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Abstract:
This paper is a study of collective action in asymmetric access to a common resource. An example is an irrigation system with upstream and downstream resource users. While both contribute to the maintenance of the common infrastructure, the upstream participant has first access to the resource. Results of our two-player asymmetric commons game show that privileged resource access player invest more than the downstream players. Investments by the downstream player into the common resource are rewarded by a higher share from the common resource by the upstream player. Decisions are mainly explained by the levels of trust and trustworthiness. Introducing uncertainty in the production function of the common resource did not affect the results in a significant way.

Keywords:
Asymmetry, Common-Pool Resources, Laboratory Experiment

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1. Introduction

Social dilemmas capture the conflict between the outcomes when individuals pursue their selfish interests and when they maximize the interests for the group as a whole. Experimental results show that participants do not solely pursue their self-interest but often take into account the earnings of others when making their decisions (Ostrom et al., 1994; Fehr and Gächter, 2000). In a one-shot linear public good experiment, participants invest on average 50% of their endowment into the public good (Ledyard, 1995).

One way to classify social dilemma games is based on whether participants have equal positions in the game. In standard public good and common-pool resource games they do, but in dictator and ultimatum games they don't. In dictator and ultimatum games, one of the two participants has to decide on the allocation of the resource and, on average, the participants claim more than 50% of the resource for themselves. In dictator games where the dictator has earned the endowment, she is not likely to share with the other participant (Cherry et al., 2002). In this paper, we allow the group to create the resource for which one participant has the power to distribute the resource.

In this experiment, participants first create a common-pool resource, and then one participant decides how to distribute the resource. The game is inspired by the dilemma between upstream and downstream farmers in irrigation systems (Ostrom and Gardner, 1993). For the resource system to succeed, upstream farmers need the cooperation of downstream participants to maintain and repair the irrigation infrastructure, but they also have first access to use the common resource. Since the upstream participants are dependent on the long-term contributions from downstream participants, we may expect that upstream participants do not extract all the common resources (Janssen et al., 2012).

The problem of constructing a common resource where some participants have first access is not restricted to irrigation problems. Another example is the creation of pension funds where elder participants are the first to access the resource. In this paper we use an abstract game to address the problem of collective construction of the fund and asymmetric access to the fund. How does the co-construction of a fund affect its distribution compared to a dictator game where the fund is considered a windfall for the participants?

Previous experiments in public goods and common pool resources have used asymmetric endowments and power of appropriators (e.g., Cox et al., 2011). Asymmetric access to resources, however, has been given less attention, notwithstanding its importance for governing many common pool resources (Rapoport, 1997, Budescu and Au, 2002, Janssen et al., 2012, D'Exelle, 2012).

Besides asymmetry, we also explore the effect of uncertainty. Inspired by irrigation systems, we test the effect of resource uncertainty on the asymmetric game. Earlier studies show that increased resource uncertainty due to climate change may hinder cooperation (e.g., Döll, 2002), while others suggest that cooperation initially increases with uncertainty in the resource but later decreases leading to an inverse U relationship between cooperation and uncertainty (Dinar, 2009; Dinar et al., 2010). In experimental studies scholars have shown that uncertainty reduces the level of cooperation in public goods games (Wit and Wilke, 1998; Gustafson et al., 2000; Au, 2004).

Here, we analyze 1) the role of asymmetry in resource access when a common resource is endowed or collectively created, 2) how resource uncertainty influences behavior in asymmetric resource access games, and 3) what other socio-economic factors may explain collective actions.

2. Experimental design

The two-player asymmetric commons game (ACG) is a two-part game. First, each participant receives $3. Once she receives the amount, she has to decide how much to invest into the public fund and how much to keep for herself. The amount invested by two participants is then calculated. If $3 or less has been invested by the two players, no resource is generated. If $4 or more are invested, the resource size is doubled (Table 1). In the second part of the experiment Player One decides how much to take from the resource and how much to leave for Player Two. Each player's earnings are the amount they did not invest into the public fund, plus the amount they kept or received from the public fund. The Nash equilibrium of selfish rational actors predicts that neither of the players will invest into the public fund. The social optimum is achieved when both players invest $3 into the public fund.

We incorporate resource uncertainty by determining the resource availability based on the roll of a die. The expected outcomes remain the same, but in the Low Variability case, the probability for the Medium level payoff column is 2 out of 3. In the High Variability case, the probability for the Medium level payoff column is only 1 out of 3 (Table 1).

Table 1

Resource size based on the investment in the public fund and the roll of a 6-face die.

	Probability		
No variability		1	
Low variability	1/6	4/6	1/6
High variability	1/3	1/3	1/3
	Resource		
Public fund	Low	Medium	High
0-3	0	0	0
4	3	8	13
5	4	10	16
6	5	12	19

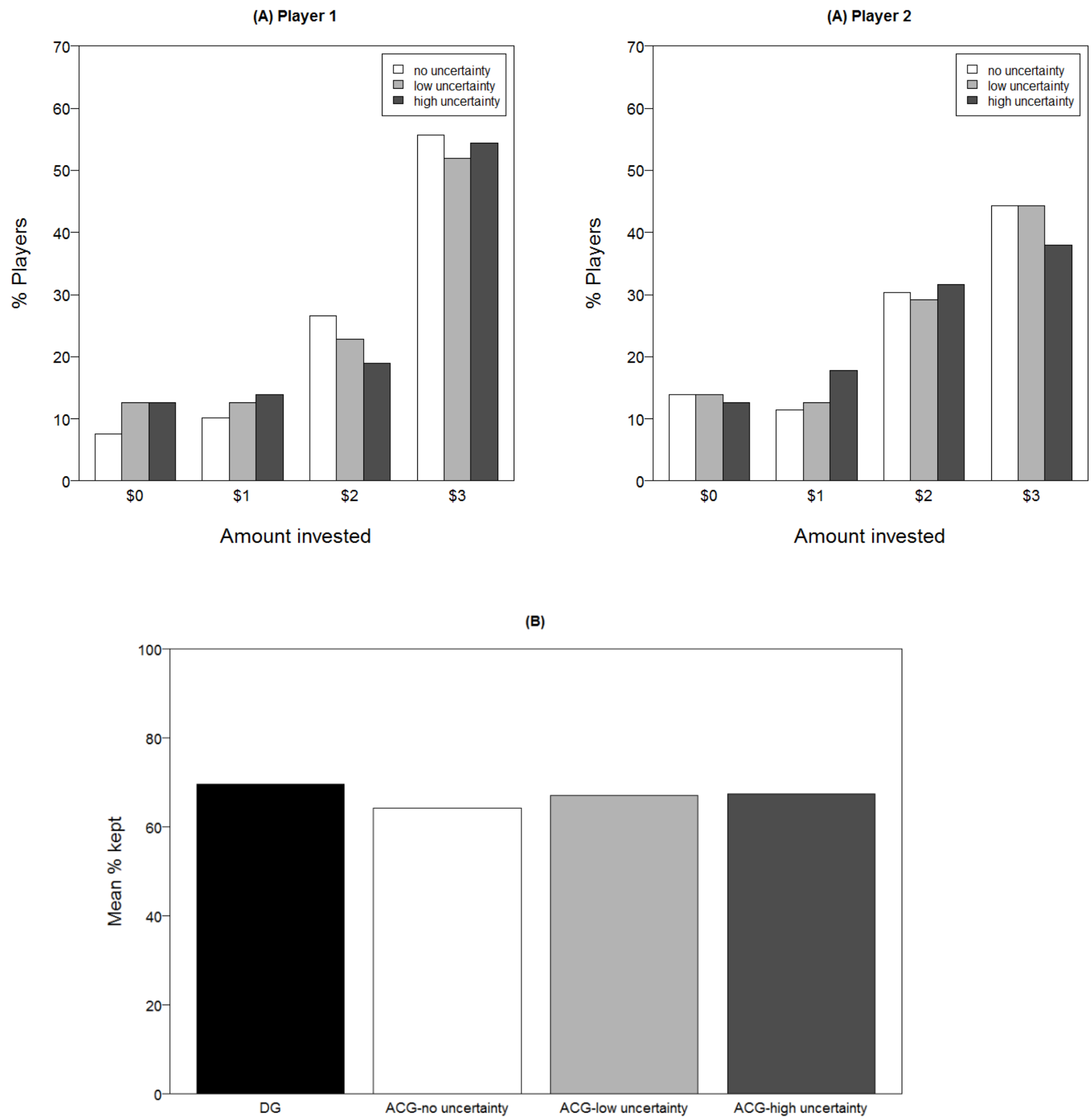
The experiments were conducted using a strategy method, where players wrote their intentions for both roles as Player One and Player Two. Besides the three asymmetric commons dilemmas, we performed a Risk Aversion task (RG, Holt and Laury, 2002), a Trust Game (TG, Berg et al., 1995), and a Dictator Game (DG, Kahneman et al., 1986). In each experiment session, the participants were randomly matched with another participant in the room after completing their strategy forms (see Appendix A for instructions).

The experiments were performed at Arizona State University in the spring of 2012. The participants were recruited from a database of undergraduate students who had indicated that they were willing to participate in experiments with human subjects. This database consists of students from all majors, and invitations were sent out to a random sample of the whole population when an experiment was scheduled. We performed four experiment sessions in which we changed the sequence of the exercises. For example, in one session the TG game was given before the ACG games, while in another session ACG games were given before the TG game. Non-parametric tests show that exercise order did not have a significant effect on our core results ($p>0.05$; Kruskal-Wallis test). Based on exit surveys, of the 79 students that participated in the experiments reported in this paper, 44% were female and the average age was 19.8 years. Average earnings were $26.26, including a show up bonus of $5 plus payments for their play (made in private) for experiments with an average duration of 60 minutes. The individual minimum and maximum earnings were $14.00 and $47.60, respectively.

3. Results

Our results show that participants kept less in ACG with no uncertainty rather than when playing the DG ($p<0.05$; Wilcoxon signed-rank test). We also found that the players' positions have a significant effect in the ACG on their investment decisions. Participants invest more into the public fund if playing as Player One rather than Player Two (p-value < 0.05; Wilcoxon signed-rank test) (Fig. 1). The median investment level is three dollars when playing as Player One and two dollars when playing as Player Two. However, uncertainty nullifies the significance of collective resource (i.e., ACG vs DG) and position in affecting extraction and investment levels respectively (p-value > 0.05; Wilcoxon signed-rank test). Player One leaves more resource for Player Two when the resource is collectively created and there is no uncertainty (Fig. 1). With uncertainty, investment is reduced by both players, although Player One's reduction is slightly higher than that of Player Two. Thus, the difference between the investments of both players decreases in the uncertain ACG (Fig. 1).

Figure. 1. (A) Investment of player one (left) and two (right) depending on the uncertainty level (no, low, and high) in ACG. (B) Mean percentage of the available resource kept by player 1 in the Dictator Game (DG) and in the three levels of uncertainty of the ACG.



We perform OLS-regressions to test how robust these results are when controlling for risk aversion (number of As in the RG; mean=5.38, sd=1.82), trust (amount sent in the TG; mean=2.00, sd=1.01), trustworthiness (amount given back / total amount at disposal in TG; mean=0.32, sd=0.19), selfishness (amount given in the DG; mean=0.91, sd=0.75), and gender due to their importance in explaining decisions (e.g., Eckel and Grossman, 1998; Fischbacher et al., 2001). As our uncertainty variable is based on probabilities, we also control for probability reasoning (score obtained in seven questions of the exit survey measuring probability reasoning; mean=0.81, sd=0.20). We use a model selection approach (Johnson and Omland, 2004) and we apply the Akaike Information Criterion (AIC) method to compare the fits of all possible combinations of explanatory variables (Burnham and Anderson, 2002). In order to compare models, we calculated Akaike weights (w) as the probability that a model would be selected as the best fitting model if the data were collected again under identical circumstances (Burnham and Anderson, 2002). Tables A.1 and A.2 (see appendix B) reports confidence sets of models, i.e., the smallest subset of candidate models for which w sum to 0.95, for investment in ACG and extraction in ACG and DG respectively. This represents a set of models for which we have 95% confidence that the set contains the best approximating model to the true model. Table 2 reports the relative variable importance and the averaged estimates weighted by its w (Burnham and Anderson, 2002). The relative variable importance refers to the probability that a specific variable is included in the best approximating model.

Table 2

Model averaged coefficients and variable relative importance.

	Investment				Extraction			
	Estimate	Std. Error	Sig.	Imp.	Estimate	Std. Error	Sig.	Imp.
(Intercept)	1.674	0.222	***	1.00	0.585	0.043	***	1.00
Collective resource	n.a.	n.a.	n.a.	n.a.	-0.042	0.022	*	0.75
Gender: 1 if male	0.230	0.099	**	0.86	0.000	0.017		0.23
Position	-0.186	0.086	**	0.81	n.a.	n.a.	n.a.	n.a.
Probability reasoning	-0.018	0.222		0.25	0.013	0.042		0.26
Risk aversion	-0.018	0.024		0.32	0.001	0.005		0.25
Selfishness	-0.169	0.066	**	0.95	0.121	0.012	***	1.00
Trust	0.392	0.049	***	1.00	n.a.	n.a.	n.a.	n.a.
Trustworthiness	n.a.	n.a.	n.a.	n.a.	-0.484	0.048	***	1.00
Uncertainty	-0.063	0.053		0.43	0.015	0.012		0.43

Significance at the 1%, 5%, and 10% are denoted by ***, **, and * respectively. n.a. = non-available for the specific model.

Consistent with the literature, results show that Trust (for investment), Trustworthiness (for extraction), and Selfishness (for both dependent variables), are the most important variables explaining participants' decisions (Fischbacher et al., 2001). Trust has a positive and significant effect on investment levels, while Selfishness has a negative effect on investment (Table 2). Trustworthiness has a negative effect on extraction levels, while Selfishness has a positive effect on extraction (Table 2). In other words, Trust and Trustworthiness increase the social outcomes of resource investment and extraction, while Selfishness decreases it. In most of the selected investment models, Trust and Selfishness are accompanied by Position (Table A.1, see appendix B). Position has a selection probability of 0.81 with a negative coefficient, meaning that players with privileged access to resources are prone to invest more (Table 2). For extractions, models show that the collective creation of the resource, although marginally significant, has a high selection probability and increases the amount of resource that Player One leaves for Player Two (Table 2). Uncertainty, although not significant, also has a relatively important role in explaining investment (Table 2).

4. Discussion and concluding remarks

Shared construction of the common resource leads participants, who allocate the resource, to allocate more resources to the other player. The participant with first access to the resource invests on average 8% more to the construction of the resource. The effect of uncertainty on the investment levels is not significant.

In dictator games, participants receive an individual windfall or earn an individual endowment. The source of the endowment explains the distribution by the dictator in the DG. In the ACG, the participants collectively generate a common resource which one participant then decides how to distribute. We found that the participant with first access to the resource rewarded the contributions made by the other participant.

The participants' decisions are mainly explained by their selfishness and the level of trust and trustworthiness they demonstrated toward the other participants. We did not find an effect from including uncertainty, but the results were also unaffected by the participants' level of probabilistic reasoning.

In summary, participants with privileged access reward the contributions of other participants in the creation of the common fund, and they invest 8% more than participants without that privileged access. The mutual dependency between creation and extraction can lead to a cooperative outcome, if the participants have sufficient trust in the potential partners in the collective action situation. This provides some insights into the capabilities of self-governance when there is asymmetry in the commons.

Acknowledgments

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Supplementary Material A: Experimental instructions

Risk aversion game

This exercise sheet lists ten decisions. Each decision is a paired choice between "Option A" and "Option B." You will make ten choices and record these in the final column, but only one of these choices will be used in the end to determine your earnings. Before you start making your ten choices, please let me explain how these choices will affect your earnings for this part of the experiment.

We will use a ten-sided die to determine the payoffs; the faces are numbered from 1 to 10. After you have made all of your choices, we will throw this die twice, once to select one of the ten decisions to be used, and a second time to determine what your payoff is for the option you chose, A or B, for the particular decision selected. Even though you will make ten decisions, only one of these will end up affecting your earnings, but you will not know in advance which decision will be used. Obviously, each decision has an equal chance of being used in the end.

Now, please look at Decision 1 at the top. Option A pays $2.00 if the throw of the ten sided die is 1 and it pays $1.60 if the throw is 2-10. Option B yields $3.85 if the throw of the die is 1, and it pays $0.10 if the throw is 2-10. The other Decisions are similar, except that as you move down the table, the chances of the higher payoff for each option increase. In fact, for Decision 10 in the bottom row, the die will not be needed since each option always pays the highest payoff, so your choice here is between $2.00 or $3.85.

To summarize, you will make ten choices: for each decision row you have to choose between Option A or Option B. You may choose A for some decision rows and B for other rows, and you may change your decisions and make them in any order. When you are finished, we will collect the forms. When we pay you your earnings at the end of today's exercises, we will throw the ten-sided die to select which of the ten Decisions will be used, and a second time to determine your money earnings for the Option you chose for that Decision. Earnings for this choice will be added to your other earnings, and you will be paid all earnings in cash.

So now please fill in each of the empty boxes on the right side of the record sheet. You need to enter your choice, A or B, in each of these boxes. Are there any questions? Now you may begin making your choices. Please do not talk with anyone while we are doing this; raise your hand if you have a question.

Die	**Option A**	**Option B**	**Your Choice (A or B)**
1	$2.00 – 1 $1.60 - 2, 3, 4, 5, 6, 7, 8, 9, 10	$3.85 – 1 $0.10 – 2, 3, 4, 5, 6, 7, 8, 9, 10	
2	$2.00 – 1, 2 $1.60 – 3, 4, 5, 6, 7, 8, 9, 10	$3.85 – 1, 2 $0.10 – 3, 4, 5, 6, 7, 8, 9, 10	
3	$2.00 – 1, 2, 3 $1.60 – 4, 5, 6, 7, 8, 9, 10	$3.85 – 1, 2, 3 $0.10 – 4, 5, 6, 7, 8, 9, 10	
4	$2.00 – 1, 2, 3, 4 $1.60 – 5, 6, 7, 8, 9, 10	$3.85 – 1, 2, 3, 4 $0.10 – 5, 6, 7, 8, 9, 10	
5	$2.00 – 1, 2, 3, 4, 5 $1.60 – 6, 7, 8, 9, 10	$3.85 – 1, 2, 3, 4, 5 $0.10 – 6, 7, 8, 9, 10	
6	$2.00 – 1, 2, 3, 4, 5, 6 $1.60 – 7, 8, 9, 10	$3.85 – 1, 2, 3, 4, 5, 6 $0.10 – 7, 8, 9, 10	
7	$2.00 – 1, 2, 3, 4, 5, 6, 7 $1.60 – 8, 9, 10	$3.85 – 1, 2, 3, 4, 5, 6, 7 $0.10 – 8, 9, 10	

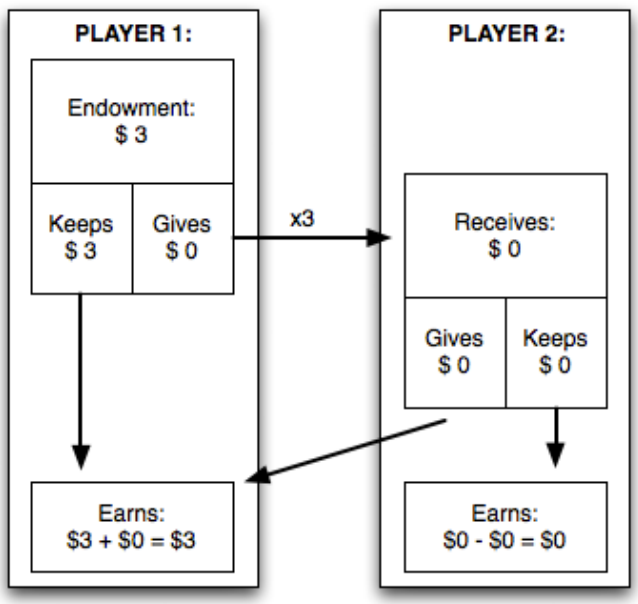
8	$2.00 – 1, 2, 3, 4, 5, 6, 7, 8 $1.60 – 9, 10	$3.85 – 1, 2, 3, 4, 5, 6, 7, 8 $0.10 – 9, 10	
9	$2.00 – 1, 2, 3, 4, 5, 6, 7, 8, 9 $1.60 – 10	$3.85 – 1, 2, 3, 4, 5, 6, 7, 8, 9 $0.10 – 10	
10	$2.00 – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	$3.85 – 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	

Trust game

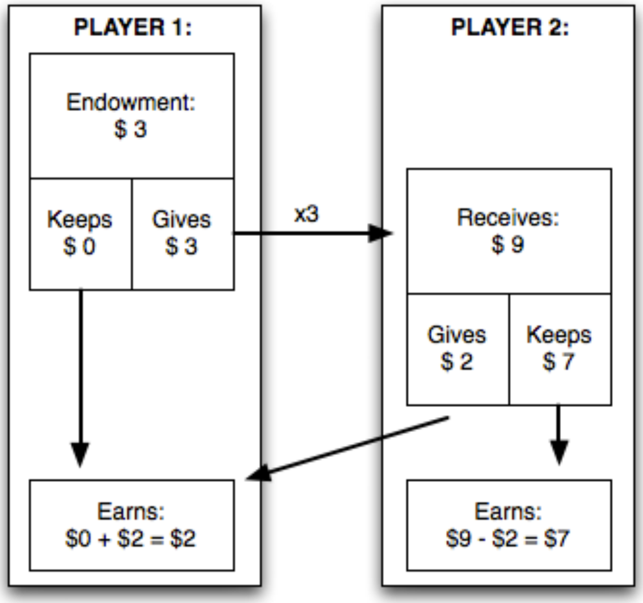
In this exercise you will be randomly matched with another person in this room, but you will not know who that person is. That person will also not know who you are. You must write down your decisions for the possibility if you are selected to be Player 1 in this exercise or if you are selected to be Player 2.

The person randomly selected to be Player 1 has the following decision to make: You will receive 3 dollars and must decide how much to keep for yourself and how much to send to Player 2 in this room.

The amount you send to Player 2 will be tripled and then given to Player 2. Player 2 will decide how much to keep and how much to send back to you. For example, if you, Player 1, send 0 dollars to player 2, 0 dollars will be sent to player 2 and you will keep 3 dollars for yourself.



However, if you choose to send 3 dollars to Player 2, those 3 dollars will be multiplied into 9 dollars and sent to Player 2. Player 2 would then decide how much to return to you. In the example below Player 2 keeps seven dollars and returns two dollars to Player 1.



Player 2 has the following decision to make: You have to choose for each of the 4 possible cases, how much to keep for yourself and how much to send back to player 1.

Please complete both tables for Player 1 AND for Player 2. We will randomly select whether you are Player 1 OR Player 2 after we receive all these forms.

Are there any questions? If you have a question, raise your hand and I will try to answer it.

Player 1: **Please check ONE of the following allocations.**

Dollars kept by you	Dollars send to other	Received by other	**Check One Row**
$0	$3	(3x$3) = **$9**	
$1	$2	(3x$2) = **$6**	
$2	$1	(3x$1) = **$3**	
$3	$0	(3x$0) = **$0**	

Player 2: **Please enter your choice for ALL of the following allocations:**
(column 3 and 4 must add up to column 2)

Sent by other	Received from other	Kept by you	Send back to other
$0	(3x$0) = **$0**	$0	$0
$1	(3x$1) = **$3**		
$2	(3x$2) = **$6**		
$3	(3x$3) = **$9**		

Dictator game

In this exercise you will be randomly matched with another person in this room, but you will not know who that person is. That person will also not know who you are. One of you will be randomly selected to be Player 1 and the other will be Player 2. You must write down your decision for the possibility if you are selected to be Player 1 in this exercise.

Your task is to decide how to allocate a sum of money between yourself and the other player in this room. If you are selected to be Player 1, you will receive 3 dollars, and you have to decide how much to keep for yourself and how much to give to Player 2. If you are selected to be Player 2, you will receive what Player 1 decides to send to you.

As an example, you can keep 2 dollars and give 1 dollar to Player 2. Or you can keep 1 dollar and give 2 dollars to Player 2. You can choose any amounts you wish.

If you have any questions, please raise your hand and I will try to answer your question in private.

Please check ONE of the following allocations.

Amount to keep for yourself (if you are Player 1)	Amount to send to other person (if you are drawn Player 1)	Check one row
0	3	
1	2	
2	1	
3	0	

Two player asymmetric commons game with no uncertainty

In this exercise you will be randomly matched with another person in this room, but you will not know who that person is. That person will also not know who you are. One of you will be randomly selected to be Player 1 and the other will be Player 2. You must write down your decision for the possibility if you are selected to be Player 1 in this exercise.

You have to make the following decision: you will receive 3 dollars and must decide how much to keep for yourself and how much to invest in a public fund. The total investment in the fund will be doubled by the experimenter to create a common resource, but only if the total investment is 4 dollars or higher. If less than 4 dollars are invested, the resource will be 0.

Table 1: Resource quantity is dependent on the amount of total investment

Public fund	**Resource**
$0-$3	$0
$4	$8
$5	$10
$6	$12

Once the resource is generated, Player 1 will make the first decision on how much to collect from the common resource. Player 2 receives the remainder. Each player's earnings are the sum of the amount of endowment they kept for themselves and the amount of resource they received.

For example, if the total investment in the public fund is 5 dollars, the common resource will become 10 dollars. Player 1 will first decide how much of the resource to take, and then Player 2 will receive the rest. If the total investment in the public fund is 3 dollars, the common resource is 0.

Are there any questions? If you have a question, raise your hand and I will try to answer it.

Please check ONE row in EACH column (i.e. Your decision for BOTH Player 1 and Player 2.)

Dollars kept by you	Dollars invested in public fund	If you are Player 1 (choose one)	If you are Player 2 (choose one)
$0	$3		
$1	$2		
$2	$1		
$3	$0		

What would you do if you were randomly selected to be Player 1:

Please enter your choice for ALL the following choices

Common Resource	Take For Yourself	Leave for Player 2
$0	$0	$0
$8		
$10		
$12		

Two player asymmetric commons game with low uncertainty

This exercise is a variation of exercise 4. In this exercise you will be randomly matched with another person in this room, but you will not know who that person is. That person will also not know who you are. One of you will be randomly selected to be Player 1 and the other will be Player 2. You must write down your decision for either possibility, if you are selected to be Player 1 or Player 2 in this exercise.

Each player must first make the following decision:

You will receive 3 dollars and must decide how much to keep for yourself and how much to invest in a public fund. The total investments will be adjusted by the experimenter to create a common resource, but only if the total investment is 4 dollars or higher. If less than 4 dollars are invested, the resource will be 0.

The resource quantity for a given investment into the public fund depends on the roll of a die (Table 1). We will throw a die, and if it rolls a 1, we will use the Low Payoff column. If the roll is a 6, we will use the High Payoff column. If the roll is a 2, 3, 4 or a 5, we will use the Medium Payoff column. Therefore, there is a 1 out of 6 chance that the Low Payoff column will be used, a 1 out of 6 chance that the High Payoff column will be used, and a 4 out of 6 chance that the Medium Payoff table will be used.

Table 1: Resource size based on the investment in the public fund and the roll of the die

Dice Roll	**1**	**2, 3, 4, or 5**	**6**
Public fund\ Resource	**Low**	**Medium**	**High**
0-3	0	0	0
4	3	8	13
5	4	10	16
6	5	12	19

Once the resource is created, Player 1 will make the first decision on how much to collect from the common resource. Player 2 receives the remainder. Each player's earnings are the sum of the amount of endowment they kept for themselves and the amount of resource they received.

For example, if the total investment in the public fund is 5 dollars and we roll a 6, the common resource will become 16 dollars. Player 1 will first decide how much of the resource to take, ad then Player 2 will receive the rest. If the total investment in the public fund is 3 dollars, the common resource is 0.

Are there any questions? If you have a question, raise your hand and I will try to answer it.

Please check ONE row in EACH column (i.e. Your decision for BOTH Player 1 and Player 2.)

Dollars kept by you	Dollars invested in public fund	If you are Player 1 (choose one)	If you are Player 2 (choose one)
\$0	\$3		
\$1	\$2		
\$2	\$1		
\$3	\$0		

What would you do if you were randomly selected to be Player 1:

Please enter your choice for ALL the following choices

Common Resource	Take For Yourself	Left for Player 2
$0	$0	$0
$3		
$4		
$5		
$8		
$10		
$12		
$13		
$16		
$19		

Two player asymmetric commons game with high uncertainty

This exercise is a variation of exercise 4. In this exercise you will be randomly matched with another person in this room, but you will not know who that person is. That person will also not know who you are. One of you will be randomly selected to be Player 1 and the other will be Player 2. You must write down your decision for either possibility, if you are selected to be Player 1 or Player 2 in this exercise.

Each player must first make the following decision:

You will receive 3 dollars and must decide how much to keep for yourself and how much to invest in a public fund. The total investments will be adjusted by the experimenter to create a common resource, but only if the total investment is 4 dollars or higher. If less than 4 dollars are invested, the resource will be 0.

The resource quantity for a given investment into the public fund depends on the roll of a die (Table 1). We will throw a die, and if it rolls a 1 or 2, we will use the Low Payoff column. If the roll is a 3 or 4, we will use the Medium Payoff column. If the roll is a 5 or 6, we will use the High Payoff column. Therefore, there is an equal 1 out of 3 chance that either the Low Payoff, Medium Payoff, or High Payoff columns will be used.

Table 1: Resource size based on the investment in the public fund and the roll of the die

Dice Roll	**1, 2**	**3, 4**	**5, 6**
Public fund\ Resource	**Low**	**Medium**	**High**
0-3	0	0	0
4	3	8	13
5	4	10	16
6	5	12	19

Once the resource is created, Player 1 will make the first decision on how much to collect from the common resource. Player 2 receives the remainder. Each player's earnings are the sum of the amount of endowment they kept for themselves and the amount of resource they received.

For example, if the total investment in the public fund is 5 dollars and we roll a 6, the common resource will become 16 dollars. Player 1 will first decide how much of the resource to take, ad then Player 2 will receive the rest. If the total investment in the public fund is 3 dollars, the common resource is 0.

Are there any questions? If you have a question, raise your hand and I will try to answer it.

Please check ONE row in EACH column (i.e. Your decision for BOTH Player 1 and Player 2.)

Dollars kept by you	Dollars invested in public fund	If you are Player 1 (choose one)	If you are Player 2 (choose one)
$0	$3		
$1	$2		
$2	$1		
$3	$0		

What would you do if you were randomly selected to be Player 1:

Please enter your choice for ALL the following choices

Common Resource	Take For Yourself	Left for Player 2
$0	$0	$0
$3		
$4		
$5		
$8		
$10		
$12		
$13		
$16		
$19		

Supplementary Material B: Model selection

We use a model selection approach to hypothesis testing (Johnson and Omland, 2004) and apply the Akaike Information Criterion (AIC) method to compare the fits of all possible combinations of explanatory variables (Burnham and Anderson, 2002). In order to compare models, we calculate Akaike weights (w) as the probability that a model would be selected as the best fitting model if the data were collected again under identical circumstances (Burnham and Anderson, 2002). Tables A.1 and A.2 reports confidence sets of models, i.e. the smallest subset of candidate models for which w sum to 0.95. This represents a set of models for which we have 95% confidence that the set contains the best approximating model to the true model.

All analyses were performed using the R statistical package (R Development Core Team, 2008). The script we use is:

```
require(MuMIn)
library(stats4)
require(unmarked)
fm1<-lm(y ~ ., data = data)
ms1 <- dredge(fm1,beta = FALSE,rank=AIC)
confset.95p <- get.models(ms1, cumsum(weight) <= .95)
avgmod.95p <- model.avg(confset.95p)
sumavgmod99<-summary(avgmod.95p)
confavgmod<-confint(avgmod.95p)
sumavgmod<-summary(avgmod.95p)
confset.95p <- get.models(ms1, cumsum(weight) <= .95)
```

Table A.1
Selected models explaining investment in the ACG using the AIC method.

Model	logLik	ΔAIC	*w*	Intercept	Pos(1)	Prob(2)	Risk(3)	Self(4)	Gender(5)	Trust(6)	Unc(7)
1456	-638.83	0	0.19	1.667*** (0.174)	-0.186* (0.086)			-0.177*** (0.063)	0.234** (0.097)	0.385*** (0.046)	
14567	-638.1	0.54	0.1	1.730**	-0.186*			0.177***	0.234**	0.385***	-0.063

Model	logLik	ΔAIC	*w*	Intercept	Pos(1)	Prob(2)	Risk(3)	Self(4)	Gender(5)	Trust(6)	Unc(7)
			4	* (0.182)	(0.086)			(0.063)	(0.097)	(0.046)	(0.053)
13456	-638.57	1.49	0.09	1.752*** (0.211)	-0.186* (0.086)		-0.017 (0.024)	-0.1718*** (0.063)	0.2316** (0.097)	0.384*** (0.046)	
12456	-638.82	1.98	0.07	1.648*** (0.221)	-0.186* (0.086)	0.030 (0.221)		-0.1786*** (0.064)	0.233** (0.098)	0.385*** (0.047)	
134567	-637.84	2.02	0.07	1.815*** (0.217)	-0.186* (0.086)		-0.017 (0.024)	-0.1718 (0.063)	0.2316** (0.097)	0.384*** (0.046)	-0.063 (0.053)
124567	-638.09	2.52	0.05	1.712*** (0.227)	-0.186* (0.086)	0.030 (0.221)		-0.1786*** (0.064)	0.233** (0.098)	0.38445*** (0.047)	-0.063 (0.053)
456	-641.17	2.69	0.05	1.574*** (0.169)				-0.1768*** (0.063)	0.234** (0.098)	0.385*** (0.047)	
4567	-640.45	3.24	0.04	1.637*** (0.177)				-0.1768*** (0.063)	0.234** (0.098)	0.385*** (0.047)	-0.063 (0.053)
123456	-638.57	3.48	0.03	1.741*** (0.257)	-0.186* (0.086)	0.016 (0.222)	-0.017 (0.024)	-0.173*** (0.065)	0.231** (0.098)	0.384*** (0.047)	
146	-641.74	3.82	0.03	1.600*** (0.173)	-0.186* (0.086)			-0.12** (0.058)		0.425*** (0.044)	
1234567	-637.84	4.02	0.02	1.804*** (0.263)	-0.186* (0.086)	0.016 (0.222)	-0.017 (0.024)	-0.173*** (0.065)	0.231** (0.098)	0.384*** (0.047)	-0.063 (0.053)
3456	-640.92	4.18	0.02	1.659*** (0.207)			-0.017 (0.024)	-0.172*** (0.063)	0.232** (0.098)	0.384*** (0.047)	
1467	-641.01	4.37	0.02	1.663*** (0.181)	-0.186* (0.086)			-0.12** (0.058)		0.425*** (0.044)	-0.063 (0.053)
2456	-641.16	4.67	0.02	1.555*** (0.218)		0.03 (0.222)		-0.179*** (0.064)	0.233** (0.098)	0.384*** (0.047)	
34567	-640.19	4.73	0.02	1.722*** (0.214)			-0.017 (0.024)	-0.172*** (0.063)	0.232** (0.098)	0.384*** (0.047)	-0.063 (0.053)
1346	-641.42	5.18	0.01	1.695*** (0.211)	-0.186** (0.086)		-0.019 (0.024)	-0.115* (0.059)		0.423*** (0.044)	
24567	-640.44	5.22	0.01	1.619*** (0.224)		0.03 (0.222)		-0.179*** (0.064)	0.233** (0.098)	0.384*** (0.047)	-0.063 (0.053)
1246	-641.68	5.71	0.01	1.557*** (0.219)	-0.186** (0.087)	0.071 (0.222)		-0.125** (0.06)		0.422*** (0.044)	
13467	-640.7	5.74	0.01	1.758*** (0.217)	-0.186** (0.086)		-0.019 (0.024)	-0.115* (0.059)		0.423*** (0.044)	-0.063 (0.053)
156	-642.8	5.95	0.01	1.282***	-0.186**				0.131 (0.091)	0.422*** (0.045)	

Model	logLik	ΔAIC	*w*	Intercept	Pos(1)	Prob(2)	Risk(3)	Self(4)	Gender(5)	Trust(6)	Unc(7)
				(0.109)	(0.087)						
16	-643.85	6.04	0.01	1.319*** (0.106)	-0.186** (0.087)					0.44*** (0.043)	
23456	-640.91	6.17	0.01	1.648*** (0.255)		0.016 (0.223)	-0.017 (0.024)	-0.173*** (0.065)	0.231** (0.098)	0.384*** (0.047)	
12467	-640.96	6.27	0.01	1.62*** (0.225)	-0.186** (0.086)	0.071 (0.221)		-0.125** (0.06)		0.422*** (0.044)	-0.063 (0.053)
46	-644.05	6.45	0.01	1.507*** (0.168)				-0.12** (0.059)		0.425*** (0.044)	
1567	-642.08	6.51	0.01	1.345*** (0.121)	-0.186** (0.087)				0.131 (0.091)	0.422*** (0.045)	-0.063 (0.053)
167	-643.13	6.61	0.01	1.382*** (0.118)	-0.186** (0.087)					0.44*** (0.043)	-0.063 (0.053)
234567	-640.19	6.72	0.01	1.711*** (0.26)		0.016 (0.223)	-0.017 (0.024)	-0.173*** (0.065)	0.231** (0.098)	0.384*** (0.047)	-0.063 (0.053)
1356	-642.28	6.9	0.01	1.419*** (0.173)	-0.186** (0.087)		-0.024 (0.024)		0.132 (0.091)	0.419*** (0.045)	
467	-643.34	7.02	0.01	1.57*** (0.176)				-0.12** (0.059)		0.425*** (0.044)	-0.063 (0.053)
136	-643.34	7.03	0.01	1.454*** (0.171)	-0.186** (0.087)		-0.024 (0.024)			0.437*** (0.043)	
12346	-641.39	7.12	0.01	1.659*** (0.256)	-0.186** (0.087)	0.055 (0.223)	-0.019 (0.024)	-0.119* (0.061)		0.421*** (0.044)	
13567	-641.56	7.46	0	1.482*** (0.181)	-0.186** (0.087)		-0.024 (0.024)		0.132 (0.091)	0.419*** (0.045)	-0.063 (0.053)
1367	-642.62	7.59	0	1.518*** (0.179)	-0.186** (0.087)		-0.024 (0.024)			0.437*** (0.043)	-0.063 (0.053)
123467	-640.66	7.67	0	1.722*** (0.262)	-0.186** (0.087)	0.055 (0.222)	-0.019 (0.024)	-0.119* (0.061)		0.421*** (0.044)	-0.063 (0.053)

For each model, the table indicates the log-likelihood (logLik), delta weight (ΔAIC, difference between the AIC for a given model and the best fitting model), and Akaike weights (*w*, the model selection probability). Model standard error in parenthesis. Model codes: Pos = position, Prob = probability reasoning, Risk = risk aversion, Self = selfishness, Unc = uncertainty. Significance at the 1%,5%, and 10% are denoted by ***, **, and * respectively.

Table A.2
Selected models explaining extraction in the DG and ACG using the AIC method.

Model	logLik	ΔAIC	*w*	Intercept	Coll Res(1)	Gender(2)	Prob(3)	Risk(4)	Self(5)	Tw(6)	Unc(7)
1567	165.6	0	0.1	0.596***	-0.050**				0.122**	-	0.016

Model	logLik	ΔAIC	*w*	Intercept	Coll Res(1)	Gender(2)	Prob(3)	Risk(4)	Self(5)	Tw(6)	Unc(7)
	5		5	(0.038)	(0.022)				* (0.012)	0.484*** (0.047)	(0.012)
156	164.63	0.03	0.15	0.596*** (0.038)	-0.033* (0.019)				0.122*** (0.012)	-0.484*** (0.047)	
56	163.03	1.24	0.08	0.570*** (0.035)					0.122*** (0.012)	-0.484*** (0.047)	
13567	165.7	1.90	0.06	0.585*** (0.049)	-0.050* (0.022)		0.013 (0.041)		0.121*** (0.012)	-0.482*** (0.048)	0.016 (0.012)
1356	164.68	1.93	0.06	0.585*** (0.049)	-0.033* (0.019)		0.013 (0.042)		0.121*** (0.012)	-0.482*** (0.048)	
14567	165.68	1.94	0.06	0.591*** (0.042)	-0.050*** (0.022)			0.001 (0.005)	0.121*** (0.012)	-0.486*** (0.048)	0.016 (0.012)
1456	164.66	1.98	0.06	0.591*** (0.042)	-0.033* (0.019)			0.001 (0.005)	0.121*** (0.012)	-0.486*** (0.048)	
12567	165.65	2.00	0.05	0.596*** (0.038)	-0.050** (0.022)	-0.000 (0.017)			0.122*** (0.012)	-0.484*** (0.047)	0.016 (0.012)
1256	164.63	2.03	0.05	0.596*** (0.038)	-0.033* (0.019)	-0.000 (0.017)			0.122*** (0.012)	-0.484*** (0.047)	
356	163.08	3.13	0.03	0.560*** (0.048)			0.013 (0.042)		0.121*** (0.012)	-0.482*** (0.048)	
567	163.07	3.16	0.03	0.568*** (0.036)					0.122*** (0.012)	-0.484*** (0.048)	0.003 (0.010)
456	163.06	3.18	0.03	0.566*** (0.039)				0.001 (0.005)	0.121*** (0.012)	-0.486*** (0.048)	
256	163.03	3.24	0.03	0.570*** (0.035)		-0.000 (0.017)			0.122*** (0.013)	-0.484*** (0.048)	
134567	165.73	3.83	0.02	0.580*** (0.053)	-0.050** (0.022)		0.014 (0.042)	0.001 (0.005)	0.121*** (0.012)	-0.484*** (0.048)	0.016 (0.012)
13456	164.72	3.86	0.02	0.580*** (0.053)	-0.033* (0.019)		0.014 (0.042)	0.001 (0.005)	0.121*** (0.012)	-0.484*** (0.048)	
123567	165.7	3.89	0.02	0.585*** (0.049)	-0.050** (0.022)	-0.001 (0.017)	0.013 (0.042)		0.121*** (0.013)	-0.482*** (0.048)	0.016 (0.012)
12356	164.68	3.93	0.02	0.585*** (0.050)	-0.033* (0.019)	-0.001 (0.017)	0.013 (0.042)		0.121*** (0.013)	-0.482*** (0.048)	
124567	165.68	3.94	0.02	0.591*** (0.004)	-0.050** (0.022)	0.000 (0.002)		0.001 (0.005)	0.121*** (0.013)	-0.486*** (0.048)	0.016 (0.012)
12456	164.66	3.98	0.02	0.591*** (0.004)	-0.033* (0.019)	0.000 (0.002)		0.001 (0.005)	0.121*** (0.013)	-0.486*** (0.048)	
3567	163.12	5.06	0.01	0.558*** (0.048)			0.013 (0.042)		0.121*** (0.012)	-0.482*** (0.048)	0.003 (0.010)
3456	163.1	5.07	0.0	0.555***			0.014	0.001	0.121**	-	

Model	logLik	ΔAIC	*w*	Intercept	Coll Res(1)	Gender(2)	Prob(3)	Risk(4)	Self(5)	Tw(6)	Unc(7)
	1		1	(0.052)			(0.042)	(0.005)	* (0.012)	0.484*** (0.049)	
4567	163.09	5.10	0.01	0.564*** (0.040)				0.001 (0.005)	0.121*** (0.012)	-0.486*** (0.048)	0.003 (0.010)
2356	163.08	5.13	0.01	0.560*** (0.048)		-0.000 (0.018)	0.013 (0.042)		0.121*** (0.013)	-0.482*** (0.048)	

For each model, the table indicates the log-likelihood (logLik), delta weight (ΔAIC, difference between the AIC for a given model and the best fitting model), and Akaike weights (*w*, the model selection probability). Model standard error in parenthesis. Model codes: Coll Res=collective resource, Prob = probability reasoning, Risk = risk aversion, Self = selfishness, Tw = trustworthiness, Unc = uncertainty. Significance at the 1%, 5%, and 10% are denoted by ***, **, and * respectively.

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