EXPERIMENTS IN TEACHING AND IN UNDERSTANDING ECONOMICS

to accompany

ECONOMICS

Second Edition

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PREFACE

This pamphlet is an introduction to experimental economics for the principles instructor and includes a "how to" guide for integrating experimental demonstrations into the classroom. These classroom experimental demonstrations are simple in design and at the same time powerful teaching devices and educationally motivating tools. They bring students into the study of economics, and are a welcome change from a lecture format. Even when they don't come out the way economic theory says they should, they motivate lively discussions.

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EMPIRICAL TESTING AND EXPERIMENTAL ECONOMICS

Economics is an empirical discipline: ultimately economic arguments must be "tested" empirically so that an argument can be shown to be, or not to be, relevant. The inherent ambiguity of empirical testing, the complicated nature of the interrelationships, and the social subject matter make it extraordinarily difficult to test economic theories formally. We believe that students should know that too; it provides the rationale for experimental economics. For that reason we begin our introduction to experimental economics by explaining to students the difficulties in testing theories empirically.

The Identification Problem

An approach we have found useful when introducing students to the problems of empirical testing is to start out with some empirical observations. In micro, we start with price/quantity observations such as those in (a) and in macro we start out with consumption/income data such as those in (b).

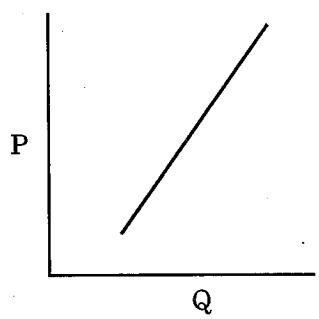
Price of Candy Bars	Quantity of Candy Bars Sold
40	300
50	400
60	500

(a)

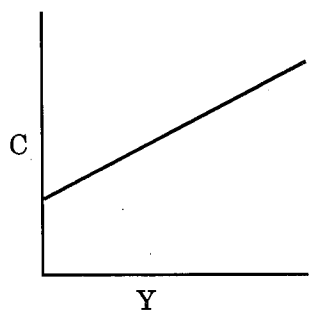
C	Y
300	500
380	600
460	700

(b)

We then ask them to graph the data. If they do it correctly, they should get the following:



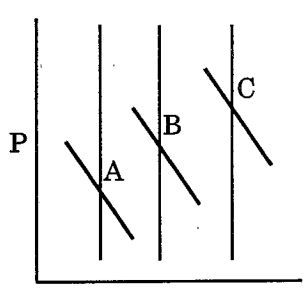
(a)

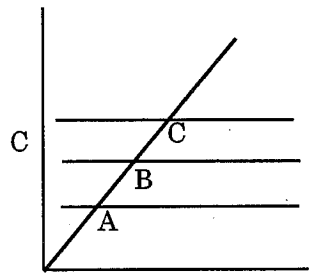


(b)

After they have plotted these curves, the students are asked what the curves they have drawn are. After the perfunctory, "I don't know," they eventually conclude that they have graphed a supply curve and a consumption function because they look like what they expect a supply curve and a consumption function to look like.

Assuming that this is their answer, we show them the following curves and ask them what empirical observations they make from them.





Then we pose the question once again: What did the empirical observations tell us? This time they are far less certain.

Having gone through these exercises, we then briefly discuss some statistical techniques for determining which models the curves best fit and discuss the additional knowledge needed to interpret empirical observations—assumptions about whether the data represent equilibrium or disequilibrium points, and how other information about what is held constant is necessary to identify a curve.

Eventually, it becomes clear to students that these curves could also have generated the above price/quantity observations. We conclude by pointing out that depending on what assumptions one makes, many alternative combinations of curves could generate the same data points.

Introducing Experimental Economics

Having led students to an appropriate level of confusion and concern about economists' ability to test empirically, we introduce experimental economics as an alternative to statistical testing.

We discuss how in experimental economics we can control the environment differently than we can in empirical real-life economics, and how, with the appropriate control, we can better separate the different causes of empirical observations and thereby increase our knowledge.

We further explain that controlled experiments are exceptionally complicated, and conducting them in an appropriately controlled manner is a painstaking process that is inappropriate to a classroom. However, we do tell the students that it is possible to demonstrate some empirical tendencies in economics by conducting experimental in-class demonstrations of the ways in which people decide markets work, or fail.

We hesitate to call these experimental demonstrations "experiments" because they are not; to call them experiments would demean true experimental economics in which controls are carefully considered and maintained. For example, typically classtime is limited, making appropriate controls difficult. In addition, experimental economics has conventions and standards that are compromised by the very nature of the classroom. For instance, classroom experiments involve students and their teachers which leads to the problem of good subject behavior, i.e., students making choices that they believe their teacher expects them to make. (For an example of such behavior see discussion of Experiment 5 in this pamphlet.) Also it is a common practice in experiments to motivate subjects with monetary payoffs. Typically,

experiments are calibrated such that subjects can earn two to three times the minimum wage, prohibitively expensive for the classroom. That doesn't mean that classroom experimental demonstrations are unimportant; it simply means that they are not true experiments. Nonetheless, they convey what experimental economics is about.

We have narrowed down the experimental demonstrations to seven simple ones and one more complicated one. We suggest that only experienced experimentalists or adventurous types with small classes try the more complicated one. For most professors the process of setting up the more complicated experimental demonstration becomes burdensome, and the result can easily be total confusion.

These eight experimental demonstrations can be done successfully with classes of up to 40; for larger classes, the success of the experiment depends on the room structure and the ability to choose a subset of students, leaving the others in the class easily able to observe.

AN OVERVIEW OF THE EXPERIMENTAL DEMONSTRATIONS IN THIS PAMPHLET

In this pamphlet we discuss eight experimental demonstrations.

1. The bonus allocation experiment.
2. A demonstration of gains from trade.
3. A common resource experiment.
4. A 0-1 collusion experiment.
5. A variant of the common resource and collusion experiment.
6. A moral hazard experiment.
7. A rational expectations quiz experiment.
8. A double auction market experiment.

The first seven of these are feasible in most classes and can take as little as ten to twenty minutes, or can be combined with discussion and take one or two class periods, depending on the time available and the focus of the class.

The last experiment is more complicated. It will take at least one 50-minute period to conduct, along with 15-20 minutes of preparation and 20-30 minutes of discussion afterwards. We have written the instructions so that the demonstration can be conducted by individuals who have no experience in experimental economics, and we have chosen games that fit the introductory course level.

Experiments 1 and 2 are designed for either micro or macro, experiment 7 is primarily for macro, and the remaining are for micro.

A FULL DESCRIPTION OF THE EXPERIMENTS

1

The Bonus Allocation Experiment

Motivation of the experiment: The following experimental demonstration has a double purpose: First, it is meant to illustrate *the economic problem* and the many ways it can be addressed. Second, and possibly just as important, if conducted at the beginning of a course—for instance, following such preliminaries as discussion of syllabus, etc.—it allows students to get to know each other and thus "warm up." One of the authors uses this experiment routinely and finds that it positively affects class dynamics and atmosphere.

Physical requirements of experiment: None

Description of the experiment: The instructor makes (possibly in written form) the following announcement to the class:

> I will give away n/2 bonus points (where n = number of students in class at the end of the course). You have to decide within twenty minutes who is to become the bonus allocator for these points. He or she is free to distribute them as he or she wishes, but must announce the decision, in writing, within 10 days. Points cannot be given away in fractions.

After clarifying whatever questions may arise, the instructor ought to leave the classroom, possibly asking students to let him or her know if they come to a decision early. After a short discussion of how a limited supply of points and an unlimited demand for wants created *the economic problem* and depending on the time frame, the instructor may want to do one of two things: (1) Draw up a list of possible allocation mechanisms in class, or (2) assign this as a homework assignment. Have each student write a list of allocation mechanisms.

Since we have been conducting this experimental demonstration, students have never failed to come up with a variety of interesting mechanisms, including random distribution (lottery) and mechanisms that, often in a rather sophisticated manner, balance efficiency and equity. Students tend not to come up with mechanisms that are second nature for many economists. For example, rarely does one encounter the idea of auctioning off points. Students are often puzzled by such a suggestion and it makes for a great point of departure to discuss the obvious economic issue. On a final note, the selection of a bonus allocator leads naturally into a discussion regarding the relation between political and economic spheres. It also allows for discussion of principal-agent problems at a very early stage.

2
A Demonstration of Gains From Trade.

Motivation of the experiment: This is hardly an experimental demonstration, but it leads nicely into a discussion of the gains from trade.

Physical requirements of experiment:

4 or 5 apples
4 or 5 bananas
Cost: About $3.00

Description of the experiment: Find out which students like apples (but not bananas) and which like bananas (but not apples). Ask one student who likes apples and another who likes bananas to skip lunch. Tell them that you will feed them during the class period. Give 4-5 apples to the student who likes bananas and 4-5 bananas to the student who likes apples. (Many variations are possible—such as salty potato chips and soda, muffins and coffee for early classes, etc.) Tell them that they are to eat what you have given them during the class, but before they eat, tell them that they may, if they wish, go outside the classroom and discuss whether they would like to trade their "endowments." Generally we have found that they do trade, which leads to a discussion of the gains from trade.

3

A Common Resource Experiment

Motivation of the experiment: This experimental demonstration illustrates the "Tragedy of the Commons" phenomena of degradation/depletion of common pool resources like the environment, town commons, fisheries, etc. (For a very nice exposition of the problem see Ostrom's *Governing the Commons*, [1990, 2-3].)

As H. Scott Gordon put it, "There appears then to be some truth to the conservative dictum that everybody's property is nobody's property. Wealth that is free for all is valued by no one because he who is foolhardy enough to wait for its proper time of use will only find that it has been taken by another. The fish in the sea are valueless to the fisherman, because there is no assurance that they will be there for him tomorrow if they are left behind today" [Ostrom, 1990, 3].

Physical Requirements of Experiment:

10 small paper clips or similar items
one set of car keys or a similar item
Cost: quite likely $1.25 (max: $2.50)

Description of the experiment: Select 6-8 students and ask them to form a half-circle. Define the half-circle as the sea. Then throw the small fish (represented by small paper clips) and the big fish (represented by a larger paper clip or a set of car keys) into the sea. Tell your students that they will have two chances to retrieve them for you and that you will pay the students who do so. Tell them that the payment will be 10¢ for small fish in the first period and 20¢ in the second; likewise, the payment for the big fish will be 25¢ in the first period and 50¢ in the second.

Inform them that when you say "Go," the first chance to retrieve the fish will begin and that this chance will last 20 seconds. They are free to take as many or as few as they want in either the first or second period. (Rich professors, or professors with departmental support, can increase the payout and more strongly motivate students.) Tell them that the second period will begin immediately after the first period and will also last for 20 seconds. If there are no questions, start the first period.

In our experience, this experimental demonstration has never failed to produce "overfishing;" i.e., experimental subjects diving towards the fish as soon as the first period has started. After they have done so, show them that they all would have been better off if they had refrained from grabbing in the first period, since the choice of values of the fish guarantees that normally even those who are the most successful at "fishing" come out with about the same as, or less than, everyone could have received had they collaborated. The game is an ideal starting point to introduce two-sided prisoner's dilemma type situations, the differences in outcomes of one-shot and repeated games, and the possibilities of reputational and other enforcement mechanisms (in-shore lobster fisheries, private-access fisheries).

4

A 0-1 Collusion Experiment

Motivation of the experiment: Students usually doubt solemn declarations that collusion tends to be doomed because of self-interested behavior of agents. The following experimental demonstration illustrates why cartels tend to break down. The impact of the experimental demonstration can be increased by explaining in the preceding class the simple analytics of cartel behavior, followed by a hypothetical survey of who as a member of such a cartel would cheat on the cartel. While the number of students who claim that they would cheat tends to be rather small, the number of students who do cheat in the experimental demonstration tends to be rather large. This fact allows the instructor to drive home an important point: Talk is cheap. Unless people have to put their money where their mouth is, their verbal utterances can't be easily trusted.

Physical requirements of the experiment:

Mimeographed copies of the following payoff table. (See Exhibit A in the appendix for copies.) The first row specifies the number of students choosing the number 1; the second and third rows specify the payout for students choosing the number 1 or the number zero respectively. Thus, if 15 students chose number 1, students choosing 1 would get 60¢; students choosing zero would get $1.10.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
0	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170

Two pieces of paper for each student in the class

Cost: Depends on class size and the payout rate. (At this payout rate, the largest payout for a class of 30 would be $36, and the likely payout would be on average $15. For a class of 20, the maximum payout would be $16 and the likely payout rate would be about $10. With larger classes we suggest using a quiz to reduce the number of participants to about 20, or the use of smaller payout rates.)

Description of the experiment:[1] Each participant is given a copy of the payoff table. Each participant choses either "1" or "0" in a concealed vote. The payout to individuals in the class for their respective choices depends on their individual choice and the total number of "1's" chosen. For example, if there are 30 students in the class and 20 choose zeros and 10 choose 1's, the payout will be determined by the 10 column and the 10 individuals choosing 1's will get 40¢ each, while the 20 individuals choosing zeros will get 90¢ each. Thus, it is in their individual interest to choose zeros but in the group interest to choose 1's. Students should be admonished not to talk to each other before writing their choice on a piece of paper to be collected by the instructor. If there are no questions, the vote should be taken without further ado. (The result can be safely predicted to illustrate the widespread breakdown of cooperation.) It is worthwhile to offer students a second chance at the game; for the second round, it is recommended that the instructor allow students to talk before writing down their choice. In their discussion, students tend to conclude that the common good requires that everyone write down the "1." (The result again tends to illustrate the widespread breakdown of cooperation.)

The experimental demonstration lends itself to an array of variations. For example, one clearly can do more than one repetition. Also, one can conduct the experimental demonstration with or without anonymity. In the latter case, the instructor can append another experimental demonstration by putting payoffs into small envelopes that are marked as containing either the larger or the smaller payout. After the instructor has put the small envelopes into a larger one, each student can then choose which envelope he or she earned. By putting more envelopes with the larger payoff in the larger envelope the instructor can, unbeknownst to the class, run another free-rider experimental demonstration. (Note that there could be reputational spill-over effects.)

This experimental demonstration is the ideal illustration of a custom that one finds in many states: farmers offering their wares at the side of the road without supervision. The experimental demonstration also allows an interesting discussion of the well-known results by Marwell and Ames [1981] and Carter and Irons [1991], who found that economics students were more selfish than were non-economics students. (We discuss their results below.)

5

A Variant of Common Resource and Collusion Experiments

The following variation of both the collusion and common resource experiments discussed in Experiements 3 and 4 was suggested by Professor William Bormann in a workshop we gave at West Palm Beach Community College. It is usually less expensive, but is also slightly less transparent. It has interesting features, though, that we will discuss presently.

Motivation of the Experiment: An alternative method of illuminating the common resource and collusion problem.

Physical requirements of the experiment:

> One piece of paper per student. If you plan repetitions of the experiment (see description), you will need an additional piece of paper per student per repetition.
>
> Two to four quarters per student depending on class size and risk aversion of the instructor. (Quite likely you will end up not having to pay out many of the quarters. If you plan repetitions of the experiment you will need additional quarters.)

Description of the experiment: The instructor makes (possibly in written form) the following announcement to the class:

> I have here (number of students times number of quarters) dollars. You are to bid for these dollars privately by submitting to me a bid on a piece of paper. Whoever has the highest bid will get (...) dollars minus his or her bid. If several of you submit an identical bid, those students will share the difference between the (...) dollars and the value of their (identical) bid. You have 5 minutes to discuss your optimal group strategy. (Hint: What happens if you all were to bid zero?) Do not write down your bid until you are asked to do so. Physical and other threats are unacceptable means of enforcement in this classroom experiment.

It is important that the instructor makes sure that students understand why bidding zero would be an optimal strategy for the group as a whole. It is also important that students submit their bids privately.

This experiment is different from both the collusion experiment and the common resource experiment presented earlier in one important aspect. Unless the group or some members of the group manage to coordinate on a uniform bid, the student with the highest bid wins it all. Thus, the incentives in this game are high-powered. This can work in two directions. An informal summary of several classroom experiments that one of us ran in the Spring of 1994 may illustrate the consequences.

In the most intriguing of these experiments, 28 of 30 students in a class on "Environmental Ethics" (which is part of the course offerings of the philosophy department), chose to bid 0; the other two bids came in at one cent and two dollars. In that round of bids, students were asked to initial their bids and they had reason to believe that their instructor, while he did not conduct the experiment, would see their bid. We believe the high number of cooperative bids was the result of good subject behavior and strong community norms established by the instructor. In a follow-up experiment that guaranteed students that their bids would be known only to the experimenter (who was from the economics department), about half of the subjects bid everywhere from one dollar to 15 dollars. While the fact that this experiment followed another one probably played a role, we believe that the anonymity of the second round made almost all the difference.

Similar experiments in economics classes tend to confirm the results of the collusion and common resource experiments presented earlier, with a significant percentage of students choosing the noncooperative option (choosing to make non-zero bids.) In general, the experiment leads to high bids in the first round. (Often the winning bidder comes out with less than he or she could have earned if everyone had bid zero.) Our example shows that the experiment can be highly sensitive to subject pool effects and information treatment. It is worthwhile (and in our experience very inexpensive) to repeat this experiment. The costs of repetitions of the experiment converge quickly to zero.

6

A Moral Hazard Experiment

Motivation of the Experiment: The common resource and collusion experiments are actually problem isomorphs; the underlying incentive structure can in both cases be illustrated by the two-sided prisoners' dilemma game.

A typical parameterization of the two-sided prisoners' dilemma is

		Player 1	
		p_1	p_2
Player 2	a_1	1,1	-1,2
	a_2	2,-1	0,0

where the entries could denote quarters or dimes.

Likewise, a typical parameterization of the one-sided prisoners' dilemma[2] is

		Principal	
		p_1	p_2
Agent	a_1	1,1	0,0
	a_2	2,-1	0,0

This game represents situations of strategic uncertainty where an agent, say a seller of a good (hi-fi stereo or computer) or service (car repair), can supply either high quality or low quality, and a principal can either verify the quality (at a cost) or trust the agent's claims. Thus both the agent, here represented as the row player, and the principal, here represented as the column player, have two actions each ({a_1=provide high effort, a_2=provide low effort}, {p_1=don't inspect, p_2=inspect}) for a total of four outcomes.

Note that this set-up also describes employee-employer interaction, with the employee (the seller of labor) being the agent and the employer (the buyer of labor) being the principal. Also note that the numerals are chosen so that the joint payoffs in the upper left corner are greater than those in the lower left corner, which in turn are higher than those in the lower (and upper) right corner—suggesting that (high quality, no inspection) is socially preferred to (low quality, no inspection), which in turn is socially preferred to (low quality, inspection).

Finally, note also that if agent and principal were to agree on playing the upper left corner, the agent could (and likely will) make himself better off if, in a one-shot game, he switches strategies and ends in the lower left corner. If the principal knows the payoff matrix and anticipates the likely mode of reasoning of the agent, then she can make herself better off by switching strategies and ending in the lower right corner. Using the standard assumptions of individual rationality and common knowledge of the payoff matrix, this outcome is indeed the game-theoretic prediction for this game.

Physical requirements of the experiment:

2 quarters per participant (This is the maximum amount needed. Chances are that the actual cost of the experiment will be lower. If you plan on several rounds of play, multiply the maximum amount needed by the number of rounds you intend to play.)

Number of participants ought to be even, but can range from approximately 8 to 20.

As many pieces of paper as participants; half of them in one color, the other half in another. (If you plan on several rounds of play, multiply the number of pieces of paper accordingly.)

Ask participants to provide their own writing instruments (otherwise you will have to provide them).

Description of the experiment: Determine participants in the experiment and ask them to come to the front of the room. Define one half of them as buyers and the other half as sellers by giving out the colored pieces of paper. Give every participant a one-quarter endowment. Then instruct participants to walk randomly around the room until they meet a participant of the opposite kind. Once paired off, they may talk with each other about the optimal strategy combination, but they must write down their choice privately. (They also have to write down their initials on the pieces of paper.) Finally, ask them to hand in the pieces of paper in pairs—one paper of each color.

Count the outcomes one at a time. With every announcement of an outcome, do one of the following:

Upper left corner: Give an additional quarter to both.

Lower left corner: Take the initial endowment away from the principal and give it to the agent. Then give the agent an additional quarter.

Lower right corner: Take no action.

In our experience you will find about the same degree of cooperation in the one-sided prisoners' dilemma game as in the two-sided prisoners' dilemma. A number of variations are possible. For example, the experiment could clearly be repeated using different information conditions or the track records of participants could be kept secret or revealed. (See both Tullock [1985] and Frank [1988] for inspiration.)

Again, this drives home the issue of reputational enforcement.

7
A Rational Expectations Quiz Experiment

Motivation of the experiment: Some of the most powerful experimental demonstrations are conducted as part of life, not as specific controlled experiments. Individuals are always gaining knowledge of events around them through observation. This experimental demonstration is designed to emphasize the importance of observation to students, and to motivate a discussion of various types of expectations and expectation formations that play significant roles in different macro theories.

Physical requirements of the experiment: None

Description of the experiment: This is a simple experimental demonstration that can be done as part of one's class. Students are only told of the experimental demonstration after the fact. To implement it, all one need do is to build a habitual activity or action into the class, and continue it for half the semester or quarter. Then one day the instructor varies that habitual action. The students inevitably notice the change, and then, depending on how devious the professor is, he or she gets the students to point it out. At first the professor acts surprised; then he or she tells them about the experimental demonstration, and enters into discussion of expectations of various types. Here are four possible habitual actions:

1. If one gives frequent multiple choice questions, always have the first four or the last four answers follow a pattern—for example, a, b, c, d—and see if any of the students notice.
2. Whenever you are to give a quiz or are going to put something on an exam, build in a marker—for example, say, "And here's an especially important issue."
3. Always wear a striped shirt, red tie, beret, earring, or the like, and then change it one day.
4. Habitually call on students in the front (rear) right, and then suddenly change.

This experimental demonstration can be useful for introducing adaptive and rational expectations explanations of shifts in the Phillips curve and in discussing policy credibility problems.

8

A Double Auction Market Experiment.[3]

Motivation for the experiment: Earlier we pointed out the well-known identification problem. It is not at all obvious to students that markets will converge to a competitive equilibrium and, hence, that any price/quantity observations will correspond to supply - demand equilibrium points. Experimental economics provides insight into the convergence properties of markets. It does so because, as we will show presently, the demand and supply schedules are constructed by the experimenter and thus are known.

These double auction experiments are the most often used market experiments; they derive their name from the fact that two groups of participants—buyers and sellers—make simultaneous bids (buyers) and asks (sellers) for a good—not unlike participants in stock markets such as the New York Stock Exchange or the NASDAQ system.

To undertake this experiment the professor must be highly motivated since it requires more structure and work than do the other experiments we have described. Literally hundreds of such double auction experiments have been conducted with myriad parametrizations [Vernon Smith, 1986; Smith and Williams, 1992; Taylor, 1988]. The overwhelming evidence of these experiments is that, even for small numbers of participants, prices converge quickly to the supply - demand equilibrium point. By the same token, it has been shown that prices in "posted - offer markets," markets in which prices are stated, converge much more slowly [Plott, 1989].

Physical Requirements of the Experiment:

A (large) chalkboard and chalk.

Copies of *Instructions for Participants:* (See Exhibit B in the appendix).

Cost value/record sheet index cards for sellers: (See Exhibit C1 in the appendix).

Redemption value/record sheet index cards for buyers: (See Exhibit C2 in the appendix).

A set of redemption and cost values: (See Exhibit C3 in the appendix).

One assistant to keep (and announce) the time and record a complete set of bids, asks, and transactions for later use.

One assistant to record results on chalk board. (Experienced experimenters can possibly do with one assistant; inexperienced experimenters are advised to use two.)

Approximately 24 subjects. (If your class is larger than 24, you might consider a tournament quiz to get that number: the 24 students who score highest on the quiz participate in the experiment; the others watch.)

Cost: Depends

Description of the experiment: Of the experiments presented in this booklet, the double auction is likely to be the most intimidating for the professor who has not had training in experimental economics. Here we supply a step-by-step description of this experiment. A video of an actual

classroom experiment is available upon request; a professor without training should look at this video to get a better feel for the experiment.

We divide the description of the experiment into two sections—preparation and the actual experiment.

Preparation

Before Class

1. Make sure that your classroom has a (large) chalkboard and chalk.

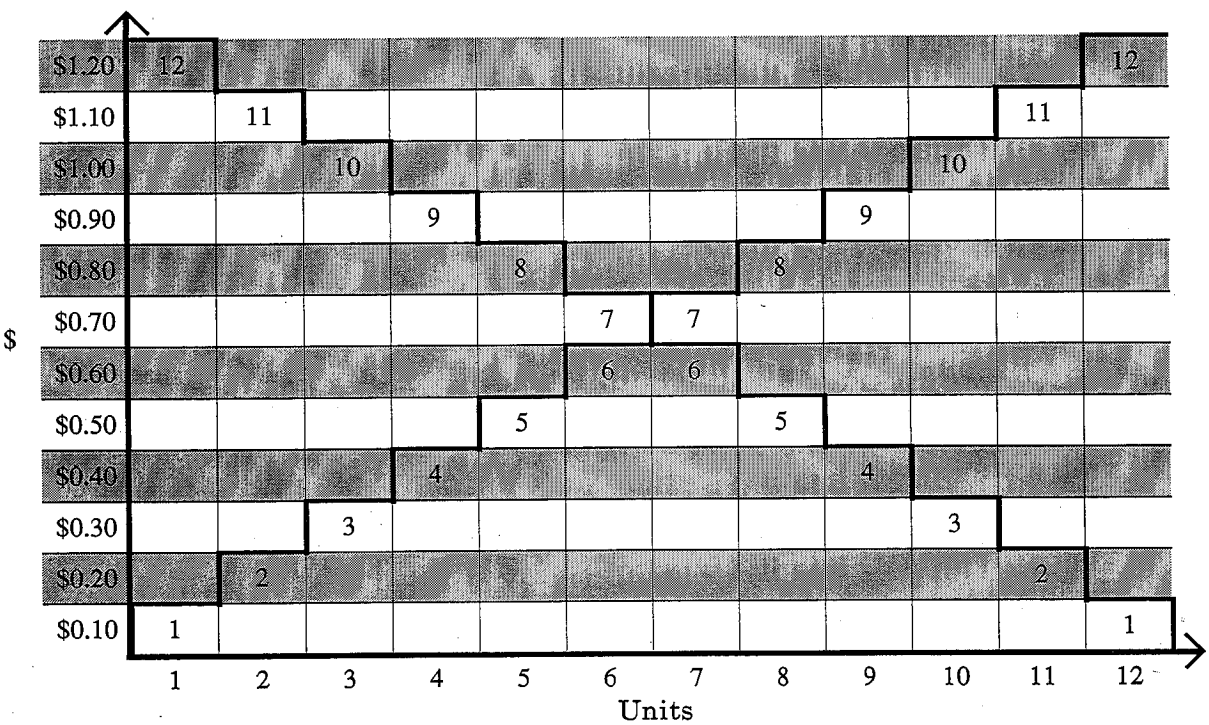
2. Photocopy the *Instructions for Participants* (see Exhibit B in the appendix) for each student in the class.

3. Determine a set of redemption and cost values.

The key to the experiment is the incentive values (redemption values for buyers and cost values for sellers): What are the students' gains from their decisions? One easy way of constructing a set of incentive values is to take in descending order integers from 12 to 1 (as redemption values) and in ascending order integers from 1 to 12 (as cost values). One can interpret these integers as dimes to get the demand and supply schedules shown below.

Below we show such a set of redemption values for 12 buyers (ranging in descending order from 12 to 1) and a set of cost values (ranging in ascending order from 1 to 12). Note that these incentive schedules can be easily customized to accommodate any number of students (although for inexperienced experimenters the use of significantly more students is not recommended). Note also that the expected payouts per period are easily computed as the surplus area.

A Possible Set of Redemption and Cost Values



The incentive values presented above thus could actively involve 24 participants—12 buyers (x = 12 redemption values) and 12 sellers (y = 12 cost values).[4]

Note that the number of participants is easily adjustable. For example, in order to accommodate 13 buyers instead of 12, one merely has to add a redemption value, say 13. For the obvious reason, it is important to have a reasonably good idea about the number of participants. While this experiment can accommodate up to thirty or thirty-five students per buyer/seller group, we recommend that in a first experiment a smaller number be chosen. The instructor is advised to plan for slightly more students than are likely to show up; one can easily dispose of some of the prepared redemption and cost values. While we encourage experimentation with less symmetric designs than the one in Exhibit C3, we recommend the above set of incentive values (or a slight variant thereof) as a point of departure. We recommend that you run 5 or 6 periods, then have students tally up their earnings and hand in their index cards.

4. Determine the monetary units and the costs of the experiment.

Once the instructor has determined a set of redemption and cost values, it is important to approximate the costs of the experiment. Towards this end two pieces of information are needed: First, the surplus for the example of Exhibit C3 in the appendix, (11 + 9 + 7 + 5 + 3 + 1 = 36 monetary units); second, the number of anticipated periods of play. (We recommend conducting a minimum of 5 periods.) The expected cost of the experiment is then the cost per period (approximated by the surplus) times the number of periods. Note that the number thus computed is an upper bound since we have implicitly assumed that all possible trades are indeed consummated. In the first few rounds the ratio of actual to possible trades is typically about 75 percent, although in double auction experiments this ratio tends to reach 100 percent within 5 periods.

Monetary payoffs should not be trivial. The top earners should come out of the experiment with 2 to 4 dollars. (Given that the equilibrium price will prevail after a few rounds of play, the top earner will be the buyer with the highest redemption value and/or the seller with the lowest cost value; their respective earnings are the difference between redemption value and price, and price and cost value.) Note that participants will come out of the experiment with anywhere from 2 to 4 dollars, to zero or less (if they make bids above their redemption values or offers among their cost values). There are two important caveats here: First, the experimenter needs to make sure that the assignment of redemption and cost values is random. Second, we recommend that everyone be given an initial balance of 50¢. This will make "irrational" strategies (making bids above the redemption value or asks below the cost value) costly for participants. If such "irrational" strategies are inconsequential, the experiment is more likely to derail since students, aware that the experimenter cannot credibly commit to collect "debts," might engage in "irrational" asks and bids.

5. Prepare x redemption value and y cost value record sheet index cards.

For seller's cost values see Exhibit C1 in the appendix; for buyer's redemption values see Exhibit C2 in the appendix.

6. Determine two assistants.

One assistant will have to keep (and announce) the time left in each period and record a complete set of bids, asks, and transactions for later use (debriefing). The other assistant will have to record results on the chalkboard. It is recommended that the positions of "assistant" be auctioned off the day before. It is also recommended that their responsibilities be explained to them beforehand.

In Class Before the Experiment

1. Go to the front of the class and determine buyers and sellers. Concentrate buyers on one side of the room and sellers on the other. Participants ought to be seated so that they cannot read other participants' information. Make sure that all participants can see the chalkboard well.

2. While students re-arrange their seats, draw several columns on the chalkboard, as follows. (Alternatively, instruct one of your assistants to do it.)

ASKS	BIDS	ASKS	BIDS	ASKS	BIDS

3. Tell the students not to talk with each other for the duration of the experiment. Ask them to raise their hands if they have questions.

4. Identify participants as buyers or sellers, then assign buyer and seller identification numbers (Buyer One, Two, ...; Seller One, Two, ...). The conduct of the experiment is facilitated if the assignment is done in a somewhat systematic manner (say from the right to the left); it will make calling on participants easier.

5. Hand out and read aloud the *Instructions for Participants*. (See Exhibit B in the appendix.)

6. As you read these instructions:

a. Give out the prepared cards found in the appendix with "cost values" to sellers and the prepared cards with "redemption values" to buyers.
b. Announce the value of the initial endowment.

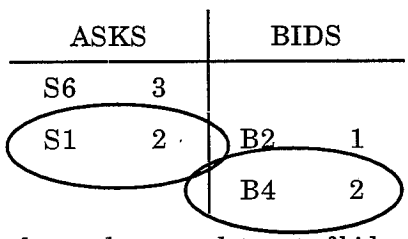
c. We recommend that the cards be explained by drawing sample cards on the chalkboard. The advantage of this procedure is that both sellers' and buyers' understanding of the experiment is enhanced and public knowledge of the set-up can be taken for granted.
d. Once you are done reading the instructions, ask whether anyone has questions. If so, answer them.[5]
e. Begin conducting the experiment by stating that the market is now open.

The Experiment

In Class During the Experiment

The experimenter's major task is to call on students in the order that they raise their hands; it is also important that the experimenter keep an eye on the assistant who records asks and bids on the chalkboard. (The assistant's job demands quickness and can become confusing if bids and asks are not submitted sequentially with enough time for the assistant to write them down.) The experimenter also ought to make sure that bids are made in ascending order only and asks are made in descending order only.

Assistant One. Writes down on the chalkboard buyer and seller ID number and the amount of the ask or bid; whenever an ask and bid match, it is the assistant's responsibility to circle the matching ask and bid. For example,



Assistant Two. Takes time and records a complete set of bids, asks, and transactions for later use (debriefing). We recommend you run (at least) 6 periods with (given the parameterization in Exhibit B3) five minutes for the first period, four minutes for the second period, and three minutes for every period thereafter. It is important to enforce the time constraint. Instruct your assistant to announce to the class periodically how much time is left.

In Class After the Experiment (Debriefing)

Have students tally up their earnings and hand in their index cards. While it is a well-established convention in experimental economics to pay out students immediately, in the classroom it may make more sense to promise payouts at the beginning of the next class and to proceed with a debriefing using Exhibit C4 in the appendix. Alternatively, one can pay out first, and assign Exhibit C4 as homework. In this exhibit the trades are to be plotted with a point for each of the five or six periods. For example, in period 1, the first trade in our example above was a sale at 2, so the students should plot a point at 2 in period one. They will continue this, and if all goes correctly in the later periods, the plots should begin corresponding to the equilibrium—somewhere between 6 or 7.

WHAT CAN EXPERIMENTAL ECONOMICS TELL US?

Experimental economics has come a long way since its early days (roughly the late fifties/ early sixties). Since then, experimental economics has become a standard item in many economists' tool-kit; it is probably the fastest growing subdiscipline in economics today.

The surge in experimental work is closely tied to the successes of game theory,[6] whose concern for individual behavior, strategic interaction, and the precise nature of the information sets lends itself in a very natural way to experimental testing. Game theory, in turn, experienced its stunning growth after it was discovered that many, if not most phenomena in industrial organization can be framed in game-theoretic terms.[7] Since then, game theory has been used to frame many sub-disciplines from microeconomic theory [Kreps, 1990] to macroeconomic policy [Barro, 1990].

Accordingly, experimental economics has ventured beyond its initial concerns with individual choice behavior, and its practitioners nowadays investigate almost every aspect of economic theory conceivable.

It is interesting to note that experimental economics started out in many instances with classroom experiments ("Unternehmenspiele") that had originally been devised and used for educational purposes [Sauermann, 1969, 2]. Thus, the recent interest in classroom experiments brings us full circle. En route to its current respectability, experimental economics went through a variety of stages, evolving into today's experimental protocol, which was canonized in Smith [1976; 1982]. The single most important aspect of this protocol was the reaction of experimental economists to questions regarding hypothetical choices, which led to today's practice of monetary payoffs.

Over the past few years, a number of authors have tried to answer the question: "What can experimental economics tell us?" by looking at the successes and failures of experimental economics to date. Among the numerous assessments of this kind are Davis and Holt's "textbook" [1993] and several articles by Vernon Smith [1989; 1991; 1994]. Davis and Holt, both well-known experimentalists, have, among other things, contributed immensely to our understanding of double auctions and related pricing institutions (the posted offer auction, for example). They conclude their book with a summary, offering a list of major results of experiments:

1. *In many situations, neoclassical price theory explains observed behavior quite well.*
2. *Institutions matter.*
3. *Some predictions of game theory describe behavior well.*
4. *Other game-theoretic predictions have a more restricted range of application.*
5. *Even apart from the institutional specification, many results are characterized by a "gray" area where variables irrelevant to the theory affect outcomes.*
6. *Our understanding of individual behavior is incomplete; some recurrent anomalies are fundamental challenges to rational models of behavior.*

[Davis and Holt, 1993, 506-509]

The double auction market experiment that we discussed is a good example of results 1 and 2. The related experimental work on posted offer institutions (which one can think of as double auction where adjustment of prices is restricted on one side, usually the seller's) illustrates nicely the importance of institutions. It has been shown over and over again that the efficiency and convergence properties for posted offer markets are, under certain conditions, systematically worse than those of the double auction markets. See Davis and Holt [1993] for a summary of the literature in this area. See also Plott [1989], some of whose work in this area illustrates the policy relevance of experimental economics; for an implementation that could be used as a classroom exercise, see DeYoung [1993].

As regards Davis and Holt's results 3 and 4, the common resource, collusion, and moral hazard problems presented as classroom experiments in this brochure all demonstrate, to the extent that they tend to show the widespread breakdown of cooperation, the validity of the predictions of game theory. By the same token, the persistent degree of cooperation that one finds in these experiments for certain treatment conditions has led to important questions regarding the proper design of experiments, i.e., the issue of what constitutes a proper experimental test of game-theoretic predictions, as well as the domain of validity of the predictions of game theory.

At the heart of this discussion (not surprisingly) is the rational actor paradigm that is the backbone of much of current economic reasoning and simultaneously a bone of contention. To the extent that arguments against the economic way of looking at behavior are often based on anecdotal evidence and/or evidence of what looks like systematic departures of subject behavior from the predictions of game theory in experimental tests of prisoner's dilemma games, recent research has suggested that earlier studies were marred by serious design flaws. Earlier, theorists had taken up the challenges produced by what looked like systematic departures of subject behavior from the predictions of game theory and produced models (including, for example, incomplete information) that could account for the experimental results. Smith gives an excellent summary of this discussion and concludes: "Experimental economics documents a growing body of evidence that is consistent with the implications of rational models, although there are many important exceptions. In the latter, often the data can be comprehended by modifying the original models" [1991, 878].

In the context of the preceding discussion, and in light of the informal survey of results of classroom experiments that one of us conducted in the Spring of 1994, one important issue deserves special mention in this brochure: Marwell and Ames [1981], in a justly famous article, "Economists Free Ride, Does Anyone Else?" reported that graduate students in economics are more likely to free-ride in public good provision experiments of the kind presented in our examples than other students. Carter and Irons [1991] investigated whether (aspiring) economists are different by using simple ultimatum experiments.[8] Using undergraduate students, they confirm that in their experiments, economists, too, act more in accordance with the predictions of game theory. They then investigate whether these results stem from self-selection or whether economists are successfully drilled in "the economic way of thinking" during the course of their undergraduate studies. While their results are somewhat inconclusive, they make for a good discussion of the issue as well as the methodology.

Frank et al. [1993] continue this line of research summarizing, among other things, the major objections to both the Marwell and Ames [1981] and the Carter and Irons [1991] studies. They address the question of whether the difference in behavior is the result of undergraduate training through additional prisoner's dilemma experiments involving both economics and non-economics majors. Frank et al., too, find that economics majors are more likely to act in accordance with the predictions of game theory. One of the intriguing results of their study is that a significant part of the differences seems attributable to gender.

In summary, this set of articles addresses important philosophical, design, and curricular issues and makes for material that in our experience has rarely failed to stimulate class discussion. (All three articles are easy enough that an undergraduate, possibly with some coaching, should be able to summarize and present them in class. One of us assigns these articles routinely using a Dutch auction as allocation mechanism.)

In addition, these results are a good illustration of Davis and Holt's results 5 (many results are characterized by a "gray" area where variables irrelevant to the theory affect outcomes) and 6 (our understanding of individual behavior is incomplete). There is reason to believe that some of the question marks underlying results 5 and 6 will disappear once the dust has settled on several discussions involving surrounding issues. Among the issues currently the subject of discussion are:

1. The Harrison or "payoff-dominance" critique. Harrison [1992] claims that the anomalies observed in a variety of experiments "may simply reflect the failure of the experiment to meet widely accepted sufficient conditions for a valid controlled experiment as proposed by Vernon Smith [1982, 930-39]. The result of this failure is simply that the opportunity cost of 'misbehavior' in these experiments is, by any reasonable standard, minuscule. Observed 'anomalies' may then not be 'anomalies' at all: they reflect theoretically consistent behavior under conditions where misbehavior is virtually costless" [1992, 1428]. Harrison's critique drew varied reactions, some of which the interested reader can find in four comments to an article of his that preceeded the reply from which the above quotation was taken.

2. The critique of Hoffman et al. [1994] who studied non-repeated ultimatum and dictator games, with experiments which were designed to explore the underlying reasons regarding the "apparent taste for 'fairness'" that had been found in a great number of experiments. (Recall results by Carter and Irons [1991].) In one of their treatments, they explicitly created subject-experimenter anonymity. Their so-called double-blind experiments suggested strongly that much of what looked like systematic departures from the predictions of game theory was possibly the artifact of designs that did not control for social influence. In their words, "These Double Blind experimental results are inconsistent with any notion that the key to understanding experimental bargaining outcomes is to be found in subjects' autonomous, private, other-regarding preferences (or 'fairness'). At the very minimum, these results suggest that other-regarding preferences may have an overwhelming social, what-do-others know, component, and therefore should be derived formally from more elementary expectational considerations." Their results also drew varied reactions. See, for example, Bolton et al. [forthcoming].

3. There are recent discussions about the sensitivity of certain experimental designs to subject pool effects (including gender and culture). See Frank et al. [1993] and Roth et al. [1991] for examples. The interest in subject pool effects goes hand in hand with a swiftly developing interest in the impact of heterogeneity of subjects on likely outcomes.

From our point of view, the biggest result of experimental economics has been its moving the profession towards the acceptance of a research mode that induced one leading practitioner to ask rhetorically, "Will Economics Become An Experimental Science?" [Plott, 1991]. It is safe to answer no. By the same token, it is also safe to say that the availability of increasingly sophisticated experimental methods has forced new standards and burdens of proof on economists, increasing the credibility of economics as a science and supporting some of its fundamental and historically often-questioned premises (such as the rational actor paradigm). Furthermore, as pointed out above, experimental economics had a hand in the successes of game theory which have brought to many aspects of mainstream economics a concern for individual behavior, strategic interaction, the precise nature of the information, the importance of history, and many other issues that heretofore had not been considered of relevance. In sum, both game theory and experimental economics have helped to make economics a multi-faceted and tremendously vibrant discipline.

A FEW RECOMMENDATIONS FOR FURTHER READING

The early history of experimental economics has recently been summarized by Roth [1993; forthcoming] who himself is a highly regarded game theorist and experimentalist; he is also co-editor of a forthcoming handbook of experimental economics [Kagel and Roth, forthcoming]. Roth concentrates on experiments up to 1960 which he groups into early experiments concerning individual choice, early experiments concerning interactive behavior, and early experiments in industrial organization including important experiments by Fouraker and Siegel [1963] and Sauermann and Selten [1967]. Roth's article must be considered, at least for now, the definitive piece for anyone who wants to read up on the origin and early evolution of experimental economics.

Other readable articles worth mentioning are Smith [1986], Smith and Williams [1992], and Taylor [1988]. These articles are concerned for the most part with classic market experiments. The excellent article by Taylor, written by a so-called outsider to the experimental literature, is probably the most accessible for the novice. Plott [1989] updates his earlier *Journal of Economic Literature* article on industrial organization theory and experimental economics, comparing competitive pricing institutions (double auction, negotiated prices, posted prices), and summarizing the state of the art of experimental work on imperfect competition and product quality.

It is an indication of the growing importance of experimental economics that the early 1990s three textbooks of sorts [Hey, 1991; Davis and Holt, 1993; Friedman and Sunder, 1994] were published. Of the three, the most accessible for the novice is the one by Davis and Holt, which covers relevant topics from decisions and games (Chapter 2), double-auction and posted-offer markets (Chapters 3 and 4), bargaining and auctions (Chapter 5), public goods, externalities, and voting (Chapter 6), to asymmetric information and individual decisions in risky situations (Chapters 7 and 8). These chapters are framed in an eminently readable chapter in which Davis and Holt introduce the reader to, among other things, the advantages and limitations of experimental work and include 13 pages of procedural and design considerations. One of the many remarkable things about their book is the inclusion of a number of appendices in which they reproduce instructions that were used in experiments. In short, the book is highly recommended for anyone getting seriously interested in experimental economics. Also highly recommended is Roth's "Introduction to Experimental Economics" found in Kagel and Roth [forthcoming].

To wrap up our short list of recommendations, let us direct you to the Fall 1993 issue of the *Journal of Economic Education*, which is dedicated to experimental economics. In the lead article, Williams and Walker [1993] discuss "Computerized Laboratory Exercises for Microeconomics Education: Three Applications Motivated by Experimental Economics." The issue contains other articles suggesting interesting non-computerized classroom exercises. (See in particular DeYoung [1993].) Juergen Brauer [1994] has collected 25 "non-computerized class-room games in college economics" in a recent paper.[9] Greg Deelemester and John Neral have, since 1992, circulated *Expernomics*[10]—an unpretentious newsletter on classroom experiments. And, last but not least, David Whitehead's *Handbook for Economics Teachers* [1979] offers a number of interesting ideas for classroom experiments, among them an experiment on the creation of money.

NOTES

1. This experiment was devised by Charles Plott, Mark Isaac, and James Walker; its use as a teaching device was documented in the *Wall Street Journal*, Thursday, December 1, 1986. See Bishop [1986].
2. The catchy label originated from Rasmusen [1989].
3. A previous double auction experiment can be seen on a videotape available from your Irwin representative.
4. The first time around an even smaller number, say seven or eight buyers and sellers each, may be a good idea. The same set of redemption and cost values can be used by cutting off the four or five rightmost incentive values for both buyers and sellers.
5. In a "real" experiment you would not answer questions; for reasons of replicability you would simply repeat the relevant passages in the instructions.
6. As Roth points out: "It is striking to note the distinguished game theorists among the earliest experimenters. Nash, Schelling, Selten, and Shubik, for example, set a high standard of distinction by any measure" [1993, 201].
7. See Sauermann [1969] and Sauermann and Selten [1967].
8. Two players, a proposer and a responder, have to split a reward. The proposer suggests a division. The responder can accept or reject the offer. If the responder rejects the offer, both proposer and responder end up empty-handed. If continuous division of the reward is ruled out, the game-theoretic prediction is for the proposer to offer the minimum possible amount and for the responder to accept the offer.
9. Juergen Brauer, Department of Accounting, Economics, and Finance, School of Business Administration, 2500 Walton Way, Augusta, GA 30904-2200, or jbrauer@admin.ac.edu.
10. Greg Delemester, Department of Economics, Marietta College, Marietta, OH 45750, or, John Neral, Department of Economics, Frostburg State University, Frostburg, MD 21532, or e2ecner@fre.fsu.umd.edu.

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APPENDIX

Exhibit A
Payoff Tables

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
0	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
0	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
0	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100	104	108	112	116	120
0	50	54	58	62	66	70	74	78	82	86	90	94	98	102	106	110	114	118	122	126	130	134	138	142	146	150	154	158	162	166	170

Exhibit B
Double Auctions: Instructions for Participants

This is an experiment in the economics of market decision making. There are (twelve) buyers and (twelve) sellers in the market who are identified as Buyer 1 through Buyer (__) and Seller 1 through Seller (__), respectively. Buyers are demanders and sellers are suppliers in a market where an abstract commodity is traded.

Instructions to Sellers

You have been given an index card with a "cost value." This information is private and not to be shared. This cost value reflects your individual marginal cost of the commodity that you will trade in the market. As a *seller*, you will be charged your cost value for each unit you sell; your earnings will be the market price minus your cost value. As a seller you have an initial endowment of ___.

Please draw seven columns on your index card and label the first row of columns 2 through 7, period 1, 2, 3, and so on. In the second row of the first column please write price; in the third row of the first column write CV (for cost value); in the fourth row of the first column write earnings; and in the fifth row of the first column write balance. Enter now both your cost value for each of the periods and your endowment, as initial balance.

Once the auction has begun, you can try to sell your unit of the commodity by offering an ASK price which will be recorded on the chalkboard.

Instructions to Buyers

You have been been given an index card with a "redemption value." This information is private and not to be shared. This redemption value reflects your willingness to buy a unit of the same commodity that the seller is offering. As a *buyer*, you can turn in each unit bought, receiving cash at the redemption value. Your earnings will be the redemption value minus the price you paid in the market. As a buyer you have an initial endowment of ___.

Please draw seven columns on your index card and label the first row of columns 2 through 7, period 1, 2, 3, and so on. In the second row of the first column please write RV (for redemption value); in the third row of the first column write price, in the fourth row of the first column write earnings; and in the fifth row of the first column write balance. Enter now both your redemption value for each of the periods and your endowment, as initial balance.

Once the auction has begun, you can try to buy your unit of the commodity by offering an BID price which will be recorded on the chalkboard.

Rules for the Auction

Asks and Bids

Signal your willingness to make a BID or ASK by raising your hand.

BIDS are made by buyers by first stating their ID number (say, "Buyer 6") and the price they are bidding (say, "two").

BIDs cannot be retracted and have to increase until a transaction is made.

ASKS are made by sellers by first stating their ID number (say, "Seller 1") and the price they are bidding (say, "two")

ASKs cannot be retracted and have to decrease until a transaction is made.

All BIDS and ASKS will be recorded by my assistant in the following format:

ASKS		BIDS	
S6	3		
S1	2	B2	1
		B4	2

Trades

If an ASK and a BID match, they will be circled. New ASKs and BIDs will no longer be accepted. You may not submit new BIDs or ASK until a new period begins.

When a BID matches an ASK or vice versa, a trade is consummated. The involved parties will record their ask or bid price on their index cards and compute their earnings.

Determination of Earnings

Sellers: For every unit sellers sell in the market the experimenter will pay them the difference between price and cost value. For example, say a seller sells her first unit at a price of 2 and the cost value of the first unit is 1—then she will earn 1.

Buyers: For every unit buyers buy in the market the experimenter will pay them the difference between the redemption value and the price. For example, say a buyer buys his first unit at a price of 2 and the redemption value of the first unit is 3—then he will earn 1.

Successive Auctions

After each trade, new BID and ASK prices can be offered regardless of the price of the transaction just completed. Participants can make unlimited BIDS or ASKS in each period, until they successfully complete a transaction. After they have completed a transaction they can no longer submit BIDS or ASKS until a new period has begun.

With every new period all cost values and redemption values are re-activated, irrespective of whether they were used in the preceding period.

The first period will last five minutes, the second four, and all periods thereafter three minutes.

Any Questions?

APPENDIX

Exhibit C1
Cost Value/Record Sheet for Sellers

Seller #_____ **Cost Value _____**

Periods:	1	2	3	4	5	6
Price						
C. V.						
Earnings						
Balance						

Exhibit C2
Redemption Value/Record Sheet for Buyers

Buyer #_____ **Redemption Value _____**

Periods:	1	2	3	4	5	6
R. V.						
Price						
Earnings						
Balance						

Exhibit C3
A Possible Set of Redemption and Cost Values

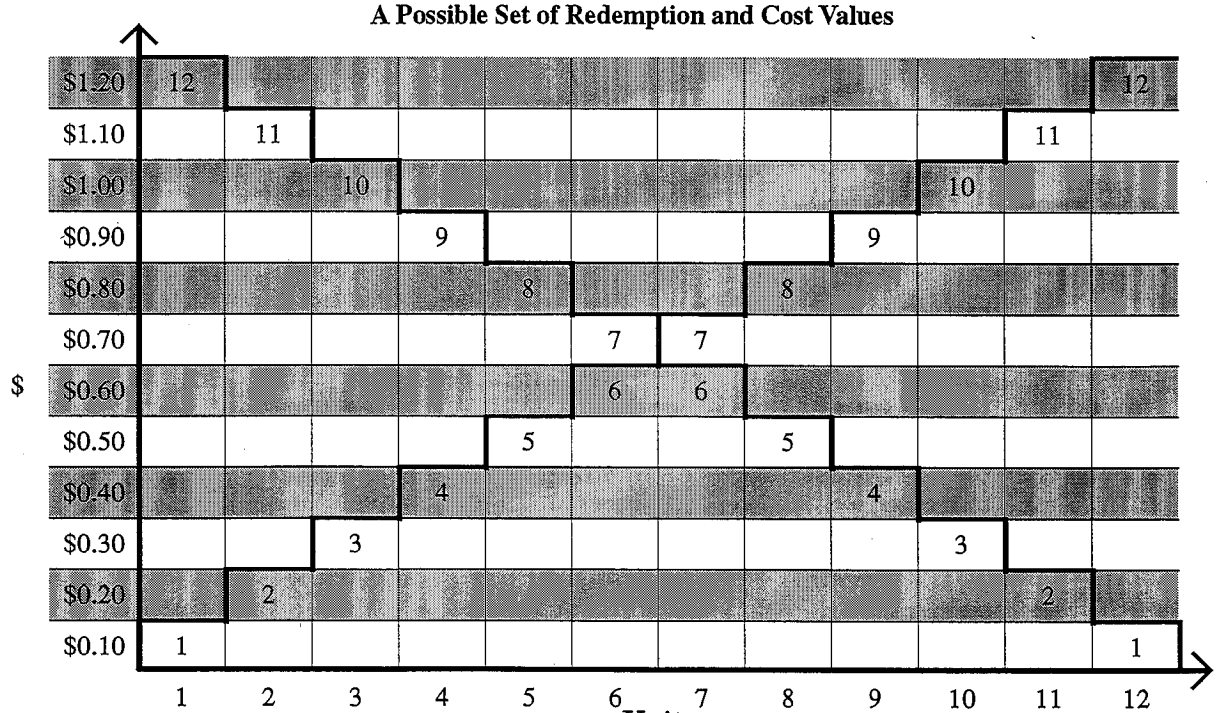

Exhibit C4
Plots of Underlying Values