Experimental Economics in the Classroom

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June 1996

If you are frustrated with how little students seem to retain from your standard lecture classes, you may wish to mix some classroom experiments into the schedule. Although the idea of using experiments in class has been around since the time of Chamberlin [1948], most applications are the product of recent research in experimental economics. This research is not intended to facilitate teaching, but the spinoffs include easy-to-explain setups in which the students are placed into the market or economic decision-making situation being studied. Even non-experimentalists have realized that these laboratory exercises can be effective teaching devices.

Classroom experiments are short, interactive exercises designed to facilitate understanding of key economic ideas. For example, students can be allowed to negotiate trades in a market where it is possible to compare their behavior with equilibrium predictions. In this manner, their first exposure to a particular economic concept is experiencing the economic incentives and forces first hand. In effect, they are producing the data that (with luck and carefully structured discussion) can allow them to discover relevant economic principles for themselves. We have found that this "bottom-up" participatory approach to learning can raise student interest and motivation. We believe that effective experiments can induce learning at a deeper level that results from being convinced about the usefulness of an otherwise abstract economic theory.

This chapter describes how to design and run teaching experiments, with simple props (no computers necessary). We begin with examples of basic market and game setups. Then we provide some hints about how to make such experiments more effective. Finally, we survey the various types of experiments that have been developed and the admittedly limited research on the effectiveness of this approach.

SOME EXAMPLES

The two most popular types of classroom experiments are competitive markets and games. We begin with an example of each. These examples will get you started and will provide a context for the specific hints and suggestions in the subsequent section.

A Market Experiment

The supply-and-demand model is the central concept of any introductory microeconomics course and the starting point of most macroeconomics courses. Students are often lulled into a false sense of understanding as they draw the smooth intersecting curves. This overconfidence may be mixed with skepticism when they go through the list of assumptions needed for "perfect competition." We have found that a market experiment is a useful way to begin the class, even before the presentation of the supply-and-demand model.[1] Playing cards can be used to eliminate the need for a lot of advance paper work. For example, the instructions in Holt [1996] begin:

> We are going to set up a market in which the people on my right will be buyers, and the people on my left will be sellers. Several assistants have been selected to help record prices. I will now give each buyer and seller a numbered playing card. Some cards have been removed from the deck(s), and all remaining cards have a number. Please hold your card so that others do not see the number. The buyers' cards are red (hearts or diamonds), and the sellers' cards are black (clubs or spades). Each card represents one "unit" of an unspecified commodity that can be bought by buyers or sold by sellers.

If the seller can arrange to sell the unit at a price above this cost, then the seller "earns" a profit that equals the difference between the price and the cost. Similarly, the number on a buyer's card is the monetary value of a "unit" to the buyer, and a buyer earns profit by arranging a purchase at a price that is below this value. A buyer with a 10 of diamonds, for example, would be willing to purchase a unit of the commodity at any price below $10, the lower the better.

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[1] Some early examples of classroom market experiments are found in Chamberlin (1948), Smith (1962), and Joseph (1965).

Earnings in an experiment like this are not necessarily paid, and you can say this in advance, but to maintain interest it helps to pass out forms on which the students can keep track of their hypothetical earnings. A single page of instructions, with an earnings record form on the back, can be made up in advance, using the materials presented in Holt [1996], which also contains instructions for the assistants who record and verify prices. One advantage of these instructions is that the only advanced planning required is selecting the cards and copying the instruction sheets; the instructor does not have to write value and cost numbers for each period on these sheets.

After the cards are distributed and the instructions are read, the buyers and sellers are brought together in a trading "pit" where they can negotiate prices, as instructed:

> Buyers and sellers will meet in the center of the room (or other designated area) and negotiate during a 5-minute trading period. Prices must be multiples of 50 cents. When a buyer and a seller agree on a price, they will come together to the front of the room to report the price, which will be announced to all. Then the buyer and seller will turn in their cards, return to their original seats, and wait for the trading period to end. There will be several market periods.

Some of the high-cost sellers and low-value buyers may not be able to arrange mutually profitable trades, but the others form buyer-seller pairs. Prices are reported to an assistant who checks to be sure that the price for a buyer-seller pair is "legal", i.e. is above the seller's cost and below the buyer's value. Legal prices are announced aloud so the other traders can find out about the going prices. After the trading stops, the remaining cards are collected. While students return to their desks to calculate their earnings, the cards are counted, shuffled, and dealt again to traders prior to the start of the subsequent period. Prices typically stabilize around some general average after several periods of trade.

The numbers on the black cards given to sellers are the marginal costs that determine market supply (although this fact is not explained prior to the trading). Similarly, the numbers on the red cards given to buyers are marginal valuations that determine the market demand. Equilibrium prices are those for which the number of units demanded equals the number supplied, and this can be illustrated by drawing the (step-function) supply and demand curves

or by counting up supply and demand directly. For example, consider the following configuration:

Black (spades or clubs):	2, 2, 3, 3, 4, 4, 4, 5, 5, 5, 7, 7, 7, 8, 8, 8
Red (hearts or diamonds):	10, 10, 9, 9, 8, 8, 8, 7, 7, 7, 5, 5, 5, 4, 4, 4

At a price of $6, there should be ten sellers who are willing to sell (those with costs of 2, 3, 4, and 5). Similarly, the ten buyers with values above $6 should be willing to purchase, so $6 is an equilibrium price.

The best procedure here is to lead the students into discovering the supply-and-demand model for themselves (whether or not they have previously seen general textbook presentations). One way is to reveal the card numbers *ex post* and focus discussion on what would (or did) happen out of equilibrium. A sequence of questions might be: if the initial prices were too low, say at $3, would there be more interested buyers than sellers, how would sellers respond to this buyer enthusiasm, and how high would prices rise in response? If you need to be convinced of the inadequacy of standard teaching methods, just reveal the card numbers (out of sequence), calculate price averages, and ask for a theory that explains the observed outcomes.

The result of this discussion will be a supply-and-demand array similar to the one shown in figure 1. The price sequences are shown on the right side of the figure for four periods of trading; each dot represents a negotiated price in the order in which it was reported.[2] Period 1 began with three trades at $8, but all subsequent trades were in the equilibrium range. These data show a clear convergence to the competitive price and quantity predictions.

Students often want to find out about relative earnings, but it is useful to focus their attention on the total earnings of the group as a whole and on whether it is possible to reconfigure the trades to increase this total. This leads naturally to a discussion of surplus

[2] This price sequence is from a classroom experiment conducted in Tsukuba, Japan, with the instructions translated into Japanese by Steve Turnbull.

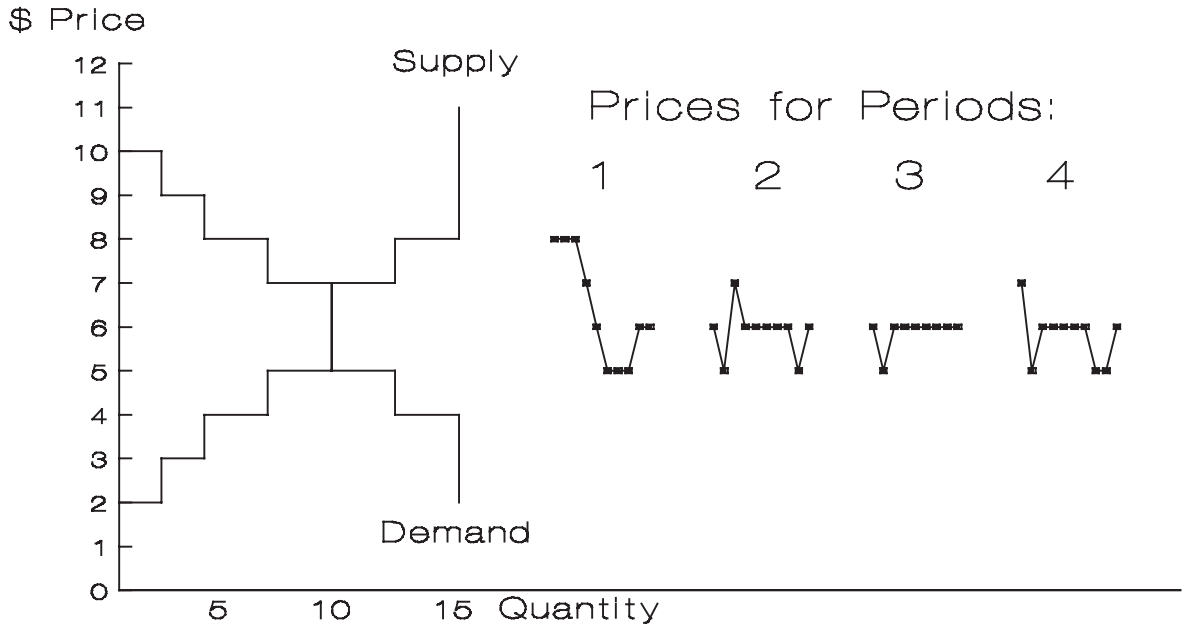

Figure 1. Data From a Classroom Market

maximization and the efficiency of market allocations. There is a lot of public information about the going price; this information tends to keep low-value buyers and high-cost sellers out of the action. The result is that the market achieves 90-100% of the possible gains from trade for most supply-and-demand arrays, without the help of a perfectly informed and all-powerful planner. In fact, the contrast between the clarity of the competitive, surplus-maximizing outcomes and the complexity of the underlying theoretical assumptions could not be greater. If we had only one lecture to give to non-majors, it would be a classroom trading exercise designed to show how a decentralized market allocates resources efficiently.

Economic Games

It is also straightforward to use playing cards to implement many economic games. To get some feel for how students might perceive such a game, without knowing the context or purpose, please read the following instructions taken from Holt (forthcoming, 1997):

This is a simple card game. Each of you will be given 4 cards, two of which are red (hearts or diamonds), and two of which are black (clubs or spades). The exercise will consist of a number of rounds. When a round begins, I will come around to each of you in order, and you will play two of your four cards by placing these two cards face down on your desk. I will pick up the cards you play and put them on top of the stack in my hand. Your earnings in dollars are determined by what you do with your red cards. For each red card that you keep, you earn two dollars for the period, and for each black card that you keep you will earn nothing. Red cards that are placed on the stack will affect everybody's earnings in the following manner. I will count up the number of red cards, and everyone will earn this number of dollars. Black cards placed on the stack have no effect on the count. When the cards are counted, I will not reveal who made which decisions, but I will return your cards to you at the end of the round (by returning to each of you in reverse order and giving you the top two cards off of the stack in my hand). To summarize, your earnings for the period will depend only on what people do with their red cards:

your earnings = $2 times the # of red cards you kept +
$1 times the total # of red cards that I collect from everyone, including yourself.

Are there any questions?

Each person has a *unilateral* incentive to keep the red card, worth $2 instead of playing it for a private gain of $1. However, as long as there are more than two people in the class, the aggregate earnings of the class as a whole go up when the red card is played. This is just a stylized public goods game where everyone has an incentive to free ride and not contribute (not play red). Notice that the black cards are used so that students cannot see and react to what the others ahead of them are doing.

The most convenient way to prepare the experiment is to print the instructions above a record form to be used by students to record their decisions and earnings. This form would have a row for each period (1-5) and 4 columns labelled: "period", "# red cards kept", "total # red cards played", and "cumulative earnings". Any change in treatment, like altering the payoffs, can be explained above the row for the period in which the change goes into effect. This experiment is less interesting for the subjects than the market experiment discussed previously, so it is a good idea to pick one person at random *ex post* and pay them some

fraction of their earnings, in cash.[3]

The discussion can focus on the fact that we typically see a lot of free riding in this experiment, just as one would expect in economic situations where the cost of cooperating is high and the benefits are widely dispersed over a large group of others. Here you can offer an example (e.g., what if it were up to each individual to clear the snow in front of his own house) and ask the class for others. The discussion can also touch on whether there would be more selfish behavior in large groups (an anonymity effect) or whether there would be more cooperation in large groups (since there are more people who might benefit from an individual's generosity).

This public goods game is a type of prisoner's dilemma in which individual and social incentives differ. Indeed, the importance of the prisoner's dilemma paradigm is indicated by its inclusion in many principals books. Another simple prisoner's dilemma game can be set up by giving each student two numbered cards, say a 4 and a 6 (which correspond to dollar amounts). Students are paired, and each person decides which card to play. This decision is a choice between "pulling" $4 to oneself or "pushing" $6 to the other person.[4] Here, the cooperative outcome is for each person to "push" a 6, but the individually rational outcome is for each person to "pull" a 4. The discussion can focus on how cooperation may be affected by payoffs and repetition, and on what the results mean in terms of economic applications. For example, the point of modern bankruptcy law is to get investors in an insolvent firm out of a prisoner's dilemma in which each has a private incentive to demand loan repayment, but

[3] Random payment can be explained: "All earnings are hypothetical, except as noted below. You can use the space below to record your decisions, your earnings and your cumulative earnings. After we finish all periods, I will pick one person with a random throw of dice and pay that person 5% of his or her total earnings, in cash. All earnings for everyone else are hypothetical. To make this easier, please write your name: _____ and the identification number that I will now give each of you: _____. Afterwards, I will throw a 10-sided die twice, with the first throw determining the "tens" digit, until I obtain the ID number of one of you, who will then be paid 5% of his or her total earnings in cash."

[4] Hal Varian has written a computer program that implements the playing card version of a prisoner's dilemma game.

the firm would be worth more if it were allowed to continue after renegotiation of the debts.[5]

PRACTICAL SUGGESTIONS

This section discusses a number of factors you should keep in mind if you are planning to use experiments as a teaching aid: class size, the amount of time available, the subject and level, student motivation, and the nature of your current lectures.

Experiments which require many steps or props are obviously more difficult with large lecture classes. Many problems can be mitigated by advanced planning, however. Specifically, the design and procedures should be well planned, and it usually helps to have brief instructions, one page if possible, to hand out and to facilitate recording of decisions and outcomes. If you teach very large classes, you may consider using only a subset of the class as participants in the experiment.

In some cases it is necessary to devote an entire class period in order to allow for discussion of the results. To make the best use of time, it will be helpful to plan your discussion in advance. Specifically, think about what types of questions should be asked, and the clearest way to present the data. One way to begin a discussion is by asking leading questions such as those suggested in the market experiment described above. However, too many questions will give the answers away and may create boredom. Having students participate in recording data can be helpful, e.g. a student observer can plot transactions prices on a transparency with the same scale as the figure used to show supply and demand, as in figure 1.[6]

Because more issues in microeconomics lend themselves to experimental study, you

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[5] Scott Bohannon developed a bankruptcy game as one of a series of experiments for a very popular Law and Economics class at the University of Virginia. The popularity of this class is indicated by the fact that about 200 students enrolled during the year (in a program with about 200 majors who graduate each year).

[6] See DeYoung [1993] for some useful advice on presenting results in a market experiment. In particular, he suggests plotting a trader's price directly above the cost step if the person is a seller and directly below the value step if the person is a buyer. This allows students to visualize the split of the trading surplus and to spot inefficient trades of units to the right of the intersection of supply and demand.

will likely find more opportunities to use experiments in microeconomics courses.[7] As noted above, supply and demand and market efficiency are central concepts of all introductory economics courses; therefore, one of the best opportunities for using experiments may be in the very beginning of your principals classes (micro or macro) before these concepts are formally introduced. Classes that involve applications of game theory are also a good place to try simple experiments. This can be done easily by having students play the games themselves before the underlying theory is discussed.

Experiments can be useful in graduate classes as well, but on a more limited basis because of time constraints and subject matter. Some students from non-capitalist economies may be skeptical about the effectiveness of markets. By having them participate in market experiments they can observe for themselves how prices and quantities adjust in response to supply and demand.

Even if you teach non-economics majors you may find it beneficial to incorporate experiments. For instance, in general business classes one of the core concepts studied is bargaining. Many types of experiments have been designed to study various types of bargaining behavior, e.g., ultimatum and multilateral bargaining (see description below). In fact, several universities offer Practical Bargaining classes with significant amounts of in-class negotiations.

To maintain students' interest, try using experiments that are imaginative and rich in detail. As a research tool, experiments are often formatted in context-free language so as not to bias subject responses, but this is less of a concern for classroom experiments where the goal is to illustrate as opposed to test ideas. In fact, it is sometimes best in a classroom setting to actually tie the experiment to real economic applications. There is no fixed rule here, and the amount of richness depends on the context and the time available. Suppose that you ran the previous section's voluntary contribution experiment, but with playing a red card being associated with "working an hour on the church flower bed", and keeping a red card being associated with "watching football on TV". Here the context might dominate the admittedly minor economic incentives and divert discussion to issues of social morality.

[7] Joyce [1996] suggests a number of classroom experiments for an intermediate microeconomics class.

Similarly, the playing card version of the prisoner's dilemma game discussed above is quick and simple, and appropriate for generating a discussion of behavioral determinates of cooperation (e.g., repetition) in a game theory class. On the other hand, putting this game into a more complex, multi-person setting, as in the bankruptcy application discussed above, may be more appropriate for a class like Law and Economics where the focus is on the applications. For an international trade class, the prisoner's dilemma setup could be formulated and explained in terms of two countries in trade dispute. That is, although each country involved in 2-way tariff war would be better off if both countries would abolish all tariffs, each country may have a unilateral incentive to impose protectionist policies in order to secure political support from blocks of swing voters.[8]

Another way to encourage students to take the exercise seriously is to provide incentives. For example, tell students that one of them will be randomly chosen at the end of class and paid some fraction of his cumulative earnings. Incentives do not have to be monetary, however; non-monetary motivations can be just as effective in promoting serious participation in market experiments where student interest is likely to be high. In a somewhat less interesting prisoner's dilemma card game, we prefer to pay a randomly selected person, *ex post*. This practice also deflects questions about "What am I supposed to be trying to do?" Sometimes a simple solution can be effective and entertaining. One of us was giving a lecture on forecasting at Louis Pasteur University in Strasbourg on Valentine's Day. Correct forecasts were rewarded by passing out small red hearts (from a graffiti pack), and this seemed to stimulate a lot of interest in using past information efficiently.

Some people prefer to use extra credit as an incentive, e.g. Williams and Walker [1993]. This no doubt raises student interest and motivation, but we see several potential problems.[9] First, extra credit raises anxieties, reduces the fun, and increases the burden on the instructor to allocate earnings opportunities in a fair manner. For example, a seller with high costs in a market experiment would be justifiably upset about losing extra credit as a result of

[8] Of course, the unilateral imposition of tariffs may reduce surplus-based welfare measures.

[9] Some of these issues are discussed in Williams and Walker [1993].

low earnings. Second, to the extent that an implicit grade distribution is used, extra credit turns the situation into a zero-sum game, which gives students an incentive to be more rivalistic. Similarly, basing payments on points or competition between groups of students can misrepresent the relevant economic incentives in a subtle but harmful manner. For instance, all of your efforts to convince students that international trade is not a zero-sum game may be wasted if you have a trade experiment in which the reward goes to the group with the best economic performance relative to the others.

KINDS OF EXPERIMENTS

To make the best use of experiments in the classroom you should carefully consider which types of issues to address. We believe that the best use of classroom experiments is to illustrate important fundamental ideas that require a deep understanding (e.g., market efficiency), or abstract theoretical concepts (e.g., backward induction). It is especially true with abstract concepts that students may welcome discussions and demonstrations that make the ideas tangible and more concrete. In this section we list the various types of experiments that can be done easily in the classroom.[10]

Individual decisions: Many policy issues are closely tied to measuring contingent valuations of non-traded goods, like environmental quality. In practice, these valuations are obtained with hypothetical questions about what one would be willing to pay for a specific good. It is interesting to compare the valuation numbers obtained form hypothetical questions with the numbers obtained from procedures designed to elicit true values (based on real economic commitments). For example, one can ask students what they are willing to pay for ball point pens, and then auction them off in a manner that elicits their maximum willingness to pay.[11] One way to do this is to show the students ten ball point pens and ask them to write their name and bid on a scrap of paper with the understanding that the bids will be

[10] Fels [1993] provides a list of published accounts of various experiments that have been used in classes, along with other information such as class sizes, the type of class (micro or macro), the type of reward used, and whether or not the experiment was computerized.

[11] Davis and Holt [1993, chapter 8] discuss such elicitation procedures.

collected and ordered, and the ten pens will be sold to the ten highest bidders at a price that equals the highest rejected bid (the eleventh highest bid). Other individual decision experiments can involve forecasting and Bayes' rule [Holt and Anderson, 1996] and information cascades [Anderson and Holt, 1996].

Auctions: these include both first price (English and Dutch) and second price (Vickrey) auctions. In first price auctions, the person with the highest bid receives the auctioned good and pays the price he bids. The first price auction is more exciting when it is run as a Dutch auction, with the price lowered sequentially until the first person calls out "mine" and purchases at that price. Here, the purpose can be to point out the wide variety of auction institutions that can be and are used around the world. In second price auctions the person with the highest bid receives the auctioned good but pays the second highest bid. The auction of ball point pens described in the previous paragraph is the n-prize analogue of a second price auction.

Bargaining: these include ultimatum and multilateral bargaining experiments. In an ultimatum game, a single player makes a take-it-or-leave-it offer to another player. In multilateral bargaining experiments, two players alternate making proposed divisions of a sum of money the total of which decreases after each rejected offer. It is also possible to let students bargain in an unstructured context with neither knowing the other's valuations or costs. Some discussion issues include: when are stalemates more likely, what are effective negotiation strategies, etc?

Games: In addition to the Prisoner's Dilemma and Public Goods games described above, it is easy to use cards to implement other games. Of particular interest are games with multiple equilibria, such as the Battle of the Sexes and Chicken (this is a game useful for modelling defense strategies between counties). Also, Davis and Holt [1993, Chapter 2 appendix] describe how to use trays and coins to demonstrate the failure of backward induction in a Centipede game.

Markets: Students seem to enjoy interacting in market situations. These experiments can be used to illustrate the effects of monopoly power, price controls, and quality deterioration in "lemons" markets. Be warned, monopolists are not always successful at raising prices in a pit-market encounter with a group of buyers who negotiate prices sequentially. The

monopolist has a stronger position if you require him to sell all units at a single price posted in advance [Davis and Holt, 1993, chapters 3 and 4].

Macroeconomics: The multi-market nature of macro models makes these exercises harder to implement, and the attempts that we know of often involve major commitments where the students interact repeatedly a number of times during the semester [Gremmen and Potters, 1996]. It is possible instead to set up simpler situations that illustrate particularly difficult concepts, like costly search for a high wage or the inverse relationship between interest rates and bond prices.[12]

As you gain experience using various types of experiments and evaluate their usefulness for your own classes, you can stay updated on new approaches using the following sources: (i) The *Journal of Economic Education* contains articles about economic experiments in general; (ii) the "teaching tips" section of *Economic Inquiry* periodically contains notes on classroom experiments; (iii) The *Journal of Economic Perspectives* contains an ongoing column featuring short descriptions of various classroom exercises; and (iv) *Classroom Expernomics* is a newsletter put together by participants of a series of conferences at the University of Arizona on classroom experiments.[13] In addition, the Southern Economic Association and the Western Economic Association annual conferences now have sessions focused on experiments in the classroom. Also, classroom experiments are becoming increasingly available as part of the axillary material provided by textbook publishers (e.g., Delemeester and Neral [1995]).

EVIDENCE ON EFFECTIVENESS

Fels [1993, p. 69] is careful to point out that the extent to which experiments can be useful teaching tools depends on their quality, "Whether several experiments can make a real difference probably depends on how well they reinforce other material in the course." In assessing whether a particular series of experiments promotes learning and interest, it will be

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[12] A sequential search computer program is available from the authors on request by email: holt@virginia.edu.

[13] Past issues of *Classroom Expernomics* are available on the World Wide Web at http://www.marietta.edu/~delemeeg/expernom.html.

necessary to evaluate the overall quality of the program. To date, statistical evidence is hard to find. Gremmen and Potters [1996] conclude that experimental techniques can be effective in raising exam scores in a controlled comparison. In contrast, Cardell *et al.* report that standardized tests were not raised by an experimental treatment that included active learning, data analysis and classroom experiments. Most comments on the effectiveness of classroom experiments are admittedly subjective and anecdotal, e.g. DeYoung [1993] and Joyce [1996]. Although the evidence on learning effectiveness from controlled comparisons is limited, we are confident that classroom experiments are useful in maintaining student interest and in promoting understanding of basic concepts. Classroom experiments require additional time to reinforce points that are covered in the regular lectures, so there is a tradeoff between depth and bredth of coverage. We believe that it is important to drive home the basic lessons about how and when markets allocate resources efficiently. Joseph (1965, p.565) concluded his discussion of classroom experiments by remarking: "It may well be that if we taught less, the students would learn more."

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