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Communication in a Common Pool Resource Environment with Probabilistic Destruction

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Abstract

We replicate and extend an experiment due to Walker and Gardner by investigating the effect of communication in a common pool resource subject to probabilistic destruction when group appropriation exceeds a safe zone. We replicate the Gardner and Walker result that destruction of the resource is rapid and efficiencies are low when communication is not allowed. Face-to-face communication significantly increases mean efficiency. Three groups of five sustain a "good" Nash equilibrium in the safe zone. The remaining two groups quickly destroy the resource. Achieving a "good"equilibrium is highly dependent on the emergence of a leader in the group communication.

Keywords: Common Property, Experiments, Communication, Probabilistic Destruction

JEL Classifications: Q22, C92

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Introduction

Common pool resources[2] (CPRs) have two key characteristics, exclusion of potential users is difficult and subtractibility. (Berkes *et al*., 1989, p. 91). The main problems of CPR management are control of access and regulation of individual appropriation.

Gordon (1954) provided the classic demonstration that under conditions of open access individuals are driven to appropriate more than socially optimal levels of the resource, until in the limit all rents from the resource are dissipated. Common responses have been direct regulation by a relatively high level of government and privatization. However both these solutions are often impossible for political, social or technical reasons. Anthropologists, political scientists and sociologists have reported that community organizations and practices have been sufficiently strong to achieve co-operative outcomes in common pool resource management, especially in developing countries. Perhaps because of these, there has been active interest in promoting community-based management of common property resources.

In a recently published book, Ostrom, Gardner and Walker (OGW, 1994) bring together a number of field studies of common property management with a systematic series of laboratory experiments designed to isolate the key factors affecting success in CPR management. OGW are chiefly interested in whether self-govening institutions for common property management are feasible. Many have argued they are not due to the inability of appropriators to make enforceable contracts. Incomplete information about the actions of individual appropriators creates a moral hazard, namely the incentive for appropriators publicly to agree to limits on their harvest while privately violating them.

Drawing on prior literature[3], OGW identify communication and sanctioning as key institutional elements promoting efficiency in self-governed CPRs. Sanctioning promotes co-operation, because it alters the structure of the game and may convert co-operation into a sub-game perfect equilibrium. The role for non-binding communication has a much weaker theoretical basis. In a full information, finitely repeated game, communication and non-enforceable agreements do not alter the payoff structure of the game and hence cooperation is still not an equilibrium. Nevertheless, OGW find that face-to-face communication among laboratory subjects dramatically increases the efficiency of resource use, as measured by the subjects' earnings as a fraction of the maximum achievable earnings.

OGW's laboratory sessions had subjects investing between two "markets". Market One corresponded to production from a privately held resource in which individual returns depended only on an individual's own contributions. Market Two corresponded to production from a CPR. Total returns from Market Two depended on group investment in the Market and each individual's share in the proceeds depended on his or her share of the total investment. Marginal returns in this market declined as investment increased.

On average participants in the baseline treatment of No Communication and No Sanctioning invested too heavily in the CPR. At the aggregate level, Nash equilibrium best describes the data, but individual investment did not converge to this point. A second design allowed one-shot non-binding communication. The aggregate rents in two of the three experiments were greater then the predicted levels of rent at the Nash equilibrium, but without continued communication the deal faltered in the long run. With repeated communication efficiency increased with subjects consistently obtaining higher payoffs along with defection rates being lower. OGW concluded that subjects were able to find and implement an optimal solution when allowed to communicate and devise a sanctioning plan.

This line of research is limited in that it ignores the fact that many CPRs, e.g. fisheries and forests, can be destroyed if they are overexploited. A second line of research, originally reported by Walker and Gardner (1992), modelled this aspect. The main focus is whether probabilistic destruction will significantly change the appropriation behaviour in the game (OGW, 1994, p.130). The new experiment modified the baseline treatment, first by announcing the maximum duration of the experiment to all participants and secondly by allowing destruction. In this environment the optimal strategy for the group is to invest nothing in the CPR resource until the last four periods of the session but a subgame perfect equilibrium is to invest 53.8 tokens in each of the first fifteen periods, followed by a gradual increase to a one-shot Nash equilibrium group investment of 64.

OGW found that this environment was extremely hostile to group management of the CPR. No group followed the optimal strategy even once and all sessions terminated within six rounds. OGW then attempted to introduce a less hostile environment by introducing a "safe zone". If the aggregate number of tokens invested in Market Two was less then 40, the experiment continued. The safe zone introduces a new, sub-game perfect equilibrium in which group investment is 40 tokens for the first 18 periods and which yields 97 percent of the optimal earnings. The optimal level of investment, 36, was included within the safe zone, so optimal levels of rent could be attained without risking ending the experiment.

This second design was still hostile to co-operative management, yielding about 36% of optimal earnings on average, well below the mean efficiency of 72% found in the communication portion of OGW's baseline experiments but still noticably above the baseline non-communcication efficiency of 9%. The median length of session was 6 periods. In two sessions, however, a combination of relatively low investments and fortunate draws of the random variable allowed the session to continue for 15 and 17 rounds. Excluding these sessions the mean efficiency of the destruction experiments was 12%, much closer to the non-communication baseline.

OGW's probabilistic destruction experiments leave open two intriguing questions. First, is it true that introducing a safe zone can actually increase efficiency in a self-governed CPR when communication is not possible? Second, will communication in a probabilistic destruction environment be as effective in promoting co-operation as it is in the non-destruction case? This paper investigates both questions by adding communication to the OGW probablistic destruction environment with a safe zone.

Experimental Design

Environment

We followed the second OGW design closely. We created a common pool resource environment in which a group of eight subjects repeatedly allocated a fixed endowment of twenty-five tokens (representing production effort) between Market One (representing production using a private resource) and Market Two (representing a common pool resource). The payoff function for each individual was

$$\pi_i = 5(25 - x_i) + (\frac{x_i}{\sum_j x_j})(23\sum_j x_j - .25(\sum_j x_j)^2)$$

where x_i is the *i*th subject's appropriation of the CPR. The environment was framed as an investment decision with no reference to resource management. Sessions were conducted at the McMaster University Experimental Economics Laboratory using a network of personal computers and a custom-written program to present decisions and record data. Ten sessions were held in all: five with and five without communication.

Subjects were recruited from the undergraduate student population at McMaster University. All but four of the eighty were experienced in previous common property or public goods experiments using the same software. Subjects assembled in a common area. When all had arrived they were seated at individual carrels and each received a set of instructions (Appendix C1, available on request). These instructions were read aloud by the experimenter. Payoffs were presented to subjects in payoff tables. Subjects' comprehension of the payoffs was tested by a short quiz built into the instructions. Questions were allowed and answered orally by the experimenter before beginning the first period. All sessions began with five practice rounds to introduce the concept of probabilisitic destruction. In each of these sessions subjects chose an investment in Market Two. The decision screen is reproduced as Figure 1. Note that subjects were able to use a "scratch-pad" calculator to determine their payoff for any combination of their own and others' appropriations.

When all subjects had entered their choice, each subject's own payoff and the total group investment in Market Two were displayed. The experimenter then announced the total contribution and the probability of terminating the experiment. Random numbers were generated by having a subject roll two ten-sided dice, one for each digit of the random number. If the random number was equal to or less than the probability of termination the experimenter announced that in a “real” period the experiment would have ended, otherwise the announcement was that a “real” session would continue. Group investment, the probability of destruction, the realized random number and the outcome (Continue or Stop) were all recorded on a chalkboard.

Following the five practice periods, subjects remained at their terminals playing computer games while the “real” session was set up. This session had twenty-five token endowments and the same parameters as the OGW Design II, using a safe zone of forty tokens. The real sessions proceeded exactly as the practice sessions, except that the session actually was terminated if the realized random number was equal to or less than the announced probability of destruction. When the session was over, subjects remained in their carrels until they were called to another room to be paid privately in cash.

The communication sessions used the same parameters and procedures as outlined above, except that communication was introduced after the five period practice round. The participants were given an announcement describing how they could communicate (Appendix C4, available on request). They rose from their seats and were permitted five minutes to communicate prior to making their first investment decision.[4] Subsequently they were allowed to discuss for no longer then three minutes before each period.

Benchmarks and Predictions

The experimental design induces a finitely repeated non-cooperative game for the subjects. The constituent game has a unique Nash equilibrium of a total of sixty-four tokens invested in

Market Two, each subject investing eight. A group investment of thirty-six tokens yields maximum rents while a group investment of seventy-two tokens in Market Two earns zero rents from Market Two (OGW, 1994, pp. 114-15.). Using dynamic programming techniques, OGW compute group optimal and subgame perfect individual strategies for the entire game. These are reported in Table 2. The introduction of a safe zone leads to two subgame perfect symmetric equilibria: a high expected value equilibrium in which each subject appropriates 5 units for the first 18 periods and a low expected value strategy in which group investment begins at 53.8 tokens for the first 15 periods and then rises.

Walker and Gardner (1992) observed that the participants in their experiment failed to receive optimal rents. On average the total tokens invested per period exceeded the alternative Nash equilibrium of 40 tokens. Because the safe zone was exceeded there was a risk of the experiment ending prior to the 20 periods. Five of the seven experiments were terminated within six periods (Table 3). The introduction of communication should increase the percentage of optimal income earned and increase the number of periods before destruction.

Results

The period-by-period results for our ten sessions are reported and compared to OGW's results in Table 3. Table 4 reports efficiencies by session for our experiment, for the Walker-Gardner probabilistic destruction experiment and for the OGW communication sessions. Table 5 reports a number of hypothesis tests. Inspection of these tables and our observations during the sessions leads to the following observations

Observation *1 Median duration and efficiency are lower than in the Walker-Gardner probabilistic destruction experiment. The difference in mean efficiency is weakly significant at conventional levels.*

Our median non-communication session lasted three periods, with a minimum of one and a maximum of five. Walker and Gardner obtained a median duration of six periods, with a minimum of two and a maximium of 17. Our median efficiency was 12 percent, compared to Walker-Gardner's 24 percent. An exact randomization test shows that the difference in mean efficiencies (12.6% and 36.7%) is significant at the 7.2 percent probability level.

Observation 2 *Mean efficiencies in the baseline (no-communication) sessions are higher than in the no-communication periods of OGW's communication experiments, but the difference is not statistically significant.*

OGW's communication sessions began with ten periods in which communication was forbidden. Our mean and median efficiencies (12.62 and 12 percent) are somewhat higher than the mean and median efficiencies obtained by OGW in these non-communication periods (-3.25 and -1.92 percent respectively). An exact randomization test shows that the difference in means is not statistically significant ($p = 0.167$).

Observation 3 *Communication significantly raises mean duration and efficiency.*

The mean and median duration of our communication sessions were 13.2 and 20 periods respectively. Mean and median efficiency were 66.2 and 98.9 percent respectively. An exact randomization test shows that the difference in means is statistically significant on a one-tail test ($p=0.028$).

Observation 4 *The distribution of efficiencies under the communications treatment is bi-modal. Highly efficient outcomes are associated with the emergence of a clear group leader.*

It appears that payoff dominance and symmetry are sufficient conditions to select a one equilibrium point solution as long as this solution is verbally agreed to by all players (Harsanyi and Selten, 1988). The payoff dominance and symmetry conditions enable the players to pinpoint the equilibrium point of investing 5 tokens apiece. However, selecting this point is not enough to ensure a binding agreement. The emergence of a leader in a group can be instrumental in confirming a solid investment arrangement.

In three of our communication sessions, subjects immediately agreed to contribute 5 tokens each, thus staying in the safe zone of 40 tokens. There were no defections, and the sessions continued for twenty periods. In the twentieth period, appropriation increased. Efficiencies were very high (98.9, 99.3, and 99.6 percent). In all of these sessions, one subject took the lead in the initial communication period and did so immediately. Once a leader emerged and 'broke the ice' communication between all members of the group was relaxed. In each of these three sessions one subject seemed to lead the discussion. This was especially apparent in Session 2 where the 'leader' asked questions to each member of the group ensuring that everyone understood and agreed to the decision. This subject also warned the group not to cheat and "ruin it for the rest of them". A group leader emerged in all three of these sessions and was responsible for virtually ordering the other players to play five tokens each. The leader was responsible for the group committing to a binding agreement. This was not the case in the remaining two sessions, subjects seemed very reluctant to communicate in the inital communication sessions. Subjects remained uncomfortably silent with no one person taking the lead role. When communication did occur it was extremely strained. In both of these sessions, and in the other three, all members of the group easily pinpointed the alternative Nash investment of 5 tokens each. However in the remaining two sessions the group would not commit to a definite investment path. In both of these sessions the group seemingly agreed that indivdual investments of 5 tokens each to Market 2 would be good but they would not agree to it. In one of these sessions, the first round appropriation was well within the safe zone, at 33, but the next period appropriations rose to 67 and the session ended. This group of subjects contained at least one anti-social individual; while subjects were waiting to be paid, one stole a mouse from his computer station!

Observation 5 *Mean efficiency in the communications sessions is not significantly different from the efficiency of the communication periods in the OGW communication experiment.*

OGW obtained mean and median efficiencies of 70.5 and 75.9 percent, compared to our 66.2 and 98.9 percent. An exact randomization test shows the difference in mean efficiency is not statistically significant (two-tailed test, p= 0.842)

Discussion

This experiment has strengthened Ostrom, Gardner and Walker's results on non-binding communication by extending them to the case of common pool resource subject to probabilistic destruction, when a safe zone is provided. The fact that the efficiencies in our communication sessions are indistinguishable from OGW's communication efficiencies suggests that the OGW results may be quite robust to changes in the trading environment. This conclusion is reinforced by Observation 2, which shows that our non-communication environment was essentially as inimical to co-operation as OGW's.

Our baseline efficiencies were close to and not significantly different from the non-communication results obtained by OGW in a non-destruction environment. They were comparable to five of the seven non-communication, probabilistic destruction sessions reported by Walker and Gardner. This suggests that the relatively high mean efficiency (36.7%) obtained by Walker and Gardner overstates the probable level of co-operative management in a probabilistic destruction environment.

The bi-modal nature of our communciation results, together with the important role played by a leader in organizing co-operation, suggests that social and psychological factors may play an important role in maintaining efficient CPR management. Attention to the social psychological literature concerning this point may be particularly useful.

Most broadly, we have extended the range of institutions in which “cheap talk” has been shown to be effective in promoting co-operative outcomes. Whether non-binding communication could lead to co-operative resource management in environments with no safe zone remains an open question. As noted above, Walker and Gardner’s design with no safe zone proved extremely hostile to co-operation. This may be due to the extreme nature of the optimal path, which called for no appropriation at all for the first sixteen periods. There is no evidence from our results that subjects were effectively applying dynamic programming strategies, although there is evidence of increasing contributions in the last period of our communication sessions. Had subjects been following a subgame perfect equilbrium strategy they would have started to increase appropriations at an earlier stage. All this suggests that the effect of a safe zone might be better studied in an environment in which some degree of appropriation could occur without incurring significant probablities of destruction, a suggestion which we leave for future research.

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Table 1
Experimental Design

Experiment Type	Probabilistic Destruction
Number of Subjects	8
Individual Token Endowment per Period	25
Safe Zone	40 tokens or less and there is no risk of ending experiment
Production Function for Market 2*	$23\sum x_i^2 - 0.25(\sum x_i)^2$
Market 2 Return/unit of Output	$1
Market 1 Return/unit of Output	$5
Number of Sessions	
No Communication	5
Communication	5

Note:
$\sum x_i$ = total number of tokens invested by the group in Market 2.

Table 2
Benchmarks

			Aggregate Appropriations (Tokens)	Payoff per Capita
Optimal Strategy				
	periods	1-20	36	3310
Subgame Perfect Nash Equilibria		**High Value**		
	periods	1 - 18	40	
		19	61.5	
		20	64	
		Total		3213
		Low Value		
	periods	1 - 15	53.8	
		16	57.3	
		17	58.3	
		18	59.7	
		19	61.5	
		20	64	
		Total		574

Source:
Ostrom, Gardner, Walker (1994, 136-138)

Table 3

Appropriation by Session and Period

Session	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Muller & Vickers, No Communication, Probabilistic Destruction																				
960214r	81																			
960215rb	71	77	51																	
960229ra	41	55	50	55	49															
960229rc	53	46	42	52																
960304r	55																			
Muller & Vickers, Communication, Probabilistic Destruction																				
960215ra	33	67																		
960216rrc	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	47
960228r	55	42	45	53	54															
960229rb	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	56
960301r	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	65
Walker & Gardner, No Communication, Probabilistic Destruction (Ostrom, Gardner. Walker ,1994,144)																				
Exp't. 1	45	40	41	44	36	51														
Exp't. 2	62	59	58																	
Exp't. 3	78	45	63	64	67															
Exp't. 4	58	75	87	44	46	58														
Exp't. 5	50	21	28	45	30	28	38	36	34	38	44	50	42	40	37	42	42			
Exp't. 6	41	30	32	55	32	45	43	28	30	41	36	40	37	36	43					
Exp't. 7	55	50																		

Table 4

Comparative Efficiencies by Experiment and Session

Muller & Vickers, Probabilistic Destruction

Session	**No Communication**	**Session**	**Communication**
960214r	3.1	960215ra	9.1
960215rb	12.0	960216rrc	99.6
960229ra	24.0	960228r	24.0
960229rc	19.4	960229rb	99.3
960304r	4.7	960301r	98.9
Mean	12.62		66.18

Walker & Gardner, Probabilistic Destruction

Session	**No Communication**
1	30
2	13
3	21
4	25
5	84
6	74
7	10
Mean	36.7

Ostrom, Gardner & Walker, No Destruction

Session	**No Communication**	**Session**	**Communication**
1 periods 1-10	-4.00	periods 11-25	68.33
2 periods 1-10	34.00	periods 11-25	84.00
3 periods 1-10	-2.00	periods 11-25	65.67
4 periods 1-10	-23.50	periods 11-25	90.67
5 periods 1-10	-13.50	periods 11-25	30.67
6 periods 1-10	-2.50	periods 11-25	83.37
Mean	-1.92		70.45

Table 5

Exact Randomization Hypothesis Tests

Test No.	Null Hypothesis	Alternative Hypothesis	P-value
1	Mean efficiency in MV Communication Sessions equals Mean Efficiency in MV No Communication Sessions	Mean efficiency in MV Communication Sessions exceeds Mean Efficiency in MV No Communication Sessions	0.028
2	Mean Duration of MV Communication Sessions equals Mean Duration of MV Non-Communication Sessions	Mean Duration of MV Communication Sessions exceeds Mean Duration of MV Non-Communication Sessions	0.032
3	Mean Efficiency of MV Non-Communication Sessions equals Mean Efficiency of WG probabilistic destruction sessions	Mean Efficiency of MV Non-Communication Sessions does not not equal Mean Efficiency of WG probabilistic destruction sessions	0.072
4	Mean Efficiency of MV non-communication sessions equals Mean Efficiency of OGW non-communication, non-destruction periods	Mean Efficiency of MV non-communication sessions does not equal Mean Efficiency of OGW non-communication, non-destruction periods	0.167
5	Mean Efficiency of MV communication sessions equals Mean Efficiency of OGW communication, non-destruction periods	Mean Efficiency of MV communication sessions does not equal Mean Efficiency of OGW communication, non-destruction periods	0.842

Note:
MV denotes this paper
WG denotes the Walker and Gardner (1992) probabilistic destruction experiment.
OWG denotes the Ostrom, Walker, Gardner (1994) communication experiment.

Endnotes

1.Professor and Honours Student, respectively. We gratefully acknowledge support of the Government of Canada's Green Plan through the McMaster University Eco-research Program for Hamilton Harbour. This paper was first presented at the meetings of the Public Choice Society / Economic Science Association, Houston, Texas, April 12-14, 1996. We thank David Feeny and Stuart Mestelman for helpful comments.

2.Also known as common property resources.

3.See Feeny (1992, p. 276 and p. 284, n6) for discussion and references.

4. Subjects were seated in two rows of carrels facing each other, but separated by low baffles. When standing they could easily conduct face-to-face conversation.

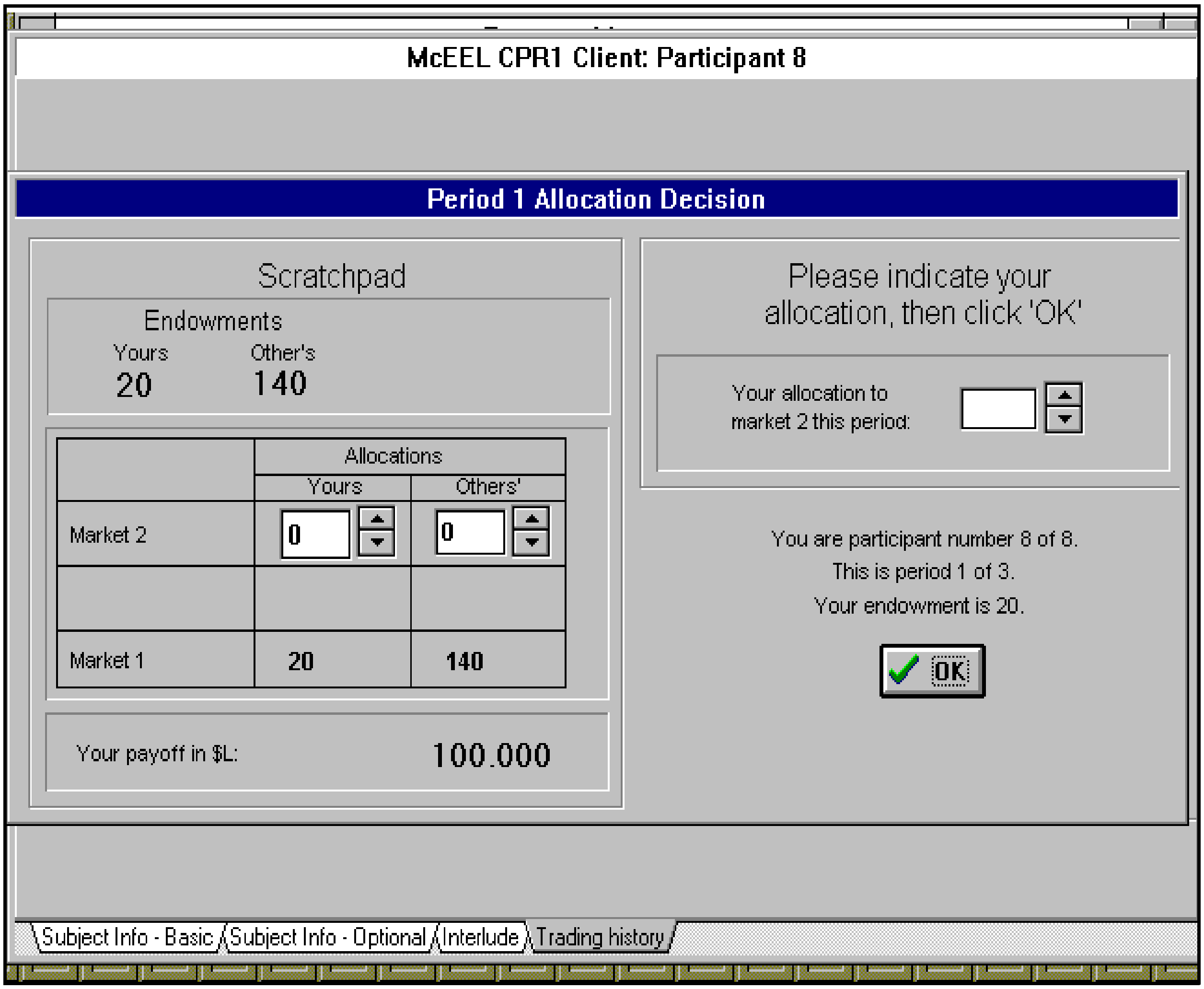

Figure 1 - The Subject's Decision Screen

Appendix C
Research Instruments

Item	Title	File Name
C1	Instructions	INSTR.WPD
C2	Payoff Table - Practice Rounds	10PAY.WB2
C3	Payoff Table - Data Rounds	PAYOFF.WB2
C4	Announcement	ANNOUN.WPD

Instructions

General

This is a study of economic decision-making. You and seven others will be making a series of investment decisions. Your earnings will depend both on your decisions and on the decisions of the others in your group. No one else in your group will know your decision and you will be paid privately, in cash, at the end of the session.

Introduction

This session will consist of up to 25 periods. In each period you will be making an investment decision. At the beginning of each period you will be given a number of tokens. For this session you will be given 10 tokens in each of the first five periods and 25 tokens in each of the remaining periods. You are to invest these tokens in two markets. Each token invested in Market 1 yields a fixed rate of output. Each unit of output earns you a fixed number of laboratory dollars. Thus the return for each token invested in Market 1 will be the same regardless of the total amount invested by the group. This is not true for Market 2. Market 2 yields a rate of output per token which depends upon the total number of tokens invested by the entire group. Your share of output in Market 2 is equal to your share of total tokens invested in Market 2. Please note that the additional return per token in Market 2 declines as the total tokens invested by the group increases.

During the actual experiment you need only make one decision, how many tokens to invest in Market 2. Any remaining tokens will automatically be invested in Market 1.

To assist your decision you will be provided with a payoff table. The table gives your payoff (in lab dollars) for any combination of your investment in Market 2 and others investment in Market 2. This payoff is for Markets 1 and 2 combined.

Consider the **sample** payoff table on the following page. This table has **no** relation to the ones you will actually use.

TABLE 1

Sample Payoff Table

		OWN ALLOTMENT IN MARKET 2					
ALLOTMENT		**0**	**1**	**2**	**3**	**4**	**5**
OF	**0**	2	3	8	5	4	2
OTHERS	**1**	10	4	6	8	6	4
IN	**2**	1	2	3	8	3	5
MARKET	**3**	6	1	4	7	2	9
2	**4**	9	5	2	5	1	6
	5	5	11	4	12	12	8
	6	5	9	7	3	3	2
	7	1	4	4	3	6	9
	8	10	8	6	0	2	3
	9	4	6	5	2	3	6
	10	3	1	1	0	7	2

At the top of the table is your own allocation of tokens to Market 2. On the left is the total allocation of tokens to Market 2 of the seven other participants. The numbers in the table represent your total payoff (in lab dollars) from both Market 1 and Market 2.

Suppose you invest 3 tokens in Market 2 and the others in the group invest a total of 7. Your payoff (in lab currency) would be 3.

Exercise

Using the table above please answer the following questions. Raise your hand when you are finished and I will check your answer:

1) What would be your payoff if you invested 2 tokens in Market 2 and the combined investment of the others was 9?_________________.

2) What would be your payoff if you invested 0 tokens, one player invested 3 and the remaining invested a total of 5 tokens?_________________.

The Market

! Each participant will be paid $0.50 Canadian dollars for every 100 laboratory dollars earned during this session, plus a show-up fee of $5.00.

! The experiment will continue for at least 5 periods and up to 25 periods. The first 5 periods are training periods to help you understand the market.

! The actual number of periods will depend on the overall group investment in Market 2.

There will be a **safe zone** of **24** tokens or less in the first 5 periods and **40** tokens or less in the remaining periods.

! If the overall group investment is in the safe zone the session will automatically continue for another period.

! If the overall group investment is greater than the safe zone, there is some probability that the session will end without going on to another period. This probability is given in the following table,

TABLE 2

PROBABILITY OF ENDING THE SESSION

PERIODS 1-5		PERIODS 6-25	
Group Investment in Market 2	Probability of being warned	Group Investment in Market 2	Probability of Ending Session
*Increase in Probability of being warned per additional token invested in Market 2 = **1.25%***		*Increase in Probability of Ending session per additional token invested in Market 2 = **0.5%***	

! A randomly chosen number will be used to determine if the session will continue. Ten sided dice will be used in determining this random number. One of the dice will be rolled. The first number will be the first digit of the random number while the second roll of the die will give the second digit of the random number. For example, if a **3** is rolled then a **6**, then the number becomes **36**. If this number is equal to or below the probability given in **Table 3** the session will end. Each number has an equal chance of occurring on each side of the dice.

! An Illustration: Assume that, in the ninth period of a session, each of the 8 members of the group invests 6 tokens in Market 2 (for a total of 48 tokens). The probability of ending the experiment would be 24%. If the random number had a value of 24 or less the experiment would end. If the random number decided upon at the end of period nine had a value of 25 or more the experiment would continue to the next round.

! Remember, if the group invests **24 or less** in Market 2 (in the first 5 periods) and **40 or less** in Market 2 (in the remaining periods), the probability of ending the experiment is zero. The experiment automatically proceeds to the next round.

There will be a total of 8 participants in this experiment. The computer will prompt you for your allocation to Market 2. You will also be able to use a calculator on the screen that will allow you to forecast payoffs given your investment and the groups investment in Market 2. Once all the participants have entered their investment decision, a results table will appear. The results table will show your payoff and the combined allotment of all others in Market 2. Using the information on the screen, you can verify the computer's payoff calculation by using your payoff table. At the end of the period, write your information down on the **Record Sheet**.

If you have any questions or difficulties during the experiment please raise your hand.

You will be allowed 5 periods to become familiar with the experiment. During these periods the session will **NOT** automatically end if the random number is less than the entry in Table 3. Instead, you will be warned that the session would have ended if this had been a later period. After the first five periods are over, we will load a new program into the computer before continuing with periods 6-25.

The payoff functions in this experiment are in the form:
Periods 1-5: 5 xi + 17 g I-.25 gi G
Periods 6-25: 5 xi + 23 gi - .25 gi G

where xi is your contributions to Market 1
where gi is your contributions to Market 2
where G is the groups contributions to Market 2

Record Sheet

Date:_____________________.
Participation No:_______________.

Rough Work

Period	**Endowment**	**Your Allotment to Mkt 2**	**Group Total**	**Your Payoff**
1	10			
2	10			
3	10			
4	10			
5	10			
6	25			
7	25			
8	25			
9	25			
10	25			
11	25			
12	25			
13	25			
14	25			
15	25			
16	25			
17	25			
18	25			
19	25			
20	25			
21	25			
22	25			
23	25			
24	25			
25	25			

ANNOUNCEMENT

Sometimes in previous experiments, participants have found it useful, when the opportunity arose, to communicate with one another. You will have an initial period of 5 minutes to communicate prior to the sixth period. You will also be allowed to have short discussions before each remaining period. There will be some restrictions.

1) You are not allowed to discuss side payments.
2) You are not allowed to make physical threats.
3) You are not allowed to see the private information on anyone's monitor.

Since there are still some restrictions on communication with one another, we will monitor your discussions between periods. To make this easier, we will have all discussions in this room.

When we invite you to communicate, please;

1. Cover your screen with paper provided.
2. Stand up
3. Conduct your communication.

When you are finished communicating, or when we announce the three minutes have ended;

4. Sit down.
5. Uncover your screen.
6. Make your decision for the period.