedback from other members of the group when deciding future contribution levels. The feedback is used by the subjects as information about the internal uncertainty and such information seems to guide subjects in their decision. These results are consistent with Dickinson (1998) who also finds that the deviation of a person's contributions in the previous round from the group affects individual contributions. Furthermore, they confirm Festinger's (1954) conjecture that the more uncertain people are in their knowledge about the task, the more likely it is that they will try to reduce their uncertainty via information on how others respond. In sum, information on fellow group members' cooperation seems to serve as a means of how to deal with the uncertainty. The variable *lprobincr*: which captures the impact of the lag of the increase in probability in the provision of the good, shows that as the probability in the previous period increases, the contributions increase

[14]The specification of this variable captures the non-linearity in the data. Figure 2 indicates that contributions have a non-linear pattern with a sharper drop in the early periods and a more gradual decline in the later period for most treatments, hence this particular specification was used to highlight the time element of the contributions.

[15] This variable however does not have a consistent pattern across regressions.

in this period. The variable, EM is positive and highly significant in explaining contributions.[16] This result corroborates previous findings (e.g. Dickinson, 1998) and suggests that even when the dominant strategy of Nash equilibrium of zero contribution is maintained, higher marginal incentives, *per se*, significantly increased contribution levels. Individual level characteristics like age, gender and risk behavior of the subject do not provide a consistent pattern of behaviour.[17]

4. Conclusions

We use laboratory experiments and a standard public goods game to examine the decisions of subjects when facing both internal (strategic) and external (environmental) risks and uncertainties. We keep the internal uncertainty constant throughout the seven treatments and introduce different forms of risk and uncertainty regarding the provision of local and global environmental goods. We find that even in a payoff equivalent situation, external risk and uncertainty associated with both local and global environmental problems act as a significant factor when making decisions, with subjects moving away from the external uncertainty or risk. The location of the external risk or uncertainty matters, with subjects moving away from the external uncertainty in favor of

[16] Several studies (for example, Isaac et al., 1984 and Kim and Walker, 1984) have investigated the importance of marginal incentives (EM) on contribution levels. In the results reported in the paper, we include EM as an explanatory variable in regressions where we only have data on individuals who want to know the probability they face.

[17] These individual specific variables are sometimes significant in the tobit regressions. Risk behavior matters, with risk averse subjects (74% of our sample) contributing less and risk neutral subjects (10% of our sample) contributing significantly more than risk loving subjects (16% of our sample). It seems that risk neutral subjects see the underlying payoff equivalence between the treatments and they also see that regardless of the risk associated with the returns, the underlying problem is a public goods game with Pareto efficient contribution levels of 100%. Risk averse subject, however, divert away from not only the external risk and uncertainty but also from the internal uncertainty associated with contributing to the global good.

internal uncertainty, when that uncertainty relates to the local good. When it relates to the global good, then subjects face internal and external uncertainty on the same global good leading to a complete collapse of the contributions towards this good. These results are in line with the observation of Wit and Wilke (1998) who found a dramatic drop in the contribution levels when high external variability was coupled with internal uncertainty. Our results also confirm the observation in Rapoport et al. (1992) and Suleiman et al. (1996) that when subjects had to interpret different forms of uncertainty they had a tendency to bias their estimates by what they hoped for ("wishful thinking").

The long period between when the Kyoto Protocol was negotiated in 1997 and its final entry into force in 2005 has been compared unfavorably with the rapid formal recognition and overwhelming success of the Montreal Protocol which banned CFCs, primarily responsible for depletion of the ozone layer. While both negotiations involved strategic uncertainty, the two global environmental problems differed in the degree of knowledge about the environmental uncertainties. While climate change is undoubtedly a case of "uncertainty" (treatment 5), the ozone layer depletion is more characterized as "risk" (treatment 3). This study explains the difference in the success of the environmental negotiations by the results that when internal (strategic) uncertainty is coupled with external (environmental) uncertainty, the contribution levels are close to zero, and this is more so when individuals face external uncertainty as compared to external risk. Our results suggest that it was not the internal uncertainty, *per se*, but the presence of the external uncertainty that led to the long period of negotiations on climate change.

In the Incentives (endogenous probability of provision) treatment, subjects contribute more than they do in the other treatments, i.e. when given a chance to reduce the uncertainty relating to the global environmental good subjects contribute more (comparing treatments 5 and 7 and treatments 7 and 3). This relates to the role of innovation in determining environmental outcomes. The reward for research and development and innovation is captured here by the increased probability of obtaining the desired environmental outcome in the endogenous probability treatment. Subjects seem to understand this incentive and contribute more towards global goods in this treatment.

Subjects are willing to pay a fee to reveal the uncertainty in treatments where the uncertainty relates to a local good rather than a global good. Interestingly, we find that some subjects are willing to pay to avoid uncertainty (unknown probabilities) in favor of risk (known probabilities) even if such probabilities play little role in their decision making. This may explain the ambivalent behavior of governments of being committed to financing research on environmental problems, yet placing little importance on the scientific results when having to make decisions. (The climate change research and US and Australian governments are good examples.) We also find that information on fellow group members' cooperation seems to serve as a norm of how to deal with uncertainty. This indicates that transparency of international environmental negotiations could serve as an important factor in the success of the negotiations, since participants use the contributions of other group members as yardstick when facing internal (strategic) and external (environmental) uncertainty.

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Tables

Table 1. Treatment parameterization

Treatment		α	β	p_x		p_g	
Baseline	**1**	1	1.5	1	Known	1	Known
Risk	**2**	2	1.5	0.5	Known	1	Known
	3	1	3	1	Known	0.5	Known
Uncertainty	**4**	2	1.5	$p_x = r_x$ uniform distribution $r_x \in (0,1)$	Unknown, unless requested	1	Known
	5	1	3	1	Known	$p_g = r$ uniform distribution $r_g \in (0,1)$	Unknown, unless requested
Incentives	**6**	2	1.5	$p_{xi} = r_x + f(x_i)$	Unknown	1	Known
	7	1	3	1	Known	$p_g = r_g + f(G)$	Unknown

Table 2.Total and mean investment into the private and the group accounts

Treatment	Investment into the Private Account		Investment into the Group Account		St Dev (Priv and Group Accounts)
	Total	Mean	Total	Mean	
1	56539	75.39	18461	24.61	32.66
2	36449	48.60	38551	51.40	38.26
3	65664	87.55	9336	12.45	21.74
4	41230	54.97	33770	45.03	41.90
5	67269	89.69	7731	10.31	22.89
6	63928	85.24	11072	14.76	26.07
7	62976	83.97	12024	16.03	28.31
Total	394055	75.06	130945	24.94	

Table 3. Pairwise t-tests and non-parametric Wilcoxon rank-sum tests for the difference in means

Treatment	1	2	3	4	5	6
2	3.379*** 2.721***					
3	-1.873* -1.739*	-5.790*** -3.628***				
4	2.899*** 2.343***	-0.879 -0.983	5.758*** 3.780***			
5	-2.237** -2.192**	-6.197*** -3.704***	-0.443 -0.302	-6.265*** -3.780***		
6	-1.540 -1.285	-5.521*** -3.704***	0.478 0.680	-5.454*** -3.628***	0.947 0.983	
7	-1.140 -1.361	-4.562*** -3.099***	0.570 0.151	-4.236*** -2.948***	0.926 0.756	0.205 -0.151

Note: The pairwise estimates use the horizontal as the comparison base. The first number reported in each cell is the t-statistic and the second number reported is the z-statistic from the Wilcoxon rank-sum test.
*** significant at the 1% level
** significant at the 5 % level
* significant at the 10 % level

Table 4. Pairwise GLS and Tobit estimates

	Treatment 2 & 3		Treatment 4 & 5		Treatment 6 & 7	
	GLS	TOBIT	GLS	TOBIT	GLS	TOBIT
Invperiod	0.4607***	0.7925***	0.2654***	0.6170***	0.3204***	0.9573***
	(0.0527)	(0.0937)	(0.0646)	(0.1501)	(0.0416)	(0.1061)
Treatment	-0.3883***	-0.6099***	-0.3412***	-0.7204***	0.0307**	0.0950***
	(0.0125)	(0.0237)	(0.0153)	(0.0400)	(0.0122)	(0.0308)
Lout	0.0425***	0.0721***	0.0053	0.0115	-0.0118	0.0004
	(0.0126)	(0.0227)	(0.0154)	(0.0370)	(0.0106)	(0.0310)
Deviation	0.0047***	0.0063***	0.0038***	0.0056***	0.0044***	0.0068***
	(0.0003)	(0.0005)	(0.0004)	(0.0009)	(0.0003)	(0.0008)
Sex	-0.0002	0.1405***	0.0277	-0.0984*	0.0246	0.3699***
	(0.0342)	(0.0269)	(0.0304)	(0.0587)	(0.0305)	(0.0542)
Age	-0.0001	-0.0054**	0.0029	0.0013	0.0102***	0.0152***
	(0.0032)	(0.0023)	(0.0028)	(0.0041)	(0.0028)	(0.0042)
risk_av	0.0166	-0.1030***	0.0166	0.0930	-0.0347	-0.0432
	(0.0459)	(0.0372)	(0.0409)	(0.0733)	(0.0410)	(0.0568)
risk_neutral	0.0432	0.0580	0.1506**	0.5188***	0.0724	0.1082
	(0.0681)	(0.0495)	(0.0606)	(0.0914)	(0.0607)	(0.0662)
Lprobincr					0.0024***	0.0060***
					(0.0007)	(0.0020)
Constant	0.3944***	0.4143***	0.2868***	-0.0355	-0.1629**	-0.9051***
	(0.0826)	(0.0631)	(0.0744)	(0.1130)	(0.0745)	(0.1956)
Observations	1400	1400	1400	1400	1400	1400
Number of group(session subject)	50	50	50	50	50	50
χ^2	1316.68	919.38	639.39	404.32	353.69	353.29
Prob > χ^2	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes: *: Significant at the 10% level; **: Significant at the 5% level; ***: Significant at the 1% level.

Numbers in paranthesis are standard errors.

Table 5A.

	Treatment 2 & 4#			Treatment 3 & 5			
	GLS	Tobit	GLS	GLS	Tobit	GLS	Tobit
invperiod	0.5059***	0.8869***	0.4568***	0.2344***	0.5461***	0.2890***	0.5739***
	(0.0704)	(0.1324)	(0.0756)	(0.0375)	(0.0841)	(0.0468)	(0.0896)
treatment	-0.0665***	-0.1132***	-0.1633***	-0.0225**	-0.0826***	0.1062***	0.0304
	(0.0167)	(0.0318)	(0.0224)	(0.0089)	(0.0210)	(0.0220)	(0.0420)
Lout	0.0671***	0.1378***	0.0618***	-0.0203**	-0.0690***	-0.0209*	-0.0512**
	(0.0168)	(0.0319)	(0.0178)	(0.0090)	(0.0212)	(0.0117)	(0.0236)
Deviation	0.0029***	0.0045***	0.0026***	0.0034***	0.0044***	0.0035***	0.0039***
	(0.0004)	(0.0007)	(0.0004)	(0.0003)	(0.0006)	(0.0004)	(0.0006)
Sex	0.0226	-0.0684*	0.0153	0.0077	0.0351	-0.0064	0.0942**
	(0.0443)	(0.0398)	(0.0477)	(0.0209)	(0.0251)	(0.0242)	(0.0426)
Age	0.0035	0.0100***	0.0002	0.0003	-0.0044**	0.0010	-0.0047*
	(0.0041)	(0.0034)	(0.0045)	(0.0019)	(0.0020)	(0.0023)	(0.0025)
risk_av	0.0590	0.0319	0.0683	-0.0219	-0.0339	-0.0287	0.0649
	(0.0596)	(0.0544)	(0.0638)	(0.0281)	(0.0359)	(0.0327)	(0.0473)
risk_neutral	0.1211	0.2959***	0.1004	0.0841**	0.0908**	0.0499	0.0680
	(0.0883)	(0.0721)	(0.0944)	(0.0417)	(0.0445)	(0.0479)	(0.0444)
EM			0.7325***			1.7056***	2.6959***
			(0.0393)			(0.1085)	(0.2248)
Constant	0.2450**	-0.1525	0.1080	0.0896*	-0.1838***	-0.4336***	-1.0548***
	(0.1074)	(0.0971)	(0.1167)	(0.0508)	(0.0609)	(0.0668)	(0.0999)
Observations	1400	1400	986	1400	1400	771	771
χ^2	159.54	166.18	447.56	174.11	133.51	440.35	254.31
Prob > χ^2	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes:

#: We could not run the Random Effects Tobit regression because of convergence problems. *: Significant at the 10% level; **: Significant at the 5% level; ***: Significant at the 1% level. Numbers in paranthesis are standard errors.

Table 5B.

	Treatment 2 & 6		Treatment 4 & 6#	Treatment 3 & 7		Treatment 5 & 7	
	GLS	Tobit	GLS	GLS	Tobit	GLS	Tobit
invperiod	0.4477***	0.9322***	0.3682***	0.3445***	0.7706***	0.2299***	0.6789***
	(0.0559)	(0.1093)	(0.0630)	(0.0379)	(0.0854)	(0.0391)	(0.0983)
treatment	-0.3769***	-0.7049***	-0.3040***	0.0260***	-0.0014	0.0481***	0.0830***
	(0.0134)	(0.0296)	(0.0153)	(0.0090)	(0.0214)	(0.0092)	(0.0248)
lout	0.0404***	0.0830***	0.0140	-0.0045	0.0035	-0.0138	-0.0154
	(0.0139)	(0.0278)	(0.0156)	(0.0092)	(0.0218)	(0.0094)	(0.0251)
Deviation	0.0043***	0.0069***	0.0034***	0.0037***	0.0045***	0.0025***	0.0038***
	(0.0003)	(0.0006)	(0.0003)	(0.0003)	(0.0006)	(0.0003)	(0.0006)
Sex	0.0314	-0.0002	0.0492	-0.0069	-0.1457***	-0.0002	-0.0137
	(0.0327)	(0.0543)	(0.0319)	(0.0318)	(0.0328)	(0.0355)	(0.0368)
Age	0.0057*	0.0211***	0.0103***	0.0045	0.0184***	0.0038	0.0002
	(0.0030)	(0.0030)	(0.0030)	(0.0030)	(0.0023)	(0.0033)	(0.0023)
risk_av	0.0310	0.1940***	0.0322	-0.0523	0.0429	-0.0457	0.2881***
	(0.0440)	(0.0596)	(0.0429)	(0.0427)	(0.0361)	(0.0477)	(0.0542)
risk_neutral	0.0408	0.0069	0.1016	0.0794	0.1439***	0.1296*	0.2084***
	(0.0652)	(0.0877)	(0.0636)	(0.0633)	(0.0506)	(0.0707)	(0.0528)
EM							
Constant	0.2437***	-0.4194***	0.0827	-0.0029	-0.6576***	0.0016	-0.4541***
	(0.0794)	(0.0884)	(0.0782)	(0.0765)	(0.0695)	(0.0854)	(0.0716)
Observations	1400	1400	1400	1400	1400	1400	1400
χ^2	1073.77	773.19	568.92	264.76	265.26	139.65	142.45
Prob> χ^2	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Notes:

#: We could not run the Random Effects Tobit regression because of convergence problems. *: Significant at the 10% level; **: Significant at the 5% level; ***: Significant at the 1% level. Numbers in paranthesis are standard errors.

Table 6. Random Effects GLS and Tobit estimates for the individual contribution levels

	Model 1		Model 2		Model 3		Model 4	
Variables	**GLS**	**Tobit**	**GLS**	**Tobit**	**GLS**	**Tobit**	**GLS**	**Tobit**
Invperiod	0.226*** (0.016)	0.490*** (0.033)	0.369*** (0.030)	0.811*** (0.065)	0.369*** (0.030)	0.808*** (0.065)	0.003 (0.128)	0.140 (0.290)
T2	0.267*** (0.014)	0.438*** (0.029)	0.279*** (0.014)	0.435*** (0.029)	0.279*** (0.014)	0.440*** (0.029)		
T3	-0.122*** (0.014)	-0.251*** (0.031)	-0.108*** (0.014)	-0.209*** (0.031)	-0.108*** (0.014)	-0.208*** (0.031)		
T4	0.204*** (0.014)	0.335*** (0.029)	0.211*** (0.014)	0.332*** (0.029)	0.211*** (0.014)	0.335*** (0.029)		
T5	-0.143*** (0.014)	-0.356*** (0.032)	-0.131*** (0.014)	-0.312*** (0.032)	-0.131*** (0.014)	-0.308*** (0.032)	-0.043 (0.044)	-0.025 (0.097)
T6	-0.099*** (0.014)	-0.274*** (0.032)	-0.093*** (0.013)	-0.275*** (0.031)	-0.093*** (0.013)	-0.271*** (0.031)		
T7	-0.086*** (0.014)	-0.246*** (0.032)	-0.081*** (0.014)	-0.233*** (0.031)	-0.081*** (0.014)	-0.228*** (0.031)		
Lout			0.017** (0.008)	0.040** (0.017)	0.016** (0.008)	0.044** (0.018)	-0.038 (0.031)	-0.075 (0.069)
ldeviation			0.004*** (0.000)	0.007*** (0.000)	0.004*** (0.000)	0.007*** (0.000)	0.000 (0.001)	0.002 (0.002)
Sex					0.006 (0.029)	0.070* (0.020)	0.038 (0.064)	0.083 (0.153)
Age					0.004 (0.003)	-0.003* (0.005)	-0.005 (0.008)	-0.009 (0.017)
risk_av					-0.008 (0.040)	0.005 (0.025)	0.078 (0.082)	0.154 (0.199)
risk_neutral					0.092 (0.059)	0.167** (0.032)	0.155 (0.108)	0.325 (0.231)
EM							0.773*** (0.040)	1.852*** (0.135)
Constant	0.196*** 0.023	-0.220*** (0.030)	0.156*** (0.019)	-0.101*** (0.030)	0.057*** (0.072)	0.275 (0.053)	0.121 (0.189)	-0.429 (0.408)
χ^2 Prob > χ^2	1933.99 0.000	1359.94 0.000	2748.52 0.000	184.60 0.000	2757.27 0.000	1752.41 0.000	394.50 0.000	191.69 0.000

Notes: For Model 3, Tobit: Pairwise tests within pooled regressions: Test T2=T3, $\chi^2(1)$= 491.76 ***; Test T4=T5, $\chi^2(1)$= 444.49 ***; Test T6=T7, $\chi^2(1)$= 1.84; Test T2=T4, $\chi^2(1)$= 14.61 ***; Test T3=T5, $\chi^2(1)$= 10.08 ***; Test T2=T6, $\chi^2(1)$= 543.66 ***; Test T4=T6, $\chi^2(1)$= 392.08 ***; Test T3=T7, $\chi^2(1)$= 0.39; Test T5=T7, $\chi^2(1)$= 6.33 ***.

*: Significant at the 10% level; **: Significant at the 5% level; ***: Significant at the 1% level. Numbers in paranthesis are standard errors.

Figures

Figure 1. Proportional Investment into the Private and the Group Accounts

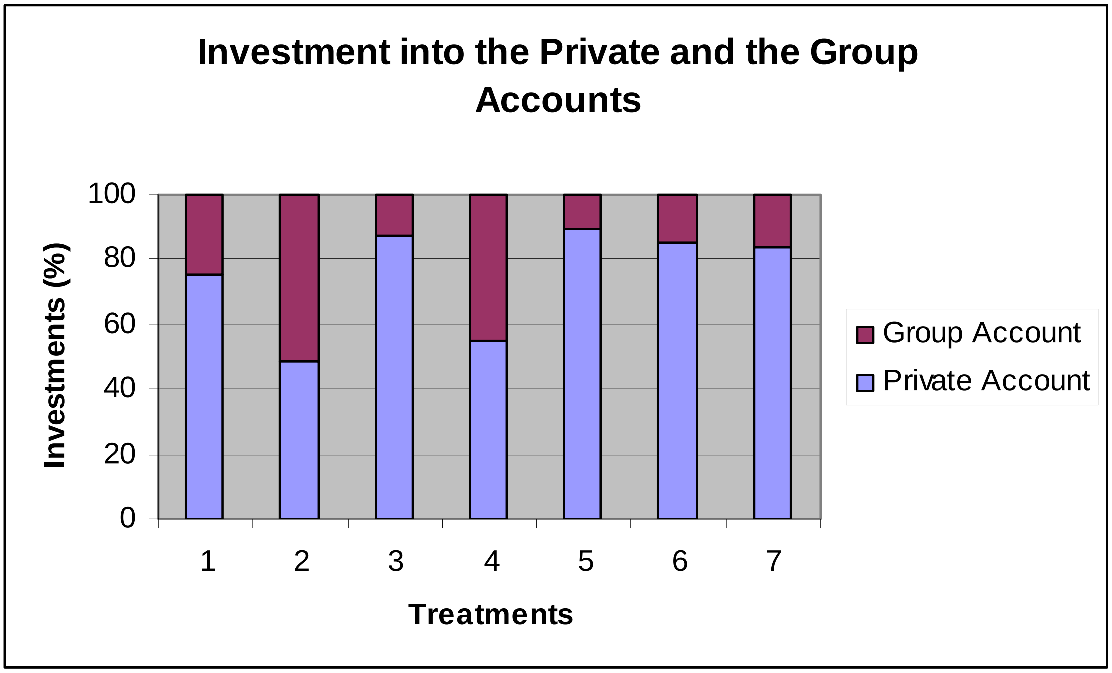

Figure 2. Average contribution levels over the fifteen periods

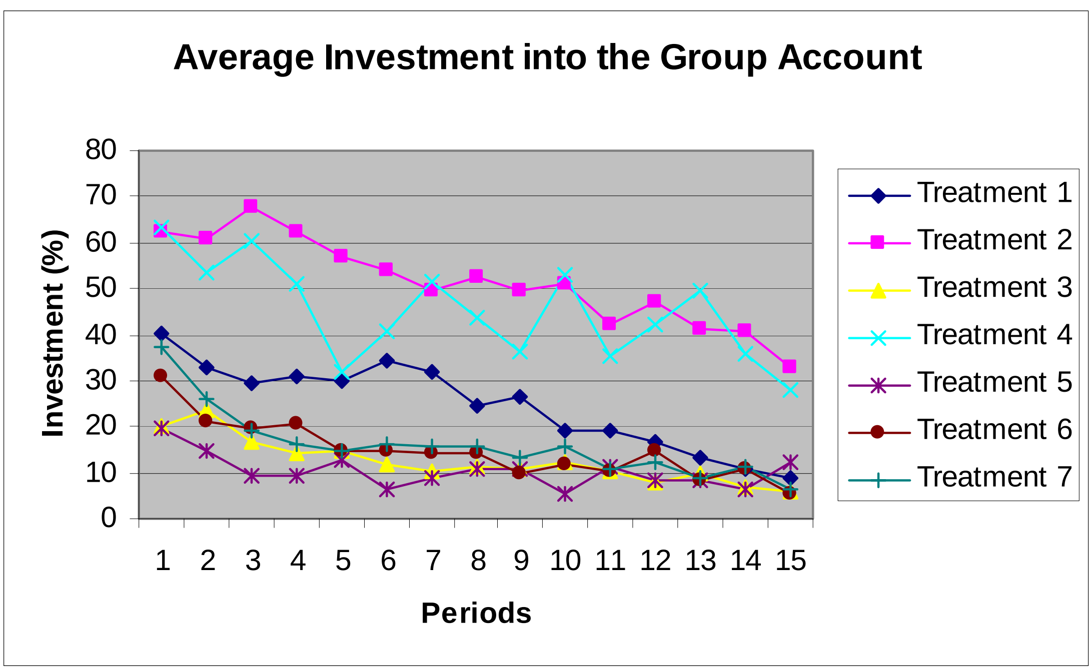

Figure 3. Average contribution levels relative to the Baseline treatment

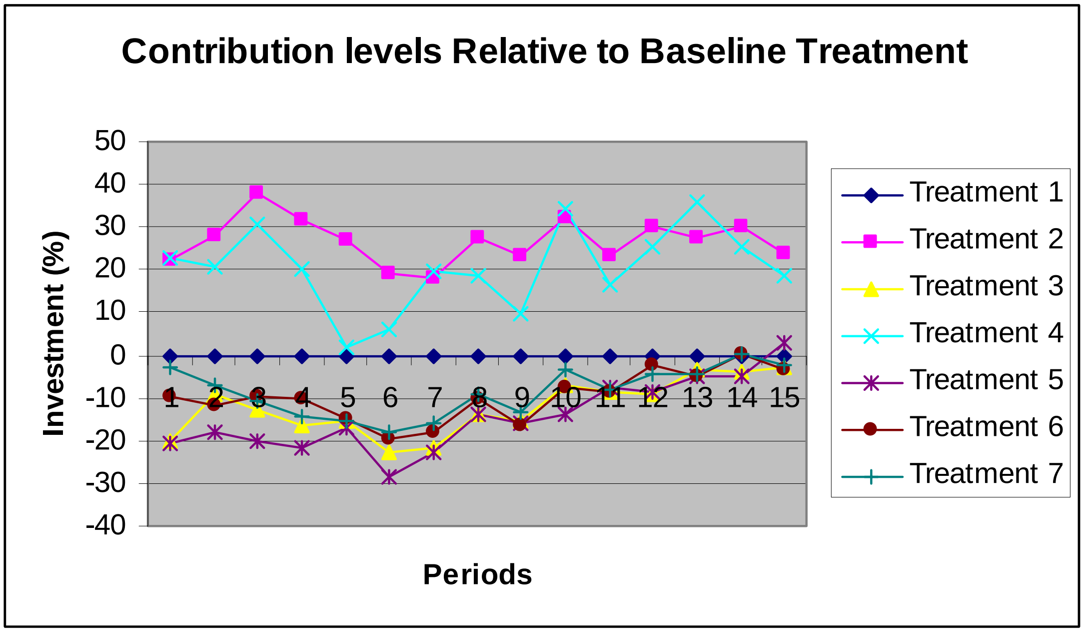

Figure 4. Investment into the Group Account in Environmental Risk and Uncertainty (treatment 4)

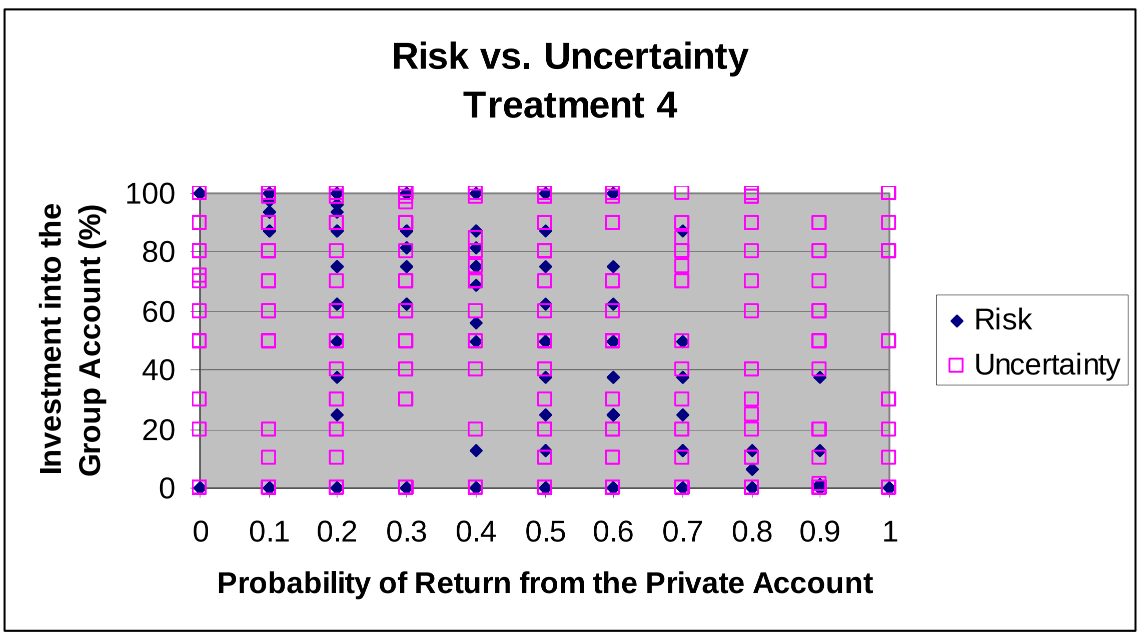

Figure 5. Investment into the Group Account in External Risk and Uncertainty (Treatment 5)