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In a laboratory experiment, the voluntary provision of public goods is investigated when there is probabilistic uncertainty about the monetary return from production of the public good. After group members make their provision decisions, the return is drawn from an exogenously determined probability distribution. In a linear decision setting, voluntary provision of the public good is contrasted across three treatments. In the "uncertainA" treatment, the return is randomly drawn from a discrete probability distribution. In the "uncertainB" treatment, the return is drawn from a discrete probability distribution that is a mean-preserving spread of the distribution in the uncertainA treatment, but has larger variance. In the "certain" treatment, the return is known with certainty and equal to the expected value of the return in the uncertainA and uncertainB treatments. The data reveal that average provision of the public good is lower in treatments with uncertainty. However, the negative impact of uncertainty on provision only occurs when subjects experience the certain treatment prior to experiencing an uncertain treatment, suggesting an order effect to uncertainty. Also, there is evidence that subjects in treatments with higher uncertainty (variance of the public-good return) display a version of the "gambler''s fallacy."

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1. Introduction

Experimental evidence from social-dilemma settings, such as the voluntary provision of public goods, reveals that group members often cooperate despite dominant self-interested strategies to free ride on others' contributions (Isaac et al. 1994, Ledyard 1995). In many field situations, investments or contributions are made to the production of public goods without the providers knowing with certainty the return they will receive from the public goods. For instance, often the quality of the public good provided by charitable organizations depends on factors that may be uncertain at the time a donation is given. For example, with some probability, the weather conditions will be good and the quality of cleanup and reconstruction after a natural disaster will be high. Otherwise, the quality of the cleanup and reconstruction will be lower. If providers are risk averse, uncertainty regarding the quality of the public good may lead to lower donations. Thus, examining subjects' provision decisions in experimental settings with uncertainty offers insight into how contribution choices can be influenced by uncertainty.

In this study, empirical evidence is provided that examines the impact of uncertainty regarding the public-good return in an experiment in which subjects make repeated decisions and learn about others' actions across decision rounds. In a linear decision setting, voluntary provision of a public good is contrasted across three treatments. In the "uncertainA" treatment, the return is randomly drawn from a discrete probability distribution. In the "uncertainB" treatment, the return is drawn from a discrete probability distribution that is a mean-preserving spread of the distribution in the uncertainA treatment, but has larger variance. In the "certain" treatment, the return is known with certainty and equal to the expected value of the return in the uncertainA and uncertainB treatments. The experimental data reveal that in settings where subjects experience the certain treatment condition prior to experiencing an uncertain treatment condition, average provision of the public good is negatively impacted by uncertainty, consistent with risk aversion. However, in settings where subjects experience an uncertain treatment condition first, the negative impact of uncertainty disappears, suggesting an order effect in regard to the impact of uncertainty on behavior. Additionally, in treatments with higher variance of the public-good return, there is evidence that some subjects display a version of the "gambler's fallacy."

The experimental studies most directly related to this study are Dickinson (1998) and Gangadharan and Nemes (2009). In Dickinson (1998), hereafter referred to as Dickinson, each session of the experiment consists of three decision sequences. The first sequence is a baseline condition with a certain group-fund return. The second or third sequence, depending on the session, is an uncertain treatment condition. Dickinson finds that public-good provision in the first half of decision rounds in an uncertain treatment is significantly lower than that in a certain treatment. In Gangadharan and Nemes (2009), hereafter referred to as GN, each session of the experiment consists of seven decision sequences. The first sequence is a baseline condition with a certain group-fund return. The second or third sequence, depending on the session, is an uncertain treatment condition. GN find that public-good provision across all decisions rounds in an uncertain treatment is significantly lower than in a certain treatment.[1]

[1] Levati et al. (2009), Levati and Morone (2012), and Potters et al. (2007) also examine experimental settings with uncertainty similar to the settings discussed here. However, these studies differ by, among other things, employing groups of size two and provide complete information regarding the other group member's provision decision.

This study contributes to the literature in three fundamental ways. The first relates to how the variance of the probability distribution for the public-good return impacts public-good provision. This is examined by comparing public-good provision in two treatments with uncertainty, where the probability distributions have different variances. The second contribution relates to examining order effects as a determinant of the response to uncertainty. The third contribution relates to how subjects in uncertainty treatments respond to previous realizations of the return to the public good. More specifically, the study examines the correlation of individual provision decisions with the one-round lagged group-fund return.[2]

2. The Decision Setting

The experimental sessions for this study were conducted at Indiana University-Bloomington. Undergraduate subjects from a wide range of disciplines were recruited from classrooms and from an online subject data base. At the beginning of each decision sequence, subjects privately read a set of instructions, which were then summarized publicly.[3] After reading the instructions, subjects took a post-instruction quiz and were not allowed to continue until all answers were correct. Subjects made all decisions on computers in private.

In aggregate, data were collected from 136 subjects. All subjects were paid a $5 show-up fee. In all sessions, monetary information was denominated in ECUs (Experimental Currency Units). The conversion rate of ECUs to U.S. dollars was 20 to 1. Earnings averaged $21.74 per subject across all sessions, which each lasted approximately 60 minutes.

Each session consisted of two sequences of 10 rounds, which was public information. Subjects were told that instructions regarding Sequence 2 would be given at the conclusion of Sequence 1. The "certain" treatment condition was used in Sequence 1 of each treatment. In the "certain" condition, subjects knew the value of the group-fund return and also knew that it would not change across decision rounds. As mentioned above, treatments varied by the support of the discrete uniform probability distribution used in Sequence 2 to draw the public-good return. Table I summarizes the design for each treatment.

[2] There are other less related experimental studies examining uncertainty in social dilemma games. For instance, Stoddard (2014) examines exogenously imposed uncertainty over the value of group-funds in one-shot, payoff-equivalent appropriation and provision games. Blanco et al. (2014) examine probabilistic endogenous degradation of a common-pool resource in one-shot appropriation games. Cox (2014) examines noisy signals regarding common-value public goods. Finally, in Fischbacher et al. (2012) and Stoddard et al. (2014) the production of the group resource is certain, but group members are uncertain about the share of the group resource they will receive.
[3] See the Appendix for copies of the instructions. The experiment was programmed using Z-tree (Fischbacher 2007).

Table I-Design Information for Treatments

Treatment	Support in Sequence 1 (Variance)	Support in Sequence 2 (Variance)	Independent Groups	Subjects
Certain-Certain	[2.4] (σ^2=0)	[2.4] (σ^2=0)	12	48
Certain-UncertainA	[2.4] (σ^2=0)	[0.4, 2.4, 4.4] (σ^2=2.67)	11	44
Certain-UncertainB	[2.4] (σ^2=0)	[0.4, 4.4] (σ^2=4)	11	44

2.1 Treatment Conditions

2.1.1 Certain-Certain Treatment

At the beginning of a session, the computer randomly and anonymously assigned subjects to four-person groups. These groups did not change throughout the experimental session. No person could identify his/her group members. In each decision round, each person received an endowment of 10 tokens in his/her individual fund, any number of which could be moved to a group fund. Each person earned 1 ECU for each token placed in his/her individual fund. Each token moved to the group fund produced a return of 2.4 ECUs for the group. The ending value of tokens in the group fund was allocated evenly between group members. Thus, each group member received a Marginal Per Capita Return (MPCR) of 0.6 ECUs (marginal group-fund return / marginal individual-fund return). At the conclusion of each round, each subject was informed of his/her group's aggregate provision to the group fund and his/her round earnings. Subjects received this information from previous rounds in a history table.

2.1.2 Certain-UncertainA Treatment

Sequence 1 in the certain-uncertainA treatment was identical to that in the certain-certain treatment. Sequence 2 differed from Sequence 1 in that the group-fund return was determined probabilistically. In each round in Sequence 2, the group-fund return was drawn from the discrete uniform probability distribution [0.4 ECUs, 2.4 ECUs, 4.4 ECUs]. Thus, the expected return from each token provided to the group fund was 2.4 ECUs (expected MPCR=0.6 ECUs) and the probability distribution was a mean preserving spread of the return in the certain-certain treatment. The variance of the uncertainA probability distribution is 2.67. Subjects did not learn the value of the group-fund return in a given round until all group members finalized their decisions. In addition to the information provided in Sequence 1, subjects were also informed of the group-fund return for all previous decision rounds.

2.1.3 Certain-UncertainB Treatment

To examine the effect of variance of the group-fund return on provision behavior, the certain-uncertainB treatment was also conducted. The certain-uncertainB treatment was identical to that of the certain-uncertainA treatment, except for one difference. In each round in

Sequence 2, the group-fund return was drawn from a discrete uniform probability distribution [0.4 ECUs, 4.4 ECUs]. Thus, the expected return from each token provided to the group fund is the same as in the certain-uncertainA treatment (2.4 ECUs with the expected MPCR=0.6 ECUs). However, the variance of the uncertainB probability distribution is larger (σ^2=4). Subjects received the same information as in the certain-uncertainA treatment.

2.1.4 Comparison to Related Studies

In Dickinson, the variance of the group-fund return in the uncertain condition is 2.67. In GN, the variance of the group-fund return in the uncertain condition is 2.25. The variance of the group-fund return in the uncertainA treatment is the same as in Dickinson, allowing for a comparison to previous work. The variance of the group-fund return in the uncertainB treatment provides a setting with larger variance than has been previously studied in the prior research in this area.

3. Predictions

3.1. Sequence 1 Decisions

In Sequence 1, subjects play a finitely repeated game with a known final round. Assuming common knowledge that each group member maximizes his/her own material self-interest, the one-shot theoretical prediction is straightforward. Because the individual marginal benefit from a token in an individual fund is greater than the individual marginal benefit from a token in the group fund, MPCR=0.6 ECUs, the one-shot Nash equilibrium is for each member to provide zero tokens to the group fund. As noted above, during Sequence 1 of all treatments, however, subjects play with incomplete information. Subjects know there will be a second sequence of 10 rounds, but are not given additional information. Game theoretic predictions under incomplete information, in this case, depend on the subjects' beliefs about Sequence 2. Assuming common knowledge that all group members believe that decisions from Sequence 1 will not affect the game in Sequence 2, the material self-interested subgame Nash equilibrium is to provide zero tokens to the group fund in each round in Sequence 1 of each treatment with a certain group-fund return. On the other hand, research on linear public-goods games indicates that aggregate provisions to the group fund are positive and positively correlated with the MPCR (Isaac et al. 1994, Ledyard 1995). These and other "non-classical" experimental results have led to models with alternative preference structures (Fehr and Schmidt 1999, Fischbacher et al. 2001, and Croson 2007). Based on this evidence, aggregate provision of the group fund is predicted to be positive.

3.2. Sequence 2 Decisions

Recall that in Sequence 2, the distributions of group-fund returns in the certain-uncertainA and certain-uncertainB treatments are mean-preserving spreads of the certain group-fund return in the certain-certain treatment. Assuming group members are risk neutral, the marginal incentives across all treatments are the same as in Sequence 1. Thus, provision of the group fund in Sequence 2 of the certain-uncertainA and certain-uncertainB treatments is predicted to be the same as in the certain-certain treatment. Alternatively, Dickinson provides a model that predicts, assuming group members are risk averse and make positive provision decisions, provision of the group fund will be larger when the group-fund return is certain than when the return is a mean preserving spread of the certain return. This implies that, if subjects are risk averse, provision of the group fund will be larger in Sequence 2 of the certain-certain treatment than in the certain-uncertainA and certain-uncertainB treatments.[4] By extension, since the variance is lower in the uncertainA treatment condition compared to the uncertainB treatment condition, Dickinson's model also predicts that provision of the group-fund will be larger in Sequence 2 of the certain-uncertainA treatment compared to the certain-uncertainB treatment.[5]

4. Results

For brevity in the discussion of results, the certain-certain treatment will be referred to as CC, the certain-uncertainA treatment as CUA, and the certain-uncertainB treatment as CUB.

4.1. Descriptive Overview

Table II presents the means and standard deviations of group provision of the group fund across sequences and treatments. Mean group provision of the group fund by sequence is similar in all treatments, but within each treatment the Sequence 2 average is lower than the Sequence 1 average. Figure 1 shows the path of mean group-fund provision for each treatment condition. Recall, the certain treatment condition is used in all treatments in Sequence 1. The pattern of mean provision of the group fund yields a pattern consistent with similar linear public-goods games (see Sefton, et al. 2007).

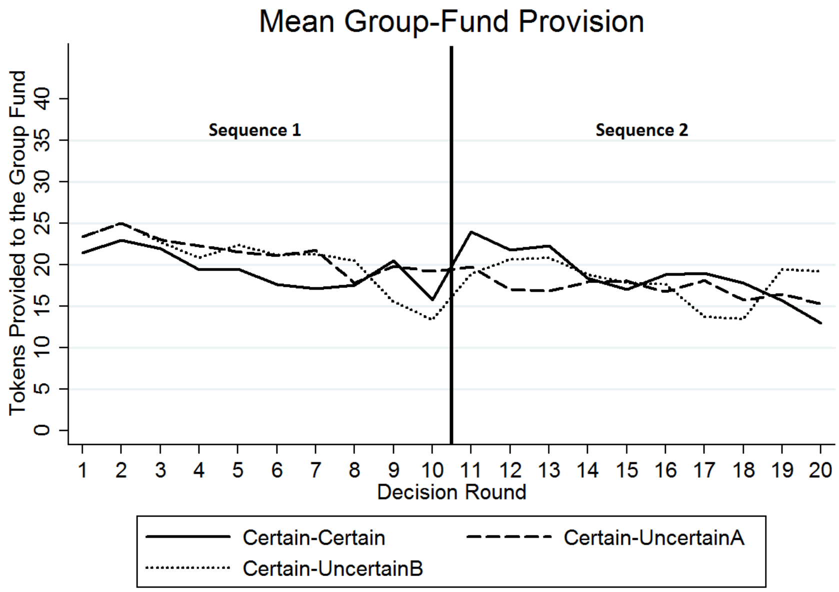
Table II-Summary Statistics: Group-Level Data, by Sequence and Treatment

Mean Group Provision of the Group Fund (standard deviation)		
Treatment	Sequence 1	Sequence 2
Certain-Certain	19.36 (7.72), N=12	18.75 (7.51), N=12
Certain-UncertainA	21.48 (7.60), N=11	17.17 (6.26), N=11
Certain-UncertainB	20.61 (9.09), N=11	18.05 (8.71), N=11

[4] Using the principle of second-degree stochastic dominance, Dickinson's prediction holds for any subject with a concave utility function. See Dickinson for a formal proof.

[5] Levati and Morone (2013) hypothesize that risk aversion *per se* does not cause the significant decline in group-fund provision, but that losses relative to the endowment are the main driving force behind the negative effects of uncertainty. They test this in groups of two by examining a distribution of the group-fund return where the lowest possible value is still "efficiency-enhancing" for the group. This hypothesis is not considered here because in both the uncertainA and uncertainB distributions the lowest possible return is not efficiency-enhancing.

Figure 1-Mean Group-Fund Provision, by Treatment



4.2. Group-Level Regression Analysis: Sequence 2 Decisions

Table III reports an estimated pooled OLS model for observations from Sequence 2. To control for any group effects from Sequence 1, the dependent variable is the difference between group-level provision in each decision round in Sequence 2 and mean group-level provision in Sequence 1 for each group. The estimated model comprises treatment and round dummies as independent variables, with the certain-certain treatment serving as the reference treatment condition.

Using a two-tailed test, the coefficients for the CUA and CUB treatment dummies are not significant, (p=0.139) and (p=0.458), respectively. However, using a one-tailed test, suggested by Dickinson's model, the difference in group-fund provision is weakly significantly higher in the CC treatment than in the CUA treatment (p=0.070).[6] Lastly, a Wald test of regression coefficients for the CUA and CUB treatments fails to reject the pairwise null hypotheses that the coefficients are equal [p=0.320]. Thus, as in previous studies, uncertainty significantly lowers group-fund provision, after subjects first experience the certain treatment condition. Although, despite the difference in variances in probability distributions, group-fund provision is not statistically different between the CUA and CUB treatments.

[6] Using two-tailed tests, the coefficient for the CUA treatment dummy is significant at the 10% level when data from the last decision round (20) is dropped.

Table III- Group-Level Provision, Pooled OLS Regression: Pooled Across All Sequence 2 Decisions

Dependent Variable: Difference between Group-Level Provision in Sequence 2 and Mean Group-Level Provision from Sequence 1 for each Group	
Certain-UncertainA	-3.70 (2.44), [p=0.139]
Certain-UncertainB	-1.96 (2.61), [p=0.458]
Constant	2.35 (1.31), [p=0.082]
The reference categories are the certain-certain treatment and round 11. Round dummy for rounds 14-20 are negative and significant at least at the 5% level. Figures in parentheses are robust standard errors clustered on 34 independent groups, 10 observations per cluster. R^2=0.08; N=340	

5. Additional Treatments

This section presents additional treatments that check for order effects among treatment conditions with uncertainty. In the two additional settings, subjects experience uncertainty in both sequences. The first additional treatment, uncertainA-uncertainA (or UAUA), is the same as the CUA treatment except that the group-fund return is drawn from the uncertainA probability distribution, [0.4, 2.4, 4.4], in both sequences. The second additional treatment, uncertainB-uncertainB (or UBUB), is the same as the CUB treatment except that the group-fund return is drawn from the uncertainB probability distribution, [0.4, 4.4], in both sequences.[7]

The theoretical predictions of the initial treatments extend to the UAUA and UBUB treatments. That is, provision of the group fund will be larger in the UAUA treatment with lower variance than the UBUB treatment in Sequence 1. Note that comparing decisions made in Sequence 2 between the UAUA and UBUB treatments is not prudent because subjects experienced different treatment conditions in Sequence 1.

5.1. Results

5.1.1 Descriptive Overview

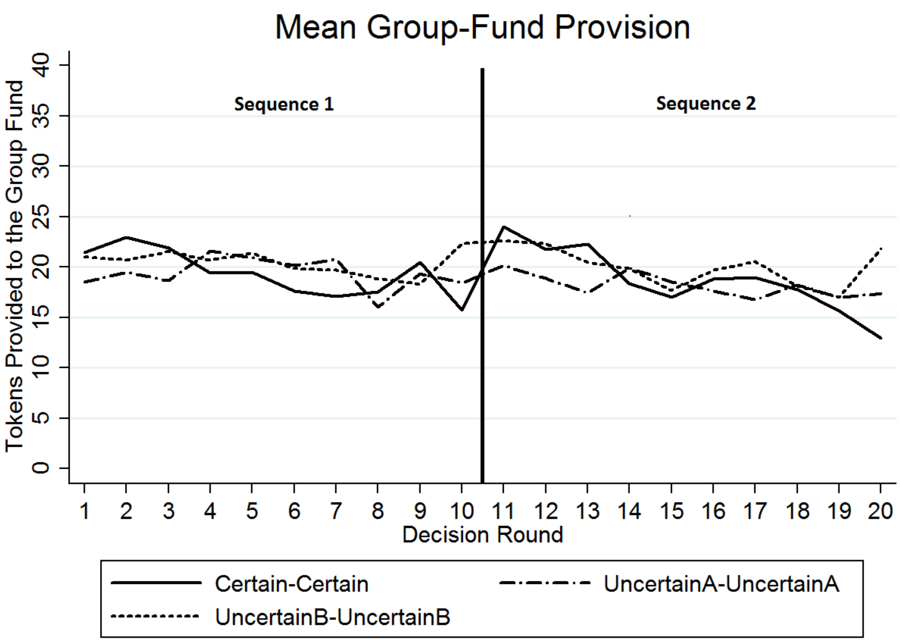
Table IV presents the means and standard deviations of group provision of the group fund across sequences and treatments. Mean group provision of the group fund by sequence is similar in both treatments, but within each treatment the Sequence 2 average is lower than the Sequence 1 average. Figure 2 reports the path of the mean group-fund provision for the UAUA and UBUB treatments, as well as the CC treatment for a visual control. The primary observation is that the paths of mean provision of the group fund for the additional treatments and the CC treatment are very similar in Sequence 1.

[7] Recruiting and experimental protocols in the additional treatments were the same as with the initial three treatments. Data was collected from 108 subjects. Earnings averaged $21.72 per subject across all sessions.

Table IV-Summary Statistics: Group-Level Data, by Sequence and Treatment

Mean Group Provision of the Group Fund (standard deviation)		
Treatment	Sequence 1	Sequence 2
UncertainA-UncertainA	19.39 (7.92), N=14	18.19 (9.79), N=14
UncertainB-UncertainB	20.43 (6.56), N=13	20.02 (7.58), N=13

Figure 2-Mean Group-Fund Provision, by Treatment



5.1.2 Group-Level Regression Analysis: Sequence 1

Table V reports a regression analysis that pools group-level observations in Sequence 1 of all five treatments. The dependent variable is group provision of the group fund in each round. The independent variables are treatment and round dummies. The treatment dummy serving as the reference category is a dummy that equals 1 for observations from treatments with the certain treatment condition in Sequence 1.

The coefficients for the treatment dummies are negative and highly insignificant when using one-tailed and two-tailed tests. A Wald test of regression coefficients for the UAUA and UBUB treatments fails to reject the pairwise null hypotheses that the coefficients are equal [*p*=0.903]. Recall, Table III reports similar regression analysis of group-fund provision between the initial three treatments in Sequence 2. The coefficient for the CUA treatment in Table III was significant at the 10% level using a one-tailed test. Thus, combining the results of Table V to those of Table III, there is evidence of a weak order effect with the uncertainA treatment condition.[8]

Table V- Group-Level Provision, Pooled OLS Regression: Pooled Across All Sequence 1 Decisions

Dependent Variable: Group-Level Provision Sequence 1	
UncertainA-UncertainA	-1.06 (2.49), [p=0.670]
UncertainB-UncertainB	-0.02 (2.24), [p=0.993]
Constant	21.61 (1.11), [p=0.000]
The reference categories are the pooled Sequence 1 certain treatments and round 1. Round dummy for round 2 is positive and significant at the 5% level. Round dummies for rounds 8-10 are negative and significant at least at the 5% level. Figures in parentheses are robust standard errors clustered on 61 independent groups, 10 observations per cluster. R^2=0.03; N=610	

6. Individual-Level Regression Analysis

6.1 Sequence 1: Three Initial Treatments

Recall subjects in the CC, CUA, and CUB treatments experience the certain treatment condition during Sequence 1. The purpose of this section is to confirm that group-fund provision decisions were not significantly different from each other across treatment conditions, making them appropriate for comparisons with decisions made in Sequence 2. Table VI reports random-effects models for each of the initial treatments using only observations from Sequence 1. The dependent variable in each regression is the change in an individual's provision decision in round (*t*) minus the provision decision in round (*t*-1). The random-effects models control for the

[8] To further investigate the carryover effect from subjects experiencing the certain condition in Sequence 1 as a potential drive for the lower group-fund provision in Sequence 2 with uncertainty, additional regression analysis comparing Sequence 2 group-fund provision between the CUA and UAUA treatments, as well as CUB and UBUB treatments, is reported in the appendix. In both comparisons, group-fund provision in Sequence 2 is higher in the treatment where subjects experience uncertainty in Sequence 1, but the difference is not significant.

subject-specific effect in addition to the idiosyncratic error. The independent variables are rounds dummies and the one-round lagged deviation of person *i* from the mean provision decision of his/her other three group members.

Consistent with previous linear public-good studies (Chaudhuri and Paichayontvijit 2006, Ashley et al. 2010, Ferraro and Vossler 2010, and Smith 2013), the coefficient for the lagged deviation from other group members is significant and negative in all treatment models. This indicates the presence of reciprocal norms in decision strategies used by group members. Wald tests of regression homogeneity reveal that the Sequence 1 data for pairwise subsamples are not significantly different. The joint null hypothesis of homogeneous coefficients are rejected across pairwise Sequence 1 subsamples (p>0.10) for CC=CUA, CC=CUB, and CUA=CUB.[9]

Table VI- 1-Round Change in Individual Provision Decisions, Random-effects Panel Regression: Sequence 1 Decisions, by Treatment

Dependent Variable: 1-Round Change in Individual Provision Decisions in Sequence 1			
Independent Variables	Certain-Certain	Certain-UncertainA	Certain-UncertainB
Lagged Deviation from Mean Provision Decision of Other Members	-0.35 (0.04), [p=0.000]	-0.32 (0.07), [p=0.000]	-0.51 (0.09), [p=0.000]
Constant	0.38 (0.32), [p=0.236]	0.41 (0.32), [p=0.207]	0.41 (0.25), [p=0.103]

Data from round 1 were dropped because there are no lagged comparisons.
The reference category is round 2.
Certain-Certain:
Dummy variables for rounds 4 and 10 are negative and significant at least at the 10% level.
Figures in parentheses are robust standard errors clustered on 12 independent groups,
36 observations per cluster. R^2=0.22; N=432
Certain-UncertainA:
Dummy variables for rounds 3 and 8 are negative and significant at least at the 5% level.
Figures in parentheses are robust standard errors clustered on 11 independent groups,
36 observations per cluster. R^2=0.17; N=396
Certain-UncertainB:
Dummy variables for rounds 3, 4, and 9 are negative and significant at the 1% level.
Figures in parentheses are robust standard errors clustered on 11 independent groups,
36 observations per cluster. R^2=0.29; N=396

[9] The Wald test used here is conducted by pooling data across subsamples and then including subsample dummy and interaction terms. The null hypothesis is that the dummy and interaction coefficients are jointly zero. Unlike the traditional Chow test of regression homogeneity, the Wald test utilizes the estimated variance-covariance matrix from the regression, which incorporates the robust variance estimates with clustering.

6.2 Sequence 2: Three Initial Treatments

Table VII reports random-effects models for each of the initial treatments using only observations from Sequence 2. The dependent and independent variables are the same as those utilized in models in Table VI. Additionally, in models of the CUA and CUB treatments with uncertainty in Sequence 2, the one-round lagged group-fund return is included as an independent variable to control for the effect an uncertain group-fund return has on provision decisions.

Consistent with the results from Table VI, the coefficient for the lagged deviation from other group members is significant and negative in all treatment models. This indicates the presence of reciprocal norms in decision strategies used by group members is unaffected by the uncertainty condition.

The negative coefficients for the lagged group-fund return indicate that some subjects decreased (increased) their provision when they received a high (low) group-fund return in the previous round. To the extent that the lagged group-fund return significantly affected provision behavior across rounds, some subjects may have exhibited a version of the "gambler's fallacy." That is, a subject believes that the probability of drawing a particular return has decreased because it recently occurred, even though subjects were informed that the probability of drawing each possible return was independent of the returns drawn in previous rounds.[10] The small and insignificant coefficient in the CUA model indicates some subjects exhibited a weak version of the "gambler's fallacy." The large and significant coefficient in the CUB model indicates some subjects exhibited a strong version of the "gambler's fallacy." Although, a Wald test of the homogeneity of regression coefficients across the CUA and CUB models does not indicate a significant treatment effect on the change in individual provision decisions (fail to reject CUA=CUB, $p>0.10$).[11]

[10] The standard version of the gambler's fallacy occurs in individual decision making (see Ayton and Fischer 2004 and Oskarsson et al. 2009). In the public-goods games studied here, an individual's provision decision has implications on other group members' earnings. For instance, there may be an interaction between a mistaken belief of the probability of drawing a possible return and other-regarding preferences for other group members.

[11] Individual-level regression analysis for the additional treatments is reported in the appendix. Evidence of a strong version of the "gambler's fallacy" is also found in the UBUB treatment, but only in the Sequence 2 decision data.

Table VII- 1-Round Change in Individual Provision Decisions, Random-effects Panel Regression: Sequence 2 Decisions, by Treatment

Dependent Variable: 1-Round Change in Individual Provision Decisions in Sequence 2			
Independent Variables	Certain-Certain	Certain-UncertainA	Certain-UncertainB
Lagged Deviation from Mean Provision Decision of Other Members	-0.33 (0.06), [p=0.000]	-0.24 (0.05), [p=0.000]	-0.31 (0.05), [p=0.000]
Lagged Group-Fund Return	----	-0.06 (0.12), [p=0.616]	-0.41 (0.15), [p=0.007]
Constant	-0.56 (0.33), [p=0.093]	-0.55 (0.39), [p=0.159]	1.18 (0.31), [p=0.000]

Data from round 11 were dropped because there are no lagged comparisons.
The reference category is round 12.
Certain-Certain:
Dummy variable for round 16 is positive and significant at the 10% level.
Figures in parentheses are robust standard errors clustered on 12 independent groups, 36 observations per cluster. R^2=0.20; N=432
Certain-UncertainA:
Dummy variable for round 17 is negative and significant at the 10% level.
Figures in parentheses are robust standard errors clustered on 11 independent groups, 36 observations per cluster. R^2=0.13; N=396
Certain-UncertainB:
Dummy variables for rounds 14 and 17 are negative and significant at least at the 10% level. Dummy variable for round 19 is positive and significant at the 10% level.
Figures in parentheses are robust standard errors clustered on 11 independent groups, 36 observations per cluster. R^2=0.20; N=396

7. Conclusion

This study examines uncertain group-fund returns in voluntary-provision public-goods games. As found in related studies, uncertainty reduces public-good provision compared to settings without uncertainty. This study contributes to the literature in three fundamental ways. The first relates to how the variance of the probability distribution for the public-good return impacts public-good provision. This is examined by comparing public-good provision in two treatments with uncertainty, where the probability distributions have different variances. The second contribution relates to examining order effects as a determinant of the response to uncertainty. The third contribution relates to how subjects in treatments with uncertainty respond to previous realizations of the return to the public good. More specifically, the study examines the correlation of individual provision decisions with the one-round lagged group-fund return

Theoretical predictions assuming risk-averse subjects predict that the negative impact of uncertainty on group-fund provision would be stronger in the treatment with greater variance. However, the data supports the opposite conclusion. The treatment with the lower variance, certain-uncertainA, had the stronger negative impact on group-fund provision. At the group level, this suggests that the variance of an uncertain return from a public good may not be an important determinant in public-good provision. The data from the additional treatments, where subjects experienced uncertainty in both sequences, support an order effect to uncertainty. Group-fund provision in Sequence 1 is not significantly different between the certain and uncertain treatments. This result suggests that subjects are sensitive to when they are exposed to uncertainty.

At the individual level, at least some individuals increase (decrease) their provision after observing a low (high) group-fund return in the previous period. This result suggests that subjects may have exhibited a version of the "gambler's fallacy." An alternative explanation may be that subjects expected the group-fund return to revert towards the mean in the next round. Evidence of such behavior is stronger in the treatment with greater variance, certain-uncertainB.

The results from this study offer insights to organizations that produce public goods with voluntary contributions. Variation in the productivity (or quality) of a public good may have a negative effect on contributions, if preceded by time intervals with no or little variation in productivity or quality in producing the public good. However, if the variation in productivity is large, individual contributions across time intervals may increase (decrease) after a time interval of randomly relatively poor (strong) productivity.

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