TEACHING ECONOMICS WITH CLASSROOM EXPERIMENTS

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Southern Economic Journal, January 1999, 65(3), 603-610

Abstract

Classroom experiments are effective because students are placed directly into the economic environments being studied. This paper surveys some diverse applications, e.g. speculation and multiple markets, coordination games, voting and agendas, and a simple macroeconomy, with particular attention to practical details. After participating, students bring first-hand experience to the discussion, which enhances the effectiveness of the Socratic method, as opposed to traditional lectures. The papers surveyed here also enable bright undergraduates to run the experiments on their own classmates and lead the ensuing discussions, which creates a special kind of teaching/learning environment.

JEL codes: A22, C92

1. Introduction

One of the most exciting recent developments in the teaching of economics is the increased use of classroom exercises that insert students directly into the economic environments being studied. For example, students who participate in market trading as buyers and sellers come away impressed with the strong pressures to trade at a uniform price. This reaction is then mixed with surprise when they later discover that the observed price standard is the competitive price determined by the intersection of supply and demand functions constructed from information that was not available to any single trader. Even when standard theories fail, they can fail in interesting ways, e.g. when trading prices for assets veer away from present value fundamentals during price bubbles (Ball and Holt, 1998). Regardless of the outcomes of classroom experiments, the structural parameters of standard theories are determined by individual incentives and the rules specified in the instructions, so theoretical predictions can be calculated and used as a benchmark of comparison. As economics has become more technical, even at the undergraduate level, the use of classroom experiments provides an important connection between theories and key features of the markets and institutions being studied. Before surveying specific applications, it will be useful to discuss the origins and role of classroom experiments, as well as some general advice about procedures and pitfalls.

* A revised version of this paper will appear in the *Southern Economic Journal*, as an introduction to a Symposium on Classroom Experiments. I would like to thank Jonathan Hamilton and Susan Laury for comments and suggestions.

2. Origins and Uses of Classroom Experiments

Traditionally, economics has not been an experimental science, and this fact has shaped the kinds of questions addressed and arguments presented. Keynes (1936) stressed the important role of conversation and criticism in evaluating economic arguments, "...where it is often impossible to bring one's ideas to a conclusive test either formal or experimental."[1] As a result, theories often rose or fell in popularity on the basis of generality, mathematical elegance, or clever terminology. Samuelson (1947) noted that economics lacked the "self-cleansing" nature of a hard science, and therefore he stressed the methodology of deriving comparative statics predictions of changes of *observable* variables. Ironically, at about the same time, Chamberlin (1948) was conducting the first in-class market experiments, which began a process of changing what we think of as being observable. Chamberlin had his students (doctoral students at Harvard) circulate around the room and bargain. Some were sellers, with numbered cards that determined their costs, and others were buyers, with numbered cards that determined their redemption values. Once a price was negotiated, the seller would earn the difference between the price and the cost, and the buyer would earn the difference between the redemption (or "resale") value and the price. The use of cards (e.g. playing cards) to distribute confidential information to subjects is a common feature of many of the classroom experiments to be discussed below.

Chamberlin noted that the quantity of trades in these markets was often too high relative to the predictions of competitive theory. To see how this can happen, suppose that buyers B11 and B2 each have the chance to buy a single unit, with redemption values of $11 and $2 respectively, and that sellers S1 and S10 each have a single unit that could be produced, at costs of $1 and $10 respectively. These costs and values provide incentives to trade. In particular, a seller "earns" the difference between the sale price and the cost, and the buyer "earns" the difference between the redemption value and the purchase price, so B11 and S10 would each earn 50 cents if they agree on a price of $10.50. The cost is not incurred unless the unit is sold. The difference between the buyer's value and the seller's cost is the sum of their earnings, and the actual price determines how this "surplus" (of value over cost) is divided. If B11 and S10 agree on a price of $10.50 and if B2 and S1 agree on a price of $1.50, both trades increase the participants' earnings and the total surplus is: ($11 - $10) + ($2 - $1) = $2. This outcome is very inefficient since the pairing of B11 and S1 will yield a surplus five times as large, i.e. $10. Chamberlin conjectured that the decentralized nature of the market trading was the source of the inefficiency; with decentralization there can be price dispersion, which prevents price from conveying information about relative value. Thus the efficiency of the market is affected the degree of centralized trading, which

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[1] Keynes (1966, p. *vii*).

presumably would decrease price dispersion, since sellers would not want to sell at lower prices than other sellers are obtaining, and buyers would not want to pay higher prices than other buyers are receiving. To see how price uniformity might increase efficiency, consider the above example. At any "going" price between $2 and $10, only the high-value buyer and the low-cost seller are willing to trade, and the second unit should not be produced since its cost, $10, is above the highest available value, $2. Thus the surplus-based measure of efficiency would increase from $2 to $10.

One of Chamberlin's students, Vernon Smith, was the first to demonstrate that efficient, surplus-maximizing outcomes are actually obtained when trading in experiments is conducted in a more centralized manner. Smith (1962) set up a centralized trading exchange by requiring that all bids, asks, and trading prices be announced publicly. This was a "double auction" in which buyers' bids would rise as in a standard auction, and at the same time, sellers' asking prices would fall; a trade resulted from an agreement on price terms. The public nature of the terms of trade in a double auction prevented the formation of surplus-reducing trades that may be observed in Chamberlin's decentralized markets. This result illustrates one of the most important findings that has come out of the subsequent literature: outcomes can be sensitive to the nature of the economic or political institution, a theme that will come up in the papers that follow. A second, and more important, finding is that efficient competitive outcomes can arise in markets with relatively small numbers of traders and only very limited information about others' values and costs. The teaching of supply and demand theories of market equilibrium no longer needs to be prefaced with unrealistic assumptions about an infinity of agents, etc. Finally, it should not go unnoticed that the seeds for these discoveries were sown in a classroom experiment!

Laboratory experiments have had a particularly strong influence on the development of game theory. Two of the three recipients of the first Nobel prize that recognized game theory, Reinhard Selten and John Nash, used laboratory experiments early on in their work. Nash apparently participated first as a subject in someone else's experiment at RAND, and his sister recalls him earning $50 a day in 1952 "to play games."[2] Nash was a coauthor on one bargaining experiment, but the unexpected results discouraged him from continuing, as he veered back into the world of pure mathematics, and other afflictions. In contrast, Selten remains an active experimentalist and has become increasingly interested learning and models of boundedly rational behavior as ways of explaining observed laboratory results. Many classroom experiments today involve simple games, even if they are dressed up in the context of some substantive application to law and economics, industrial organization, public choice, etc.

The work of Smith, Selten, and others later stimulated an ever-expanding amount of research

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[2] Nasar (1998, p.149).

experiments, which are surveyed in Davis and Holt (1993) and Kagel and Roth (1995). There is a professional association (the Economic Science Association) with meetings in Europe and the U.S., and the first issue of a new journal, *Experimental Economics*, was just published. These developments seem to answer the rhetorical question posed in the title of Charles Plott's (1979) Presidential Address to the Southern Economic Association: "Will Economics Become an Experimental Science?" Many of the people who are involved in this research (and their colleagues) have been most active in developing classroom experiments, which often show a strong similarity to the earlier research experiments. There are important procedural differences between teaching and research experiments, which is the topic of the next section.

3. Procedural Considerations

Reservations about doing experiments in class should not be confused with the requirements of a careful research experiment. For example, some instructors are leery of classroom experiments because they think large monetary payments are required. Since economic theories normally pertain to situations in which the agents have a financial stake in outcomes, research experiments are almost always conducted in a manner that provides participants with significant financial incentives. A seller, for example, may be told that the cost of a commodity unit is $3, so that the difference between the selling price and this cost will be paid to the seller, in cash, at the end of the experiment. A typical two-hour market session with ten-to-fifteen buyers and sellers may cost between $300 and $500 in subject payments. Although the theoretical reasons for using significant financial incentives in research experiments are compelling, such incentives are often unnecessary in classroom exercises. Most market trading situations are sufficiently competitive that aggressive, even selfish, behavior emerges without extra incentives. If anything, the "irrelevance" of hypothetical payments is at least balanced by the tendency for some students to behave in a more rivalistic manner with their classmates than would be the case with a group of anonymous subjects in visually isolated booths. For this reason, the instructions for the market-based classroom experiments surveyed below state that all earnings are hypothetical.

Small incentives may be useful in games, if only because they reduce "noise" in the decisions. Even here, the cost in a classroom situation can be lowered by announcing in advance that one person will be picked at random to be paid a percentage of earnings. Random payment, of course, reduces incentives, but this procedure offers a way out of having to answer the question of why someone should care or what they should do. Such incentives may raise interest, but they are usually not necessary.

The use of extra credit points as incentives is much more controversial, since fairness (e.g. giving sellers equal costs) becomes a constraint that may conflict with the teaching purpose. Moreover, the instructor may not wish to base grade increments on trading skills or the cooperativeness of trading partners, factors that are often not related to what has been learned from the course material. And no matter how hard you try to dissuade them, some students will perceive that there is a fixed grade distribution, in which case the grade competition is like a zero-sum game. In this case, the use of extra credit points in classroom experiments adds stress and often conflicts with key economic ideas, like mutual benefits from trade. Personally, I never use extra credit incentives; hypothetical payments or small random payments seem to work fine.

Research experiments are often conducted in a laboratory using computerized instructions and interfaces. Computerization permits control of information flows and rapid communications that make it possible to go through more trading periods, but such advantages are seldom critical in classroom experiments. Moreover, setting up computerized experiments typically requires a lot of advance planning, which can end up being thwarted by unexpected crashes and glitches. The most promising computerized classroom experiments are run over the internet, which frees the instructor from having to deal with the annoying and ever-changing details of a local area network. Grobelink, Prasnikar, and Holt (1998) describe how to download a matrix game experiment that was written specifically for classroom use. Students can log on from any PC connected to the web (at a time specified by the instructor, with a password given out to the class). This after-hours "virtual laboratory" allows involvement of any number of students, who are matched in pairs to play two-person games with payoffs and matching protocols chosen by the instructor. The decisions are stored on a computer that is specified in the setup, so the instructor can retrieve the data for subsequent class discussion. The playing of the game requires no class time, and there is no restriction on the class size.

In a research experiment, the use of standard instructions facilitates scientific replication, and research papers without carefully documented instructions are rarely published. In a classroom exercise, the reading of instructions has a different value; it ensures that essential details are not overlooked by the instructor and that inessential side comments are avoided. One of the common errors in running classroom experiments is to add a lot of interjected comments, which can delay the quick start needed to save time for ex post discussions. A good way to prepare for running a classroom experiment is to read the instructions out loud to a teaching assistant and then entertain clarifying questions. Indeed, an anonymous referee for the papers in this symposium reported having trouble "getting the idea" without reading the instructions.[3]

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[3] There are many good sources of instructions and ideas for classroom markets, some of which are listed in the references to the four papers in this symposium. In addition, see Davis and Holt (1993, Chapter 1, Appendix A1.1) for double auction instructions that are adapted for classroom use. Ball and Holt (1998) contains a set of double auction instructions for trading assets, i.e. where the roles of buyer and seller are endogenous. See also Holt (1996) and Bergstrom and Miller (1997) for instructions in

Many instructors are hesitant to run a classroom experiment for fear of losing control or of obtaining anomalous results that will be difficult to explain. Market experiments (e.g. Holt, 1996; Holt and Sherman, 1998) are surprisingly consistent, and small variations in outcomes can provide interesting points for discussion. If you want to convince students of the potential inefficiencies of rent seeking contests, putting them in competition works every time (Goeree and Holt, 1997). Experiments that are sensitive to altruism, rivalry, and other attitudes about others' payoffs, like a public goods provision game (Holt and Laury, 1997) are more difficult to predict, but are often just as effective in eliciting thoughtful discussion about standard assumptions. Some aspects of game theory conflict with simple economic intuition and simply do not predict behavior well, both in class and in research experiments. One wonders why they are being taught (more on this below). One way to prepare for variability in results is to bring in transparencies of data from previous classes and from research experiments.

Another reservation about classroom experiments is the time involved. With discussion, the experiments described in the papers that follow will require most or all of a typical class period. Only important concepts merit this amount of time. This is somewhat a matter of teaching philosophy, i.e. whether it is better to survey a lot of material or to reinforce key ideas. In any case, there is not much risk in trying several classroom experiments and evaluating the outcomes before introducing more.

Classroom experiments are more difficult to use effectively in large classes, since it is the personal involvement that stimulates student interest. Similarly, the Socratic method of extracting lessons from these exercises is more effective in smaller classes (although law professors have long used the stress associated with the possibility of being called by name to make large classes feel small). Even in very large lecture classes, the discussion sections that are often attached provide an ideal setting for many of these classroom games. Discussion can be especially fruitful, since the student participants are coming to the table with some first-hand experience. All of the papers surveyed in the next section provide suggestions for how to structure a series of questions in a manner that enables the students to discover the main ideas for themselves. For example, you only have to ask them things like "at this high price, will there be more buyers or more sellers?" to get them to start a line of thought that leads to the notion of a competitive equilibrium.[4] Let me stress, it is very hard for the typical lecturer to restrain the impulse to ask a question, and if nobody answers it, to go straight to the final answer. In my experience, it is more effective to think about follow-up questions, to take incorrect answers seriously and let students critique them, etc.

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a "pit market" in which buyers and sellers intermingle in a trading pit, as with some commodity trading exchanges.

[4] Holt (1996) describes how to structure a discussion so that students discover the laws of supply and demand after trading in a pit market.

Another problem is that the exercises may not match the points that you are having difficulty conveying in your courses. Here the best approach is to try some of these "canned" experiments to pick up tricks and techniques that have worked for others, before developing your own materials.[5] Standard exercises are becoming more available in supplements to textbook materials, in the Classroom Games column that I do on an irregular basis for the *Journal of Economic Perspectives*, or in publications with an interest in teaching methods, like the *Journal of Economic Education* and (henceforth) the *Southern Economic Journal*. There is also a relatively informal network through which instructors exchange materials. e.g. the newsletter *Expernomics* and via web pages.[6] The instructions for the papers surveyed in the next section are, for example, available on the authors' web pages, with the complete set on http://theweb.badm.sc.edu/laury.

4. Diverse Applications of Classroom Experiments

The wide range of classroom experiments is illustrated by four recent papers that introduce students to games, voting, markets, and even a simple macro-economy with fiat money. In "Multi-Market Equilibrium, Trade, and the Law of One Price," Laury and Holt (1999) provide a useful variation of the standard market trading exercise for teaching supply and demand. The setup with two separate markets allows students to see the effects of a supply shift, which helps them discover the theory of supply and demand for themselves. The discrete units make surplus areas into rectangles, which simplifies discussion of consumer and producer surplus. The introduction of traders who can buy in one market and sell in the other promotes the price uniformity that allows prices to convey correct signals about relative scarcity. The discussion can bring out the fact that free trade creates winners and losers, and that aggregate surplus-based measures of efficiency increase as the goods are transferred from low-value buyers in one market to high-value buyers in another.

In "Agendas and Strategic Voting," Holt and Anderson (1999) describe an exercise designed to develop a main point of the public choice literature: outcomes of the political process may be beset by possible inefficiencies. The agendas used in this classroom voting game take the students through a voting cycle, where the final outcome depends on the agenda used. The item-by-item consideration of spending measures can result in the adoption of a series of projects that pass by majority vote, but the end effect is a set of services that would be rejected as a package in a kind of tax revolt. Students who participate

[5] For example, one of the graduate students at the University of Virginia participated in a market trading experiment in the first problem section meeting of his graduate micro theory class. He subsequently developed a series of classroom negotiation exercises for a very successful Law and Economics class that he taught several years later.

[6] For information about *Expernomics*, contact Greg Delemeester at delemeeg@mcnet.marietta.edu.

come away with a deeper understanding of strategic voting and the effects of political institutions on economic allocations.

Capra and Holt (1999) describe how to put students quickly into a coordination game with multiple equilibria, some of which are worse for all players than others. This game is analogous to a situation in which the group earnings depend on the minimum of everyone's efforts, so it is useless to exert more costly effort if the others will not do the same. The possibility of getting stuck in a "bad" equilibrium has intrigued macroeconomists since Malthus' speculation about a "general glut." The observed behavior also illustrates how changes in the game can have dramatic effects on behavior that are not predicted by a standard Nash equilibrium analysis. For example, increases in the numbers of participants tend to reduce coordination, as intuition suggests, despite the fact that any common effort level is a Nash equilibrium.

Almost all published classroom experiments being pertain to microeconomics applications, but this is changing. In "Employment and Prices in a Simple Macro-Economy," Goeree and Holt (1999) use ordinary playing cards to set up a self-contained economy with labor and goods markets. The black cards (clubs and spades) represent real goods and services, and the red cards (hearts and diamonds) represent fiat money. This exercise helps students understand a number of important distinctions, including the difference between real and nominal wages. These classroom economies sometimes exhibit significant efficiency losses due to under-employment. A simple graph can be used to illustrate and derive predictions about increases in the money supply, changes in labor productivity, etc.

All of these papers provide instructions and hints on how to run the games in classes of various sizes. Another common element is that ordinary playing cards are used to determine preferences, decisions, or to keep track of goods and money balances. In each case, the suggested questions for post-experiment discussion are designed so that the students discover the main points without being told directly. These classroom exercises have been heavily influenced by research experiments, which are cited in the "further reading" sections, which provide perspective on the literature and related issues.

5. Teaching Effectiveness

Most of the evidence about teaching effectiveness is anecdotal, but the growing popularity of in-class experiments is encouraging. Already, laboratory exercises have been incorporated into introductory classes at places like the University of Arizona, California Institute of Technology, the University of Arkansas, and the University of Amsterdam. The experience in Amsterdam is dramatic; the failure rate in the introductory course was reduced by 50 percent in the year following the introduction of a required series of laboratory exercises.[7]

The papers surveyed above, like those in the *Journal of Economic Perspectives* column, are written for college and university instructors, but I have found that this type of paper can be understood by bright undergraduates in their third and fourth year. This raises the possibility of a somewhat unconventional but effective approach in small seminar classes like advanced microeconomics, game theory, or experimental economics. Recently, I have taught courses in which these classroom experiment papers are given to pairs of students who then take full responsibility, both for running the experiment on schedule in their own class and for leading the subsequent discussion.[8] Often one student will take the lead in procedural matters and the second person will prepare transparencies and take a primary role in the discussion. The other students will not have been given the paper in advance. As always, the discussion leaders are warned not to present the answers, but rather to use a more Socratic approach. In order to set a high standard, it is useful for the instructor to run the first in-class experiment and then to make sure that some of the more interested and competent students follow suit. This active teaching/learning combination can have dramatic results, in terms of student interest and learning.[9]

Finally, I believe that these exercises serve a subtle but extremely valuable purpose, that of reinforcing the instructor's own understanding of and confidence in basic economic principles.[10] This is important since the justifiably technical orientation in good graduate programs may leave little time for developing a feel for things like the efficiency of markets and the inefficiency of many non-market allocation mechanisms. My own confidence in the relevance of what I teach has increased significantly since I began to incorporate experiments into my classes. And I enjoy teaching more than before.

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[7] The Amsterdam experience was explained to me by Professor Arthur Schram.

[8] The Classroom Games column that I edit for the *Journal of Economic Perspectives* contains a number of similar papers, all of which have the kind of detailed suggestions on procedures and discussion needed by students and instructors with limited experience in conducting classroom experiments.

[9] An additional benefit from the instructor's point of view is the possibility of higher student satisfaction. The most recent teaching evaluations at the University of Virginia show that the highest ratings (among all 35 graduate teaching assistants and instructors) were received by a graduate student who let students conduct a number of in-class experiments. The results for senior faculty (alas) have been a little less apparent.

[10] This is a two-edged sword, since some of the things we teach simply do not explain how people actually behave, except by coincidence, and I find myself de-emphasizing such concepts. For example, the notion of a mixed-strategy Nash equilibrium does not predict well, except in symmetric games (Ochs 1995; and Goeree and Holt 1998). No wonder it is so hard to get students to understand the idea that a change in one's *own* payoffs does not affect one's own choice probabilities in a mixed equilibrium!

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