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Abstract

We use behavioral and experimental economics to study a particular aspect of the economics of climate change: the potential tradeoff between countries' investments in mitigation versus adaptation. While mitigation of greenhouse gases can be viewed as a public good, adaptation to climate change is a private good, benefiting only the country or the individual that invests in adaptation. We use a one-shot public-goods game that deviates from the standard public-goods game by introducing a stochastic term to account for probabilistic destruction in a climate-change setting. Probability density function is mapped to within-group levels of mitigation. We compare low-vulnerability and high-vulnerability treatments by varying the magnitude of disaster across treatments. Our results show that there is no significant difference in the level of mitigation across these treatments. Further, our results emphasize the important role of trust in enhancing cooperation.

Key Words: Public good, climate change, mitigation, adaptation, experiment, risk

JEL Classification: Q54, H41, D03

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Introduction

Climate change is most likely the greatest social dilemma in history: each country and individual faces private costs to reduce greenhouse gas emissions, while the benefits of such mitigation efforts are shared by all countries and individuals, regardless of their own contributions. Hence, what is rational on individual and country levels is not globally optimal.

Although climate-change analysis is a growing area of economic research, it has been surprisingly underinvestigated within the subdiscipline of experimental and behavioral economics, except in the area of permit trading in the context of climate change (see, e.g., Bohm and Carlen 2002; Cason 2003; Cramton and Kerr 2000; Wråke et al. 2008). Also, several studies in the experimental and behavioral economics literature concern climate change, offering important insights regarding the behavior of individuals and nations regarding climate change (specifically, Brekke and Johansson-Stenman 2008). Such results are related to the effect of conditional cooperation (e.g., Gächter 2007; Fischbacher, Gächter, and Fehr 2001), reciprocity (e.g., Falk and Fischbacher 2006; Fehr and Gächter 2000b), and trust (e.g., Gächter, Herrmann, and Thöni 2004). Conditional cooperation, reciprocity, and trust have been shown to explain a large part of the (nonrational) positive cooperation levels found in both field and laboratory experiments.

In this paper, we use behavioral and experimental economics to study a particular aspect of the economics of climate change: the potential tradeoff between countries' investments in mitigation versus adaptation. Mitigation of greenhouse gases can be viewed as a public good, but adaptation to climate change is a private good, benefiting only the country or the individual that invests in adaptation. We use a one-shot public-goods game framework and add, in our view, two fundamental differences, compared to an "ordinary" public goods game. First, our public goods game, framed in terms of climate change, implies that the public good does not generate a potential gain; rather, subjects can only experience a loss. The size of that loss is determined by the type of investments made in preparing for climate change (mitigation or adaptation). This illustrates that most countries are likely to experience a loss of wealth due to climate change and not a gain (UNFCCC 2007). Second, the effects of climate change are highly uncertain and there is a risk that even if countries mitigate there could be a negative effect of climate change. We model this uncertainty by including a stochastic risk element in the public goods game.

A valid question at this point is whether or not there a tradeoff really exists between adaptation and mitigation investments. While adaptation and mitigation are still treated as distinctly different mandates by most national governments, we believe that, as climate disasters become more frequent, countries will increasingly have to make hard choices in allocating scare resources. However, this should not be confused with the external funding of adaptation measures in developing countries, such as the UNFCCC funding through the Global Environment Facility (GEF) and the Adaptation Fund, established under the Kyoto Protocol (which is expected to start in 2009).

The question whether or not we can carry over results from individuals to the country level is, of course, readily contestable, but because individuals make decisions, it seems reasonable to assume that we can draw qualitative conclusions from research on individuals that would also hold at the country level. However, we do not claim that the quantitative results would be the same, and they should be interpreted with caution. Also, it is not clear from existing research whether countries would be more or less cooperative than individuals. (See the discussion in Brekke and Johansson-Stenman [2008].) The subjects in the current experiment were specifically asked to think of themselves as a country's policymaker charged with dealing with climate change. While recognizing that the external validity of lab experiments is limited in many ways (as discussed extensively by Levitt and List [2009]), we believe that the behavior of individuals revealed in the lab context can be used as a basis for understanding and analysing key factors that underlie decisionmaking on mitigation and adaptation, such as vulnerability, trust, and beliefs about the behavior of others.

We recruited South African students from the University of Cape Town as our subject pool. A few public goods experiments have been conducted in South Africa and they generally reveal lower rates of contribution than the international average. In a public goods experiment carried out in rural fishing communities in South Africa, Visser and Burns (2007) reported an average level of contribution of 46.7% in the first round of the treatment. In the final round of a six-stage treatment, this level declined to 40%. Lower levels of contribution were observed in an experiment conducted with high school students in Cape Town, with an average rate of contribution of 33.7% (Kocher, Martinsson, and Visser 2008). Kocher et al. (2008) also tested for an effect of stake size on behavior and concluded that it had no significant effect on contribution levels (ibid.). Another study with urban high-school students lent further support to the above result, showing contributions to the public good averaging 33% throughout the game (Hofmeyr, Burns, and Visser 2007).

We relate contribution behavior to the subjects' socioeconomic background, as well as to their attitude toward trust in other people and beliefs about others contributions. Further, we analyze the effect of different levels of vulnerability on contribution levels because the effect on countries or individuals of climate change is highly dependent on how vulnerable a country or individual is to changes, such as increases in the number and magnitude of storms, flooding, heat waves, and droughts.

Many experiments have been conducted to try to better understand the dynamics of collective action, but none to our knowledge has investigated the tradeoff between mitigation and adaptation in the climate change context, and there are no studies of the effect of vulnerability on cooperation levels. This research contributes both to the public good literature and to analysis of climate change policy.

The Model

Our model illustrates the tradeoff between mitigation and adaptation, using a standard linear public-goods experiment, where each agent is endowed with a fixed asset and must choose how much to contribute toward the public good. However, because it is uncertain whether a climate change-related disaster will occur or not (even if subjects choose to contribute to the public good—mitigation), we express an individual's earnings in terms of their expected payoff. The first term shows the expected payoff if there is a disaster, and the second term shows the expected payoff if there is no disaster. Even if expected utility theory is a standard framework for analyzing decisions involving risk (Camerer and Kunreuther 1989), this theory has been challenged by other theories explaining individuals' choices under risk and uncertainty. For example, Kahneman and Tversky's (1979) prospect theory seemed to predict individuals' behavior under risk better than expected utility theory. Hence, individuals can have other decision strategies than the expected payoff, and we therefore discuss a number of alternative decision strategies at the end of this section. The expected payoff for each individual is thus given by:

$$E(\pi_i) = p\left[e - Ve\left(1 - d\left(\frac{B-x_i}{B}\right)\right)\right] + [1-p]e\,, \qquad (1)$$

where:

$p = Probability\ of\ disaster, \qquad p = 1 - m\left(\frac{\sum x_i}{nB}\right)$

$e = Initial\ endowment$

$B = Budget\ to\ address\ climate\ change, B = x_i + a_i$

$n = group\ size$

$x_i = Investment\ in\ mitigation, \quad x_i \leq B$

$a_i = Investment\ in\ adaptation, \qquad a_i = B - x_i$

$m = Return\ to\ mitigation, m < 1.$

$d = Return\ to\ adaptation$

$V = Vulnerability$

In the model, an investment in mitigation (x_i) lowers the probability of a disaster (p) for all subjects, while adaptation (a_i) lowers the actual cost of a disaster only for that subject. The total mitigation by the group is divided by the total budget available to all subjects (nB), so the more people that invest in mitigation, the lower the probability of disaster. This setup is in line with the probabilistic destruction model by Walker and Gardner (1992).

The cost of a disaster is also affected by the vulnerability of the subject (*V*)—in other words, the more vulnerable (a higher *V*), the higher the cost of a disaster. Note that vulnerability is the same for all subjects; however, it varies between treatments.[1] A disaster is not a certain event, but is dependent on two factors: total mitigation and an element of chance. Hence, the likelihood of a disaster is partly endogenously and partly exogenously determined. The element of chance (stochastic component) in our experimental design reflects the fact that the effect of mitigation on climate change is complex and partly uncertain. Models designed to estimate long-term climatic effects, such as increases in the numbers and magnitudes of storms, flooding, droughts and temperature, for similar reasons has to take this variability into account.

Hence, there is a risk of climate change disasters occurring even if subjects choose to mitigate. The return from mitigation is largest if all players mitigate. Also, the probability of a disaster (*p*) is the same for all members of the group, regardless of their individual contributions. If no disaster occurs, then players keep their full initial endowment (*e*). If there is a disaster, the payoff is a function of the amount invested in adaptation (a_i), as well as the vulnerability (*V*). The return to mitigation (*m)* is less than 1, so even if all agents within a group choose to mitigate, there will still be some chance of a disaster equal to $1 - m$.

For a social dilemma to exist, the following constraint must hold:

$$n \times MPCR_m > MPCR_a > MPCR_m \, ,$$

where:

$$MPCR_m = \frac{m}{n \times B} \text{ and } MPCR_a = \frac{d}{B} \, . \qquad (2)$$

This states that the marginal per capita return to mitigation with full cooperation ($n \times MPCR_m$) must be greater than the marginal per capita return for one unit of adaptation

[1] We could have added a treatment where we had subjects with different vulnerability levels in the same groups, paralleling the literature on income inequality. However, our primary interest was whether vulnerability affects contribution behavior, so therefore we kept vulnerability constant in the groups.

($MPCR_{a}$). This, in turn, must be greater than the marginal per capita return for one unit of mitigation ($MPCR_{m}$).

The Experiment

The model (equation 1) can be analyzed in both continuous and discrete frameworks. However, in order to limit the cognitive burden of the experiment, the subjects are faced with only a binary choice between mitigation and adaptation, i.e., a simple prisoner dilemma framework. Each subject can choose to invest their climate budget (*B*) either in adaptation or in mitigation; hence, it is not possible to invest part of the budget in mitigation or adaptation. Further, the subjects do not have the option to keep (not spend) their budget.

The experiment is designed so that the private rational incentive (Nash equilibrium) will contribute nothing to mitigation—the public good. Subjects were randomly placed into groups of four and were each given a sum of money—in other words, their initial endowment (*e*), as well as a budget to invest in addressing climate change (*B*). The experimental design is discussed in depth below.

Choice of Parameters

Simple data trials using Microsoft Excel show the sensitivity of the model to some of the parameters. The initial endowment (*e*) was set at 100 and affected the absolute payoff, but not the relative structure of the game. The budget (*B*) was set at 10 and because the returns were calculated using a ratio of total mitigation to total budget, it was also inconsequential to the final payoffs.[2] The severity of the disaster (*V*) influences the absolute payoff; however, it does not

[2] The participants were also given a fee of SAR (South African rand) 30 for showing up. This is more than the average participation fee for experiments, but it was necessary because, in the case of high vulnerability, subjects could experience a loss that had to be funded from this show-up fee. The amount of the participation fee is comparable to the amount students can earn by tutoring at the University of Cape Town, approximately SAR 40 per hour.

change the prisoner dilemma framework of the model. In the low-vulnerability treatment, the vulnerability level is set at $V = 0.8$, and the high-vulnerability environment to $V = 1.2$.

Unfortunately there is no data in the current literature that provides quantitative figures for the return of an investment to either mitigation or adaptation. The parameters used in the experiment are $m = 0.7$ and $d = 0.475$, which fulfill the public good constraint in equation (2), that is: [3]

$$0.07 > 0.0475 > 0.0175$$

Table 1 shows the expected payoff charts, given the abovementioned parameters, where the payoffs are moderated by taking into account the likelihood of a disaster and the earnings, given the respective outcomes. In each of the tables, the payoffs are shown for the column player as combination of the player's decision and the number of other people in the group that choose to mitigate.

Tables 1A and 1B Expected Payoff Tables by Vulnerability

1A (V = 0.8)

		My choice	
		Adapt	Mitigate
Number of other people who mitigate	0	58	34
	1	65	48
	2	73	62
	3	80	76

1B (V = 1.2)

		My choice	
		Adapt	Mitigate
Number of other people who mitigate	0	37	1
	1	48	22
	2	59	43
	3	70	64

[3] It should be noted that the prisoner dilemma framework does not hold for all values of *m* and *d*, where *m* represents the return to mitigation and *d* the return to adaptation. When the difference between *m* and *d* is roughly less than 30%, there is a strict prisoner's dilemma conflict ($0.37<d<0.7$). When the difference is greater than 50%, there is no social dilemma and it is in everyone's best interest to mitigate ($d<0.2$). A weak social dilemma environment exists between the two extremes, such that if a certain number of players mitigate one should also mitigate.

"Adapt" is the dominant strategy in all cases, and because it is a symmetrical game, the resulting equilibrium will be for all players to adapt. Consequently, society lands up at a Pareto-inferior outcome, where the expected payoff for each player is significantly lower than if everyone cooperated and chose to mitigate. The social optimum position of full mitigation is the bottom right cell in each table.

The differences between the low-vulnerability and high-vulnerability models can be observed by comparing the two tables 1A and 1B. The prisoner dilemma structure is maintained, irrespective of the level of vulnerability. However, the payoffs in the low-vulnerability treatment are greater than in the high-vulnerability treatment.

The risk/return ratio calculates the potential loss from free riding, compared with the potential gain from free riding.[4] The risk/return ratio is 4.44 for both levels of vulnerability. These ratios are thus constant across vulnerability levels.

Decision Rules

Decision rules other than maximizing expected payoffs have been found in various experiments, such as the "maximin" principle, "maximax" rule (Arrow and Hurwicz 1972; Kelsey 1993; Woodward and Bishop 1997), and the "minimax" regret rule (Linhart and Radner 1989; Savage 1954). In our experiment, there is additional uncertainty compared to a standard public goods game (related to the behavior of the other subjects) because we added an element of risk. The weakness of using expected payoff is that it assumes that individuals are risk neutral in that they treat expected payoffs the same as certain payoffs. In practice, however, this assumption may not hold. Furthermore, individuals may use other decision rules besides probabilistic analysis when deciding which strategy to adopt.

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4 $Risk\ Return\ Ratio = \left(\frac{Social\ Optimum\ Payoff - Nash\ Equilibrium\ Payoff}{Maximum\ Payoff - Social\ Optimum\ Payoff}\right)$

An alternative way of portraying the decision environment in table 1 is to show the probability of disaster based on one's chosen strategy and the possible *actual* outcomes based on whether a disaster occurs or not. This is shown in tables 2 and 3 below.

Table 2 Probability of Disaster

		My choice	
		Adapt	Mitigate
Number of other people who mitigate	0	100%	83%
	1	83%	65%
	2	65%	48%
	3	48%	30%

Table 2 shows that the more people mitigate, the lower the probability of disaster; and when nobody mitigates, a disaster is experienced with certainty. It is worth noting that the probability values utilized in the experiment are large enough not to be subject to the irregularities in behavior often observed for low probability hazards[5] (McClelland, Schulze, and Coursey 1993). Table 3 shows the *actual* outcomes, depending on whether a disaster occurs or not, and the strategy adopted.

Table 3 Summary of Possible Outcomes

	V = 0.8	V = 1.2
If no disaster and I adapt	100	100
If no disaster and I mitigate	100	100
If disaster occurs and I adapt	58	40
If disaster occurs and I mitigate	20	-20

[5] Evidence from the field and lab experiments reveals that people are inconsistent in how they respond to low-probability, high-consequence risks. A bimodal distribution is typically observed, where people tend to either significantly overvalue or undervalue the risk.

One possible decisionmaking criterion would be for the individual to “play it safe” by considering the disaster payoffs more seriously than the nondisaster outcomes. (This decision criterion is in line with prospect theory in which individuals are assumed to be loss averse.) Such a decisionmaking strategy embodies the maximin principle. This is clearly shown in table 4, which reorganizes table 3 to show a payoff matrix that only has options for the treatment where *V*=0.8.

Table 4 Payoff Matrix for V = 0.8

		State of the world	
		No disaster	Disaster
Strategy	Adapt	100	58
	Mitigate	100	20

If the choice is between an outcome of 58 or 20, an individual may choose to adapt because it would maximize earnings in the worst-case scenario. This is a conservative approach to decisionmaking, whereby the agent selects the best strategy, given the “worst possible outcome.” A disaster is clearly the worst outcome and the choice to adapt will maximize the agent’s earnings in this circumstance.

Another possible decision rule is the maximax rule (Arrow and Hurwicz 1972; Kelsey 1993; Woodward and Bishop 1997). This rule implies that the individual identifies the best payoff for each strategy and selects the option that maximizes the largest payoff. In this case, the individual would be indifferent between mitigating and adapting, as both have a payoff of SAR 100 if no disaster occurs.

A final decisionmaking strategy is to adopt the minimax regret rule with the aim of avoiding “costly mistakes” (Linhart and Radner 1989; Palmini 1999; Savage 1954). A regret matrix is first derived, which displays various outcomes as deviations from the largest payoff for each state of nature (see table 5 below). The agent then uses the regret matrix to identify the strategy with the lowest possible regret value and this strategy is chosen. Table 5 shows that the lowest regret value is achieved by choosing to adapt, which gives a regret value of zero, compared with 38 if one chose to mitigate.

Table 5 Regret Matrix Derived from Table 4

		State of the world	
		No disaster	Disaster
Strategy	Adapt	0	0
	Mitigate	0	38

The above discussion reveals that adaptation is the dominant strategy, regardless how the agent chooses to make a decision (which is also true for $V = 1.2$).

Experimental Design

An important factor in analyzing climate change is that decisionmaking is, to a large extent, characterized by irreversibility. For this reason, we chose a one-shot game as a decisionmaking context, reflecting the fact that crucial decisions on climate policy made by global leaders today will determine the long-term consequences that society will face.[6] This is unlike other environmental commons, where there are multiple rounds and the stakeholders are able to observe, learn, and act based on the results of their previous decisions. Furthermore, we are primarily interested in understanding preferences, which can best be elicited through a one-shot game. (See, e.g., Fischbacher, Gächter, and Fehr [2001] for a discussion.)

In our experiment, we presented the participants with actual payoff tables instead of the expected payoff tables.[7] This was done because the expected payoffs could be misleading. Such payoffs best represent a game with multiple rounds, where in the long run the average payoff is the expected payoff. Moreover, from a practical perspective, the expected payoff table was

[6] Thanks to Glen Harrison for this insight.

[7] Tables 2 and 3 were presented instead of tables 1a and 1b.

deemed too confusing: first, because students would not actually earn the amounts indicated in the table; and second, because its use would require more detailed explanation because most students do not have a background in statistical analysis. These concerns were validated in the focus groups.

By providing an external budget that needed to be entirely spent, we were able to narrowly assess the decision between mitigation and adaptation. This simplified the game structure and the results could be more clearly understood, compared to an experiment where participants could choose to spend any amount of their endowment on mitigation, adaptation, or doing nothing (the “business as usual” option).

A random number generated by the computer was used to determine whether a disaster happened or not. To ensure that participants understood how the random draw worked, several examples were conducted for the subject group, using a bag of identical balls numbered from 1 to 100. Thus, if the probability of disaster was 30%, any number below 30 would result in a disaster.[8] All the experiments were programmed and conducted with z-Tree software (Fischbacher 2007).

Furthermore, all the experiments were conducted as homogenous, symmetrical games, both in terms of the initial endowment and vulnerability level.

Subjects

The experiment was conducted with 144 subjects recruited from the University of Cape Town’s student body. The median age of the participants was 20 years, and 43% were female. Racially, 57% of the subjects classified themselves as African, 15%, white; 12%, colored; 8%, Indian; and 8%, other. Approximately 70% were South African citizens. The majority of participants had taken at least one course in economics. See summary of individual characteristics below.

[8] The instructions for the game in are available from the authors upon request.

Table 6 Summary Statistics of Sample

Subjects	
Total number in sample	64
Average age	19.9
Gender	
Females	42.19%
Males	57.81%
Race	
African	60.94%
Colored	6.25%
Indian	9.38%
Other	4.69%
White	18.75%
Schooling Type	
Private	40.63%
Public/Government	59.38%
Nationality	
South African	58%
Other	42%
Home	
Average no. of people in home	5.5
Families' financial situation	
Lower income	15.63%
Middle income	62.5%
Upper income	21.88%
Describe yourself in terms of risk-taking behavior	
I never take risks	4.69%
I often take risks	12.5%
I sometimes take risks	82.81%
Can most people be trusted?	
Agree	31.25%
Disagree	20.31%
Neutral	35.94%
Strongly disagree	12.5%
Are most people selfish?	
Agree	40.63%

Disagree	9.38%
Neutral	23.44%
Strongly agree	25%
Strongly disagree	1.56%
Do you participate in communal activities?	
No	31.25%
Yes	68.75%
Are you familiar with any agreements on greenhouse gases?	
No	4.69%
Yes	95.31%

Further, 31% of the subjects stated that most people can be trusted, while 33% disagreed or strongly disagreed. Almost all subjects, 95%, were familiar with any agreements on greenhouse gases.

Results and Analysis

On average, 26.5% of participants chose to mitigate. This result is in accordance with the general findings from experiments on collective action problems that show cooperation levels significantly greater than zero, as predicted by traditional game theoretic models of rational selfish behavior. However, this result is less than the average level of contribution found in international public good and prisoner dilemma games, which is approximately 40% to 60% as discussed in the introduction (Fehr and Gächter 2000a; Anderson and Putterman 2006; and Zelmer 2003). Furthermore it is less than the 30%-to-50% average reported by South African public good experiments (as discussed in the introduction). When compared to one-shot prisoner dilemma games, the cooperation rates in our experiment are more similar, but still below the 30% found by Dawes, McTavish, and Shaklee (1977), and the 38% reported by Cooper et al. (1996). The lower rate of cooperation could reflect a framing effect—that adaptation was sometimes selected as the strategy of choice and not just as the noncooperative alternative to mitigation. It is worth noting that, unlike other public good games where not contributing to the public good can be interpreted as "selfish" free-riding behavior; in our model the decision environment is more complex. Both adaptation and mitigation are suitable strategies to follow in addressing climate change.

Furthermore, the results from the two-sample Wilcoxon rank-sum (Mann-Whitney) test show that there is no statistically significant difference in the mitigation rates (contribution levels) between the two treatments, high and low vulnerability ($z = -0.609$; $p = 0.5422$). This finding lends further support to the study by Kocher, Martinsson, and Visser (2008), who also reported that stake size has no significant effect on the level of contribution in a public goods game.

We further elicited expectations about what action players believed the majority (two or more) of other players in their groups did (see table 7). Expectations were surmised after players had already made their own choices as to mitigate or to adapt. Although there is a substantial difference in expectations about the behavior of other group members in the low-vulnerability treatment (19% of players believed the majority of others in their group would mitigate), compared to the high-vulnerability treatment (34% of players believed the majority of others in their group would mitigate), this difference is not significant according to the Mann-Whitney rank-sum test ($z = -1.404$; $p = 0.1603$).

The variant of the strategy method[9] (Burlando and Guala 2005; Keser 1996; Fischbacher et al. 2001) was also used to obtain information about which actions players would take, conditioned on contributions by other players. These results indicate that the willingness to cooperate unconditionally is significantly higher in the low-vulnerability treatment than in the high-vulnerability treatment, according to the non-parametric Mann Whitney rank-sum test ($z = 1.809$; $p = 0.0704$). Here, 47% of players stated that they would mitigate, even if none of the other players in their group mitigated in the low-vulnerability treatment, whereas only 25% of players in high-vulnerability case indicated the same. This result is not surprising because it is

[9] Subjects were asked what they would be willing to contribute, given no contributions from the rest of the group or contributions by 1, 2, and 3 other group members, respectively. This question was asked after participants had already made their contribution, but before they knew what the rest of the group's contributions were. Participants were not paid for any of these choices, whereas the strategy method requires that participants be paid for one of their choices based on a random draw.

more costly (in terms of cost of a disaster) to mitigate in the high-vulnerability treatment. The strategy method yielded further interesting results. When conditioned on cooperation by others, individuals indicated a much higher willingness to mitigate, and differences in stated willingness to mitigate between low- and high-vulnerability scenarios was, on average, very small (63% versus 59%). This has important implications for binding commitments at multilateral levels, as well as at national levels, in terms of signaling cooperative intent by all stakeholders. It is clear that uncertainty about the preferences for cooperation by others greatly reduces the individual's own willingness to engage in cooperative measures.

Table 7 Summary of Data Relating Actual Behavior to Subjects Expectations before and after Making Their Decision to Mitigate (Yes = 1, No = 0)

	Low vulnerability	**High vulnerability**
Percentage of people who chose to mitigate	28%	25%
Group size (n)	32	32
Conditional contribution elicited (after the subjects had already submitted their own choices)		
Would you mitigate if you believed:		
a. No one else in your group is going to mitigate.	47%	25%
b. One of the other people in your group will mitigate.	41%	28%
c. Two of the other people in you group will mitigate.	50%	53%
d. All three of the other people in your group will mitigate.	63%	59%
Expectations elicited (after the subjects had already submitted their own choices)		
Which strategy do you think the majority of other players chose? (I.e. do you think the majority of others chose to mitigate?)	19%	34%

Determinants of the Choice to Mitigate

The results of the experiments portray the decisions made by individuals acting in their own interest. Just as individuals choose a strategy they believe to be in their best self interest, so too is it reasonable to expect policymakers to decide on a course of action in the best interest of their constituents. Policymakers have priors depending on which country they represent, as well as their individual background characteristics. To shed more light on the decision to mitigate, we analyzed what determines the choice of mitigation or adaptation controlling for individual characteristics.

Table 8 shows the results obtained from tobit analysis, comparing an individual's choice to mitigate when purely controlling for experimental treatment, beliefs about whether the majority of others in their group mitigated, and individual characteristics (gender, age, race), as well as other socioeconomic information (education, family's financial situation, and number of people living in household) and individual perceptions about risk and trust.

As the results from the non-parametric tests show, our parametric estimates also indicated that there is no significant difference in the level of mitigation observed in the low- and high-vulnerability treatments. Beliefs about the behavior of others is a significant determinant of own behavior, as has also been shown in a number of other studies (Gächter 2007; Fischbacher et al. 2001).

Controlling for individual and socioeconomic characteristics had no significant impact on our treatment effects. Trust in others, however, is important in determining whether an individual mitigates or not, even when expectations are controlled for. Individuals in our study who disagreed with the statement "most people can be trusted" were significantly less likely to mitigate than those who agreed with the statement. This is line with results found in Gächter et al. (2004).

Table 8 Tobit Regressions: Comparing High- and Low-Vulnerability Treatments, Controlling for Socioeconomic Heterogeneity

	Tobit 1			Tobit 2			Tobit 3		
Dependant variable: Mitigate	***Coeff.***	***Std. err.***	***P>|z|***	***Coeff.***	***Std. err.***	***P>|z|***	***Coeff.***	***Std. err.***	***P>|z|***
High vulnerability	-0.10	(0.34)	0.78	-0.26	(0.36)	0.46	-0.33	(0.50)	0.51
Do you think most other players in your group choose to mitigate?				0.86	(0.38)	0.02	1.54	(0.56)	0.01
Education: public							0.91	(0.62)	0.15
Number of people living in your home							0.09	(0.10)	0.37
Family's financial situation: middle income							1.47	(0.95)	0.12
Family's financial situation: upper income							-0.07	(1.10)	0.95
Most people can be trusted_2 (disagree)							-1.59	(0.93)	0.09
Most people can be trusted_3 (neutral)							-0.55	(0.67)	0.41
Most people can be trusted_4 (strongly disagree)							-1.26	(1.06)	0.23
I often take risks							0.49	(1.14)	0.67
I sometimes take risks							0.08	(0.96)	0.93
Constant	-0.58	(0.34)	0.01	-0.76	(0.26)	0.00	-2.10	(3.56)	0.56
No. of observations		64			64		61		
LR chi2		0.08			5.22		25.26		
Prob > chi2		0.7771			0.0734		0.0654		
Pseudo R2		0.0011			0.0705		0.3499		
Log likelihood		-37.007			-34.44		-23.47		

Conclusions

Our study used an experimental design to test tradeoffs between spending funds on adaptation and mitigation. We believe that, as climate disasters become more frequent, countries will increasingly have to make hard choices in allocating scarce resources. Specifically, for countries where large portions of the national budget are already being dedicated to disaster management of floods and fires, this is very real consideration.

The design we used deviates from a standard public-goods game because we introduced a stochastic term to account for probabilistic destruction in a climate-change setting, where the probability density function is mapped to within-group levels of mitigation. We compared low-vulnerability and high-vulnerability treatments by varying the magnitude of disaster across treatments. Our results showed that there is no significant difference in the level of mitigation across these treatments.

One of the findings of this paper of interest to policymakers is the important role of trust in enhancing cooperation. At multilateral and local levels, trust can be fostered through communication, signaling, and commitment devices in negotiating mitigation. This finding is further strengthened by the subjects' responses to the variant of the strategy method we employed, indicating that significant differences in unconditional cooperation for the low- and high-vulnerability treatments disappear when mitigation is conditional on other group members also mitigating. Hence, it is extremely important that countries trust each other and believe each other's stated intentions to mitigate. This has important implications for all multilateral agreements, including the upcoming climate-change negotiations in Copenhagen in 2009.

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