EXPERIMENTAL LAW AND ECONOMICS: AN INTRODUCTION*

by

Elizabeth Hoffman
Purdue University

and

Matthew L. Spitzer
University of Southern California

October, 1984

draft:please do not quote
comments are invited
*The authors wish to thank Michael Levine and Alan Schwartz for their helpful comments on an earlier draft. All errors are, of course, our own.

I. INTRODUCTION

This paper reviews a new research technique in law and economics--experimental law and economics. Although some economists have used laboratory techniques to study and develop economic theory for more than 20 years, researchers have only recently started to use these techniques specifically in law and economics. In this paper we review the literature in economics relevant to law and economics and then show how the technique makes it possible to both test theories and examine the effects of alternative legal policies without costly social experiments. Finally, we discuss the few experimental studies dealing directly with propositions in law and economics and suggest some appropriate directions for future research.

II. INTRODUCTION TO EXPERIMENTAL ECONOMICS

A. A Brief Introduction to Experimental Technique

In the sections which follow we will review in some detail the techniques and results of a substantial amount of experimental work. However, to prepare the reader who is completely unacquainted with experimental procedure to understand the discussion below, we will first very briefly sketch the techniques and methodological motivations for using experiments.

First, what are "experimental techniques"? An experiment in economics almost always includes at least four important features. First, the experimenters observe the behavior of human subjects--often college students--who are following a set of instructions. The instructions ask the subjects to make certain decisions and promise to pay them money at the conclusion

of the experiment. The amount of money each subject ia paid depends on the decisions he makes.

Second, the instructions place the subjects in an abstract version of some naturally-occurring economic environment, in which they are required to play the roles of specific economic agents, such as consumers or firms. These instructions also provide the social institutions within which the subjects may interact. An experiment must abstract from the naturally-occurring environment because the "real world" subjects of economic inquiry, such as stock exchanges or disputes between landowners, are often tremendously detailed and complex. To analyze these complex subjects, economists build theories which abstract from many of these details.[1] Laboratory experiments abstract in an entirely analogous fashion.

Third, the payoffs to subjects are structured so as to induce preferences in any subject who prefers earning more money to earning less money. For example, if an experimenter wishes to study a "seller's" behavior, the instructions might inform a subject that he may purchase a "commodity" at a fixed price from the experimenter ('p'), that he can sell the commodity to another subject at any price he can persuade the other subject to agree to ('a'), and that the experimenter will pay the subject

[1] In exchange for the loss of detail in the theories, economists (hope to) gain theoretical tools which, can, in many circumstances, predict behavior. Such economic theories commonly presume that an "environment" contains utility-maximizing consumers who have various amounts of wealth and differing preferences, and profit-maximizing firms, each with its own ability to turn raw materials into valued goods and services. There are abstract versions of social institutions, such as the law of tort end contract, which enable these consumers and firms to interact. This interaction produces goods and services, which are distributed to the consumers.

the difference between sale and purchase price (s-p). Under these circumstances, any subject who prefers to take home as much money as he can will also prefer to make his sale at as high a price as he can. In this way, the experimenter can induce subjects to try to "sell high, buy low," just as real sellers and buyers try to do.

Fourth, the experimenter observes both the subjects' decisions and the associated cash payouts to subjects. Then, he uses the data to infer something either about an economic theory, or about the real world subject of that economic theory.[2]

What does one need to assume in order to make laboratory experiments a valid source of data about naturally-occurring environments? The literature on the philosophy behind the use of experiaental techniques in economics[3] has focused on three crucial assumptions. First, one must assume that subjects will prefer more money (in payoffs) to less money. In this way, the use of reel money payoffs can be used to induce preferences in the subjects in a predictable fashion.[4] Second, one must assume that the same general rules of human behavior apply in both the laboratory and the

[2] This last step is discussed in much greater detail, below.

[3] Charles R. Plott, Industrial Organization Theory and Experimental Economics, 20 J. Econ. Lit. 1465 (1982) Vernon L. Smith, Experimental Economics: Induced Value Theory, 66 Am. Ec. Rev. 274 (1976) and Microeconomic Systems as an Experimental Science, 72 Am. Ec. Rev. 923 (1982); Louis L. Wilde, On the Use of Laboratory Experiments in Economics, in J. C. Pitt (ed.) Philosophy in Economics 137 (1981).

[4] Smith (1976), Id. Actually, subjects must prefer more money to less money in just the same way that people prefer more to less in real life--not always, but to an overwhelming degree and in certain regular, predictable ways. This is enough to make experimental data useful.

naturally-occurring environments which the experiments attempt to model. Only if this is true, will the observed behavior in the laboratory support inferences about human behavior in the naturally-occurring environment.[5] Third, only if one can safely assume that he has distilled the essential features of naturally-occurring institutions and incorporated the features into parallel laboratory institutions will the results be of interest. Smith refers to this crucial ingredient in an experimental design as parallelism[6] The experimental psychology literature refers to it as external validity.[7]

The first assumption can be tested and the results suggest that the experimenter must use a delicate, sensitive touch. For example, in another paper[8] we report experiments in which subjects were led to behave more or less altruistically, depending on subtle changes in the experimental instructions. These results have led us to caution experimentalists to be aware of the possibility that there may not always be a simple relationship between the experimental payoffs and the preferences of experimental subjects. However, there also may be no simple correspondence in many situations in real life. Experimenters must be sensitive to the possibility, in some situations, that the experiment leads subjects to prefer less to more,

---

[5] Smith (1982) and Wilde, supra, note 3.

[6] Smith (1982), Supra, note 3.

[7] See, e.g., D.T. Campbell and J.C. Stanley, Experimental and Quasi-Experimental Designs for Research (1966).

[8] Elizabeth Hoffman and Matthew L. Spitzer, Entitlements, Rights, and Fairness: An Experimental Examination of Subjects' Concepts of Distributive Justice, J. Leg. Stud. (forthcoming)

just as people occasionally do in the natural world. The second and third assumptions are far more difficult to test. Although, with sufficient comparative naturally-occurring data it may be possible to test for parallelism.[9] However, because these assumptions are often difficult and costly to test, scholars in the field tend to rely upon peer consensus in evaluating experimental design. This "consensus" evolves out of the standard academic institutions for quality control -- workshops on the papers before critical audiences, and referred journal acceptances (in all but legal, publications).

What are the basic allocations for using experimental techniques? We can cluster the uses into five groups. First, experiments can provide the cleanest possible tests of fundamental theories in economics.[10] Economic theories often specify little institutional detail, and can be mimicked ('modeled') quite easily in the laboratory. By inducing in subjects preferences that conform precisely to a model's specification, and by excluding all of the 'noise' of the natural world which the model does not include, the experimentalist can produce an environment in which a theory has, on its own terms, the very best chance to predict behavioral outcomes.

If the theory fails under these circumstances, there is little reason

---

[9] Elizabeth Hoffman, James Marsden, and Andrew Whinston, Efficient Use of Economic Data, Xerox (1984), proposes a method for testing for parallelism. In the experimental psychology literature, Donald T. Campbell and Donald W. Fiske, Convergent and Discriminant Validity by the Multitrait-Multimethod Matrix, 56(2) Psych. Bul. 81 (1959) suggest that both assumptions can be presumed to be satisfied if several different studies, using different experimental designs all reach the same conclusions. They refer to this as convergent validity.

[10] See, e.g., Smith (1982) and Wilde, Supra, note 3.

to have faith that its predictions will fare any better under the less hospitable conditions of the natural world. In many instances the experimental approach to falsifying theory is 'cleaner' than using econometric tests on naturally-occurring data. The econometrician is not able to control for underlying parameters such as preferences, technology, or market institutions. Thus, the data are not structured so as to directly test a model under a set of specific simplifying assumptions. If the data seem to disconfirm the model, the econometrician cannot be sure that the environment which generated the data failed to fit the assumptions of the model.[11]

Second, experimental techniques can explore the domain of a theory. The experimentalist first replicates, as closely as possible, the assumptions of the model being tested. If the model's predictions are confirmed, then the experimentalist changes one parameter or relaxes one assumption in each subsequent replication of the basic design.[12] In this way, the experimentalist can map the domain in which a theory has predictive power.

Third, sometimes two or more theories provide very different predictions about human behavior in the same circumstance. The experimentalist can often set up an experiment which distinguishes clearly between the predictions of different theories. The experimental results can then be

---

[11] See Hoffman, Marsden, and Whinston, Supra, note 9, for a discussion of how one might combine these data into a better test than either kind of data could perform alone.

[12] See, e.g., Elizabeth Hoffman and Matthew L. Spitzer, Experimental Tests of the Coase Theorem with Large Bargaining Groups, Xerox (1984), for an illustration of the use of this approach and a discussion of its value. This study is discussed on pp. 33-39, Infra.

compared to both predictions to see which model predicts the results better.

Fourth, experiments may stimulate the creation of new theory. This can occur when en experiment produces results that no existing theory can explain. Under such circumstances, theorists may be lead to create new theories which explain the data, and which also have a great deal to say

about naturally-occurring situations.

And fifth, laboratory experiments are relatively inexpensive, compared to some ways of testing competing theories or policies in naturally-occurring environments. If the naturally-occurring data have already been collected end summarized, then econometric work on those data is likely to be less expensive than experiments. However, if a new data series would have to be collected, or if a completely new policy for which naturally-occurring data do not yet exist is being considered, then experiments are likely to be far cheaper. Collecting a lengthy data series can be quite expensive. To collect any data on a previously untried policy would require tinkering with important natural institutions as part of a potentially costly social experiment. New alternatives can be considered much more

See, e.g., Arlington W. Williaas, The Formation of Market Forecasts: Experimental Evidence, Xerox (1984), for an illustration of this technique. On pp. 22-26, we discuss another set of studies which illustrates this technique.

See, e.g. David Easley and John Ledyard, A Theory of Price Formation and Exchange in Oral Auctions, Northwestern University Hath Center Working Paper #461 (1983) and Daniel Frledman, Price Formation in Double Auction Markets, An. Econ. Rev. (forthcoming) for an illustration of the use of experimental results in theory development. On pp. 40-41, we discuss another set of studies which illustrates this technique.

efficiently in the controlled laboratory setting, without disrupting natural institutions.[15]

B. Competitive Markets: An Example of the Use of Experimental Economics

In a series of papers in the 1960's, Vernon Smith[16] defined the basic methodology of experimental economics, as outlined above, and illustrated the utility of experimental techniques to studying basic economic questions.[17] In this section we will review not only the early Smith market experiments, but also the more recent work which was inspired by Smith's efforts. This review should provide some specific examples of the concepts

[13] See e.g. James T. Hong and Charles R. Plott, Rate Filing Policies for Inland Water Transportation: An Experimental Approach, 13 Bell Journal of Economics 1 (1962) for an illustration of the use of experiments for policy comparison. This study is discussed on pp. 31-32, Infra.

A word of caution would be mentioned at this point. Experimental techniques are quite useful for screening out unhelpful theories from the set of all theories which policy analysts must consider, and can do so at low cost. However, these techniques will not screen out all unhelpful theories, and may actually fail to weed out many such poor theories. What experiments do well is to cheaply raise the proportion of helpful theories among those which must be considered further.

[16] Vernon L. Smith, An Experimental Study of Competitive Market Behavior, 60 J. Pol. Econ. 111 (1962); Experimental Auction Markets end the Walrasian Hypothesis, 73 J. Pol. Econ. 367 (1963); Bidding Theory and the Treasury Bill Auction: Does Price Discrimination Increase Bill Prices?, 48 Rev. Econ. snd Stat. (1966); and Experimental Studies of DiscriminationVersus Competition in Sealed-Bid Auctions, 40 J. Bus. (1967).

[17] In two more recent papers, Smith (1976) and (1982), Supra, note 3, he carefully specified that methodology and research plan. The material from these papers will be discussed below in the context of particular experiments. See also, Plott, Supra, note 3, which outlines the use of laboratory experiments in studying possible alternative governmental regulations; and Wilde, Supra, note 3.

contained in the above sketch of experimental techniques, and give the reader the needed grounding in basic results which will enable him to appreciate the experimental work which is of more direct importance to "law and economics."

The basic methodology of experimental economics can beat be illustrated

18

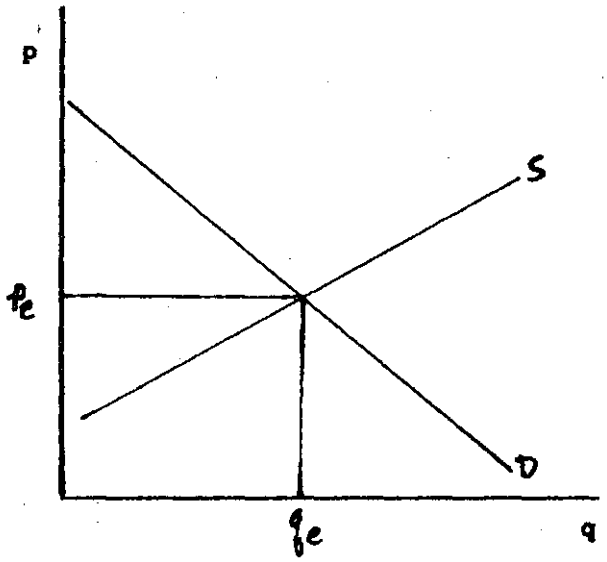
by an example from Vernon Smith's early work. The question he wished to answer in that early experiment was a simple one: do real-time, naturally-occurring markets produce the competitive equilibrium prices and quantities predicted by the the simple competitive model of supply and demand? As the discussion below demonstrates, this question seems trivial only until one tries to answer it.

Anyone who has taken a principles of economics course is familiar with the supply and demand graph depicted in figure 1. Moreover, anyone who has seen such a graph will predict that if the parameters underlying the demand and supply functions shown in this graph do not change over tine, a competitive market will generate price p_e and quantity q_e every trading period.

Smith (1962), Supra, note 16.

Figure 1

Supply and Demand



The problem with this simple analysis is that the theory is based on a static equilibrium concept and can only be shown to be true under special assumptions about the trading institution and the behavior of the agents in the market. The trading institution envisioned in this model is called the tatonnement process. The way it works is as follows. An auctioneer calls out ratios at which one good may be traded for another. Agents respond by telling the auctioneer how much of each good they wish to buy or sell at those prices. If deaand for each good equals the supply of each good, then the auctioneer declares an equilibrium and allows those proposed trades to take place. Otherwise, he does not allow any trades, calls out another set of price ratios and asks for another set of responses. Trades are only allowed in equilibrium and all trades take place simultaneously.

Real-time, naturally-occurring markets do not work that way. Even the stock market and the commodity markets allow sequential trading and no one la checking to see whether an equilibrium has been reached before a trade takes place. When we consider markets of individual firms dealing with individual customers, the similarity with the model becomes even sore distant. It turns out that we actually know very little, theoretically, about the behavior of real-time markets with a relatively small number of traders. Recent work building on the experiaenta we are about to describe

is making some progress in understanding how they work, but it is still fair to say that we don't know very much. Yet, the tatonnement process model is widely used for policy analysis and believed in by a large contingent of professional economists and policy analysts.

Even if the market is organized as a tatonnement process, however, the competitive equilibrium may not be achieved if agents do not respond at each iteration in a myopic, maximizing fashion, taking the called-out price ratios as given. In particular, agents can manipulate the mechanics by misrepresenting their "true" demands and supplies at each iteration and make the mechanism achieve a different equilibriua which benefits the manipulators.[20] Doing that requires the manipulators to *know* a great deal about the other participants' preferences and strategies, but it can be done. Moreover, the fewer participants there are in a market, the easier it is to manipulate it. If the market is not a tatonnement and there are few

Easley and Ledyard; Friedman, Supra, note 14.

Leonid Hurwicz, On Informationally Decentralized Systems, in Roy Radnor and C.B. McGuire (eds.) Decision and Organization (1972).

participants, any number of non-competitive theoretical predictions may apply.[21]

Given the importance of this simple model as a policy tool and its strict underlying assumptions, which are never replicated in naturally-occurring markets, it seemed crucial to test whether it was appropriate to use it to make predictions about naturally-occurring markets. The traditional empirical technique in economics was to collect naturally-occurring data and then subject it to hypothesis testing. The problem with testing the competitive mechanism in such a fashion is that we can't find out what peoples' preferences are. Therefore, we cannot easily reconstruct demand functions uncontaminated by the market institutions generating the observed prices and quantities. Consequently, we cannot be sure that naturally-occurring equilibria conform to the model.

Taking his clue from a classroom laboratory experiment run by E. H. Chamberlin at Harvard,[22] Smith decided that a laboratory experiment could provide a controlled environment which was parallel to the naturally-occurring environment of a real-time market. While we cannot observe preferences in naturally-occurring markets, we can induce preferences with monetary payoffs in a laboratory environment, assuming subjects prefer more money to less.

In the simple supply and demand market illustrated in figure 1, for

See Martin Shubik, Market Structure and Behavior (1980) for an introduction to game theoretic models of market processes.

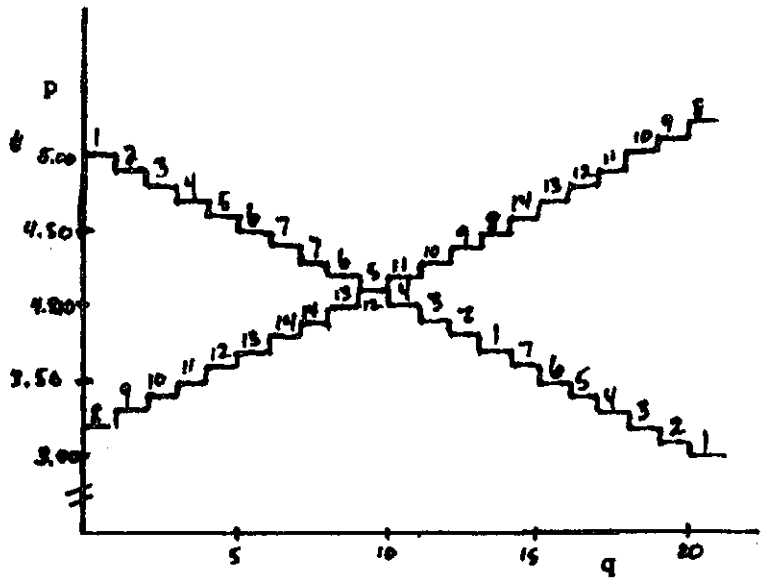
E. H. Chamberlin, An Experiaentel Imperfect Market, 56 J. Pol. Econ. 95 (1948).

example, Smith divided the subjects into agents called buyers and agents called sellers, and gave each agent a private payoff sheet. Each buyer was told that for each unit he bought in a trading period he would be paid (by the experimenter) a redemption value for that unit listed on his payoff sheet. He could not buy a unit for more than its redemption value and his profit per unit would be the difference between his redemption value and the purchase price for that unit. Each seller was told that for each unit he sold during a trading period he had to pay the experimenter the cost of that unit listed on his payoff sheet. He could not sell a unit for less than its cost and his profit would be the difference between the selling price and his cost for that unit. Actual dollar profits were paid in cash to subjects at the end of the experiment.

Figure 2 illustrates this simple experimental deign. In this experiment there are 7 buyers and 7 sel demand and supply functions represent the redemption values of the buyers and unit costs of the sellers. For example, buyer 1 has three units. The first pays $5.00, the second pays 93.70, and the third pays $3.00. Seller 8 also has three units. The first costs $3.20, the second costs $4.50, and the third costs 95.20. If we array these redemption values and costs along the step function as shown, we create induced demand and supply functions. And, assuming subjects will try to make as much money as they can, the competitive model predicts they will trade 9 or 10 units at the competitive equilibrium price of 94.10 and earn total profits equal to the shaded area.

Figure 2

Induced Demand and Supply Functions



The questions Smith asked were: 1) would a real-time experimental market achieve the competitive solution and generate all the profits to the subjects? and 2) do some trading institutions do a better job than others of achieving that equilibrium? His first paper[23] answered the first question in the affirmative, even though not all trades occurred at the equilibrium. He found that after 3 or 4 periods of learning all trades took place within a few cents of the equilibrium price. This experiment has since been replicated many times and the results are essentially the same each time. If subjects are paid a $.05 commission per trade, the price will typically exactly equal the equilibrium by the fourth or fifth trading

---

[23] Smith (1962), Supra, note 16.

period.[24]

A series of papers by Smith, Plott, and others have studied the second question.[25] Smith's original paper[26] used an auction mechanism similar to that used in commodity markets. The experimenter acted as a real-time auctioneer. Buyers were asked to submit oral bids to buy individual units at specified prices and sellers were asked to submit oral offers to sell individual units at specified prices. The auctioneer kept track of all bids and offers on a blackboard so that all agents knew all past and present bids and offers. If a buyer wished to accept a seller's offer or a seller wished to accept a buyer's bid, he would signal the auctioneer who would note on the blackboard that a contract had been made for one unit at the specified price. Thus, as the market progressed, all agents knew all past transactions and could learn about the market parameters over time. Since then, this particular institution has come to be called the double oral

Typically, subjects will not bother to trade the marginal unit the one that produces zero profit - because it is not worth the effort. This is quite similar to our expectations of behavior in the real world. To induce marginal trades, experimentalists often pay a tiny amount of money, such as $.05, per trade to the subjects so as to reduce the small friction caused by the "effort" of making a trade.

Jon Ketches, Vernon L. Smith, and Arlington Williams, A Comparison of Posted-Offer and Double-Auction Pricing Institutions, Rev. Econ. Stud, (forthcoming); Charles R. Plott snd Vernon L. Smith, An Experimental Examination of Two Exchange Institutions, 45 Rev. Econ. Stud. 133 (1978); Vernon L. Smith and Arlington W. Williams, An Experimental Comparison of Alternative Rules for Competitive Market Exchange, in Engelbrecht-Wiggins, Shibih, and Stark (eds.) Auctions, Bidding and Contracting: Uses and Theory 307 (1963); Fred E. Williams, The effect of Market Organization on Coapetitive Equilibrium: The Multiunit Case, 40 Rev. Econ. Stud. 97 (1973).

Smith (1962), Supra, note 16.

auction.

Static equilibrium theory does not suggest that institutional differences should make a difference in convergence to equilibrium. However, subsequent experimental studies have shown that experimental outcomes are actually quite sensitive to market institutions. First, some changes from the double oral auction results in prices significantly different from equilibrium and a significant reduction in the total profits earned by the participants. In particular, if buyers cannot make bids and sellers post "take it or leave it" offers which must prevail for an entire trading period, prices tend to remain above equilibrium for many trading periods. Conversely, if sellers cannot make offers end buyers post "take it or leave it" bids, prices tend to remain below equilibrium for many trading periods.[27]

Further, small differences in the way a double auction is conducted can make a difference in the degree and speed of convergence.[28] The best performance is achieved under New York Stock Exchange rules. To place a new bid a buyer must bid higher than all outstanding bids, and to place a new offer a seller must offer lower than all outstanding offers. All bids and offers are placed in a rank queue. As soon as a trade is made, the next best bid and offer become the new 'best' outstanding bid and offer, and

Ketches, Smith, and Williams; Plott and Smith; Williams, Supra, note 25.

Smith and Williams, Supra, note 25,

The rank queue models the specialist's book used in the the New York Stock Exchange.

future bids and offers must "improve" on the queue.[29]

This research has produced important implications for economic analysis. First, the results demonstrate that the simple competitive model can be used to predict the behavior of some real-time markets. Moreover, the institutional rule used by the New York Stock Exchange performs better than a number of alternative institutions studied. More importantly, however, these results show how sensitive the competitive model is to changes in market institutions. In particular, the institution used in a wide variety of consumer markets, seller posted prices, tends to allow prices to remain above equilibrium for several (i.e. more than 4 or 5) trading periods. Prices do eventually converge, but they are slow to adjust once again to changes in parameters. Thus, if demand or supply conditions are changing rapidly in comparison to the length of a "period", this institution will not encourage rapid adjustment to new equilibria.

These experimental results may have substantial policy implications for the naturally-occurring world. However, to assess the importance of the experimental work, one must confront the question of parallelism, discussed briefly above. Recall that the object in designing an experiment is to create a laboratory environment which parallels the essential features of the naturally-occurring environment being modelled.[30] The example discussed above illustrates well the development of an experiment which meets two important criteria for parallelism. First, Smith was able to capture the

[29] For discussions of parallelism. See Plott; Smith (1982); and Wilde, Sypra, note 3, and Hoffman, Marsden, and Whinston; and Campbell and Flake, Supra, note 9.

essential features of a real-time commodity market in a very simple experimental market. Consumer demand and producer supply were induced by the redemption and cost functions and agents contracted to make real, profit-making trades with one another. The blackboard and experimenter performed the role of the trading board. With the addition of New York Stock Exchange rules, the rank queue became the specialist's book.

Second, the double oral auction and the posted offer experimental design satisfy Campbell and Fiske's convergent validity criterion.[31] Many different researchers have run these experiments and gotten almost identical results. Recently, the design has been adapted for use on the PLATO interactive computer system.[32] These experiments parallel the Over-the-Counter Market and the various computerized adjuncts to the commodity markets. While there are some differences between the classroom results and the computer results, the basic conclusions remain unchanged. The double auction converges rapidly to the competitive equilibrium, while the posted offer institution does not.

To the extent that one believes that Smith's work provides a strongly parallel set of experiments to natural auctions -- and we so believe -- the work may have substantial policy implications. First, the results suggest strongly that New York Stock Exchange rules perform better[33] than a number

---

[31] Campbell and Fiske, Supra, note 9.

[32] See, e.g., Arlington W. Williams, Computerized Double Auction Experiments: Some Initial Experimental Results, 53 J. Bus. 235 (1980), and Ketchum, Smith, and Williams, Supra, note 25.

[33] Assuming that speed of convergence to competitive equilibrium prices is an appealing normative property.

of alternative institutions studied. Therefore, there is a strong burden of proof on any proponent of change in the trading rules governing the stock exchange.[34] For example, the proponent of change might run his own set of experiments, designed to show the comparative performance of the suggested rules and the current rules. If his rules performed better in the laboratory than the current rules, there might be a reason to tinker with the existing rules.[35] Otherwise, the suggested changes should, prima facie, be rejected.

Second, the experiments cast strong doubt upon the desirability of any institution with either seller-posted or buyer-posted "take it or leave it" offers, where such offers must remain unchanged for relatively long periods

[34] The object in parallelism is to create a laboratory environment sufficiently close to the naturally-occurring one to put the burden of proof on the critic who would claim that the experimental results are unit-formative because they do not perta a critic of Smith's experimental work on competitive markets would have to show what specific features of commodity or stock markets are left out and then run an experiment including those institutional features. If the critic's results were significantly different from Smith's, then we could say that the original environment had not satisfied the requirement of parallelism. Where subs are also available, it may be possible to test directly for parallelism. See Hoffman, Maraden, and Whinston, Supra, note 9.

[35] If the suggested changes were designed to remedy some "defect" in the market which cannot be replicated in a laboratory setting, then obviously the experimental outcome could not be dispositive. For example, if one were to assert that emotions such as fear of death, or overwhelming lust, somehow distort certain markets, then experiments sight have little to say about such problems. (The purchase of airline ticketa could fit in either category, depending on whether people fear crashing, or desire to be pampered by attractive flight attendants). For various reasons, including the protection of subjects by human subject review boards, one cannot teat such things in laboratory experiments.

of time.[36] Such institutions seem to discourage convergence to equilibrium by otherwise competitive markets, and may facilitate cooperation among a small number of oligopolists. As a result, posted prices may allow either sellers or buyers to earn supranormal profits (depending on which side is posting). Policies encouraging markets to switch to posted pricing are, therefore, likely to make those markets less efficient.

III. FROM EXPERIMENTAL ECONOMICS TO EXPERIMENTAL LAW AND ECONOMICS

The basic methodology discussed and illustrated above can be readily adapted to the study of questions in law and economics.[37] In this section we explain how laboratory experiments can inform research in law and economics. We discuss in greater detail the methodological techniques reviewed above and the important positive and normative conclusions which may be found in this literature.

To anticipate our conclusions, we find that experimental work seems to support at least the following four propositions.

(1) The number of participants in a market may be less important than market institutions (such as auction rules) in encouraging convergence to competitive prices (and allowing maintenance of monopoly).

Consider the filing of tariffs with regulatory bodies. Hong and Plott, Supra, note 15, and Infra, pp. 31-32, discusses an experiment on tariff filing.

Moreover, the strong policy orientation of law and economics makes this technique particularly useful. Although it may be very costly to determine the effects of proposed new policies using social experiments, laboratory experiments provide an inexpensive way to compare proposed alternatives.

(2) Where individuals in conflict can bargain with each other with low transactions costs, the bargaining process seems to produce efficient outcomes in groups of 20 people, end may well produce efficiency in much larger groups.

(3) To elicit individuals' demands for public goods, "incentive-
38
compatible" demand revelation techniques hold much promise, while survey techniques may be used only with great caution.

(4) Markets characterized by imperfect information may produce either competitive or monopolistic outcomes, depending on such variables as the percentage of consumers in the market who shop, and the cost of shopping. A high percentage of shoppers and enforceable warranties seem to promote competition. High shopping costs seem to promote monopoly. Institutional features, such as whether warranties are easily enforceable, effect the dissemination of information in these markets

A. Experiments that Test Existing Theories

Recall that experiments allow researchers to discard a theory which fails on **its own** terms. Because the laboratory provides a simple, controlled environment in which the assumptions of a theory can be replicated, free of the complications of the naturally-occurring environment, a laboratory experiment can give a theory its most favorable test. If a

See discussion at pages 42-49, Infra.

theory does not make consistent predictions in such an environment, it is unlikely to make accurate predictions of events in the more complicated naturally-occurring environment.[39] This was the point of Smith's simple supply and demand experiment.[40] If the simple experiment had not generated competitive equilibrium outcomes, it would have been difficult to continue to argue that the competitive model was an accurate description of naturally-occurring markets.

A series of monopoly end conspiracy experiments[41] illustrates the value of experiments for distinguishing among alternative theories. In the simple supply and demand market illustrated in figure 1, a monopoly outcome might be predicted instead of the competitive equilibrium. Figure 3 illustrates the monopoly prediction as compared to the competitive equilibrium. The monopoly prediction is determined by finding the price-quantity combination (p_m, q_m) which equates marginal cost and marginal revenue. Marginal coat is simply the cost of producing one additional unit of output. Marginal revenue is the additional amount of money a seller can get by selling one more unit of output, taking into account that when he sells another unit.

Again, this presumes that the theory is not premised squarely on some phenomenon, such as fear of death or lust, which cannot be accurately reproduced in the laboratory. See Supra, note 35.

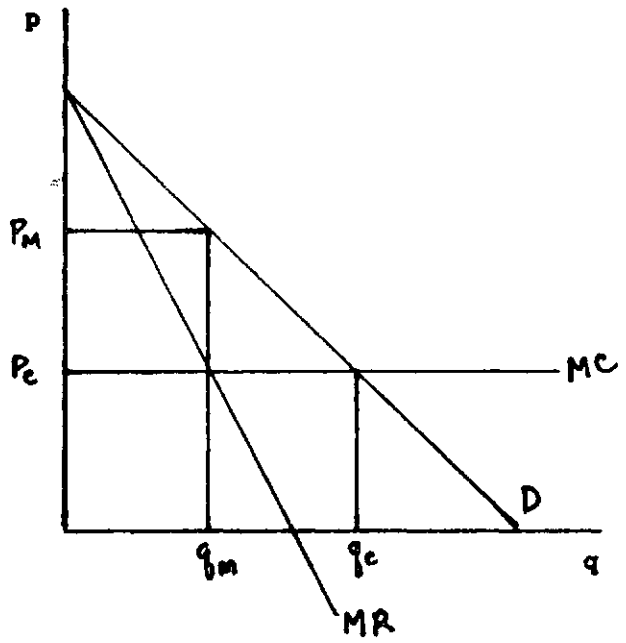
Smith (1962), Supra, note 16.

R. Mark Isaac and Charles R. Plott, The Opportunity for Conspiracy in Restraint of Trade, 2 J. Econ. Behav. and Org. 1 (1961); Vernon L. Smith, An Empirical Study of Decentralized Institutions of Monopoly Restrsint, in Janes P. Quirk (ed.) Essays in Contemporary Fields of Economics 83 (1981); R. Mark Isaac, Valerie Ramey, end Arlington W. Williams, The Effects of Market Organization on Conspiracies in Restraint of Trade, 2 J. Econ. Behav. and Organ. 1 (1981).

the price of ell of his sales will fall a slight amount. A profit-maximizing monopolist (single seller) will always produce exactly to the point where the additional amount of money he gets from selling one more unit is equal to the added cost of producing one more unit. At this point, the monopolist is making as such profit as he can from the entire market. In contrast, competitive firms do not take into account the effect that their additional sales have on the prices of rival firms' sales. As a result, competitors sell until the marginal coat of producing output equals industry demand. As shown in figure 3, if demand is downward-sloping and marginal cost is upward sloping (or horizontal) the monopoly price is always higher and quantity always lower than the corresponding competitive price end quantity. Thus, distinguishing between the models is simply a matter of comparing the experimental outcomes with the two possible predictions.

Figure 3

Comparing the Monopoly and Competitive Model Predictions



Researchers became interested in the question of whether the monopoly model would predict better than the competitive model in two crucial environments which had not been studied in the original double auction or posted-price experiments. First, if sellers could conspire with one another to set a price, would they choose the monopoly price. And, could they maintain whatever price they chose through the operation of either a double oral auction or a posted-offer market? Second, would a single seller be able to find and maintain the monopoly price under either of these market structures?

---

[42] Isaac and Plott, Id.

In the first set of conspiracy experiaents, Isaac and Plott[42] found mixed results under the double oral auction. Some groups of conspirators were able to maintain results significantly different from the competitive equilibrium, although the monopoly price was not, in general, a good alternative predictor, either. On the other hand, over time, prices tended to converge toward the competitive equilibrium, as the conspirators began to compete with one another.

Studying the pure monopoly in a double auction. Smith[43] came to a similar conclusion. Sometimes monopolists were able to maintain the monopoly price, but over time there was a tendency for prices to converge back to the competitive equilibrium. This appeared to happen because buyers would tacitly collude to withhold demand until the monopolist would reduce his offer price. The main difference between the monopoly and the conspiracy experiments was that the monopoly price did predict well in some trading periods when there was only one seller.

The next set of experiments replicated the monopoly and conspiracy experiments under the posted offer institution.[44] While not all monopolists ended up picking the monopoly price, those who did could maintain it under the posted offer institution. Conspirators tended to maintain prices between the monopoly price and the competitive price. Thus, under the posted offer institution, the monopoly model describee the behavior of a single seller, but neither model describes the behavior of a group of con-

---

[43] Smith, Supra, note 41.

[44] Isaac, Ramey, and Williams, Supra, note 41.

spirators.

This set of experiments illustrates another important way that experimental economics can inform research in law and economics. Laboratory experiments allow a policy analyst to compare the effects of two different policies in an environment parallel to the naturally-occurring environment. In the example discussed above, experimental economists compared the double auction and posted offer institutions under monopoly, conspiracy, and free competition. The results suggest strongly that market institutions are at least as important as the number of participants in determining whether monopoly or competitive prices will be observed. In particular, as long as the market is organized as a double auction, it does not seen to matter how many market participants there are. On the other hand, the posted offer institution promotes excess profits even when there are a number of participants on each aide of the market.

These experimental results on market mechanisms have important policy implications for antitrust law. In the past, size of firm and market share ("market structure") have been two of the primary factors determining whether or not a firm is presumed to be in restraint of trade. In addition to these structural inquiries, courts (and commentators' have also examined market institutions, such as posted pricing, to find violations of the antitrust laws. Two of the most commonly discussed market institutions

See, e.g.. Standard Oil Co. v. United States, 221 U.S. 1 (1911); United States v. American Tobacco Co, 221 U.S. 106 (1911); United States v. E. I. du Pont de Neaoura & Co. (General Motors) 353 U.S. 586 (1957); and Brown Shoe Co. v. United States [II], 370 U.S. 294 (1962) Also cite to antitrust division's reliance on the Hirshman-Herfindahl index for merger analysis.

have been "baaing point pricing" and information exchangee. Basing point pricing is a system under which firms only quote delivered prices to consumers. Under some basing point pricing systems, firms may quote prices as if the goods had been shipped from a particular place, such as Pittsburgh, regardless of where the goods were actually shipped from. The information exchange cases almost always involve a trade association which collects information about members' prices, sales volumes, and (sometimes) identity of customers. The industry trade association then releases the information, either in aggregated or individualized fashion, to the members.[46]

These experimental results suggest several important points for the antitrust law. First, market institutions do not merely translate, in unbiased and unchanged fashion, market structure into predictive outcomes. In oligopolistic settings, one must consider both structure and institutions, and how they interact. In the experiments described aboved, the combination of posted prices (institution) and monopoly (structure) produced the greatest level of noncompetitive profits. The experiments also suggest that if a monopolist (structure) operates in an open bidding market (institution), it may have a difficult time making greater than competitive

See American Column & Luaber Co. V. United States, 257 U.S. 377 (1921); Sugar Institute v. United States, 297 U.S. 553 (1936); and United Sates v. Container Corp. of America, 393 U.S. 333 (1969).

There is even some experimental work on fIrms which have economies of scale, but operate with a constant threat of entry. In keeping with the theory of contestable markets, W. J. Baumol, Contestable Markets: An Uprising in the Theory of Industrial Structure, 72 Am. Econ. Rev. 1 (1982), these firms are not able to earn excess profits in a double auction market either. See Don L. Coursey, R. Mark Iaaac, Margaret Luke, and Vernon L. Smith, Market Contestability in the Presence of

profits.[47] In this regard. Justices Douglas and Marshall had exactly the correct type of debate in United Sates v. Container Corp. when they disagreed over whether information exchange agreements (institutions) might facilitate anticompetitive outcomes within a moderately oligopolistic [49] (structure) cardboard container industry. Any analysis which concentrated solely on either structure or institution would be wrong.

Second, the experiments above suggest that even if there ere several, equally small firms operating in a posted-offer environment, they may be able to earn excess profits for some time. This is especially likely if market parameters are changing to the advantage of the firms. Given enough trading periods, these markets do eventually equilibrate. But, they are slow to respond to changes in market parameters and firms earn excess profits in the transition. Thus, any form of posted pricing should be viewed with great suspicion. For example, in Sugar Institute v. United States,[50] manufacturers of sugar agreed, among other things, to issue price lists and stick to the prices on the lists until there was an industry "love" to a new price. A "move" took place when one firm announced, well in advance of the effective date of the price move, that it was thinking of

---

Sunk Costs, 15 Rand J. of Econ. 69 (1984); Don L. Coursey, R. Mark Isaac, and Vernon L. Smith, Natural Monopoly and Contestable Markets: Some Experimental Results, J. Law and Econ. (1983); Glenn W. Harrison and Michael McKee, Monopoly Behavior, Decentralized Regulation and Contestable Markets: An Experimental Evaluation, University of Western Ontario xerox (1984).

[48] Supra, note 46.

[49] Id. at ___.

[50] Supra, note 46.

changing its price for sugar. If all other firms in the industry also announced their intention to move to the new price level, the price for sugar would change. Such a market institution strongly resembles (at least) posted pricing, and, without some very good justification, should be regarded as illegal.[51]

Third, further experimental work night shed a substantial amount of light on some of the central questions of antitrust in these areas. Consider basing point pricing. In Federal Trade Commission v. Cement Institute[52] the Supreme Court upheld the Federal Trade Commission's finding that the use of a basing point pricing system in the cement industry represented an unfair method of competition, and hence violated section 5 of the FTC. Although the court seemed to rest its holding, at least in part, on the reasonable inference of an explicit agreement to use basing point pricing[53] by the competing cement manufacturers, a pair of important questions have remained: 1) To what extent will a basing point pricing system evolve "naturally" in an oligopolistic situation, without an explicit agreement among competitors? and 2) Can oligopolists earn noncompetitive

It was. See Id. at_____.

333 U.S. 683 (1946).

Id. at_____. Recently, the FTC has been rebuffed twice in its attempt to charge that an industry practice of delivered pricing represented and unfair method of competition, even in the absence of any agreement. See also Boise Cascade Corp. v. FTC, 1980-2 Trade Cases at 75,662 (9th Cir. 1980); and E. I. du Pont de Nemours & Co. v. FTC, 46 Anti. & Tr. Reg. Rpt. 347 (2nd Cir. 1984).

See Cement Institute, supra, note 52, (defendants' experts answering 1) "frequently," and 2) unclear); George J. Stigler, A Theory of Delivered

profits using basing point pricing?[54]

On could easily design an experiment to begin to answer question 2. Subjects in a market experiment could be allowed to use a pricing institution which parallels basing-point pricing. The results of that experiment could be compared with the results of a double oral auction with transportation costs.

The first question is much more difficult to answer, however, because any experimental study of the evolution of an institution is suspect. The problem is that once subjects are brought together for the purpose of participating in an experiment, they will do their best to Bake a "good" decision. If a profitable basing-point pricing institution is presented to then they will probably choose it. But, that does not tell us that participants in a naturally-occurring market would invent such an institution. If you ask experimental subjects to invent their own institutions, the basing-point pricing system might be too sophisticated an idea for naive subjects to come up with uncoached. Thus, if they do not invent ***it,*** we cannot conclude that sophisticated firms would not invent it either. If they choose it after coaching we still have not learned much about its occurrence in the naturally-occurring environment.

On the other hand, one could test, in the laboratory, the effect of alternative information exchange institutions. Drawing from the institu-

Price Systems, in The Organization of Industry 147 (1968)(treating baaing point pricing as if it must emerge from a fairly explicit agreement); and George A. Hay, Oligopoly, Shared Monopoly, and Antitrust Law, 67 Cornell L. Rev. 439 (1982)(assuming that baaing point pricing might arise from either explicit agreement or merely oligopolists' awareness of their interdependence).

tions outlined in the cases summarized above,[55] in one experimental treatment subjects in a double oral auction could be given information about aggregate market parameters: e.g., supply or DEMAND curves or mean limit prices. In another experimental treatment, subjects could be given specific information about the limit prices of other individual subjects. These experimental treatments could be crossed with treatments in which subjects could and could not communicate with one another during the course of the experiment. The results of these four experimental treatments could then be compared both with one another and with the results for the double oral auction with no information dissemination or exchange.

A recent paper uses similar experimental techniques to examine a specific policy which was proposed for the Mississippi River barge industry.[56] The industry has traditionally been organized as a telephone negotiation market. There is no list of prices; owners of barges and potential renters haggle over the phone and make individual deals. The railroads had complained to the government that they couldn't compete with the barges since they did not know the barge prices. They requested that the barges be required to post prices every 15 days. Hong and Plott designed an experiment to teat whether the posted-offer telephone market would raise prices above the prices produced by the telephone negotiation market. The design was parallel to the Mississippi barge market down to the last detail: number of firms, distribution of firm sizes, seasonality of demand, elas-

Supra, note 46, and Infra, pp. 27-29.

Hong and Plott, Supra, note 15.

ticity of demand and supply. As suggested by the earlier posted-offer experiments, the institution of the posted offer significantly raised prices over the telephone negotiation market. Thus, their experimental results strongly suggested that the policy proposed by the railroads would have had the net effect of raising barge prices. This result was not favored by the government, however attractive it might have been to the railroads.

The experiment described above cost the government a few thousand dollars and took a few weeks of research time to complete. The same study could not have been done with naturally-occurring data because there was no posted-offer barge market to compare with the telephone negotiation market. The only other way to have learned the consequences of the proposed policy change would have been to conduct a long and costly social experiment in which the new policy would have been tried in the naturally-occurring market for a period of time. Even if that had been done, however, it might not have generated reliable results since the participants in that experiment would have known that the policy change was temporary. The laboratory experiment provided a much more efficient way of suggesting important consequences of the proposed change. Given the strength of the results, the burden of proof was placed on those who claimed that posting prices would not raise barge prices.

Another way that laboratory experiments can inform policy development is by allowing researchers to relax the assumptions of a model or change crucial parameter in a controlled setting. As discussed above, every model which is used to make predictions and develop policy is based on a series

of simplifying assumptions, many of which can never be duplicated in a naturally-occurring environment. In addition, many theories do not generate testable hypotheses unless the parameters of the model are specified. Therefore, one can proceed by running sets of replications of the original experiment, relaxing one assumption or changing one parameter in each new set of experiments. When the model begins to fail to make accurate predictions, we can begin to draw the boundary around the naturally-occurring environments within which the model may be applied. If it continues to make accurate predictions, even though the strict assumptions and parametric specifications are no longer satisfied, we may say that the model is a widely useful policy tool.[57]

A series of experiments by the authors illustrates this particular technique.[58] The Coase Theorem,[59] which is the cornerstone of the laissez-faire position in law and economics,[60] states that parties who can harm one another, but who can also negotiate with one another, will bargain to the same, efficient, outcome regardless of which side has the legal right to

---

[57] In economics we say that economic agents behave "as if" the assumptions of the model were satisfied.

[58] Elizabeth Hoffman and Matthew L. Spitzer, The Coase Theorem: Some Experimental Tests, 25 J. Law and Econ. 73 (1982); Hoffman and Spitzer, Supra, note 12.

[59] Ronald Coase, The Problem of Social Cost, 3 J. L. Econ 1 (1960).

[60] Richard A. Posner, Economic Analysis of the Law (2nd ed., 1977) outlines the laissez-faire position and Mark Kelman, Production Theory, Consumption Theory, and Ideology in the Coase Theorem, 52 S. Cal. L. Rev. 669 (1979) attacks that position. Kelman's paper is discussed in Matthew L. Spitzer and Elizabeth Hoffman, A Reply to Consumption Theory, Production Theory, and Ideology in the Coase Theorem, 53 S. Cal. L. Rev. 1187 (1980).

inflict harm. This statement can be shown to be true under a set of specific simplifying assumptions: a) two agents to each bargain, b) perfect knowledge of one another's (convex) production and profit or utility functions, c) competitive markets, d) zero transactions costs, e) costless court system, f) profit-maximizing producers and expected-utility maximizing consumers, g) no wealth effects, h) agents will strike mutually advantageous bargains in the absence of transactions costs.[61]

We began our research with a simple two-person, full information experimental design, which was able to control for all except assumption h). Assumption h) cannot be controlled for because it refers to subject motivation. First, we brought two people who were not close friends into a room and called one of then "A" and the other "B". Then we told them that their task was to choose a number from a list of numbers. Depending on which number was chosen, we would pay then different amounts of money. Table 1, below, gives a payoff chart, showing how much each subject would receive for each possible number between 1 and 7. Thus, if 1 were chosen, A would be paid nothing and B would be paid $12.00. If 2 were chosen, A would be paid 94.00 and B would be paid 910.00. Finally, if 7 were chosen, A would be paid 912.00 and B would be paid nothing.

[61] Hoffman and Spitzer (1982), Supra, note 58, discusses these assumptions in some depth.

Table 1

Two-person Payoff Chart

Number	A's Payoff	B's Payoff
1	$0.00	$12.00
2	4.00	10.00
3	6.00	6.00
4	7.50	4.00
5	9.00	2.50
6	10.50	1.00
7	12.00	0.00

Next, we chose one of the participants, by a coin flip, to be "controller." The controller had the absolute "legal" right to choose whichever number he or she wished, regardless of the other participant's wishes. The other subject, who had lost the coin flip, was allowed to try to influence the controller to choose a mutually agreeable number, perhaps by offering to pay part of his or her earnings to the controller. We provided a standard form contract to the subjects to facilitate agreements and guaranteed that the contract would be enforced if both participants signed.

Notice that, within the payoff structure listed above, number 2 provides the highest total joint payoff to A and B: $14.00. The Coase Theorem predicts that regardless of how property rights are initially distributed, the parties will contract so as to maximize profits. In other words, within the context of this experiment, regardless of who wins the

coin flip, subjects will agree to choose number 2. Hence, we were able to use the rate at which the parties chose number 2 as the predictive power of the Coase Theorem.

The result was that every pair of subjects chose the joint profit-maximizing number. This result provides a strong presumption in favor of the Coase Theorem within the strict environment defined by the assumptions of the model, but it doesn't indicate whether the theorem can be widely used in naturally-occurring environments. To find out whether the theorem can be more widely applied, we ran a series of replications where we increased the number of bargainers up to 20 to a group and reduced the amount of information given to the subjects at the beginning of the experiment. In addition, we ran parallel experiments in which each pair of subjects only made one decision with one another.

The overall results are striking: more than 90% of the bargaining groups in almost every set of experiments chose the joint maximizing number. Under full information it was more than 95% and with large groups it was 100%. Thus, the presumption in favor of the Coase theorem can be extended to include moderately large bargaining groups under limited information. While we have not extended our design to larger groups, or relaxed other assumptions, we have provided strong evidence that the Coase theorem will not fail merely because of the need for a moderately large group of people to strike a bargain. Contracts involving as many as 20 parties would seem to include a fairly large class of naturally-occurring environments. It may be applicable in an even larger class.

Our experimental work on the Coase Theorem clearly has application to contract and tort law. If parties who can do harm to one another will bargain to an efficient allocation of harm without court intervention, then the court should simply decide which side is a nuisance and set an injunctive rule, leaving damage settlement up to private dispute. An example constructed from our previous two papers[63] will help illustrate this point. We begin with a quote from our original paper.[64]

> The choice of remedies for the area of nuisance law provides a good example. Assume that a particular new land use, for example, a cement factory, interferes with other land uses, for example, home-owning, so as possibly to constitute a "nuisance" under the law. Regardless of whether the court finds the new factory to be a nuisance, the court must confront the thorny issue of whether to grant the winning aide the right to an injunction or to halt that side to a damages remedy. These are the two injunctive remedies, which were modeled in our experiment, from which the court must choose: (1) Factory's right -- the factory may pollute at any level it chooses. (2) Homeowner's right -- any homeowner is entitled to an order of the court directing the factory to emit no pollutants. The court may also choose from these two damages remedies:
>
> (1a) Factory's right -- the homeowners may obtain an order of the court directing the factory to emit no pollutants if and only if the homeowners pay the factory all damages it suffers from reducing its level of pollution. (2s) Homeowner's right -- the factory may pollute at any level it chooses, but it must pay homeowners for any damage caused by the pollution.
>
> These are problems associated with both damages and injunctive remedies. Injunctive relief may be inefficient because bargaining may fall to achieve Pareto optimality. Damages remedies are plagued by the difficulty of accurately appraising damages and the increased administrative costs associated with such a valuation. Where there is

In addition to the work by Hoffman and Spitzer, Supra, notes 12 and 58, there is a follow-up paper by Glenn W. Harrison and Michael McKee, Experimental Evaluation of the Coase Theorem, Journal of Law and Economics (forthcoming).

Hoffman and Spitzer, Supra, notes 12 and 58.

Hoffman and Spitzer (1982), Supra, note 58.

> only one cement factory and one homeowner, the risk associated with injunctive entitlements - the failure of contracting -- has been thought to be low.
>
> (footnotes omitted, pp. 96-97)

In our second paper, we reflect on how our large bargaining group results help us decide what rule to choose. We claim in that paper that our results are applicable for bargaining groups with up to 19 parties on each aide. We make this claim for two reasons: (1) All of our large, symmetric experiments, i.e. 5 subjects pitted against 5 subjects, produced highly efficient results; and (2) our experiments which pitted 19 against 1 produced 100% joint-profit-maximizing choices.[66]

> Our experimental results suggest that even with a substantial (38) number of parties to a nuisance dispute, a court should presume that the Coase Theorem will work. Hence, unless someone were to show that there la some reason to believe that bargaining will not work, the court should presume that the parties will get together and contract, so as to exhaust all gains from trade.
>
> If the court were to find that the factory is not a nuisance, it should choose rule 1 (instead of la), which would allow the factory to pollute unless the homeowners secure the factory's agreement to reduce pollution. The presumption is that the factory and homeowners will agree on the optimal level of pollution, and the homeowners will pay the factory some money if pollution is reduced.

Hoffman end Spitzer (1964), Supra, note 12.

Again, someone should be allowed to make his case that some phenomenon which cannot be replicated within the laboratory setting (e.g. fear of death, lust) impeaches the application of the laboratory results to the real world.

> Alternatively, if the court were to find the factory was a nuisance, the court should choose rule 2 (instead of 2a). Rule 2 would prevent the factory from polluting unless it got the permission of the landowners. Again, the presumption is that the factory *and* the landowners will agree on the optimal level of pollution, only this time the factory will either pay the homeowners some money or pay the full coat of cleanup.
>
> (pp. 23-25)

B. Experiments That Suggest the Development of New Theory

Up to now we have discussed ways that laboratory experiments can help to teat established theories and define the parameters under which those theories can be applied. However, data from laboratory experiments may also provide evidence for theory development. Where experimental results do not strongly confirm a theory, or where they suggest limitations of a theory, analyais of the experimental results may help to formulate a new set of hypotheses (which can then be tested themselves).

This role for experiments has already proved valuable in experimental economics. One important line of research has sought to develop a model of a real-time competitive market process. As mentioned above, before the aeries of competitive market experiments was undertaken, the competitive model was a static equilibrium model. There was no room in the theory for a sequence of trades, many of which night be conducted at disequilibrium prices. In the past few years a number of theorists have analyzed the 20 years of experimental data on the double auction in an effort to develop a real-time model of how the double oral auction works.[67]

Another line of research which Illustrates the link between experiments

Easley and Ledyard; Friedman, Supra, note 14.

and theory development is a University of Arizona study of individual[68] bidding experiments. The study began as a caparison of oral and sealed-bid auctions for single objects, where each bidder has some private value for the object being auctioned off. There are four prototypical auction mechanises. The two oral auctions are the English auction, in which bidders raise the price until all but one drops out, and the Dutch, in which the price is lowered until one bidder accepts. The two sealed-bid auctions studied were the first-price auction (winner, who is the highest bidder, pays his own bid price) and the second-price auction (winner, who is the highest bidder, pays second-highest bid price). The theory of auctions[69] being tested originally predicted that the English and second-price auctions would yield identical results and the Dutch and first-price auctions would yield identical results. The experimental results confirmed the isomorphism between the English and the second-price auctions, but the

---

[68] James C. Cox, Bruce Roberson, and Vernon L. Smith, Theory and Behavior of Single Object Auctions, in Vernon L. Smith (ed.) 2 Research in Experimental Economics 1 (1982); James C. Cox and Vernon L. Smith, Equilibrium Bidding Behavior When Some Bidders May be Risk-Preferring, University of Arizona xerox (1983); James C. Cox, Vernon L. Smith, and James C. Walker, Tests of a Heterogeneous Bidders Theory of First Price Auctions, 12 Econ. Let. (1983); Why Are Not the Dutch and First Price Auctions Isomorphic?, J. Econ. Organ. and Behav. (forthcoming); Individual Bidding Behavior and Theories of the First Price Auction, University of Arizona Xerox (1983); Auction Market Theory of Heterogeneous Bidders, 9 Econ. Let. 319 (1982).

[69] W. Vickrey, Counterspeculation, Auctions, and Competitive Sealed Tenders, 16 J. of Fin. 8 (1961)

[70] The problem with the Vickrey model is that it assumes bidders are <u>risk neutral</u>. The assumption of risk neutrality means that subjects are assumed to be indifferent between receiving a sum of money for certain and having the chance to play a lottery with an expected (average)

Dutch and first-price auctions were significantly different. Analysis of the bidding behavior of individual subjects has led to the development of a new, richer theory of bidding and auctions.[71]

C. Experiaents Which Aid in the Design of New Institutions

A new, exciting, and potentially rewarding avenue of inquiry involves using experiments to help design new institutions. Many real world institutions have (what many suspect are) substantial flaws, and one is tempted to suggest replacing the existing institutions with new, "improved" ones. However, before one replaces the old with the new, one must be clear how the new institution will actually work. The new institution might turn out to be even worse than the existing one. A laboratory experiment can be used

value equal to that certain amount of money. This is contrasted with risk aversion (strict preference for the certain sum of money) and risk preferences (strict preference for the lottery)

Attitudes towards risk do not affect decisions in the English and second-price auctions because it is always best to bid your true value in those auctions. The reason is that you never have to pay your true value if you win. In the English auction you pay just enough more than the second-highest price to get the second-highest valuation participant to drop out. In the second-price auction you pay exactly the second-highest bid. Since you don't have to pay your true value, the best you can do is always bid your true value. If you bid less, you might lose, even though you would have been willing to pay more. If you bid more you might win and have to pay more than you are willing to.

However, in the Dutch and first-price auctions there is risk involved. If you bid your true value you have to pay it and you get zero profit, but if you bid less you might lose the object. In the Dutch auction, there is a "beat-the-clock" game element in addition. Subjects who are risk averse or risk preferring might play the Dutch auction game differently than they would bid in the first-price auction.

Cox and Smith; and Cox, Smith, and Walker, Supra, note 68. This new theory of bidding allows for both risk aversion and risk preference as well as for risk neutrality. As is the case with most recent theoretical developments in economics, however, this theory is too mathematical to summarize neatly in plain English.

at this point to help predict the likely performance of the new proposed institution before one actually starts modifying our real world institutions. Social experiments which have been tried indicate many of the poten-

72

tial costs such modifications entail. Of course, there are many inherent Halts to the sorts of phenoaena which can be explored, and the sorts of institutions which can be evaluated in the laboratory. However, for those institutions which can conveniently be investigated in the laboratory, experiments may provide an extremely inexpensive tool for the design of institutions.

An important line of theoretical research on institutional design has focused on the design of "incentive-compatible" mechanisms both for the allocation of public goods and for regulatory policy. These mechanisms are designed to solve the free-rider problem, in the case of public goods, and principal-agent problems, in the case of regulation.

First, consider public goods. The government might use the following simple approach to decide both whether to provide a public good, and how much to assess each citizen in the event that the public good is to be provided. The government asks each citizen how much he would be willing to pay for a public good. If the sua of citizens' responses exceeds the cost of providing the good, provide the good and assess each citizen the amount he said he would be willing to pay. If the sum of the responses is less

The most famous social experiment was the New Jersey and Pennsylvania income maintenance experiment in 1968-1972. See D. Kershaw, A Negative-Income-Tax Experiment, 227(4) Sci. Am. 19 (1972) for a description of the experiment. Also see Symposium: The Graduated Work Incentives Experiment, 9 J. Hum. Res. 156 (1974).

than the cost of the public good, provide no good and assess no one anything. Under such a system, each person has an incentive to underrepresent his true preferences because each person has an incentive to free ride on the amounts other individuals are willing to provide.[73] Unfortunately, if enough people underrepresent their demands for the public good, the government may not provide it, even though the citizens would be willing to pay in excess of its cost.

A similar problem may arise in the case of regulation, where a regulated firm may be able to increase its profits by misrepresenting itself to the government. This will be true if the firm has private information which the regulatory agency may not be able to obtain. For example, consider the case of a polluting firm, about which the government seeks information regarding discharge levels and associated cleanup costs. If the firm knows this information, and believes that the the government will allow more waste discharge if the government believes it is extremely expensive to clean up waste, the firm may have an incentive to misrepresent its costs to the government. The firm will claim that it is much more expensive to reduce waste discharge levels than in fact it is. If all firms dissemble in this fashion, the government will make decisions based on bogus information. One goal in developing legal polic decisions and regulatory policy is to find mechanisms which encourage people to reveal the truth about themselves. Such mechanisms are generally

73 Our Coase experiments suggest that if the number of subscribers to a public good is not too large, an appropriate mechanism might be to bring people together to form a bargain. For larger groups that may not be feasible, however.

termed "demand-revealing" or "incentive-compatible."

The experimental work in this area is based on two related lines of theory. Incentive-compatible mechanisms for the provision of public goods stem from the observations about the English and second-price auctions discussed above. In those auctions the participant always bids his true value because what he pays is not a function of what he bids.[74] Incentive-compatible mechanisms for the allocation of public goods are based on the same idea: an individual's responses are used to determine whether or not the public good will be provided, but the size of the individual's tax bill is a function of the responses of other people.

Unfortunately, there is a fundamental limitation on the possibilities of incentive-compatible mechanisms. Green and Laffont[75] show that it is impossible to get both truth-telling as a dominant strategy and budget-balance. In other words, either the system may fail to generate the tax revenues which are needed to fund the public project, or the system will give individual an incentive to misrepresent their preferences, particularly if other people are also doing so. Groves mechanisms[76] have the dominant strategy property, but they do not collect enough taxes to cover

74 A strategy which is best, regardless of what strategies other people choose, is called "dominant." Not all games have dominant strategies.

75 Jerry R Green and Jean-Jacques Laffont, Incentives in Public Decision Making (1979),

76 This title is suggested in Green and Laffont, Ibid., and refers to work by Theodore Groves, Incentives in Teams, 41 Econometrica 617 (1973); Information, Incentives, and the Internalization of Production Externalities, in S. Lin (ed.) Theory end Measurement of Economic Externalities (1976); Theodore Groves and M. Loeb, Incentives and Public Inputs, 4 J. Pub. Econ. 211 (1975).

the cost of building the public good. Other Mechanisms[77] do not have the dominant strategy property, but they do balance the budget. In order to balance the budget, these mechanisms must base an individual's payment indirectly on his own response. As a result, these mechanisms are incentive-compatible only in the sense that if everyone else tells the truth,[78] then a citizen's best strategy is also to tell the truth.

Under such circumstances there are at least two obvious routes to follow for the governmental provision of public goods. First, one can try to develop decentralized bidding-type mechanisms. These mechanisms cannot be "perfect," but may still have some appealing properties. Second, one could resort to survey techniques, and then base governmental action on the survey responses. Experimental work has pursued both directions.

Vernon Smith pioneered experimental research on incentive-compatible mechanisms.[79] He has developed an experimental mechanisms—which he calls the auction mechanisms--which is not incentive-conpatible, but which per-

[77] See, e.g., Theodore Groves and John Ledyard, Optimal Allocation of Public Goods: A Solution to the "Free Rider" Problem, 45 Econoaetrica 783 (1977); symposium on demand-revealing mechanisms, Public Choice (1976); Brian R. Binger and Elizabeth Hoffman, Nonlinear Prices, Auxiliary Markets, and the Optimal Provision of Public Goods, Purdue University xerox (1984).

[78] A set of strategies which is best for each participant only as long as everyone else sticks to his strategy in the set, is said to be a "Nash equilibrium."

[79] Vernon L. Smith, Experiments with a Decentralized Mechanism for Public Good Decisions, 70 Am. Econ. Rev. 584 (1980); An Experimental Comparison of Three Public Good Decision Mechanisms, 81 Scan. Econ. Rev. 1 (1979); Incentive Compatible Experimental Processes for the Provision of Public Goods, in Vernon L. Smith (ed.) 1 Res. in Exp. Econ. 59 (1979).

forms very well in leading subjects to choose the optimal amount of a public good. The auction mechanism is an iterative process designed to encourage those who would benefit from a public good to reach agreement about the size of a public good and the share of its cost each participant will bear. At each round, each participant proposes a size and a personal coat share. If the sua of cost shares is sufficient to provide the means quantity proposed, the auctioneer sends a new cost share, which is a function of the other participant's responses, and the mean quantity as a proposal to each participant. Participants are then asked to bid and propose sizes again. If everyone repeats the auctioneer's proposal, they vote on whether to accept it. If some participants do not either repeat it or accept it, the auctioneer makes another proposal based on their responses. They continue until everyone accepts the auctioneer's latest proposal. Acceptance of such a proposal means both that they agree on a quantity, and that they agree to pay enough in total to provide that quantity.

As long as the participants have the time to spend in such an iterative decisionmaking process, an auction mechanism has much appeal, for it is at once both cheap and quite sophisticated. In addition, there is no particular stumbling block to utilizing these types of mechanism in the real world. In fact, the Public Broadcasting System already uses a somewhat different iterative mechanism to decide which programs to purchase and

John A. Ferejohn, Robert Forsythe, and Roger Moll, An Experimental Market for Public Goods: The PBS Station Cooperative, 66 Am. Econ. Rev. (1976); An Experimental Analysis of Decision Making Procedures for

distribute to member stations. The challenge now is to create a mechanism which is both incentive-compatible and simple to implement.[81]

Regardless of how good iterative mechanisms turn out to be, there will still be a place for survey data. In many circumstances, where large numbers of people are involved, it will still be easier to ask people how much they would be willing to pay. A recent study by Coursey, Hovis, and Schultz[82] at the University of Wyoming suggests that it may be possible to use surveys for some purposes. They used an incentive-compatible technique taken from the theory of optimal auctions to show that participants could be made to give equal responses to two questions which usually generate very different responses. Typically, survey researchers find that if people are asked how much they are willing to pay to use a good, they give a low number. However, if they are asked how much they would have to be paid to give up a right to use the good in question, they typically give a high

81 Discrete Public Goods: A Case Study of A Problem in Institutional Design, in Vernon L. Smith (ed.) 1 Res. in Exp. Econ. 1 (1979). The PBS Station Cooperative uses a mechanism in which the Center offers a menu of programs to each station and a proposed set of prices each station would have to pay in order to get each program. The prices are designed to cover the cost of providing each program. At each round, each station indicates which programs it will buy at those prices. The Center tries out different sets of prices and different menus of programs until the member stations come to agreement on a basic menu and a set of prices which cover the cost of providing that menu. Prices and menus are changed according to an algorithm which all the stations know.

Binger and Hoffman, Supra, note 77, develops a mechanism which may satisfy these conditions. Experimental work with Arlington W. Williams is currently under way.

82 Don L. Coursey and William D. Schultz, The Application of Laboratory Experimental Economics to the Contingent Valuation of Public Goods, University of Wyoming xerox (1982); John J. Hovis, Don L. Coursey, and William D. Schultz, A Comparison of Alternative Valuation Mechanisms for Nonnarket Commodities, University of Wyoming xerox (1983).

number. This illustrates the incentive problem in surveys quite graphically. People may underreport willingness to pay and overreport how much they would have to be paid.[83]

Coursey, Hovis, and Schultz[84] allowed subjects to sample some sucrose octa-acetate (SOA), a bitter tasting but otherwise innocuous liquid. The experimenters then divided the subjects into two groups. One half of the subjects were asked to reveal how much they would have to be paid to agree to taste some more SOA. (This is analogous to an asking price.) The other half were asked to reveal how much they would be willing to pay to avoid having to taste more SOA. (This is analogous to a bid price.) Each group was further divided into a "hypothetical" and a "real" group. The hypothetical groups were told their prices were totally hypothetical: they would not have to taste more SOA.

In the real asking price group the four subjects who asked the smallest amount to taste more SOA would actually taste some more. However, these four subjects would be paid the amount of the fifth lowest asking price (which would be, of course, more than any of them would have asked for). In this way, the outcome (whether or not one tastes more SAO) and the price are split up, and participants are lead to reveal their true values. The

---

[83] Knetch and Sinden, Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value, Quar. J. Econ (forthcoming), finds this result. There are also some theoretical rationales which suggest that bid and ask prices actually may be substantially different. See generally Kelman, Supra, note 60. No data has yet resolved this issue. The survey study, reported below, casts some additional doubt on the hypothesis that bid and ask prices differ.

[84] Supra, note 82.

real bid price subjects were told that the four highest bids would have to taste more SOA, but they would only pay the fifth highest bid (which would be lower than any of their bids).

Subjects hypothetical asking prices were far more than their hypothetical bid prices. In contrast, subjects reported essentially equal bid and asking prices in the incentive-conpatible auction. And, perhaps most significant, the bid and asking prices reported in the auction essential equaled the hypothetical bid price. Only the hypothetical asking price differed dramatically from the other three figures. The experimenters concluded that willingness-to-pay responses may not be as underreported as researchers had thought. Rather, selling prices may simply be severely overreported. They suggest that cautious use of survey techniques may be appropriate if only willingness-to-pay questions are asked.

While the work on incentive-compatible public goods allocation mechanisms has been going on for some time, experimental work on regulation is just beginning. This work also holds substantial promise, but it is too

Harrison end McKee Supra, note 47, use a second-price auction to sell a franchise right to be a monopoly to one of several competing firms. They find that the winning firm can be induced to charge the coapetitive price with a mechanism that ends up balancing the budget.

Other regulation experiments include a study of the effect of different liability rules on audit fees, Douglas V. DeJong, Robert Forsythe, and Wilfred C. Uecker, The Effects of Alternative Liability Rules and the Public Disclosure of Audit Fees on the Price and Quantity of Audit Services: A Laboratory Market Study, University of Iowa working paper #84-4 (1984) a study of the effect of average price regulation on the market performance of regulated industries, Andrew E. Daughety and Robert Forsythe, Regulatory-Induced Industrial Organization: A Laboratory Investigation. University of Iowa xerox (1984). and a study of the effect of different liability rules on the warranties offered to purchasers of consumer durables. Thomas R. Palfrey and

early to form any general conclusions.[85]

D. Other Experiments With Important Implications for Legal Policy

Another line of research with important implications for legal policy deals with the extent to which consumers search and infer prices or quality in a market in which either price or quality is a random variable. A strong criticism of the competitive model has come from those who claim that it might work well if market prices and quality were known with certainty, but the presence of uncertainty allows firms to earn excess profits from uninformed consumers. These critics suggest that markets with a substantial degree of uncertainty should be regulated to protect unsuspecting consumers. The laissez-faire reply to this criticism argues that the shopping behavior of the informed consumers will force prices to converge to the competitive equilibrium and thus reveal true quality differences in differences in price.[86]

Thomas Romer, An Experimental Study of Warranty Coverage and Dispute Resolution in Competitive Markets, Carnegie-Mellon xerox (1984).

[86] The formal, theoretical models of consumer search come in all sorts of varieties, and produce many different predictions. See Louis Wilde and Alan Schwartz, Equilibrium Comparison Shopping, 46 Rev. Econ. Stud. 543 (1979); and Alan Schwartz and Louis Wilde, Imperfect Information, Monopolistic Competition and Public Policy, 72 Am. Econ. Rev. 18 (1982).

[87] David M. Grether, Alan Schwartz, and Louis L. Wilde, Uncertainty and Shopping Behavior, CALTECH Social Science Working paper #459 (1983); Michael E. Lynch, Rosa M. Miller, Charles R. Plott, and Russell Porter, Product Quality, Informational Efficiency, and Regulations in Experimental Markets, CALTECH Social Science Working Paper #518 (1984); Rosa M. Miller and Charles R. Plott, Product Quality Signalling in Experimental Markets, CALTECH Social Science Working Paper #447 (1982); Carolyn Pitchick and Andrew Schotter, The "Big Lie" Hypothesis in

Several quite different experimental studies[87] tend to give some support to the laissez-faire position if a high enough proportion of consumers can shop and if shopping is not too costly. However, the results also suggest that strict enforcement of warranties can significantly improve the performance of these markets.

Grether, Schwartz, and Wilde[88] ran a series of experiments to distinguish among a variety of shopping models. In each replication they systematically varied the percentage of consumers who shop, and the cost of shopping, and then observed the distributions of prices charged in the (experimental) market. The different models made different predictions about the price distributions which should be observed. They found they could generate any of the following price distributions, depending on the proportion of shoppers and the cost of search: only the monopoly price, a price distribution consisting of the both the monopoly and either the competitive price or a price in between, and only the competitive price. Only the competitive price occurred when 64% of the buyers shopped and shopping was relatively inexpensive. The monopoly price obtained when shopping was prohibitively costly. And, intermediate conditions produced intermediate distributions.

Two other papers, one by Lynch, Miller, Plott and Porter and the other

---

Markets with Asymmetric Information: An Experimental Study, New York U. xerox (1983); Charles R. Plott and Louis Wilde, Professional Diagnosis vs. Self-Diagnosis: An Experimental Examination of Some Special Features of Markets with Uncertainty, in Vernon L. Smith (ed.) 2 Res. in Exp. Econ. 63 (1982).

[88] Id.

by Miller and Plott, have investigated the efficiency of markets in signalling and providing quality differences, with and without warranties. They found that buyers were able to distinguish quality differences from price signals quite quickly, suggesting that disclosure rules might not be necessary. On the other hand, unless warranties were strictly enforced, these markets tended to degenerate into single, low quality markets, even though everyone would be better off if high quality goods were also available.[90]

[91]

Two other papers are concerned with the question of whether sellers of diagnostic and repair services are able to profit by lying to consumers because the sellers have superior information and are in the position of advising consumers. The authors were particularly concerned about doctors and automobile repair shops, because in both cases the consumers are generally uninformed, but are in position to get a second opinion before an

---

[89] Supra, note 87.

[90] This finding lends support to the famous market for lemons example, George A. Akerlof, The Market for Lemons: Quality Uncertainty and the Market Mechanism, 84 Quar. J. of Econ. 488 (1970), in which only poor quality goods are sold. This happens because consumers come to believe that only poor quality goods will be available and, consequently, only express a demand for low quality goods.

In the experiment, buyers learned that some goods represented as high quality really were low quality. Since a seller would lose by representing a high quality good as low quality, buyers found they could trust that low quality goods really were low quality and at least make some profit on their purchase. Thus, since they might lose profit by purchasing a high quality good, buyers came to demand only low quality goods. The introduction of strict warranty enforcement meant that buyers were guaranteed a high quality unit if they purchased one. With strict warranties these markets did develop signalling equilibria in which high quality units consistently sold for a higher price.

[91] Pitchick and Schotter; Plott and Wilde, Supra, note 87.

action is taken. The "big lie" hypothesis, as interpreted by both sets, of authors, predicts that sellers will always recommend a major, more costly, repair, regardless of the true diagnostic clues. Both studies found no evidence to support the "big lie" hypothesis. Buyers tended to get second opinions and sellers tended to make truthful recommendations. Sellers who deviated much from the majority opinion were simply not patronized. The only problem with these markets seemed to be that sellers might become too conservative because they feared loss of business if they deviated from the average.[92]

V. CONCLUSIONS AND FUTURE RESEARCH IN EXPERIMENTAL LAW AND ECONOMICS

We have reviewed in some detail the methodology of experimental economics, and have summarized some of the more important substantive results, particularly as they apply to law and economics. These results are probably important enough, and cost little enough to generate, that scholars should be encouraged to use experimental techniques, particularly in areas which generate strong policy-oriented interest. While these techniques are widely-used in economics, they are only just beginning to be used in law and economics. The emphasis on policy in law and economics makes experiments an obvious tool for future empirical research. We hope

[92] These experimental results should be used with care, for they deviate so strongly from the accepted social wisdom (at least regarding auto mechanics.) Perhaps one should ask if there is some essential feature of the auto repair market which was not captured in these experiments. Do auto owners shop with respect to such purchases? Do auto mechanics discriminate between regular customers and one-shot customers? Or is something else going on? Until one feels comfortable with the answers to these questions, he should proceed with caution.

that this brief introduction to the field will encourage other legal scholars to try this valuable and exciting research tool.

Much of the research discussed above was neither done by legal scholars nor designed specifically to test or investigate theories in law and economics. The exceptions to that statement are the works on the Coase Theorem,[93] on shopping behavior,[94] and on the effect of liability rules on warranties.[95] As more legal scholars become interested in incorporating laboratory experiments into their empirical work, we should begin to see more direct testing of legal theory and the development of new legal

[93] Hoffman and Spitzer, Supra, notes 12 and 58; Harrison and McKee, Supra, note 62.

[94] Wilde and Schwartz, Supra, note 86.

[95] Palfrey and Romer, Supra, note 85.

[96] We are currently working with Glenn Harrison and Michael McKee on some extensions of the Coase experimental design to other questions of interest in law in economics. Two projects are currently under way. In one we are comparing Pigouvian taxes and Coasian bargains as ways of getting markets with externalities to produce the efficient levels of those externalities. In a recent paper, Charles R. Plott, Externalities and Corrective Policies in Experimental Markets, 93 Econ. J. 106 (1983), reports experimental results that show that if the correct Pigouvian tax is imposed, markets with externalities do produce the efficient amount. We propose to replicate that experiment, only allowing market participants to decide how much of the externality will be allowed and who will pay whom for any costs imposed.

The other experimental project is designed to test Cooter, Marks, and Mnookin's theory of bargaining in the shadow of the courts. R. Cooter, S. Marks, and R. Mnookin, Bargaining in the Shadow of the Law: A Testable Model of Strategic Behavior, 11 J. Leg. Stud. 225 (1982). In this experiment subjects will bargain on a computer against a programmed opponent. Subjects, however, will not know their opponents are not other subjects. The basic experimental design is adapted from experiments on reputations in bargaining by Roth and Schoumaker. Alvin E. Roth and Francoise Schoumaker, Expectations and Reputations in Bargaining: An Experimental Study, 73 Am. Econ. Rev. 362 (1983).

theories based on the experimental results.

Each subject will be allowed a set number of rounds of bargaining against an opponent which will be programmed to reduce its demands each round. The subject and the computer will propose a division of the profit at each round and if the computer's demands for itself plus the subject's demands for himself sum to less than or equal to 100%, the case will be said to be settled out of court. If after the set number of rounds the total requested still exceeds 100%, the case goes to court and each side gets half a reduced profit. At each round of bargaining the profit will be reduced as well. The initial set of experiments will test Cooter, Marks, and Mnookin's theory that changes in court settlement costs and round-by-round costs will result in predictable changes in the proportion of suits which come to trial.

EXPERIMENTAL LAW AND ECONOMICS BIBLIOGRAPHY

J. Allison, Demand Economics and Experimental Psychology, 24 Behavioral Science 403 (1979).

Raymond C. Battalio et. al., Commodity-Choice Behavior with Pidgeons as Subjects, 89 Journal of Political Economy 67 (1981).

Raymond C. Battalio et. al., An Experimental Investigation of Consumer Behavior in a Controlled Environment, 1 Journal of Consumer Research 52 (1974).

Raymond C. Battalio, Leonard Green, and John Kagel, A Test of Consumer Demand Theory Using Observation of Individual Consumer Purchases, 11 Western Economic Journal 411 (1973).

Raymond C. Battalio, John H. Kagel, Howard Rachlin, and Leonard Green, Individual and Market Bidding Behavior in a Vicery First Price Auction: Varying Market Size and Information, Texas A and M xerox (1983).

Raymond C. Battalio, C. Kogut, and J. Meyer, Income-Leisure Tradeoffs of Animal Workers, 71 American Economic Review 621 (1981).

Max Bazernan and William Samuelson. The Winner's Curse: An Empirical Investigation, Journal of Conflict Resolution (forthcoming).

Meyer W. Belovicz, Sealed-Bid Auctions: Experimental Results and Applications, in Vernon L. Smith (ed.), 1 Research in Experimental Economics 279 (1979).

Hans P. Binswanger, Attitudes Toward Risk: Experimental Measurement in Rural India, 62 American Journal of Agricultural Economics 395 (1980).

T. Bohm, Estimating Demand for Public Goods: An Experiment, 3 European Economic Review 111 (1972).

Yale M. Braunstein and Andrew Schotter, Labor Market Search: An Experimental Study, 20 Economic Inquiry 133 (1982).

R. A. Brealey and S. D. Hodges, Playing with Portfolios, 30 Journal of Finance 125 (1975).

D. M. Brookshire, M. Thayer, William Schultz, and Ralph C d'Arge, Valuing Public Goods: A Comparison of Survey and Hedonic Approaches, 72 American Economic Review 165 (1982).

Earl R. Brubaker, Thirteen Percent Golden Rules, Sixteen Percent Free Ride, and Seventy-one Percent Free Revelation: An Experimental Test of the Free-Rider Hypothesis,

John A. Carlson, The Stability of an Experimental Market with a Supply Response Lag, 33 Southern Economic Journal 299 (1967).

John A. Carlson and T. B. O'Keefe, Buffer Stocks and Reaction Coefficients: An Experiment with Decision Making Under Risk, 36 Review of Economic Studies 467 (1969).

Ralph Caasidy, Auctions and Auctioneering (1967)

J. Cassing and R. W. Douglas, Implications of the Auction Mechanism in Baseball's Free Agent Draft, 47 Southern Economic Journal 110 (1980).

E. H. Chamberlin, An Experimental Imperfect Market, 56 Journal of Political Economy 95 (1948).

John R. Chamberlin, The Logic of Collective Action: Some Experimental Results, 23 Behavioral Science 441 (1978).

W. D. Cook and E. C. H. Veendorp, Six Markets in Search of an Auctioneer, 8 Canadian Journal of Economics 238 (1975).

Vickey M. Coppinger, Vernon L. Smith, and Jon A. Titus, Incentives and Behavior in English, Dutch, and Sealed-Bid Auctions, 18 Economic Inquiry 1 (1980).

Don L. Coursey, R. Mark Isaac, Margaret Luke, and Vernon L. Smith, Market Contestability in the Presence of Sunk (entry) Costs, 15 Rand Journal of Economics 69 (1984).

Don L. Coursey, R. Mark Isaac, and Vernon L. Smith, Natural Monopoly and Contestable Markets: Some Experimental Results, Journal of Law and Economics (19S3).

Don L. Coursey and William D. Schultz, The Application of Laboratory Experimental Economics to the Contingent Valuation of Public Goods, University of Wyoming xerox (1983).

Don L. Coursey and Vernon L. Smith, Experimental Tests of an Allocation Mechanism for Private, Public, or Externality Goods, University of Arizona xerox (1982).

Don L. Coursey and Vernon L. Smith, Price Controls in a Posted Offer Market, 73 American Economic Review 218 (1983).

EXPERIMENTAL LAW AND ECONOMICS BIBLIOGRAPHY

James C. Cox and R. Mark Isaac, In Search of the Winner's Curse, Economic Inquiry (forthcoming).

James C. Cox, Bruce Roberson, and Vernon L. Smith. Theory and Behavior of Single Object Auctions, in Vernon L. Smith (ed.) 2 Research in Experimental Economics 1 (1982).

James C. Cox and Vernon L. Smith, Equilibrium Bidding Behavior When Some Bidders May be Risk-Preferring, University of Arizona xerox (1983).

James C. Cox and Vernon L. Smith, and James M. Walker, Tests of a Heterogeneous Bidders Theory of First Price Auctions, 12 Economic Letters (1983).

James C. Cox and Vernon L. Smith, and James M. Walker, Why are not the Dutch and First Price Auctions Isomorphic?, Journal of Economic Behavior and Organization (forthcoming).

James C. Cox and Vernon L. Smith, and James M. Walker, Individual Bidding Behavior and Theories of the First Price Auction, University of Arizona xerox (1983).

James C. Cox and Vernon L. Smith, and James M. Walker, Auction Market Theory of Heterogeneous Bidders, 9 Economic Letters 319 (1982).

James C. Cox and Vernon L. Smith, and James M. Walker, Theory and Behavior of Multiple Unit Discriminative Auctions, University of Arizona xerox (1983).

James C. Cox and Vernon L. Smith, and Arlington W. Williams, Expected Revenue in Uniform-Price Sealed-Bid Auctions, in Vernon L. Smith (ed.) 3 Research in Experimental Economics (1983).

Andrew E. Daughety and Robert Forsythe, Regulatory-Induced Industrial Organization: A Laboratory Investigation, University of Iowa xerox (1984).

Robyn M. Dawes, John M. Orbell, and Alphons J. C. van de Kragt, Normative Constrain and Incentive-Compatible Design, University of Oregon xerox (1984).

Douglas V. DeJong, Robert Forsythe, and Wilfred C. Uecker, The Effects of Alternative Liability Rules and the Public Disclosure of Audit Fees on the Price and Quantity of Audit Services: A Laboratory Market Study, University of Iowa working paper #84-4 (1984).

David Easley and John Ledyard, A Theory of Price Formation and Exchange in Oral Auctions, Northwestern University Math Center Working Paper #461 (1983).

John A. Ferejohn, Robert Forsythe, and Roger Noll, An Experimental Market for Public Goods: the PBS Station Cooperative, 66 American Economic Review (1976).

John A. Ferejohn, Robert Forsythe, and Roger Noll, An Experimental Analysis of Decision Making Procedures for Discrete Public Goods: A Case Study of a Problem in Institutional Design, in Vernon L. Smith (ed.) 1 Research in Experimental Economics 1 (1979).

John A. Ferejohn, Robert Forsythe, and Roger Noll, Practical Aspects of the Construction of Decentralized Decision-Making Systems for Public Goods, in Clifford Russell (ed.) Collective Decision Making 173 (1979).

Robert Forsythe, Thomas R. Palfrey and Charles R. Plott, Asset Valuation in an Experimental Market, 50 Econometrica 537 (1982).

Robert Forsythe, Thomas R. Palfrey and Charles R. Plott, Futures Markets and Informational Efficiency: A Laboratory Examination, Journal of Finance (forthcoming).

L. Fouraker and Sidney Siegel, Bargaining Behavior (1963).

Daniel Friedman, Price Formation in Double Auction Markets, American Economic Review (forthcoming).

Daniel Friedman and Glenn W. Harrison, The Informational Efficiency of Experimental Asset Markets, University of Western Ontario xerox (1983).

Daniel Friedman, Glenn W. Harrison, and Jon Salmon. The Informational Role of Futures Markets: Some Experimental Evidence, in M. E. Streit (ed.) Futures-Modelling, Managing, and Monitoring Futures Trading (1983).

Daniel Friedman, Glenn W. Harrison, and Jon Salmon, Price Formation in Experimental Asset Markets, University of Western Ontario xerox (1984).

James W. Friedman, An Experimental Study of Cooperative Duopoly, 35 Econometrica 279 (1967).

James W. Friedman, On Experimental Research in Oligopoly, 36 Review of Economic Studies 399 (1969).

James W. Friedman and A. C. Hoggatt, An Experiment in Non-Cooperative Oligopoly, in Vernon L. Smith (ed.) Supp. 1 Research in Experimental Economics (1979).

C. Allen Garner, Experimental Evidence on Rationality of Intuitive Forecasting, in Vernon Smith (ed.) 2 Research in Experimental Economics (1982).

M. J. Gordon, G. E. Paradis, and C. H. Rourke, Experimental Evidence of Alternative Portfolio Decision Rules, 62 American Economic Review 107 (1972).

David M. Grether, Bayes Rule as a Descriptive Model: The Representativeness Heuristic, 94 Quarterly Journal of Economics 537 (1980).

David M. Grether, R. Mark lsacc, and Charles R. Plott, The Allocation of Landing Rights by Unanimity Among Competitors, American Economic Review.

David M. Grether, R. Mark Isacc, and Charles R. Plott, Alternative Methods of Allocating Airport Slots: Performance and Evaluation, Polinomics Research Laboratory xerox (1981).

David M. Grether, and Charles R. Plott, Economic Theory of Choice and the Preference Reversal Phenomenon, 69 American Economic Review 623 (1979).

David M. Grether, Alan Schwartz, and Louis L. Wilde, Uncertainty and Shopping Behavior, CALTECH Social Science Working Paper #511 (1984).

David M. Grether, and Louis L. Wilde, Optimal and Nonoptimal Satisficing: An Experimental Analysis, CALTECH Social Science Working Paper #459 (1982).

David M. Grether, and Louis L. Wilde, Consumer Choice and Information: New Evidence on the Information Overload Hypothesis, CALTECH Social Science Working Paper #425 (1982).

Robert M. Hamm, The Conditions of Occurrence of the Preference Reversal Phenomenon, University of Colorado xerox (1984).

Glenn W. Harrison, Experimental Measurement of Risk Aversion, University of Western Ontario xerox (1984).

Glenn W. Harrison, Thin Markets and Incentive Compatible Pseudo-Markets, University of Western Ontario xerox (1984).

EXPERIMENTAL LAW AND ECONOMICS BIBLIOGRAPHY

Glenn W. Harrison and Michael McKee, Monopoly Behavior, Decentralized Regulation, and Contestable Markets: An Experimental Evaluation, University of Western Ontario xerox (1984).

Glenn W. Harrison and Michael McKee, Experimental Evaluation of the Coase Theorem, University of Western Ontario xerox (1984).

Glenn W. Harrison, Vernon L. Smith, and Arlington W. Williams, Learning Behavior in Experimental Auction Markets, University of Western Ontario xerox (1983).

Alan C. Hess, Experimental Evidence on Price Formation in Competitive Markets, 80 Journal of Political Economy 375 (1972).

Elizabeth Hoffman, James Marsden, and Andrew Whinston, Efficient Use of Economic Data, Purdue University xerox (1984).

Elizabeth Hoffman and Charles R. Plott, The Effect of Intertemporal Speculation on the Outcomes in Seller Posted-Offer Auction Markets, 95 Quarterly Journal of Economics (1981).

Elizabeth Hoffman and Matthew L. Spitzer, The Coase Theorem: Some Experimental Tests, 25 Journal of Law and Economics 73 (1982).

Elizabeth Hoffman and Matthew L. Spitzer, Experimental Teats of the Coase Theorem with Large Bargaining Groups, Purdue University xerox, 1984.

Elizabeth Hoffman and Matthew L. Spitzer, Entitlements, Rights, and Fairness: An Experimental Examination of Subjects' Concepts of Distributive Justice, Journal of Legal Studies (forthcoming).

A. C. Hoggatt, James W. Friedman, and S. Gill, Price Signalling in an Experimental Oligopoly, 66 American Economic Review 261 (1976).

Charles Holt, Competitive Bidding for Contracts Under Alternative Auction Procedures, 88 Journal of Political Economy 433 (1980).

Charles Holt, Anne Villamil, and Loren Weeks, Market Power in Double Auctions: Convergence to Competitive Equilibrium, xerox (1983).

EXPERIMENTAL LAW AND ECONOMICS BIBLIOGRAPHY

James T. Hong and Charles R. Plott, Rate Filing Policies for Inland Water Transportation: An Experimental Approach, 13 Bell Journal of Economics 1 (1982).

H. Hori, Revealed Preference for Public Goods, 65 American Economic Review (1975).

John J. Hovis, Don L. Coursey, and William D. Schultz, A Comparison of Alternative Valuation Mechanisms for Non-Market Commodities, University of Wyoming xerox (1983).

R. Mark Isaac, Laboratory Experiments as a Tool in Public Policy Analysis, University of Arizona xerox (1983).

R. Mark Iaaac, Kenneth F. McCue, and Charles R. Plott, Public Goods Provision in an Experimental Environment, CALTECH Social Science Working Paper #428 (1982).

R. Mark Isaac, Kenneth F. McCue, and Charles R. Plott, Naah Equilibrium in Public Goods Provision: Free Riding in Experimentally Controlled Markets, University of Arizona xerox (1980).

R. Mark Iaaac and Charles R. Plott, Price Controls and the Behavior of Auction Markets: An Experimental Examination, 71 American Economic Review 448 (1971).

R. Mark Iaaac and Charles R. Plott, The Opportunity for Conspiracy in Restraint of Trade, 2 Journal of Economic Behavior and Organization 1 (1981).

R. Mark Iaaac, Valerie Ramey, and Arlington W. Williams, The Effects of Market Organization on Conspiracies in Restraint of Trade, Journal of Economic Behavior and Organization (1984, forthcoming)

R. Mark Isaac and Vernon L. Smith, In Search of Predatory Pricing, University of Arizona xerox (1984).

R. Mark Isaac, James M. Walker, and Susan H. Thomas, Divergent Evidence on Free Riding: An Experimental Examination of Possible Explanation, Public Choice (forthcoming).

H. Jarecki, Bullion Dealing, Commodity Exchange Trading, and the London Gold Fixing: Three Forms of Commodity Auctions, in Y, Amihud (ed.), Bidding and Auctioning for Procurement and Allocation (1976).

John H. Kagel and Raymond C. Battalio, Token Economy and Animal Models for the Experimental Analysis of Economic Behavior, in Jan Kmenta and James Ramsey (eds.), Evaluation of Econometric Models (1980).

John H. Kagel and Raymond C. Battalio, Experimental Studies of Consumer Behavior Using Laboratory Animals, 13 Economic Inquiry 22 (1975)

John H. Kagel, Dan Levin, Raymond C. Battalio and Donald J. Meyer, First-Price, Sealed-Bid, Common Value Auctions: Some Initial Experimental Results, University of Houston xerox (1984).

John H. Kagel, et. al., Job Choice and Total Labor Supply: An Experimental Analysis, 44 Southern Economic Journal 13 (1977).

Jon Ketchem, Vernon L. Smith, and Arlington W. Williams, A Comparison of Posted-Offer and Double Auction Pricing Institutions, Review of Economic Studies (forthcoming).

Oliver Kim, Mark Walker, and Williams Dawes, The Free Rider Problem: Experimental Evidence, University of Arizona xerox (1981).

John B. Kirkwood, Antitrust Implications of Recent Experimental Literature on Collusion, in Steven Salop (ed.) Strategy, Predation, and Antitrust Analysis 579 (1981).

J. L. Knetsch and J. A. Sinden, Willingness to Pay and Compensation Demanded: Experimental Evidence of an Unexpected Disparity in Measures of Value, 97 Quarterly Journal of Economics (1983).

Michael E. Levine and Charles R. Plott, Agenda Influence and It's Implications, 63 Virginia Law Review S61 (1977).

Michael E. Lynch, Ross M. Miller, Charles R. Plott, and Russell Porter, Product Quality, Informational Efficiency, and Regulations in Experimental Markets, CALTECH Social Science Working Paper #518 (1984).

Gerald Marwell and Ruth E. Ames, Experiments on the Provision of Public Goods I. Resources, Interest, Group Size, and the Free Rider Problem, 84 American Journal of Sociology 1335 (1979).

Gerald Marwell and Ruth E. Ames, Experiments on the Provision of Public Goods II. Provision Points, Stakes, Experience, and the Free Rider Problem, 85 American Journal of Sociology 926 (1980)

Gerald Marwell and Ruth E. Ames, Economists Free Ride, Does Anyone Else? Experiments on the Provision of Public Goods IV., University of Wisconsin xerox (1980).

Richard D. McKelvey, A Theory of Optimal Agenda Design,

Gary J. Miller and Charles R. Plott, Revenue Generating Properties of Sealed-Bid Auctions: An Experimental Analysis of One-Price and Discriminative Processes, in Vernon L. Smith (ed.) 2 Research in Experimental Economics (1982).

Ross M. Miller and Charles R. Plott, Product Quality Signalling in Experimental Markets, CALTECH Social Science Working Paper #447 (1982).

Ross M. Miller, Charles R. Plott, and Vernon L. Smith, Intertemporal Competitive Equilibrium: An Empirical Study of Speculation, 91 Quarterly Journal of Economics 599 (1977).

R. C. Mitchell and R. T. Carson, An Experiment in Determining Willingness to Pay for National Water Quality Improvement, draft report to the U.S. Environmental Protection Agency, Office of Strategic Assessment, Contract #R-806906010 (1981).

F. Mosteller and P. Nogee, An Experimental Measurement of Utility, 59 Journal of Political Economy (1951).

Rudy V. Nydegger, The Use of Independently Scaled Utility Functions in the Experimental Applications of Game Theory, in Vernon L. Smith (ed.) 1 Reseerch in Experimental Economics (1979).

Thomas R. Palfrey and Thomas Romer, An Experimental Study of Warranty Coverage and Dispute Resolution in Competitive Markets, Carnegie-Mellon University xerox (1984).

Carolyn Pitchick and Andrew Schotter, The "Big Lie" Hypothesis in Markets with Asymmetric Information: An Experimental Study, New York University xerox (1983).

Charles R. Plott, The Application of Laboratory Experimental Methods to Public Choice, in Clifford Russell (ed.) Collective Decision Making 137 (1979).

Charles R. Plott, Industrial Organization Theory and Experimental Economics, 20 Journal of Economic Literature 1485 (1982).

Charles R. Plott, Externalitieses and Corrective Policies in Experimental Markets, 93 The Economic Journal 106 (1983).

Charles R. Plott and Michael E. Levine, A Model of Agenda Influence on Committee Decisions, 68 American Economic Review 146 (1978).

Charles R. Plott and Vernon L. Smith, An Experimental Examination of Two Exchange Inatitutions, 45 Review of Economic Studies 133 (1978).

Charles R. Plott and Shyam Sunder, Rational Expectations and the Aggregation of Diverse Information in Laboratory Security Markets, CALTECH Social Science Working Paper #463 (1983).

Charlea R. Plott and Shyam Sunder, Efficiency of Experimental Security Markets with Insider Information: An Application of Rational-Expectations Models, 90 Journal of Political Economy 663 (1982).

Charles R. Plott and J. T. Uhl, Competitive Equilibrium with Middlemen: An Empirical Study, 47 Southern Economic Journal 1063 (1981).

Charles R. Plott and Louis L. Wilde, Professional Diagnosis vs. Self-Diagnosis: An Experimental Examination of Some Special Features of Markets with Uncertainty, in Vernon L. Smith (ed.) 2 Research in Experimental Economics 63 (1982).

Werner Pommerehne, Friedrich Schneider, and Peter Zweifel, Economic Theory of Choice and the Preference Reversal Phenomenon: A Re-examination, 72 American Economic Review 569 (1982).

A. Randall, B. Ives, and C. Eastman, Bidding Games for Valuation of Aesthetic Environmental Improvements, 1 Journal of Environmental Economics and Management 132 (1974).

S. J. Raasenti, Vernon L. Smith, and R. L. Bulfin, A Combinatorial Auction Mechanism for Airport Time Slot Allocation, Rand Journal of Economics (forthcoming).

Robert J. Reilly, Preference Reversals: Further Evidence and Some Suggested Modifications in Experimental Design, 72 American Economic Review 576 (1982).

D. Rice and Vernon L. Smith, Nature, The Experimental Laboratory, and the Credibility of Hypotheses, Behavioral Science (1964).

Alvin E. Roth, Michael M. K. Malouf, and J. Keith Murnigham, Sociological Versus Strategic Factors in Bargaining 2 Journal of Economic Behavior and Organization 153 (1981).

Alvin E. Roth and Michael M. K. Malouf, Game-Theoretic Models and the Role of Information in Bargaining, 86 Psychological Review 574 (1979).

Alvin E. Roth and J. Keith Murnigham, The Role of Information in Bargaining: An Experimental Study, 50 Econometrica 1123 (1982).

Alvin E. Roth and Francoise Schoumaker, Expectations and Reputations in Bargaining: An Experimental Study, 73 American Economic Review 362 (1983).

R. Rowe, Ralph C. d'Arge, and D. Brookshire, An Experiment on the Economic Value of Visibility, 7 Journal of Environmental Economlca and Management (1980).

B. A. Scherr and E. M. Babb, Pricing Public Goods: An Experiment with Two Proposed Pricing Systems, 23 Public Choice 35 (1975).

Richard Schmalensee, An Experimental Study of Expectation Formation, 44 Econometrica 17 (1976).

Friedrich Schneider and Werner W. Pommerehne, Free Riding and Collective Action: An Experiment in Public Microeconomics, 95 Quarterly Journal of Economics 689 (1981).

Andrew Schotter and Yale M. Braunstein, Economic Search: An Experimental Study, 19 Economic Inquiry 1 (1981).

William D. Schultz, Ralph C. d'Arge, and D. S. Brookshire, Experimental Approaches for Valuing Environmental Commodities, in Methods Development in Measuring Benefits of Environmental Improvements, report to the U.S. Environmental Protection Agency Office of Policy Analysis, Office of Policy and Resource Management, Grant #CR808-893-01 (1983).

William D. Schultz, et. al., Valuing Environmental Commodities: Some Recent Experiments, 57 Land Economics 151 (1981).

Roger Sherman, Risk Attitude and Coat Variability in a Capacity Choice Experiment, 36 Review of Economic Studies 453 (1969).

Sidney Siegel and L. Fouraker, Bargaining and Group Decision Making (1960).

Paul Slovlc and Sarah Lichtenstein, Preference Reversals: A Broader Perspective, 73 American Economic Review 596 (1963).

Vernon L. Smith, Experimental Studies of Discrimination Versus Competition in Sealed-Bid Auctions, 40 Journal of Business (1967).

Vernon L. Smith, Microeconomic Systems as an Experimental Science, 72 American Economic Review 923 (1982)

Vernon L. Smith, Bidding and Auctioning Institutions, in V. Amihud (ed.) Bidding for Procurement and Allocation 43 (1979).

Vernon L. Smith, The Relevance of Laboratory Experiments to Teating Resource Allocation Theory, in Jan Kmenta and James Ramsey (eds.) Evaluation of Econometric Methods 345 (1980).

Vernon L. Smith, An Experimental Study of Competitive Market Behavior, 60 The Journal of Political Economy 111 (1962).

Vernon L. Smith, Experiments with a Decentralized Mechanism for Public Good Decisions, 70 American Economic Review 584 (1980).

Vernon L. Smith, Theory, Experiment, and Antitrust Policy, in Steven Salop (ed.) Strategy, Predation, and Antitrust Analysis 579 (1981).

Vernon L. Smith, Reflections on Some Experimental Market Mechanisms for Classical Environments, in L. McAlister (ed.), Choice Models for Buying Behavior (1982).

Vernon L. Smith, Experimental Economics: Induced Value Theory, 66 American Economic Review 274 (1976).

Vernon L. Smith, Experimental Auction Markets and the Walrasian Hypothesis, 73 Journal of Political Economy 387 (1965).

Vernon L. Smith, Markets as Economizers of Information: Experimental Examination of the "Hayeck Hypothesis," 20 Economic Inquiry (1982).

Vernon L. Smith, Bidding Theory and the Treasury Bill Auction: Does Price Discrimination Increase Bill Prices?, 48 Review of Economics and Statistics (1966).

Vernon L. Smith, An Empirical Study of Decentralized Institutions of Monopoly Restraint, in James Quirk (ed.) Essays in Contemporary Fields of Economics 83 (1981).

Vernon L. Smith, An Experimental Comparison of Three Public Good Decision Mechanisms, 81 The Scandanavian Journal of Economics 1 (1979).

Vernon L. Smith, Incentive Compatible Experimental Processes for the Provision of Public Goods, in Vernon L. Smith (ed.) 1 Research in Experimental Economics 59 (1979).

Vernon L. Smith, Experimental Mechanisms for Public Choice, in Peter C. Ordeschook (ed.) Game Theory and Political Science (1978).

Vernon L. Smith, The Principle of Voluntary Consent in Social Choice, 86 Journal of Political Economy 1125 (1977).

Vernon L. Smith and Arlington W. Williams, An Experimental Comparison of Alternative Rules for Competitive Market Exchange, in Engelbrecht-Wiggans, Shibih, and Stark (eds.) Auctions, Bidding, and Contracting: Uses and Theory 307 (1983).

Vernon L. Smith and Arlington W. Williams, On Nonbinding Price Controls in a Competitive Market, 71 American Economic Review 467 (1981).

Vernon L. Smith and Arlington W. Williams, The Boundaries of Competitive Price Theory: Convergence, Expectations, Indiana University xerox (1983).

Vernon L. Smith and Arlington W. Williams, The Effects of Rent Asymmetries in Experimental Auction Markets, 3 Journal of Economic Behavior and Organization 99 (1982).

Vernon L. Smith, Arlington W. Williams, W. K. Bratton, and M. Vannoni, Competitive Market Institutions: Double Auctions vs. Sealed Bid-Offer Auctions, 72 American Economic Review 58 (1982).

Louis L. Wilde, On the Use of Laboratory Experiments in Economics, in J. C. Pitt (ed.) Philosophy in Economics 137 (1981).

Arlington W. Williams, Computerized Double Auction Experiments: Some Initial Experimental Results, 53 Journal of Business 235 (1980).

Arlington W. Williams, The Formation of Market Forecasts: Experimental Evidence, Indiana University xerox (1984).

Arlington W. Williams, Intertemporal Competitive Equilibrium: On Further Experimental Results, in Vernon L. Smith (ed.) 1 Research in Experimental Economics 255 (1979).

Arlington W. Williams and Vernon L. Smith, Cyclical Double Auction Markets With and Without Speculators, 57 Journal of Business 1 (1984).

Arlington W. Williams, Vernon L. Smith, and John Ledyard, Simultaneous Trading in Two Competitive Markets: An Experimental Examination, Indiana University xerox (1983).

Fred E. Williams, The Effect of Market Organization on Competitive Equilibrium: The Multiunit Case, 40 Review of Economic Studies 97 (1973).

R. L. Winkler, Probabalisitc Prediction: Some Experimental Results, 66 Journal of the American Statistical Association (1971).