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THE COASE THEOREM: SOME EXPERIMENTAL TESTS

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ABSTRACT

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This paper reports the results of experimental tests of the Coase Proposition that the assignment of liability does not affect the level of an external benefit or cost in bargaining groups of 2 and 3 persons under full and private information. Income effects were kept small. The results strongly favor the Coase Proposition under full information in both 2 and 3 person bargains and under both information regimes in 2 person bargains. In addition, the proposition is supported in 3 person bargains under private information if one party owns the liability right and bargains with 2 affected parties.

I. Introduction

In The Problem of Social Cost[1] Ronald Coase investigated the economic effects of liability rules for externalities when the affected parties can bargain with each other. More specifically, Coase posited that a change in a liability rule will leave the agents' production and consumption decisions both unchanged and economically efficient within the following (implicit) framework:

a. two agents to each externality (and bargain);

b. perfect knowledge of one another's (convex) production and profit, or utility, functions;

c. competitive markets;

d. zero transactions costs;

e. costless court system;[1A]

f. profit maximizing producers and expected utility maximizing consumers;

g. no wealth effects;

h. agents will strike mutually advantageous bargains in the absence of transactions costs.

This result -- commonly called the "Coase Theorem" -- has generated a great deal of economic and legal discussion, much of it aimed at exploring the effects of weakening one or another of the model's assumptions.[2] Some of the most common theoretical discussions focus on the effects of transactions costs, especially those costs

generated either by imperfect knowledge of one another's production and profit functions[3] or by the need to include many agents in a bargain.[4] Many observers have theoretically assumed (or deduced) that imperfect information or multiple agents in a bargain will tend to preclude contracting by the affected parties.[5] A great deal of legal and economic work rests directly upon these two theoretical assumptions.[6]

In 1972, Donald Regan pointed out that assumption h is quite unlike assumptions about agents' behavior in most economic models.[7] For example, a proof of the existence of the competitive equilibrium might presume that an individual maximizes utility subject to a budget constraint in the fact of fixed prices by purchasing commodities in a market. In contrast, h posits that two specific individuals who find themselves in a position to strike a mutually advantageous bargain will do so. This assumption is, in essence, a statement that parties in nonzero sum games will choose a Pareto Optimal allocation.[8] As such, assumption h represents a departure from the conventional wisdom, which is that outcomes of non zero sum games are quite uncertain. Hence, Coase's Theorem is much more a proposition than a typical economic theorem. Once the analyst fully accepts this point, the Coase Theorem's appeal depends on the reasonableness of assumption h in a typical Coase Theorem setting. In other words, one must know whether or not two people who are in a situation satisfying assumptions a through g will tend to act in accordance with assumption h.

In addition, as noted above, a great deal of important legal and economic work stands upon the supposition that either including many parties to a bargaining situation (assumption a) or including imperfect information (assumption b) tends to preclude the formation of mutually advantageous contracts.[9] For example, Professors Calabresi and Melamed use these suppositions to analyze the differences between property rules and liability rules.[10] To test these suppositions, one must know of the effects of relaxing assumption a (multiple parties) in the presence of assumptions b through h, of relaxing assumption b (imperfect information) in the presence of assumptions a and c through h, and of relaxing assumptions a and b (multiple parties and imperfect information) in the presence of assumptions c through h.

II. Review of the Literature

There is a large and growing experimental literature on 2 and 3 person bargaining games.[11] Many of the experiments illuminate one or more of the axioms discussed above, but none have been designed specifically to test the Coase bargaining problem in the specific ways discussed above. However, we can make some important generalizations, which have important implications for the design of an experiment. The most important issue is whether parties to a bargain will choose a Pareto Optimal allocation. Although subjects playing nonzero sum games have not universally chosen Pareto Optimal outcomes, in general they have tended to choose Pareto Optimal outcomes more often when

the experimental conditions have looked more like the Coase axioms. In particular, Pareto Optimal choices seem to be more frequent under the following conditions:

1) when subjects play for significant amounts of real money;[12]
2) when all parties can engage in free face-to-face communication;[13]
3) when parties can make enforceable contracts with one another;[14]
4) when there is an equal split allocation among the Pareto Optimal allocations;[15]
5) when all parties have full information about one another's payoffs;[16]
6) when prizes are paid in public.[17]

The first five conditions are all clearly contained in the Coase axioms. The last condition seems to be a natural extrapolation from Coase's perfect information and zero transaction costs assumptions.

A second issue, which Coase himself does not raise, but which has troubled some commentators,[18] is how parties to a bargain typically divide the profits from a joint decision. The experimental literature differs on this issue. On the one hand, many articles conclude that subjects divide profits either equally or in proportion to the effort each party expends.[19] On the other hand, an almost equally large literature concludes that subjects try to maximize their own profits and refuse to settle for less than they could command by operating alone.[20]

The differences in results seem to be generated at least in part by different instructions and different information about payoffs given to the subjects. Subjects who divide the profits equally either tend to

know all monetary payoffs[21] or tend to be told that their "task" is to divide up a sum of money. Conversely, subjects who bargain to unequal payoffs generally either tend to be ignorant of one another's payoffs[22] or tend to be instructed by the experimenter to try to make as much money as is possible.[23] Where the instructions are less pointed about subject motivation, the results seem more mixed.[24] In general, the following experimental conditions seem to be associated with more equal splitting of profits:

1) repeated, face-to-face negotiations;[25]
2) the ability to choose a Pareto Optimal allocation which is also an equal split;[26]
3) public payoffs;[27]
4) full information about one another's profits.[28]

While the experimental literature summarized above has improved our understanding of how individuals bargain under a variety of different conditions, the general bargaining problem described by Coase has not been studied prior to the work reported here. There have been very few experiments which both have required subjects to bargain over a variety of different discrete choices and have allowed them to make side payments to one another at the same time.[29] In Coase's view, the person owning the liability right gets compensated. For example, in bilateral monopoly experiments subjects bargain over discrete choices as individuals might bargain over levels of pollution, but side payments are generally forbidden.[30] On the other hand, most of the games which implicitly

allow side payments involve only two or three alternatives from which to choose and are described in coalitional rather than discrete alternative form.[31] Typically, in such a game, subjects are given the following information. Alone you make $x. If you form a coalition with a second person, the two of you can split $2x + $y and the odd person gets $x. If all three players form a coalition, they can split $3x + y + Sz.

A set of experiments conducted by Michener, Yuen and Ginsberg comes the closest to a Coase bargaining situation.[32] Three subjects per experiment bargained over outcomes (instead of coalition divisions) and they could make side payments. Subjects were told to maximize their own payoffs. More than half, but by no means all of the choices were Pareto Optimal and the mean payoff splits were far from equal. The authors concluded that the payoff splits generally fit the Shapley value,[33] which predicts that the payoffs will be in proportion to one's power in the game. However, the above experimental situation differs crucially from a Coase bargaining situation in that no one player could unilaterally choose the allocation as can the owner of a property right.

Experiments which have granted some unilateral power to one of the parties in a bargaining game have involved somewhat different decision tasks from that described by the Coase Theorem. For example, in one study, two players were given individual values and a joint value they could divide. One player was given the right to divide the joint reward if the other player did not depart from a joint cooperative strategy and the subjects could write enforceable contracts specifying what each player would do. If the subjects wrote no contract they

were given their individual values.[34] In another experiment the subjects could divide the rewards and both could write a contract specifying the division.[35] The authors of these two studies concluded that the ability to write enforceable contracts fosters the attainment of Pareto Optimal outcomes.

Another important question raised by Coase's critics is whether a proposition describing two person bargaining can be extended to larger groups. Experiments with three and four person games suggest that Pareto Optimal outcomes can be achieved,[36] but experiments with larger groups have generally concluded that free rider problems take over unless special allocation mechanisms are imposed.[37] However, these larger group experiments have not allowed open communication, side payments and enforceable contracts.

This paper reports the results of a set of controlled experiments designed specifically to test the Coase Proposition in 2 and 3 person bargains. The results strongly favor the Coase Proposition and also strongly suggest that parties engaging in repeated negotiations with one another may split profits equally even though in single-shot negotiations they are more likely to choose individually rational divisions. 89.5% of the 114 experimental decisions were Pareto Optimal. 62 of those dictated that payoffs be divided nearly equally.

Experimental Design

A. 2 person experiments

1. Perfect Information: Instructions

As the subjects arrived at a designated room they were randomly assigned the letters A or B. Each pair was placed in a separate room, with a monitor being the only other person present. The monitor provided the following set of instructions to the subjects, who first read the instructions silently and then listened to the monitor read them aloud.

INSTRUCTIONS

General

You are about to participate in an experiment in decisionmaking. The purpose of the experiment is to gain insight into certain features of complex economic processes. If you follow the instructions carefully you might earn a considerable amount of money. You will be paid in cash at the end of the experiment.

Specific Instructions to Participants

You will be asked to make several choices. Each choice will involve choosing a number. The cash value to you of the number is given in the set of payoff sheets attached to your instructions (see pp.). For example, if $5 were next to number 2 on your payoff sheet and if number 2 were chosen, then you would be paid $5. In the example shown below, for instance, you might be person B. Your payoff sheets[38] list not only the value of each number to you, but

also the value of each number to the other participant.

Two of you will participate together on each decision. One of you will be designated the "controller." The controller may, if he or she wishes, choose the number by himself or herself and inform the monitor, who will stop the experiment and pay both participants. The other participant may attempt to influence the controller to reach a mutually acceptable joint decision; the other participant may offer to pay part or all of his or her earnings to the controller.

Example

Assume that A is the controller and that participants A and B have the following payoffs associated with numbers 0, 1 and 2.

Number	A's Payoff	B's Payoff
0	$4	$1
1	5	2
2	3	5

If A and B were to agree to set the number at 0, and further agree that B should get $1 from A's payoff, then the monitor would terminate the experiment, pay A $3 (representing the $4 payoff less the S1 transfer to B) and pay B $2 (representing the $1 payoff plus the $1 transfer from A).

If a joint agreement is reached both parties must sign the attached agreement form, stating both what the chosen number will be and how much money will be transferred from one participant's earnings to the other's. No physical threats are allowed. If a joint agreement is made and the form is signed, the monitor will terminate the

experiment and pay each participant according to the terms set forth in the agreement.

Are there any questions? We ask you to answer the questions on the attached sheet to make sure you understand the instructions.

QUESTIONS

(refer to your payoffs on page)

1. Number _____ makes me the most money. Number ____ makes me the least money.
2. If the other participant is the controller and he picks number 4, I make _____.
3. If I agree to pay $2 to the other participant and we agree on number 1, I make _____.

Agreement Form

A and B agree to set the number at _____.

A and B agree that, from the award $_____ should be paid _____ to _____.

Signed _____
A

_____
B

In essence, these instructions told subjects that they had to choose one of a given set of numbers and that they would be paid

different amounts of money, in cash, depending upon which number was chosen. In this formulation, the numbers are analogous to the productive decisions in the Coase Theorem. For example, subjects A and B might correspond to the adjacent rancher and farmer in Coase's original model. Similarly, the chosen numbers might correspond to the size of the rancher's herd, and the money that was paid to the subjects might represent the rancher's and farmer's profits. The subjects were also told that one of them had the power to unilaterally choose the number. This power is analogous to a property right in the Coase situation.[39] For example, the controller's ability to choose the number might correspond to the farmer's right to obtain an injunction preventing the rancher from allowing his cows to wander onto the rancher's land. Last, the instructions allowed subjects to transfer, by contract, payoffs from one party to another. This feature of the experiment directly mimics the contract mechanism which is central to the Coase Theorem.

Each of the instructions included some information telling the participant how much cash[40] he would be paid (depending upon which number was chosen). Table 1 shows representative payoffs for two party bargaining situations.[41] Notice that each schedule has a clear joint-profit maximizing number, which pays at least $1.00 more than the next highest number. After reading the instructions and examining their payoffs, subjects were tested on their understanding of the rules and the consequences of decisions they might make.[42] After both subjects

Table I

Sample Payoffs Schedules

Two-person Experiments

	Decision 1			Decision 2	
	Participant			Participant	
Number	A	B	Number	A	B
0	$ 0.00	$ 12.00	0	$ 0.00	$ 11.00
1	4.00	10.00	10	1.00	10.00
2	6.00	6.00	20	2.00	8.00
3	8.00	4.00	30	4.00	6.00
4	9.00	2.00	40	5.50	5.50
5	10.00	1.00	50	9.00	4.00
6	11.00	0.00	60	10.50	1.00

Three-person Experiments

	Decision 1				Decision 2		
	Participant				Participant		
Number	A	B	C	Number	A	B	C
1	$ 1.00	$ 7.00	$ 7.00	1	$0.00	$8.50	$8.50
2	5.00	5.50	5.50	2	3.00	7.00	7.00
3	10.00	4.00	4.00	3	5.50	5.50	5.50
4	12.00	0.00	0.00	4	11.00	4.00	4.00
				5	13.00	0.00	0.00

had answered all of the questions correctly, and after the monitor had answered all of the subjects' remaining uncertainties about the rules of the game, the experimenter flipped a coin and the winner of the toss was designated the controller. The subjects were then instructed to proceed with the experiment (by choosing a number).

2. Experimental Institutions

In all of the 2 person experiments the bargaining was face-to-face and public and involved more money than most students can earn for an hour's work in their next best alternative employment. Side payments were allowed; contracts were in writing and strictly enforced. All payments were made in public. Subjects were given no motivational instruction (i.e. subjects were not told what their objectives should be in choosing a number or in forming contracts.)

The above instructions for the first set of experiments modeled an environment as close as possible to one satisfying all the sufficient conditions for the Coase Theorem to hold: two parties who are fully informed about one another's payoffs and who have no transactions costs. Because we suspected that parties to a bargain might divide the profits differently if their relationship were to continue than if they only were to make one decision, there were two versions of this first set of experiments.

a. Sequential. Six pairs of subjects made two decisions each, in sequence. The coin was flipped to decide who was the controller before deliberation began on each decision. The subjects thus knew they would make two decisions together, but during the first decision,

they did not know who would be controller for the second. The object was to simulate a legal environment in which the assignment of rights was uncertain but the parties knew they would have to maintain a continuing relationship. This models, for example, a nuisance case in which the parties will interact over a period of time but in which the legal assignment of liability is not clear.

b. Non-sequential. Two groups of four subjects who did not know one another made six single, pairwise decisions each. The object was to model a legal environment in which one bargain would be struck between two parties who would never have to communicate again.

3. Two-person, Limited Information

The next set of experiments modeled an environment less favorable to Coase than the first. Subjects were only told their own payoffs. They were allowed to reveal their payoffs to the other subject in a bargain, but they did not have to do so. The instructions for this pair of experimental institutions were identical to the instructions for the pair above, with one crucial exception. Where the instructions above stated "Your payoff sheets list not only the value of each number to you, but also the value of each number to the other participant," the instructions for the limited information bargains stated "Your payoff sheets list only the value of each number to you. The other participant is free to tell you anything he or she wishes to about the value of each number to him or her." Otherwise, these experiments were exactly the same as the first. These experiments were also divided into:

a. Sequential. Four pairs made two decisions each.

b. Non-sequential. Two groups of four each made six single pairwise decisions.

A. 3 Person Experiments

1. Full Information Instructions

As the subjects arrived at a designated room they were randomly assigned the letters A, B, or C. Each triad was placed in a separate room, with the monitor being the only other person present. The monitor provided the following set of instructions to the subjects, who first read the instructions silently and then listened to the monitor read them aloud.

INSTRUCTIONS

General

You are about to participate in an experiment in decisionmaking. The purpose of the experiment is to gain insight into certain features of complex economic processes. If you follow the instructions carefully, you might earn a considerable amount of money. You will be paid in cash at the end of the experiment.

Specific Instructions to Participants

You will be asked to make several choices. Each choice will involve choosing a number. The cash value to you of the number is given in the set of payoff sheets[43] attached to your instructions (see pp.). For example, if $10 were next to number 2 on your payoff sheet and if number 2 were chosen, then you would be paid $10. In

the example shown below, for instance, you might be person B. Your payoff sheets list not only the value of each number to you, but also the value of each number to each of the other participants.

You three people will participate together. Either one of you will be chosen as the "controller" or two of you will be chosen as "joint controllers."

a) If one of you is chosen, then the controller may, if he or she wishes, choose the number by himself or herself and inform the monitor, who will stop the experiment and pay all three participants. The other two participants may attempt to influence the controller to reach a mutually acceptable group decision; either or both of the other participants may offer to pay part or all of his or her earnings to the controller.

b) If two of you are chosen as joint controllers, then either joint controller may, if he or she wishes, attempt to choose the number. (This is done by filling out one of the attached forms and handing it to the monitor.) The joint controller who chooses the lower number will determine the number. If, for example, one joint controller chooses number 2 and the other joint controller chooses number 1, then the monitor will set the number at 1, and pay the participants accordingly. The remaining participant (the one who is not a joint controller) may attempt to influence either or both of the remaining parties to reach an acceptable group decision; any party may offer to pay all or part of his or her earnings to one or both of the remaining parties.

In order to reach a group agreement, the following procedures must be followed:

a) If one person has been designated the controller, then either one or both of the other participants can join the controller in a group decision by filling out and signing one of the attached agreement forms. All of the parties to an agreement must sign, and if any portion of any participant's earnings is to be paid to someone else, then the participant agreeing to pay must sign the agreement form before the agreement will be enforced by the monitor. Otherwise, the controller can choose the number alone.

b) If two participants have been chosen joint controllers, then both joint controllers must join in a group decision before it will become effective. Otherwise, the number will be chosen in accord with the procedure described in the preceding paragraph (i.e. the joint controller choosing the lower number sets the number). The remaining participant may also be a party to a group agreement. Again, all of the parties to a group agreement must sign, and if any portion of any participant's earnings is to be paid to someone else, then the participant agreeing to pay must sign the agreement form before the agreement will be enforced by the monitor. No physical threats are allowed. If either party makes a physical threat, the threatened party will be paid his or her maximum payoff, and the threatening party will get nothing. When a group agreement is reached and the forms are signed, the monitor will end the experiment and pay the participants.

Examples

1. Assume that A is the only controller.

Number	A's Payoff	B's Payoff	C's Payoff
1	$40	$30	$30
2	50	10	10

If B and C agree on number 1, but A chooses number 2, then number 2 has been chosen and the monitor will pay accordingly.

If A and B sign an agreement form choosing number 1 and directing the monitor to pay all of C's payoff to B, the monitor will disregard the agreement, unless C also signs it.

If A, B and C sign an agreement form choosing number 1 and directing that $10 of A's payoff be paid to C, the monitor will terminate the experimental period, pay A $30 (representing the $40 payoff less the $10 transfer to C), pay B $30, and pay C $40 (representing a $30 payoff plus the $10 transfer from A).

2. Assume that B and C are joint controllers.

Number	A's Payoff	B's Payoff	C's Payoff
1	$40	$30	$30
2	50	10	10

If A and B sign an agreement form, choosing number 2, and C chooses number 1, then number 1 has been chosen and the monitor will pay accordingly.

If B and C sign an agreement form choosing number 1 and directing that A's payoff should be split equally among them, the monitor will disregard the agreement unless A signs it.

If A, B and C sign an agreement form choosing number 1, and directing that $10 of A's payoff be transferred to C and $5 of B's payoff be transferred to C, then the monitor will terminate the experiment, pay A $30 (representing a $40 payoff less the $10 transfer to C), pay B $25 (representing a $30 payoff less the $5 transfer to C) and pay C $45 (representing a $30 payoff plus the $10 transfer from A and the $5 transfer from B).

Are there any questions? We would like you to answer the questions on the attached page. These should help you understand the instructions.

Questions (refer to the decision on p.)

1. Level _____ makes me the most money. Level _____ makes me the least money.
2. If C is the only controller and if C chooses number 4, I make _____.
3. If B and C are joint controllers and if B chooses 2 and C chooses 1, I make _____.
4. If A is the controller and he reaches an agreement with B and C which chooses number 2 and directs B to pay A $2 and C to pay A $3, I make _____.
5. If B and C are joint controllers and they reach an agreement with A in which the number is set at 1 and A agrees to pay B and C each $.50, I make _____.
6. If I am the only controller, I may set the number by myself, true or false? _____.

Group Agreement Form

Three Person Experiments

Number Chosen _____

$ _____ from _____'s payoff to be paid to _____.

$ _____ from _____'s payoff to be paid to _____.

$ _____ from _____'s payoff to be paid to _____.

Signed: _____
A

_____
B

_____
C

These instructions are meant to model a pollution externality. A might correspond to a factory which wished to dump the byproducts of its production process into a stream. B and C might be downstream riparian owners who dislike increased levels of pollution. The choice of a number would correspond to the choice of a level of pollution. If A were the controller, his power to unilaterally choose the number would represent the factory's right to pollute as much as it wished, without having to pay anyone anything. If B and C were joint controllers, their shared power might represent each riparian owners' independent right to obtain an injunction preventing the factory from dumping any pollutants. Under such circumstances, B and C's right to attempt to independently set the number would correspond to each riparian owner independently telling the factory

the maximum level of pollution the riparian owner will tolerate. The factory obviously may not pollute to any greater extent than the lowest level allowed from among the independent riparian owners. In just this way, if B and C attempt to set the number independently, the lower of their choices controls. For this very reason, all riparian owners would have to join in an agreement not to seek an injunction before the factory could rely upon the agreement. Similarly, in the experiment, both B and C must join in a group agreement in order for A to be able to rely upon it.

Each of the instructions included information telling each participant how much cash he and each of the other participants would be paid (depending upon which number was chosen). Table 1 shows representative payoffs for three party bargaining situations. Once again, notice that each schedule has a clear joint-profit maximizing number, which pays at least $1.00 more than the next highest number.

After reading the instructions and examining their payoffs, subjects were tested on their understanding of the rules and the consequences of the decisions they might make. After all three subjects had answered all of the questions correctly, and after the monitor had answered all of the subjects' remaining uncertainties about the rules of the game, the experimenter flipped a coin and the winner of the toss (either A alone or B and C together) was designated the controller. The subjects were then instructed to proceed with the experiment (by choosing a number).

2. Experimental Institutions

The 3 person full information experimental institutions were almost identical to the 2 person limited information sequential institutions. Again, all bargaining was face-to-face and involved more money than most students can earn for an hour's work in their next best alternative employment. Side payments were allowed and contracts were in writing and strictly enforced.[44] All cash payments were made in public. Subjects were given no motivational instructions. 17 groups of 3 subjects made 2 decisions each, sequentially.

3. Three-person, Full Information

This final set of experiments completes a square design of 2 and 3 subjects crossed with limited and full information making sequential decisions. The instructions are exactly the same as the 3 person instructions given above, except for the crucial insert about knowledge of one another's payoffs. Where the instructions above stated, "Your payoff sheets list not only the value of each number to you, but also the value of each number to each of the other participants," the instructions for the limited information bargains state "Your payoff sheets list only the value of each number to you. The other participants are free to reveal to you anything they wish about their payoffs."

IV. Experimental Results

Table II summarizes the results of all 114 experimental decisions. Overall, 89.5% of the decisions are Pareto Optimal. In fact, the only deviation from nearly 100% joint profit maximization is with 3 parties to a bargain, joint controllers, and limited information. These results clearly demonstrate that the Coase Theorem is supported under the following conditions:

1) two parties to a bargain, with and without full information;
2) three parties to a bargain and a single controller, with and without full information; and
3) three parties to a bargain, joint controllers, and full information.

Controllers' behavior regarding splitting the profits fell neatly into two groups. With only fifteen exceptions controllers either agreed to split the payoffs nearly evenly or demanded at least their individual maxima. The second strategy is individually rational for each play of the game, and is generally predicted by game-theoretic solutions to the bargaining problem. The first strategy is more in keeping with the results of the social psychological experiments which did not instruct subjects to be individually rational.[45] If we define sharing as an allocation within $1.00 of an equal split, 67 controllers shared and 36 bargained to a core[46] allocation.

Sharing occurred most frequently in 2-person sequential decisions, and the presence or absence of full information seems to have made no difference. Eighteen of twenty controllers in 2-person sequential decisions shared, as compared to only eleven of twenty-four

Table II

Experiment	N	Experimental Results: N_1: Joint profit maximum	N_2: Equal splits	N_3: Within $1 different from equal split	Payoff Division: N_4: Controller received exactly the individual maximum	N_5: Controller received more than the individual maximum	Other
Two person							
1. Full Information sequential	12	12	12	0	0	0	0
non-sequential	12	11	5	0	4	3	0
2. Limited Information sequential	8	8	6	0	2	0	0
non-sequential	12	11	3	3	3	1	2
Three person, sequential							
1. Limited Information single controller	21	19	3	4	2	5	7
Joint Controller	15	9	2	3	5	4	1
2. Full Information single controller	13	12	3	2	1	2	5
Joint Controller	16	15	9	2	1	3	1
Coin flip barred by subjects on second decision	5	5	4	1	0	0	0
Total	114	102	47	15	18	18	16

in 2-person non-sequential decisions. This suggests that controllers are more likely to share when the parties to a 2 person agreement have a continuing relationship than when they do not. Joint controllers also frequently shared in 3 person, sequential full information decisions. In addition, a number of 3 person, sequential, full information subject groups insisted on signing a sharing agreement covering both decisions. They would sign 2 agreement forms during discussion on the first decision.

It is possible that any sharing is just an artifact of using college students as subjects. College students may not be as rationally self interested as those who are older. This possible lack of self interest might also derive from a feeling of "kinship" with fellow students.

Indeed to the extent that the sharing behavior indicates that either the subjects were failing to profit maximize or were maximizing interdependent utility functions which might violate one of the axioms of the Coase Theorem, our results cannot be taken to verify the Theorem. Since the initial conditions were not all satisfied, assumption h might not have received a good test. However, if our assumption regarding individual motivations were incorrect, then these results may take on even more significance, for they seem to indicate that the Coase Theorem's prediction about production still has great power; the Pareto Optimum was chosen almost 90% of the time. These experiments would seem to say that in two and three person situations a scholar might be able to assert with some confidence that groups will behave <u>as if</u> all of the Coase Theorem's assumptions were

satisfied. Nevertheless, the pattern of sharing vis a' vis individual maximizing behavior may not be inconsistent with rational behavior in the fact of uncertainty. Sharing buys "good will" in a continuing relationship, especially one in which the other person might be controller the next time. While the expected value of demanding at least the individual maximum may be higher, the expected utility may be lower.[47]

Moreover, the pattern in the 3 person, sequential, full information experiments is consistent with a downward sloping demand curve for risk avoidance. Once the coin has been flipped for the first decision and the outcome is known, adopting a sharing strategy for <u>both</u> decisions requires that single controllers on the first decision give up more than joint controllers relative to the minimum expected payoffs they can command. On the first decision a single controller

commands at least $12.00, while a joint controller commands a minimum of only $7.00. The second decision (before the coin flip) has an expected value of at least $6.50 to the single controller and an expected value of at least $4.25 to each joint controller, a sharing strategy yields $12.33 to each participant. Hence, the decision to share requires a single controller on the first decision to trade away an expected return of at least $6.50 on the second decision in exchange for $0.33 with certainty. Joint controllers, however, may gain $5.33 with certainty by trading away their expected value of at least $4.25. Therefore, we would expect joint controllers to share more often than single controllers.

As Table III shows, in three person, sequential, full information experiments joint controllers were more likely to share than single controllers on both decisions. Moreover, all second decision sharing was linked to a binding or implicit contract among the participants. Thus, either the participants had actually signed such a contract, or they had shared on the first decision, creating an implicit contract to share all proceeds.

Conclusion and Suggestions for Further Research

The experimental results presented in this paper provide strong support for Coase's proposition that agents will bargain to a joint-profit maximizing outcome when it exists in two and three party bargaining situations under full information and when one party has the right to make the decision unilaterally under limited information. The results neither confirm nor disconfirm his proposition in three-

Three-person, Sequential, Full Information Results

First Decision	Number	Number which Shared
Single Controller	8	4
Joint Controllers	9	7
Second Decision		
Binding Contract	5	5
Single Controller on First decision	2	2
Joint Controllers on First decision	3	3
Single Controller	5	1
Single Controller shared on First decision	1	1
Joint Controllers shared on First decision	1	0
Joint Controller	7	4
Single Controller shared on First decision	1	1
Joint Controllers shared on First decision	3	3

party bargains under limited information when two parties each have the right to make the decision unilaterally. Further experimental work with joint controllers and larger bargaining parties is needed before we can say that the Coase Proposition is confirmed experimentally as a more general behavioral prediction.

The results also provide some support for predictions about how agents in such bargaining situations will divide the profits. Controllers in two-person sequential bargains and more generally those with a previous experience sharing profits or a monetary incentive to share are more likely to share.[48] Others are somewhat more likely to demand their individual maxima.

FOOTNOTES

1. Coase, The Problem of Social Cost, 3 J.L. & Econ. 1 (1960).

1A. This assumption includes the existence of enough basic contract and tort law and enforcement that the parties can deal with one another. On the philosophy of such an assumption, see Carroll, Two Games That Illustrate Some Problems Concerning Economic Analysis of Legal Problems, 53 S. Cal. L. Rev. 1371 (1980)

2. Literature on the Coase Theorem has explored, among other things:

   A. the long run wealth effects of a change in liability rules; see, e.g., Demsetz, Wealth Distribution and the Ownership of Rights, 1 J. Legal Stud. 223 (1972); Endres, Coase Theorem in Long-Term Perspective, 27 Jahrb Sozia 430 (1976); Frech, Pricing of Pollution: The Coase Theorem and Long Run Industry Equilibrium, 4 Bell J. Econ. Management Sci. 316 (1973); Frech, Extended Coase Theorem and Long-Run Equilibrium-Nonequivalence of Liability Rules and Property Rights, 17 Econ. Inquiry 254 (1979); Maloney, Coase Theorem and Long-Run Industry Equilibrium, 17 Q. Rev. Econ. Bull. 113 (1977); Nutter, The Coase Theorem on Social Cost: A Footnote, 11 J.L. & Econ. 503 (1968); Regan, The Problem of Social Cost Revisited, 15 J.L. & Econ. 427 (1972); Schulze and d'Arge, The Coase Proposition, Information Constraints, and Long-Run Equilibrium, 64 Am. Econ. Rev. 763 (1974).

   B. the property rule/liability rule distinction; see, e.g., Calabresi and Melamed, Property Rules, Liability Rules and Inalienability: One View of the Cathedral, 85 Harv. L. Rev. 1089 (1972); Demsetz, When Does the Rule of Liability Matter?, 1 J. Legal Stud. 13 (1972); Demsetz, The Exchange and Enforcement of Property Rights, 7 J.L. & Econ. 11 (1964); Feldman, Liability Rules and the Transfer of Economic Rents, 3 J. Legal Stud. 499 (1974): Frech, supra note 2A; Inada and Kuga, Limitations of the "Coase Theorem" on Liability Rules, and Social Optimum, 114 Weltwir Arc 540 (1978).

   C. a definition of transaction costs and their effect on the efficient assignment of legal rules; see, e.g., Calabresi, Transaction Costs, Resource Allocation, and Liability - A Comment, 11 J.L. & Econ. 67 (1968); Crocker, Externalities, Property Rights, and Transaction Costs: An Empirical Study, 14 J.L. & Econ. 451 (1971); Daly, The Coase Theorem: Assumptions, Applications, and Ambiguities, 12 Econ. Inquiry 203 (1974); Polinsky, Economic Analysis as a Potentially Defective Product: A Buyers Guide to Posner's Economics Analysis of the Law, 87 Harv. L. Rev. 1655, 1671-4 (1974); R. Posner, Economic Analysis of the Law. 34 (2d ed. 1977).

   D. the consequences of imperfect information and the need for a well defined theory of 'rational' behavior; see, e.g., Davis and Whinston, Externalities, Welfare and the Theory of Games, 70 J. Political Econ. 241 (1962): Regan, supra note 2A; Schulze and d'Arge, supra note 2A; G. Stigler, The Theory of Price 113 (3d ed. 1966); Veljanovski, Coase Theorem-Says Law of Welfare Economics, 53 Econ. Rec. 535 (1977); Windisch, Coase-Paradigma versus Pigou Paradigma -- Information and Motivation as Basic Problems of Decentralized Environmental Controls, 35 Z Nation 345 (1975).

   E. the inclusion of large numbers of agents in the contracting situation; see e.g., Baumol, On Taxation and the Control of Externalities, 62 Am. Econ. Rev. 307 (1970); Calabresi and Melamed supra note 2B; Daly, supra note 2C; R. Posner, supra note 2C; Wellisz, On External Economies and the Government-Assisted Invisible Hand, 31 Economica 345 (1964).

3. See, supra note 2, those publications dealing with the consequences of imperfect information and the need for a well defined theory of 'rational' economic behavior.

4. See, supra note 2, those publications dealing with the inclusion of large numbers of agents in the contracting situation.

5. See, e.g., Davis and Whinston, supra note 2D; Regan, supra note 2A; Schulze and d'Arge, supra note 2A; Stigler, supra note 2D; Veljanovski, supra note 2D; Windisch, supra note 2D; Baumol, supra note 2E; Calabresi and Melamed, supra note 2B.

6. See, e.g., Besen, Manning & Mitchell, Copyright Liability for Cable Television: Compulsory Licensing and the Coase Theorem, 21 J.L. & Econ. 67 (1978); Calabresi, The Decision for Accidents: An Approach to Nonfault Allocation and Costs, 78 Harv. L. Rev. 730 (1965); Kessel, Transfused Blood Serum Hepatitis and the Coase Theorem, 17 J.L. & Econ. 265 (1974); Kirgis, Effective Pollution Control in Industrialized Countries: International Economic Disincentives, Policy Responses, and the GATT, 70 Mich. L. Rev. 859 (1972).

7. Regan, supra note 2A. Assumption h is clearly needed to prove the theorem; none of the other assumptions guarantee that two agents who are in a position to strike a mutually advantageous deal will do so. The assumption of profit maximizing producers (or expected utility maximizing consumers) guarantees only individual rationality. Most economic models take such assumptions about individual rationality and impose some sort of mechanism or institution, such as a market, which combines the individually rational choices into a group outcome. The Coase Theorem proffers only the existence of basic contract law, which will be perfectly and costlessly enforced by the court system. The Coase Theorem also needs an assumption which provides for combining individually rational behavior into a group outcome. Instead of providing some sort of a specific mechanism, such as allowing one of the two parties to propose a deal and let the other accept if and only if accepting the deal would increase the acceptor's individual utility (or profits), assumption h makes the most general proposition that eventually some sort of deal will be struck. Hence, assumption h is the analog, in the Coase Theorem, of the assumption in a market model that consumers will actually purchase the goods and services, subject to a budget constraint, which maximize their utilities. Further, assumption h is not captured by the assumption of zero transaction costs. It may be that even though the parties can negotiate and transact costlessly, one or both of the parties may behave strategically, so as to capture more profits for himself. As Regan, supra note 2A, p. 430, notes, the essence of making credible threats is to carry them out, sometimes. But once a threat is carried out the Coase Theorem has failed. Even if such threats are not carried out, each party may continually threaten to refuse to agree to a deal unless that party receives quite favorable treatment. Parties can refuse to agree to the deal indefinitely. The only way to handle this dilemma for the Coase Theorem is to assume that the parties will strike a deal.

Consider, in this vein, the argument found in Landes & Posner, Salvors, Finders, Good Samaritans, and Other Rescuers: An Economic Study of Law and Altruism, 7 J. Leg. Stud. 83, 91 (1978):

> Even where there is both mental capacity and adequate time for negotiating, the process of voluntary exchange may not work efficiently. Suppose the sinking ship is far out at sea - though in no immediate danger of sinking - and a potential rescuer comes upon it by chance or by responding to its distress signal. There is time for negotiation but little likelihood of another ship's chancing on the scene. The potential rescuer therefore has a monopoly position which he can use to try to extract the victim's promise, prior to initiation of any rescue efforts, to pay him all or most of the value of the ship and cargo. At the same time, because the rescuer has no alternative customer for his rescue services at the place where he has found the ship in distress, the "rescuee" has a monopoly position, making the situation one of bilateral monopoly. Transaction costs under bilateral monopoly are high because there is a range of possible prices which invites haggling. The haggling may be proteacted, costly, and sometimes unsuccessful in producing agreement on terms.

Assumption h also rules out both personal or social pressures which militate against contracting. If one of the parties to an externality were to believe that contracting is inherently evil, or that the behavior involved in the externality is terrible, the individual might refuse to ever sign a contract which pertained to the externality, and the Coase Theorem might fail. Social pressures could affect willingness to contract in an asymmetric fashion. For example, in Coase's original example of a rancher and a farmer, there were no social pressures on the two parties to resist economic forces. However, if cows were considered sacred to an extent that one who signed a contract to limit the number of cows kept on a ranch would be shunned by his friends, but no such attitude would exist towards a contract which increased the number of cows to be kept, then the following results might be obtained. First, if the farmer had a property right to exclude cows, so that the rancher had to obtain the farmer's permission to have a herd, then the farmer and rancher would strike a deal allowing the rancher to keep some cows. Second, if the rancher had a property right to have as many cows as he wished, so that the rancher and farmer could joint profit maximize only by striking a deal to limit the number of cows the rancher would keep, then no deal would be struck. Such a pair of results would violate the Coase Theorem, and assumption h rules out all such problems. Of course, to the extent that the reader remains unconvinced that assumption h does not flow naturally from the other assumptions, he will not be particularly interested in (or surprised by) the strong appeal of the Pareto Optimal outcome in the 2 person, full information experiments. Such a reader, however, should still be quite interested in the 3 person and partial information variations on the Coase scenario which we test.

8. A Pareto optimal allocation has the property that it is not possible to make one person better off without making another person worse off. In a nonzero sum game a Pareto optimal allocation maximizes the joint profits from the game.

9. See Crocker, supra note 2C; Kelman, Consumption Theory, Production Theory and Ideology in the Coase Theorem, 52 S. Cal. L. Rev. 669 (1979); Spitzer & Hoffman, A Reply to Kelman's Consumption Theory, Production Theory, and Ideology in the Coase Theorem, S. Cal. L. Rev. 401 (1980).

10. Calabresi and Melamed, supra note 2B.

11. Chertkoff and Esser, A Review of Experiments in Explicit Bargaining, 12 J. Experimental Soc. Psych. 464 (1976); Guyer and Perkel, Experimental Games: A Bibliography (1945-1971), 293 U. Mich. Mental Health Research Inst. Com. (1972); Murningham, Models of Coalition Behavior: Game Theoretic, Social Psychological and Political Perspectives, 85 Psychological Bull. 1130 (1978).

12. Daniels, Communication, Incentive, and Structural Variables in Interpersonal Exchange and Negotiation, 3 J. Experimental Social Psych. 3147 (1976); Gallo and McClintock, Cooperative and Competitive Behavior in Mixed-Motive Games, 9 J. Conflict Resolution 68 (1965); Kelley, Shure, Deutsch, Faucheaux, Lanzetta, Moscovici, Nuttin, Rabbie, and Thibaut, A Comparative Experimental Study of Negotiation Behavior, 16 J. Personality & Soc. Psych. 411 (1970); McClintock, McNeel, Reward Level and Game Playing Behavior, 10 J. Conflict Resolution 98 (1966); McClintock and McNeel, Prior Dyadic Experience and Monetary Reward as Determinants of Cooperative and Competitive Game Behavior, 5 J. Personality & Soc. Psych. 282 (1967); Medlin, Effects of Grand Coalition Payoffs on Coalition Formation in Three-person Games, 21 Behavioral Sci. 48 (1976).

13. Chertkoff and Esser, supra note 11; Druckman, The Influence of the Situation in Inter-party Conflict, 15 J. Conflict Resolution 523 (1971); Nydegger and Owen, Two-person Bargaining: An Experimental Test of the Nash Axioms, 1 Int'l. J. Game Theory 239 (1975); Roth and Malouf, Game-theoretic Models and the Role of Information in Bargaining, 588 Ill. at Urbana-Champaign C. Com. and Bus. Ad. Faculty Working Paper (1979); Swennson, Cooperation in the Prisoner's Dilemma Game I: The Effects of Asymmetric Payoff Information and Explicit Communication, 12 Behavioral Sci. 314 (1967); Wickman, Effects of Isolation and Communication on Cooperation in a Two-person Game, 16 J. of Personality & Soc. Psych. 114 (1970).

14. Murdoch, Development of Contractual Norms in a Dyad, 6 J. Personality & Soc. Psych. 206 (1967); Kelley, Beckman, and Fisher, Negotiating the Division of a Reward Under Incomplete Information, 3 J. Experimental Soc. Psych. 361 (1967); Radlow and Weidner, Unenforced Commitments in "Cooperative" and "Non-cooperative" Non-constant Sum Games, 10 J. Conflict Resolution 497 (1966); Thibaut, The Development of Contractual Norms in Bargaining: Replications and Variation, 12 J. Conflict Resolution 102 (1968); Thibaut and Faucheaux, The Development of Contractual Norms in Bargaining Situations Under Two Types of Stress, 1 J. Experimental Soc. Psych. 89 (1965); Thibaut and Gruder, Formulation of Contractual Agreements Between Parties of Unequal Power, 11 J. Personality and Soc. Psych. 59 (1969).

15. Fouraker and Siegel, Bargaining Behavior (1963); Michener, Ginsberg and Yuen, Effects of Core Properties in Four-person Games with Side Payments, 24 Behavioral Sci. 263 (1979); Siegel and Fouraker, Bargaining and Group Decision Making: Experiments in Bilateral Monopoly (1960).

16. Smith, Reward Structure and Information in the Development of Cooperation, 4 J. Experimental Soc. Psych. 199 (1968).

17. Druckman, supra note 13.

18. See Demsetz, supra note 2B; Ackerman, Economic Foundations of Property Law (Questions 2-5) (1975).

19. See, e.g., Lane and Messé, Equity and the Distribution of Rewards, 20 J. Personality & Soc. Psych. 1 (1971); Leventhal, Michaels, and Sanford, Inequity and Interpersonal Conflict: Reward Allocation and Secrecy About Reward as Methods of Preventing Conflict, 23 J. Personality & Soc. Psych 88 (1972); Lieberman, Not an Artifact, 15 J. Conflict Resolution 113 (1971); Messé, Vallacher and Phillips, Equity and the Formation of Revolutionary and Conservative Coalitions in Triads, 31 J. Personality & Soc. Psych. 1141 (1975); Morgan and Sawyer, Bargaining Expectations and the Preference for Equality over Equity, 6 J. Personality & Soc. Psych. 139 (1967); Nydegger and Owen, The Norm of Equity in a Three-person Majority Game, 22 Behavioral Sci. 32 (1977); Nydegger and Owen, supra note 13; Rapoport, Frenkel, and Perner, Experiments With Cooperative 2 X 2 Games, 1 Theory & Decision 67 (1967); A. Rapoport, J.J. Guyer and D.G. Gordon, The 2 X 2 Game (1976); Rapoport and Orwant, Experimental Games: A Review, 7 Behavioral Sci. 1 (1962); Reis and Grunzen, On Mediating Equity, Equality and Self-interest: The Role of Self Preservation in Exchange, 12 J. Experimental Soc. Psych. 487 (1976); Roth and Malouf, supra note 13; Shapiro, Effect of Expectations of Future Interaction on Reward Allocations in Dyads: Equity or Equality, 31 J. Personality & Soc. Psych. 873 (1975); E. Walster, Berscheid, and G.W. Walster, New Directions in Equity Research, 25 J. Personality & Social Psychology 151 (1973).

20. See, e.g., Chertkoff, Coalition Formation as a Function of Differences in Resources, 15 J. Conflict Resolution 371 (1971); Funk, Rapoport, and Kahan, Quota Versus Positional Power in Four-person Apex Games. 16 J. Experimental Soc. Psych. 77 (1980); Kelley, Bechman, and Fischer, Negotiating the Division of a Reward Under Incomplete Information, 3 J. Experimental Soc. Psych. 361 (1967); Michener, Ginsberg and Yuen, supra note 15; Michener, Yuen and Ginsberg, A Competitive Test of the $\mathcal{M}_1^{im}$ Bargaining Set, Kernel, and Equal Share Models, 5 Behavioral Sci. 341 (1977); Miller, Coalition Formation in Characteristic Function Games: Competitive Tests of Three Theories, 16 J. Experimental Soc. Psych. 61 (1980); Murningham, Strength and Weakness in Four Coalition Theories, 23 Behavioral Sci. 195 (1978); Rapoport and Kahn, When Three is not Always Two Against One: Coalitions in Experimental Three-person Cooperative Games, 12 J. Experimental Soc. Psych. 253 (1976). Thibaut and Gruder, supra note 14.

21. See Roth and Malouf, supra note 13 and Nydegger, Independent Utility Scaling and the Nash Bargaining Model. 22 Behavioral Sci. 283 (1977) for discussions of the effect of knowledge of payoffs on payoff splits. Guyer and Rapoport, Information Effects in Two Mixed-motive Games, 14 Behavioral Sci. 467 (1969) also find this result.

22. See, supra note 21.

23. Particularly Kelley, Beckman, and Fischer; Michener, Ginsberg, and Yuen; Michener, Yuen, and Ginsberg; Murningham, supra note 20.

24. See, e.g., Funk, Rapoport, and Kahan, supra note 20; Morgan and Sawyer, and Lane and Messe, supra note 19.

25. Greenberg, Group vs. Individual Equity Judgements - Is There a Polarization Effect?, 15 J. Experimental Psych. 504 (1979); Rapoport, Guyer, and Gordon; Shapiro, supra note 20.

26. supra, note 15.

27. Leventhal, Michaels, and Sanford; Reis and Gruzen, supra note 20.

28. supra, note 21.

29. Two such experiments are reported in Michener, Ginsberg, and Yuen; Michener, Yuen, and Ginsberg, supra note 20.

30. Chamberlin, An Experimental Imperfect Market, 56 J. Political Econ. 95 (1948); Druckman and Bonoma, Determinants of Bargaining Behavior in a Bilateral Monopoly Situation II: Opponents Concession Rate and Similarity, 21 Behavioral Sci. 252 (1976); Felsenthal, Bargaining Behavior When Profits are Unequal and Losses are Equal, 22 Behavioral Sci. 334 (1977); Fouraker and Siegel, supra note 15; Guyer, An Analysis of Duopoly Bargaining, 11 General Systems 215 (1966); Harnett and Cummings, Bilateral Monopoly Bargaining: An International Study, 3 Contributions to Experimental Economics 100 (1971); Johnson and Cohen, Experiments in Behavioral Economics: Siegel and Fouraker Revisited, 12 Behavioral Sci. 353 (1967); Komorita and Brenner, Bargaining and Concession Making under Bilateral Monopoly, 9 J. Personality & Soc. Psych. 15 (1968); Sauermann and Selton, An Experiment in Oligopoly, Ann Arbor: Society for General Systems Research Vol. 5 (1960).

31. Murningham, supra note 11 reviews much of this literature: other examples include Caplow, A Theory of Coalitions in the Triad, 21 Am. Sociological Rev. 489 (1956) and T. Caplow, Two Against One (1968); Chertkoff, supra note 20; Chertkoff and Esser, A Test of Three Theories of Coalition Formation When Agreements Can Be Short-Term or Long-Term, 35 J. Personality & Soc. Psych. 237 (1977); Cole, An Examination of the Power-inversion Effect in Three-person Mixed-Motive Games, 11 J. Personality & Soc. Psych. 50 (1969); Funk, Rapoport, and Kahan, supra note 20; Gamson, Experimental Studies of Coalition Formation in L. Berkowitz, Advances in Experimental Social Psychology Vol. 1 (1964); Groennings, Kelley, and Leiserson, The Study of Coalition Behavior (1970); Horowitz and Rapoport, Test of the Kernel, and Two Bargaining Set Models in Four and Five-person Games, in A. Rapoport, Game Theory as a Theory of Conflict Resolution (1964); Kahan and Rapoport, Test of the Bargaining Set and Kernel Models in Three-person Games, In A. Rapoport, Game Theory as a Theory of Conflict Resolution (1964); Kelley and Arrowood, Coalitions in the Triad: Critique and Experiment, 23 Sociometry 231 (1960); Medlin, supra note 12; Michener, Fleishman, and Vaske, A Test of the Bargaining Theory of Coalition Formation in Four-person Groups, 34 J. Personality & Soc. Psych. 1111 (1976); Michener, Ginsberg, and Yuen; Michener, Yuen, and Ginsberg, supra note 20; Michener and Zeller, The Effects of Coalition Strength on the Formation of Contractual Norms, 35 Sociometry 290 (1972); Miller; Murningham supra note 20; Murningham and Roth, The Effects of Communication and Information Availability in an Experimental Study of a Three-person Game, 23 Management Sci. 1336 (1977) and Large Group Bargaining in a

Characteristic Functioning Game, J. Conflict Resolution (1978); Rapoport and Kahan, supra note 20; Riker, Bargaining in a Three-person Game, 61 A. Political Sci. Rev. 91 (1967); Shears, Patterns of Coalition Formation in Two Games Played by Male Tetrads 12 Behavioral Sci. 130 (1967); Vinacke and Arkoff, An Experimental Study of Coalitions in the Triad, 22 Am Sociological Rev. 406 (1957); Weick and Penner, Triads: A Laboratory Analogue, Organization Behavior & Human Performance 191 (1966); Willis, Coalitions in the Tetrad, 25 Sociometry 358 (1962).

32. supra, note 20.

33. Shapley, A Value for N-Person Games, in H. Kuhn and A. Tucker, Contributions to the Theory of Games (1953). The Shapley value of each player in a game is that player's expected payoff, computed as follows:

$$EP_i = \sum_{S \subseteq N} ([(s-1)\,!\,(n-s)\,!\,]/n!)\,(v(S) - v(S-i)), \text{ where}$$

N = number of coalitions player i could join

S = a particular coalition

s = number of players in S

n = number of players in the game

V(S) = payoff coalition S can command

v(S-i) = payoff coalition S could command if i did not join

The interpretation of the Shapley value focuses on the power player i can command as the pivotal player in a number of coalitions. The more coalitions i can join and the more i contributes to the payoffs commanded by those coalitions, the more intrinsic power i has and the more total payoff i can expect from playing the game.

34. Murdoch, supra note 14.

35. Thibaut and Gruder, supra note 14.

36. e.g., Michener, Ginsberg and Yuen; Michener, Yuen and Ginsberg; Miller; Rapoport and Kahan, supra note 20; Medlin, supra note 12; Rapoport, Chamman, Dwyer, and Gyr, Three Person Non-zero-sum Negotiable Games, 7 Behavioral Sci. 38 (1962).

37. Chamberlin, The Logic of Collective Action: Some Experimental Results, 23 Behavioral Sci. 441 (1978) and Provision of Public Goods as a Function of Group Size, 68 Am. Political Sci. Rev. 707 (1974); R. Isaac and C. Plott, The Opportunity for Conspiracy in Restraint of Trade: An Experimental Study, 255 Cal. Inst. Tech. Soc. Sci. Working Paper (1979); C. Plott, Externalities and Corrective Policies in Experimental Markets, 180 Cal. Inst. Tech. Soc. Sci. Working Paper (1977); V. Smith, Incentive Compatible Experimental Processes for the Provision of Public

Goods, in Research in Experimental Economics Vol. 1 (1979). One exception to the conclusion that free rider problems are insurmountable is a six person prisoner's dilemma experiment in which subjects could discuss and decide on a strategy half way through the iterated game; Bixenstine, Levitt, and Wilson, Collaboration Among Six Persons in a Prisoner's Dilemma Game, 10 J. Conflict Resolution 488 (1966). While they could not legally enforce their strategy, they could subtly punish defectors. The results were that groups that knew all the payoffs and could discuss a strategy cooperated almost 100% of the time after their discussions. Groups which did not discuss cooperated much less and did not change significantly at any time.

38. Sample payoff functions are reproduced in Table I on page 12.

39. Although Coase contrasted a liability rule in favor of farmers with a property rule in favor of ranchers, we have chosen to contrast opposite property rules because they are so much easier to model.

40. See Smith, Experimental Economics: Induced Value Theory, 66 A. Econ. Rev. 274 (1976) for a theoretical justification for inducing preference orderings with monetary payoffs.

41. A variety of different payoff functions with the same structure were randomly used. The object of randomizing the payoff functions was to minimize possible experimenter effects.

42. Tests are included with the instructions.

43. Sample payoff functions are reproduced in Table I on page 12.

44. Contract forms are included with the instructions.

45. supra, note 19.

46. A core allocation is individually rational, Pareto Optimal, and rational for every possible winning coalition of players.

47. Richard Posner has recently suggested an economic rationale for the prevalence of sharing behavior in primitive (pre-literate) societies. Posner hypothesizes that in a culture that produces food that cannot be stored from one period to another, voluntary "gifts" of surplus food production to needy individuals will form the basis of a primitive form of insurance against hunger and starvation. Those who produce surplus in one period may be needy the next. As long as the fortunate give to the needy in each period, everyone's chance of starving is greatly reduced. Posner explores the ramifications of these insights in A Theory of Primitive Society with Special Reference to Primitive Law, 23 J.L. & Econ. 1 (1980). Unfortunately, however, our results cannot be explained through Posner's analysis. Each subject's production was perfectly storable from one experiment to the next. Hence, the controller on the first of two sequential decisions could self-insure against the

possibility of losing control on the second decision by refusing to share his surplus. Furthermore, Posner's thesis cannot explain any of the sharing behavior that we observed in non-sequential decisions or in the second of two sequential decisions, since there is no longer any insurance to be bought. Of course, the sharing behavior might be the "natural" outcome of this bargaining game if the subjects were to view all of the money to be paid to them as "profits", rather than just regarding the additional money which can be earned by cooperating as profits. The Nash bargaining solution is to split evenly all profits where neither party has greater power within the game. This solution would suggest that the controller would take his individual maximum plus 1/2 of the surplus from cooperation. If, for some reason, the controller failed to fully appreciate his complete control over the amount he could command by himself (although each subject answered questions indicating that he did have such an appreciation), then the observed equal splits would correspond, in some sense, to the Nash bargaining solution.

To test this possibility, the authors wish to run additional 2 and 3 person experiments, identical in all respects to the previous experiments, with one important change. When the coin is flipped and the controller is chosen, we will take an amount of cash equal to the maximum the controller can command by himself, and give it to the controller immediately. The controller will be told that the cash is his and that it is up to him as to whether or not the experiment proceeds. If the experiment proceeds, the procedures will be unchanged. However, to effect an equal split, the controller will have to give up some of the cash in hand to the other party or parties. We suspect that such a change in procedure will reduce the number of equal splits.

48. We feel that it is premature, at this stage, to draw normative conclusions from the sharing behavior between subjects in these experiments. However, before one may draw such normative implications for the Coase Theorem one would need a theory of how subjects (or people, in general) ought to behave with respect to exploiting economic rights. Such a theory might stem from a notion of just desserts. For example, one might feel that full exploitation of an economic right was justified only where the owner of the right had acquired it through labor. Under such a theory the subjects in our experiment, who acquired the right to be controller through a flip of the coin rather than through labor, should share the profits. Alternatively, one might feel that one may morally exploit a property right if and only if the other party with whom one is dealing is wealthier, of a higher caste, etc. Under this theory, we would have to know the relative status of controllers and noncontrollers in our experiments before being able to make any normative pronouncements on the sharing behavior. The development of a general, normative theory lies well beyond the scope of this paper. Even if we had a well developed normative theory of exploitation of economic rights, our data is far too sketchy to allow any meaningful application. We intend to return to these questions upon completing the full set of Coase Theorem Experiments.