Antitrust, Vol. 21, No. 2, Spring 2007.

Experimental Economics and Antitrust: What Can We Learn From Laboratory Markets?

BY BART J. WILSON

WHAT CAN A COLLEGE SOPHOMORE tell us about strategic market interactions of an antitrust concern? Verbally, not much; and certainly nothing constructive for a deposition on a matter headed for litigation. What, then, can we learn from an undergraduate setting prices for a fictitious commodity in a market conducted in a computer laboratory over the course of 90 minutes? The answer lies not in asking what any single student can articulate about what he knows about market competition but, rather, in observing what groups of cash-motivated participants do and do not do when faced with a focused task replicated under a common set of initial conditions.

Experimental economics is a laboratory method of inquiry for studying how individuals interact in controlled settings defined by a specific set of rules. When applied to issues of antitrust, the rules typically resemble an auction or other market institution in which, for salient rewards, people "buy" or "sell" products. A market institution is comprised of all of the detailed rules, formal and informal, that define what market participants can and cannot do. For example, stock exchanges formally require members to submit "asks" for their offers to sell, and buyers can either accept such offers or submit their own bids to buy, which the sellers can accept. In contrast, the custom in (most) retail markets in the United States is for sellers to post a single offer price that buyers either accept by purchasing or reject by not purchasing.

The observed experimental outcomes are the consequence of individuals' choices, initiated by an economic environment and mediated by the market institution of interest. The economic environment consists of participants' preferences, opportunity costs, knowledge, and skills, and the economic constraints they face. Given their environmental circumstances, people express their behavior by sending "messages" that the institution permits—e.g., bids, asks, acceptances, posted prices, purchases, etc. Via the governing rules, the institution maps participants' choice of "messages" into experimental outcomes.[1]

So, how does experimental economics work in theory? After framing the question of interest, an experimental economist designs the environment and institutions to answer that question. The experimenter first poses the hypotheses to be tested and selectively controls the variables to best pinpoint the market processes at work with participants making decisions within a defined environment. Econometric (or "field") studies do not have this luxury because the econometrician cannot collect direct measures of some relevant variables, such as consumer welfare or marginal cost. Furthermore, the econometrician cannot choose to define the environment and institution to best answer a specific question. An econometrician instead must make do with naturally generated data. Before an experiment is conducted, an experimenter can determine what data to collect to best answer the question, and after an experiment is conducted, what data to collect from a follow-up experiment to answer any new questions that might have arisen.

The experimenter also controls the implementation of the experiment and the instructions given to participants. What the experimenter does *not* control is the knowledge that participants bring with them. Experimental economists attempt to manage the intricacies of human decision making with anonymity among participants and with what are hoped to be neutrally posed descriptions of each person's task. But this does not mean that such instructions have induced a tabula rasa. Nor should the experimenter assume that participants view their tasks from the instructions precisely the same way that an economist understands the problem when he wrote the instructions.

No single method of inquiry is complete or without limitations. Regardless of whether one is partial to econometric field studies, experimental laboratory studies, or mathematical modeling, any method of inquiry is necessarily limited by the inherent specificity of its assumptions. Experimental economics is just another tool in the toolkit to complement what we learn from mathematical modeling and econometric field studies.

How Does an Experiment Work?

To understand how an experiment works in practice, consider the following simple example. Six participants are given an increasing cost schedule for selling four units of a fictitious commodity. They are told that for each unit they sell at a price greater than the cost of that unit, they will be paid the

Bart J. Wilson is an Associate Professor of Economics at the Interdisciplinary Center for Economic Science at George Mason University.

difference in cash at the end of the experiment. Another six participants each receive a decreasing schedule of "resale values" for four units. For each unit these participants purchase, they can resell that unit to the experimenter for their assigned resale value. Hence, if they buy at a price less than the resale value, they earn the difference in cash. And if they buy for more than the resale value or sell for less than the cost, the difference is subtracted from their earnings.

These costs and values for six buyers and six sellers comprise the economic environment for this task. Buyers only receive the resale value for the units that they buy and sellers only incur costs for units that they sell (production is to order). All information on the economic environment is strictly private and dispersed, i.e., each participant only knows his or her own costs or values.

But how do sellers sell and the buyers buy? In conducting his first economic experiment in 1956, 2002 Nobel Laureate in Economics and father of experimental economics Vernon Smith looked to financial and commodity exchanges for the rules by which the buyers and sellers would interact, and implemented the so-called oral double auction.[2] The institution that defines how sellers will sell and how buyers will buy involves an auctioneer through whom all participants must make their decisions. Buyers and sellers can each take two types of actions in an oral double auction. To take an action, a participant must first be recognized by the auctioneer. When the auctioneer calls upon the participant, a buyer, say B2, can submit a bid to purchase one unit of the fictitious commodity. This bid represents the amount that the buyer is willing to pay a seller for one unit and is displayed publicly for all market participants to view. At any time during the trading period any other buyer can submit a bid, but if one is already displayed, the buyer must submit a bid that is at least 25 cents greater than B2's current bid. If another bidder, B3, outbids B2, then B2's bid is dislodged and B2 must submit another bid greater than B3's current bid in order to buy. During the time the auctioneer accepts bids from the floor, he also calls upon sellers who can submit an ask to sell. This represents the amount that a seller is willing to sell one unit to a buyer. Any seller can displace the current lowest ask by being recognized by the auctioneer and submitting one that is at least 25 cents less than the current standing ask. (All bids and asks are also rounded to the nearest quarter.) At all times, all market participants can see the current bid-ask spread, the lowest submitted offer to sell and the highest submitted offer to buy.

To purchase a unit, a buyer can, instead of submitting a bid, accept the terms of the lowest submitted ask when recognized by the auctioneer. Likewise, at any time a seller can accept the terms of the highest submitted bid and sell to a buyer. When either of these events occurs, the bid-ask spread is cleared and the auctioneer continues to take new bids and asks from the floor. This process continues until the auctioneer does not see any new bids or asks from floor, at which time he calls out "Going once . . . going twice." If the auctioneer does not see anyone raise a card to be recognized, the market trading period closes upon the auctioneer's declaration that the market is now "Closed."

Note the knowledge conditions of the experiment: Every participant only knows his or her own particular circumstances—his cost or her value. But every participant also can observe all activity in the market—including each bid, ask, and trade. Figure 1 displays the data that buyers and sellers saw while in the first period of market trading. Each downward-pointing caret indicates an offer to sell and each upward-pointing caret represents an offer to buy. Where they meet is a contract between a buyer and a seller. The first contract is displayed on the leftmost portion of the figure and each subsequent contract is connected via the solid black

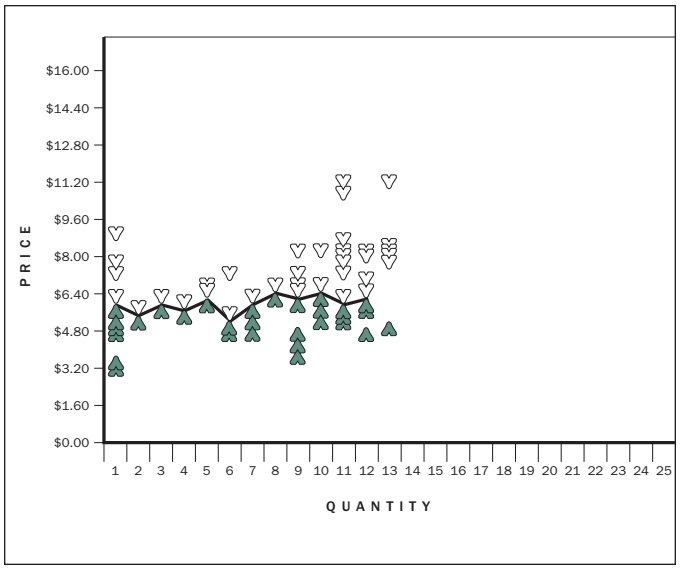

Figure 1

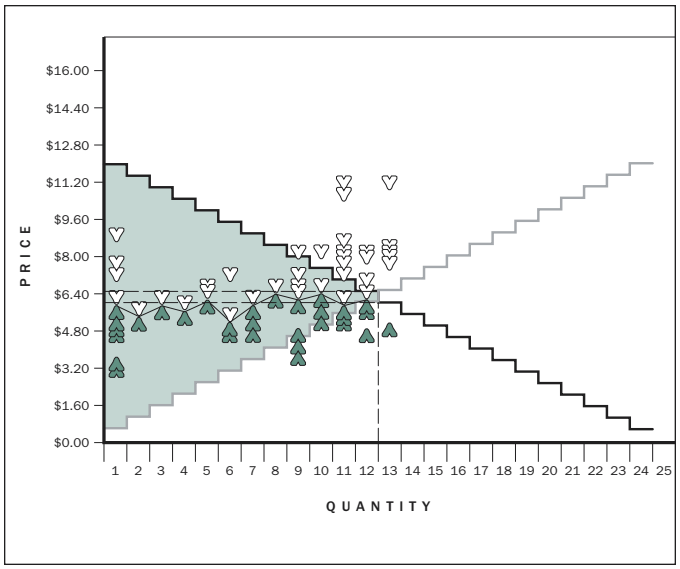

Figure 2

line. In this first period of trading, the sellers, in total, sold 12 units to the buyers, and the closing price was $6.25. The trading period lasted less than ten minutes.

The experimenter knows all of the costs and values and hence the market clearing price(s) and quantity (although the experimenter need not be the auctioneer). Figure 2 overlays the market activity with the economic environment which, in this experiment, would be the supply and demand. All of the resale values are sorted from highest to lowest regardless of to whom they belong and are plotted as the downward sloping step (demand) function. Each step represents one resale value for one unit. Similarly, costs are sorted from lowest to highest regardless of to whom they belong and are plotted as the upward sloping step (supply) function. Each of these steps represents the cost of supplying one unit.[3] The market clearing prices (plural because discrete units are being traded) are $6.25 and $6.50 and the market clearing quantity is 12. Because the experimenter knows the demand and supply schedules, he also knows the maximum possible gains from trade, i.e., the buyer and seller profits or surplus. Hence, the ratio of the realized gains from trade (what the participants actually earn in cash) to the maximum possible gains from trade is a measure of the market's efficiency. The shaded area represents the total gains from trade that the participants realized, which in this market is exactly equal to the maximum possible gains from trade. That is, the market was 100 percent efficient.

The results from this experiment typify an average oral double auction experiment (in that efficiency is in the high 90 percent range).[4] It takes very few rounds for participants in an oral double auction to converge to the market-clearing outcome and extract nearly all of the gains from trade. Notice the amazing and challenging problem that these participants solved in less than 10 minutes. With strictly private and dis-

Procedures in Deck and Wilson Laboratory Experiment

QUESTION: Do the participants have to be economics majors in order to participate?

ANSWER: No—you do not have to be taught economics to be able to make economic decisions in your own interest. A participant must be fluent in English and have the ability to enter decisions into a computer interface via a keyboard and mouse.

QUESTION: How are your participants recruited?

ANSWER: E-mail invitations are sent in batches of 40–60 by randomly drawing from a pool of approximately 1,500 undergraduate students at George Mason University who have previously indicated an interest in participating in experiments. At the time this project was conducted, students were recruited from undergraduate classes in economics, management, and engineering at George Mason University. The first 15 students to sign up by clicking on a Web link are confirmed. A student can participate in only one session of a particular project but typically will participate in several different studies depending upon whether or not the researcher would like the participant to have such experience.

QUESTION: How do you decide which of the 15 subjects to use?

ANSWER: Typically anywhere from 50–90 percent of confirmed participants show up for their appointment. All are guaranteed $5 for showing up on time. If more than 8 people show up, the monitor asks for volunteers to be bumped. If there are not enough volunteers, students are randomly bumped.

QUESTION: What does a participant do in the experiment?

ANSWER: After the participants read and sign a consent form, they are randomly seated at a visually isolated carrel in a computer laboratory. The participants are told not to talk to anyone in the experiment, except for the monitor. The participants receive a set of self-paced computerized instructions to read. Once every subject has clicked a button to indicate he is ready to begin the experiment, the monitor asks if there are any other questions. If there are none, the monitor starts the experiment on a computer in an adjoining enclosed room that looks out into the laboratory.

QUESTION: How long does an experiment last?

ANSWER: The typical experiment lasts one to two hours. This experiment lasted 90 minutes.

QUESTION: How much do the subjects earn?

ANSWER: That depends upon the decisions that a participant makes. The better decisions a participant makes, the more he earns. In this experiment, the average subject earned $13.25. The maximum amount earned was $37.25, and the minimum $8.25. ■

persed knowledge of these values and costs, the 12 highest valued units on the demand schedule transacted with the 12 lowest cost units on the supply schedule. This efficient market outcome did *not* require that buyers and sellers have complete information on the supply and demand conditions for a market to be competitive, nor did it require trading by a large number of buyers and sellers.[5]

The most interesting aspect of this finding is not that the experimental outcomes verify the static competitive equilibrium. Rather, what is remarkable is that we have identified a convergent process, a replicable spontaneous order, by which market participants quickly achieve the competitive outcome. The oral double auction demonstrates that market participants do not need to know the full conditions of supply and demand to converge to the competitive outcome. Instead, what they need to know is what people are willing to do, and that is provided by the double auction institution. Every bid by a buyer is a stimulus to all the other buyers to check their own circumstances and assess whether they are willing to outbid the current standing bid. The same is true for every seller. Inaction on the part of any subset of the participants provides equivalently valuable information to the market on everyone's individual circumstances just as any new bid, ask, or acceptance provides circumstantial information.

An often raised critique of experimental economics is that undergraduates are not "sophisticated" or "intelligent" market participants. This claim tends to assume implicitly that college students cannot make intelligent decisions because they do not know the underlying economic theory that presupposes they have complete information about their economic environment. But not even economic theory can tell us the "sophisticated" thing to do when market participants lack complete information in market settings like a double auction. Experimental economics demonstrates how crucial institutional rules are to understanding competitive outcomes and the dynamics of market interactions. Much of the unintended and unanticipated "intelligence" demonstrated by these experiments is embodied in the institution, as well as in the participants.

Experimental Economics: An Application to Antitrust

Experimental economics can help shed light on a wide range of antitrust issues—from predicting post-merger prices to assessing the welfare consequences of price regulations.

Few industries evoke such strong sentiments by consumers, retailers, wholesalers, and policy makers as gasoline. Zone pricing—the practice of refiners setting different wholesale prices for retail gasoline stations that operate in different geographic areas or zones—has been a particularly contentious topic in the public policy debate for the past several years. Refiners contend that they price to allow their dealers to be competitive in relation to their nearby competition. However, state legislators and attorneys general have proposed legislation to ban zone pricing, claiming that it is "invisible and insidious . . . [and] benefits only the oil industry, to the detriment of consumers."[6]

In our forthcoming paper, Cary Deck and I examine these opposing viewpoints.[7] Our laboratory study complements field work by implementing the chief stylized facts of naturally occurring markets to examine what cannot be measured with field data. For example, in the laboratory, we can measure the gains from trade for consumers, retailers, and wholesalers because the experimenter knows the precise consumer demands and costs of the retailers and suppliers, which are not directly observable in the naturally occurring economy. Holding constant the wide range of potentially confounding effects found in the naturally occurring economy, we compared markets in which zone pricing is permitted to arise endogenously to markets in which uniform wholesale pricing is mandated, i.e., zone pricing is prohibited. Such a comparison affords a direct examination of the welfare effects of the proposed legislation on consumers, station owners, and refiners before executing it in the field.

The laboratory environment contains two types of geographic retail areas: isolated and clustered. The geographically clustered area is at the center of a 7x7 street-avenue grid and served by four retail stations, whereas there is one station in each of the four geographically isolated areas in the corners of the grid. Four participants in the experiment serve as branded "suppliers" (refiners) to four other participants, each of whom set branded retail prices at two different "stores" (stations)—one in an isolated area and one in a cluster. The computer functions as the buyers who randomly appear at one of the 49 intersections to travel to purchase from one of the eight stores. Some buyers are willing to pay more for one brand or another, and all buyers incur increasing travel costs the farther they have to travel to buy a unit. The eight retail prices are publicly displayed for everyone to view.

The institutional rules for the zone-pricing treatment specify that each branded refiner sets the prices for each of their two like-branded stations. The station owner then sets the retail price to buyers. Any time that a station owner stocks out, he automatically restocks at the current supplier price for that station. (See sidebar at page 56 for a discussion of the experimental procedures.)

The simple difference between the four sessions in the zone-pricing treatment and the four sessions in the uniform-pricing treatment is that the suppliers must charge the same price for each of their two branded stores. The ban on zone pricing is perfectly enforced by the software. When a supplier types in his (dealer tank wagon) price to one store, it automatically copies the same price to the other store (which raises the issue of how such a ban would be monitored in the naturally occurring economy).

In our study, we find that uniform wholesale pricing harms consumers. Specifically, we find:

- When zone pricing is banned, consumers in the clustered area pay 10.9 percent higher prices than when zone pric-

ing is permitted. (In contrast to field studies, the experimenters can measure the actual transaction prices as opposed to the only posted retail prices.) As a percentage of the total value from consuming gasoline, these higher prices represent a reduction in total consumer welfare of 17–18 percent (something econometric studies cannot directly measure).

- Consumers in isolated areas pay the same prices with zone pricing as they do when it is prohibited.

Why does uniform wholesale pricing not help the consumers in isolated areas and why does it harm those in the clustered area? The answer is two-fold. First, high station prices in the isolated areas are not the result of high refiner prices with zone pricing, but rather the cause. Station prices in the isolated areas are higher because (a) consumers in those areas prefer not to travel long distances to purchase lower-priced gasoline in a more competitive area and (b) there is only one local station. The refiners then use zone pricing to capture the station profits at these isolated and hence, more profitable stations. This is consistent with the naturally occurring contexts in which refiners capture the profits of lessee dealer stations because the refiners own the land on which the station operates. (In addition, lessee dealers are unable to change their suppliers, as is the case in this experiment.) In the clustered area with strong station competition, the refiners price very competitively, and as a result, consumers pay lower prices. The upshot is that refiners capture more profits from the stations with zone pricing, but not to the detriment of consumers.

The second part of the answer stems from the unintended consequences of uniform wholesale pricing, namely that it ties refiner pricing decisions in isolated areas to those in the competitive, clustered area. When refiners are forced to sell at a uniform price, they would rather set a single price that is higher than the comparable zone price in the clustered area to capture some of the profits of the stations in the isolated areas. Hence, consumers in the clustered area pay higher pump prices. Consumers in the isolated areas do not see lower prices because nothing has fundamentally changed at the retail level. In fact, consumers have even less incentive to travel farther to the clustered area because those prices are now higher with uniform pricing. The end result is that uniform pricing stymies competition in the clustered area and yields no benefit to consumers in isolated areas. This experiment effectively shifts the burden of evidence to the critics of zone pricing, whose skeptical concerns could be incorporated into new designs that build upon these results.

Conclusion

In any economic experiment, we seek to uncover why participants implement the particular (pricing) strategies that they do and why, when aggregated, these decisions result in a particular set of outcomes, for it could have happened like that or in many other ways. By redefining the decision task counterfactually, either through a change in the environment or the institution, we aim to further explicate the reasons why we observe the set of outcomes that we do and to trace out the rationale for those that we do not. By randomly assigning participants to different experimental conditions, we learn by inferring meaning from a replicable pattern of purposive decisions.

Experimental subjects do not share preconceived notions from antitrust theory or practice as to what experimental outcomes should occur in their markets. The experimenter has given them a task to earn money, and they do what they think they need to do to earn it. Experimental economics is about suspending one's own beliefs about what should happen and listening to what the subjects are telling us through their deliberate and often entrepreneurial actions. If the goal is inquiry, experimental economics can shape the way one thinks about economics. Vernon Smith summarizes it this way in a note that precedes his prize lecture:

> Doing experimental economics has changed the way I think about economics. There are many reasons for this, but one of the most prominent is that designing and conducting experiments forces you to think through the process rules and procedures of an institution. Few, like Einstein, can perform detailed and imaginative mental experiments. Most of us need the challenge of real experiments to discipline our thinking.[8]

Economists have a long history of espousing the belief that incentives matter and, with that, recognizing that rules matter, too. What experimental economics has done to reinvigorate the way economists think about economics is to establish, robustly and vividly, that institutions matter. The devil is in the details of the market institution. ■

[1] For a more formal treatment of a microeconomic experimental system, see Vernon L. Smith, *Microeconomic Systems as an Experimental Science*, 72 AM. ECON. REV. 923–55 (1982).

[2] *See* Vernon L. Smith, *An Experimental Study of Competitive Market Behavior*, 70 J. POL. ECON. 111–37 (1962).

[3] To clarify, for ease of display the contracts in Figure 2 are plotted as they occurred in time but the values and costs are not. Hence, one should *not* necessarily infer that the buyer with the highest value purchased the first unit at a price of $6.00 from the seller with the lowest cost. As it happens, the buyer with the highest (B1) did buy the first unit at price of $6.00, but from seller S5, the seller with the fifth lowest cost of a unit.

[4] DOUGLAS D. DAVIS & CHARLES A. HOLT, EXPERIMENTAL ECONOMICS (1993).

[5] Experimental markets with as few as three buyers and three sellers regularly converge to the competitive outcome.

[6] Press Release, Connecticut Attorney General's Office (June 29, 2000), *available at* http://www.ct.gov/ag/cwp/view.asp?A=1775&Q=282936.

[7] Cary A. Deck & Bart J. Wilson, *Experimental Gasoline Markets*, J. ECON. BEHAVIOR & ORG. (forthcoming), *available at* http://gunston.gmu.edu/bwilson3/papers/ExperimentGasMarkets.pdf.

[8] Vernon L. Smith, Constructivist and Ecological Rationality in Economics, Nobel Lecture (2002), *available at* http://nobelprize.org/nobel_prizes/economics/laureates/2002/smith-lecture.pdf.