1 Introduction

Laboratory experiments have become a popular tool to design and analyze the performance of alternative market structures without their actual implementation. Experiments are a relatively inexpensive way to provide valuable insights into the properties of various mechanisms, identify potential problem areas, and help avoiding costly errors. A number of experimental studies were devoted to the design of “smart” market institutions which combine information advantages of decentralized markets with central allocation and pricing associated with command-and-control methods ([8], [4]). In a typical “smart” market, the agents submit their orders (asks and/or bids) to a computer dispatch center. The center then determines the allocation and prices by applying a set of rules. The use of sophisticated optimization algorithms to determine market allocation ensures maximization of gains from trade, thus increasing efficiency and reducing transaction costs.

Laboratory experiments are formal, replicable, and relatively inexpensive means of analyzing different market mechanisms. Properly designed experiments can be used to test the performance of these mechanisms in a variety of conditions, provide insights into the properties of these institutions, and highlight potential problem areas, thereby helping to avoid costly errors.

Three items are important in measuring the effectiveness of a market mechanism.

1. The overall efficiency,
2. the nearness to the competitive equilibria (if one exists), and
3. the revelation properties of the mechanism.

It is possible that a mechanism may obtain one objective but not the others. The welfare measure used in this study to compare the allocations in our various treatments is the percentage of the maximum possible gains from trade which is realized by the allocation process. This fraction is called the *efficiency* of the allocation. It is computed as the sum of the producer and consumer surplus (producer surplus is the revenue to the auctioneer) resulting from the allocation process divided by the sum of the producer and consumer surplus occurring in the competitive equilibrium. This measure has been used extensively in previous studies including many of those mentioned in this section.

2 Transferable pollution permits

The transferable pollution permit systems have been a focus of laboratory experiments for quite some time[1]. Following the theoretical framework, these experiments assume that pollution is uniformly mixed (and therefore it does not matter where pollution is coming from), the transactions are costless, and the sources are fully compliant. A number of experimental studies relax the assumption of the perfect competition, and introduce market power and uncertainty to their laboratory environments. Godby (1999) assesses the degree of realization of market power in a permit market consisting of one dominant firm and 5 to 10 competitive fringe firms participating in a double auction. The author argues that neither the competitive nor the monopoly model adequately describes actual behavior. However, the monopoly model is more accurate in its description of prices and quantities observed. Ledyard and Szakaly-Moore (1994) show that the efficiency of a revenue neutral auction remains high in both competitive and monopoly market environments, whereas the efficiency of the double auction falls significantly when market power is introduced.

Another deviation from the classical assumptions of the transferable permit system theory is the introduction of uncertainty regarding the actual emissions. Godby *et al.* (1997) show that uncertainty leads to price instability when transferable permits are used as a main instrument of controlling pollution, and no banking is allowed. Banking of permits significantly reduces instability, but also reduces the efficiency. Changing the instrument to tradable shares (entitlements to future permits) improves efficiency and reduces price instability.

An interesting analysis of the effects of firms' technological heterogeneity and irreversible investments on the performance of a transferable permit market can be found in [1] The authors find no relationship between heterogeneity and trade volume, however, the efficiency of the market (defined as the ratio of actual to contingent optimal abatement costs) decreases significantly with increased technological heterogeneity among the firms.

A number of experimental studies are devoted to the general design issues of a transferable permit system. [7] assesses different mechanisms for the initial allocation of permits, including single-price auctions, incentive-compatible auctions, and a free initial allocation followed by trading. The simulation results show that the initial auctioning of permits can result in

[1]See Muller and Mestleman (1998) for a comprehensive survey of the laboratory research in the area of transferable emission permit systems.

a substantial increase in abatement costs for pollution sources, even higher than in the case of uniform direct control. The free distribution achieves the cost effective outcome. [5] compare the performance of revenue neutral and uniform price auctions for emission licenses. They show that despite similar efficiency and pricing results, the revenue neutral auctions are associated with overbidding on infra-marginal units.

A growing number of studies simulate the existing pollution permit markets such as SO2 allowance trading program or RECLAIM market, and analyze the advantages and disadvantages of their design features. [2] and [3] demonstrates that in a revenue neutral discriminative auction used by EPA in the SO2 allowance trading program (where highest bids are matched against lowest asks), the sellers consistently under-reveal their costs of emission control, thus reducing the efficiency of the market. Cason and Plott (1996) compare the EPA auction to a uniform price call auction. The authors show that in addition to lower efficiency and less truthful revelation of costs and values, the EPA auction provides less accurate price information and is less responsive to changes in the underlying market conditions. Cason *et al.* (1999) find insufficient permit banking and speculative opportunities in an environment reflecting the SO2 Allowance Trading program. Cason and Gangadharan (1998) compare the performance of continuous double auction (CDA) and electronic bulletin board system (BBS) similar to the one implemented by AQMD to help RECLAIM participants to find trading partners and reduce trading costs. The BBS allows firms to post offers to buy or sell RTCs. Other firms can view these offers and contact the offering firm to negotiate the transaction. Another feature of RECLAIM, the zone trading restrictions, is also incorporated into the experiment. In all sessions, the demand and supply conditions were such that the equilibrium prices are lower in Coastal than Inland zone. Authors find that in both trading institutions prices approached to a single equilibrium price when the inter-zone trade is allowed, and zone-specific equilibrium prices when inter-zone trading is prohibited. Overall, BBS performs as well as CDA in terms of price accuracy and volatility; however, it is inferior to CDA in terms of realized trading efficiency.

The degree of cost reduction and market efficiency observed in the pollution permit system experiments varies significantly depending on the system design and the complexity of the environment. Sometimes, the results would vary even within the same experimental environment. For example, Cronshaw and Brown-Kruse (1999) create an environment closely reflecting the actual design of the SO2 Allowance Trading program (revenue neutral auction followed by EPA discriminative auction with mandatory and voluntary components). In 50% of the experiments with banking and no trade, the participants achieved at least 75% cost reduction, while in 17% of the experiments the total abatement costs exceeded those of status quo (no trade, no banking). In banking with trade experiments, the efficiency attributable to banking ranged from -10% to 92%, and efficiency attributable to trade ranged from 39% to 76%.

The experimental results are not always consistent with the theoretical predictions. In a simulation of SO2 Allowance Trading program, Franciosi *et al.* (1999) find that both banking and non-banking experiments show no tendency to converge to competitive equilibrium, although non-banking experiments are more efficient and provide less evidence of arbitrage. A discrepancy between theoretical and actual behavior was also noted in Godby (1999) for both competitive and monopoly scenarios. Similarly, [6] shows that in a revenue neutral auction with the free initial allocation of permits, the trading activity increases market efficiency, although the observed permit prices are not always consistent with the predicted ones.

Although the design issues related to transferable permit systems are studied extensively, no attention has been devoted so far to the spatial issues and their impact on the market performance.

2.1 Example Experimental Procedures

Subjects were recruited from the undergraduate student population at **X**. All the experimental subjects **had experience in other markets experiments** and **practice in a non-paying session of the iterative sealed-bid mechanism.**

Each experimental session consisted of a single market instance. Each session was run on a computer network. Experimental sessions consisted of **3 markets traded simultaneously**. Subjects were assigned randomly to sets of redemption values and costs and endowments.

Subjects' valuations and costs were provided in terms of the experimental currency, e$'s. The subjects were told the conversion rate, which was the same for each market and subject, before the start of the experiment. All subjects were paid in cash at the end of the experimental sessions.

Communication between subjects was not allowed during the experiment. It was common information that each subject knew his own valuations or costs and endowments, but nothing about the valuations, costs, or endowments of the other subjects. Each subject knew the maximum number of **competitors/subjects** in each market but not the number of subjects who had valuations or costs (a subject could have valuations or costs in only one or two of the markets). Furthermore, if the auctioneer placed units for sale, each subject knew how many items were for sale. All of this information could be found in the instructions, which were read aloud at the beginning of the sessions.

Each experimental session consisted of a single market period consisting of a sequence of rounds or iterations. Each subject had 3 minutes to enter bids and asks and had a limit of 4 bids or asks in each round. At the beginning of each round and after the first round, the current market price and the number of units tentatively accepted for trading in each market are displayed on the computer terminal. This information was available for all the past rounds.

2.2 An Example of a special design

One important point to note about the experimental design. Since the **Y** market is relatively new and most potential participants were novices and had little or no information about the environment. We felt it was important to judge the performance of the mechanisms using only a single realization of the market. We did not repeat periods, which is common in many experimental tests on markets. We were interested in how the markets would operate in the short run, when participants had little knowledge. We were not interested in the long run results, which may be observed with replication of the same economic environment and market mechanism.

3 What is Experimental Economics?, by Vernon Smith

Experimental economics applies laboratory methods of inquiry to the study of motivated human interactive decision behavior in social contexts governed by explicit or implicit rules. The explicit rules may be defined by experimenter-controlled move sequences and information events in extensive form ($n > 1$)-person games with specified payoff outcomes. Or the rules may be those at an auction or other market institution in which motivated people buy or sell abstract rights (to consume or produce) information and services (e.g. transportation) within some particular technological context. Implicit rules are the norms, traditions and habits that people bring to the laboratory as part of their cultural and biological evolutionary heritage; they are not normally controlled by the experimenter.[2]

Quite generally we can think of experimental outcomes (the observed replicable order in final allocations) as the consequence of individual choice behavior, driven by the economic environment and mediated by the language and rules governing interactions supplied by the institution. The economic environment consists of agent preferences, knowledge, skill endowments, and resource constraints. Abstractly, institutions define the mapping from agent choice of messages (e.g., bids, asks, acceptances, moves in a game tree, words, actions) into outcomes. Under the operation of these rules, or of norms, people choose messages given the economic environment. A well-established finding in experimental economics is that institutions matter because the rules matter, and the rules matter because incentives matter. But the incentives to which people respond are sometimes not those one would expect based on the canons of economic/game theory. It turns out that people are often better, and sometimes worse, at achieving gains for themselves and others than is predicted by standard forms of rational analysis. These contradictions provide important clues to the implicit rules that people may follow and can motivate new theoretical hypotheses for examination in the laboratory.

The design of experiments is motivated by two quite distinct concepts of a rational order. Rejecting or denying either of these concepts should not be construed as irrational. Thus, if people in certain contexts choose outcomes yielding the smaller of two rewards, we ask why, rather than conclude that this is irrational.

The first concept of a rational order derives from today's standard social-economic science model (SSSM) going back to the seventeenth century. The SSSM is an example of what Hayek has called, constructivist rationalism, which, in its modern forms and power, stems from Descartes, who believed and argued that all worthwhile social institutions were and should be created by conscious deductive processes of human reason. Truth is derived and derivable from premises that are obvious and unassailable. Thus, in positive economics it has been argued influentially that you judge the validity of a model by its predictions, not by its assumptions — a methodology that provides limited guidance in experimental studies where one can control the economic environment and institutional rules. In economics the SSSM leads to rational predictive models of decision that motivate research hypotheses that experimentalists have been testing in the laboratory since mid twentieth century. The test results are decidedly mixed, and this has motivated constructivist extensions of game theory, most notably based on other-regarding, in addition to own-regarding, preferences, and on 'learning' — the idea that the predictions of the SSSM might be approached over time by trial-and-error adaptation processes.

For tractability, Cartesian rationalism provisionally requires agents to possess complete information — far more than could ever be given to one mind. In economics the resulting analytical exercises, while yielding insightful theorems, are designed to aid and sharpen thinking — if-then parable. Yet, these exercises may not approximate the level of ignorance that has conditioned institutions, as abstract rules independent of particular parameterizations that have survived as part of the world of experience. The temptation, of course, is to ignore this reality, because it is poorly understood, and to proceed in the implicit belief that our parables capture what is most essential in understanding what we observe.

Our theories and thought processes about social systems involve the conscious and deliberate use of reason. Therefore, it is necessary to constantly remind ourselves that human activity is diffused and dominated by unconscious, autonomic, neuropsychological systems that enable people to function effectively without always calling upon the brain's scarcest resource: attentional circuitry. This is an important economizing property of how the brain works. If it were otherwise, no one could get through the day under the burden of self-conscious monitoring and planning every trivial action in detail. Also, no one can express in thoughts, let alone words, all that he or she knows, and does not know, but might need to know for some purposive action. For example, imagine the drain on the brain's resources if at the supermarket a shopper were required to explicitly evaluate the utility from every combination of the tens of thousands of grocery items that are feasible for a given budget. Such mental processes are costly and implicitly we must avoid costs that are not worth the benefit. The challenge of any action or problem triggers first a search by the brain to bring to the conscious mind what one knows that is related to the decision context. Context triggers autobiographical experiential memory, which explains why context surfaces as a nontrivial treatment in small group experiments.

We do not recall learning most of our operating knowledge — natural language is the most prominent example, but, of particular relevance for experimental economics, also virtually everything that constitutes our developmental socialization. We learn the rules of a language and of social intercourse without explicit instruction simply by exposure to family and extended family social networks.

These considerations lead to the second concept of a rational order, an undesigned ecological system that emerges out of cultural and biological evolutionary processes: home grown principles of action, norms, traditions, and morality. Thus, "the rules of morality?are not the conclusions of our reason." According to Hume, who was concerned with the limits of reason and the boundedness of human understanding, rationality was a phenomena that reason discovers in emergent institutions. Adam Smith expressed the idea of emergent order in both The Wealth of Nations and The Theory of Moral Sentiments. According to this concept of rationality, truth is discovered in the form of the intelligence embodied in rules and traditions that have formed, inscrutably, out of the ancient history of human social interactions. This is the antithesis of the Cartesian and contemporary belief that if an observed social mechanism is functional, somebody in the unrecorded past must have used reason consciously to create it to serve its currently perceived intended purposes. In experimental economics this tradition is represented by the discovery of emergent order in numerous studies of existing market institutions such as the double auction. To paraphrase Adam Smith, people in these experiments are led to promote welfare enhancing social ends that are not part of their conscious intention. This principle is supported by hundreds of experiments whose environments and institutions exceed the capacity of formal game theoretic analysis. But they do not exceed the functional capacity of collectives of incompletely informed human decision makers whose mental algorithms coordinate behavior through the rules of the institution — social algorithms — to generate high levels of measured performance. Acknowledging and recognizing the workings of unseen processes are essential to the growth of our understanding of social phenomena, and we must strive not to exclude them from our inquiry, if we have any hope of understanding data inside or outside of the laboratory. In this way we at least can attempt to escape the very significant disadvantage of being a human in studying human behavior. Even those who study primates must deal with natural tendencies to anthropomorphize what they observe; so strongly do we identify with our genetic cousins.

Ironically, the greatest success for non-cooperative equilibrium theory, that has emerged from experimental studies beginning over forty years ago, is its power to predict outcomes when people have incomplete (private) information on individual payoffs. This "success" has passed with little fanfare because of the standard assumption that decision-makers, like the theorist/experimentalist, must have complete information in order to construct the equilibrium.

3.1 How are the two concepts of a rational order related?

Constructivism takes as given the social structures generated by emergent institutions that we observe in the world, and proceeds to model it formally.

An example would be the Dutch auction or a sealed bid auction. Constructivists do not ask why or how that institution arose or what were the ecological conditions that created it; or why there are so many distinct auction institutions. In some cases it is the other way around. Thus, revenue equivalence theorems show that the standard auctions generate identical expected outcomes leaving no apparent economic reason for choosing between them. Using game theory to implement constructivist rationality, one represents a socioeconomic situation with an interactive game tree. The ecological concept of rationality asks from whence came the structure captured by the tree? Why this social practice, or game, and not another? Were there others that lacked survival properties and were successfully invaded by what we observe?

The two types of rational order are both expressed in the experimental methodology developed for economic systems design. This branch of experimental economics uses the lab as a test-bed to examine the performance of proposed new institutions, and modifies their rules and implementation features in the light of the test results. The proposed designs are constructivist, although most applications, such as the design of electricity markets or auctions for spectrum licenses, are far too complicated for a complete formal analysis. But when a design is modified in the light of test results, the modifications tested, modified again, retested, and so on, one is using the laboratory to effect an evolutionary adaptation as in the second concept of a rational order. If the final result is implemented in the field, it certainly undergoes further evolutionary change in the light of practice, and of operational forces not tested in the experiments because they are unknown or beyond current laboratory capability. Finally, understanding decision requires knowledge beyond the traditional bounds of economics, a challenge to which Hume and Smith were not strangers. This is manifest in recent studies of the neural correlates of strategic interaction using fMRI and other brain imaging technologies. This research explores intentions or "mind reading," and other hypotheses about information, choice, and own versus other payoffs in determining behavior.

4 Example of Trying to Sell a new Market Institution

Executive Summary

Siena Holdings, LLC ("Siena") has developed and is implementing a rigorous approach for objectively testing the claim that its new, electronic market for the buying and selling of advertising time will enable Initiative Worldwide to obtain, on average, "better buys," and thus higher profits for its clients, and will enable sellers to obtain, on average, "better prices," simultaneously.1 The approach is straightforward.

Markets vary in the degree to which they are efficient. In the most efficient market, no participant leaves "money on the table." That is, in such a market there will be no instance in which the seller could have received a higher price from a different buyer or a buyer could have paid a lower price to a different seller or received a better spot for the same or lower price. According to these conditions, whenever one side of the market leaves money on the table, the other side does as well. That means that the profits of at least one buyer and one seller must not be maximized when the market is less than perfectly efficient. The greater the inefficiency of a market, the lower the profits of market participants. Such sub-optimality is the driving force behind the tendency of markets to become more efficient over time.

Market prices assist buyers and sellers in identifying those trading partners with whom the least amount of money will be left on the table. Markets, however, vary according to their ability to establish the set of prices (i.e., "efficient prices") that will result in participants making the trades in which they leave no money on the table. Economic theory clearly indicates that Siena's proposed new market will generate more efficient prices, and hence, on average, higher profits for both buyers and sellers, than the current market process.

Siena will employ "experimental economics" to test its proposition. Experimental economics is an important branch of economics which involves the study, in a controlled laboratory setting, of how financially motivated human subjects make decisions when confronted with uncertainty and real economic choices. The experiments will consist of a set of subjects that play the role of either media buyer (buyer) or program distributor (seller), an environment that includes important economic features (e.g., complexity, financial constraints, price uncertainty) of the media trading environment, a set of market rules, and a financial payment to subjects based on their performance in that environment.

The economic experiments will consist of a series of trading periods in which participants have the opportunity to buy and sell advertising time in an effort to maximize their individual earnings. In one set of experiments, participants will conduct trades employing the current trading method, while in another set participants will conduct trades employing Siena's proposed new market. The experiments will take place at the California Institute of Technology (Caltech). Caltech has one of the world's most respected experimental laboratories and a very bright subject pool that is familiar with complex economic decision-making.

4.1 Experimental Version of the Current Media Trading Process

Testing our claim involves specifying a trading institution that mirrors the process participants currently use to buy and sell advertising. To that end, we will create in the laboratory an economic environment that includes, among other things, the following features:

4.1.1 Media Buyers

- Buyers vary according to the size of their budgets, their desired "demographics," spot length, and the programs from which they wish to acquire spots;
- Buyers vary in the value they place on a spot and the degree to which they wish to acquire viewers on a guaranteed versus non-guaranteed basis;
- Some buyers wish to limit the number of spots they acquire from a single seller and the number of spots they acquire per day;
- Buyer budgets may increase during the course of the trading period;
- Buyers are "made whole" if they acquire their desired viewers on a guaranteed basis and if the actual number of attracted viewers is less than the number guaranteed by a seller, and;.
- A buyer's profits are equal to the value it places on a spot minus the cost of acquiring the spot.

4.1.2 Media Sellers

- Media sellers are able to sell blocks of continuous seconds of time across several days;
- Each program attracts different types of viewers, the actual number of which is not known until after all participants complete their trades;
- Programs vary according to the number of viewers they attract;

- Sellers provide a "make good" when they have sold a spot on a guaranteed basis and when the actual number of attracted viewers is less than the number guaranteed by a seller, and;
- A seller's profits are equal to the sale price of each spot minus the cost, if any, of acquiring the "make good" viewers.

All market participants have a common estimate of the number of viewers each program will attract. Buyers and sellers have the opportunity to complete trades through a series of bilateral negotiations. Buyers are able to create and submit BIDS to specific sellers, and sellers are able to create and submit ASKS to specific buyers. During the negotiation process, which will be conducted electronically and which will allow participants to communicate verbally, buyers can raise their BIDs, while sellers can lower their ASKs. If a buyer (seller) accepts an ASK (BID), the seller and the buyer complete a trade at the designated price. Buyers and sellers will have a limited amount of time to complete their trades. Following the close of the market, market participants will be told the actual number of viewers attracted to each program. The earnings of the buyers and sellers are then calculated and, if necessary, adjusted according to the "make good" rules. After participating in several separate trading sessions, participants will be given a financial payment equal to their total earnings.

4.2 Comparing Markets: Measuring Participant Profits

To test whether Initiative, and other market participants, will fare better in Siena's proposed market, the profits of each participant will be recorded given their trades in the experimental version of the current market and in Siena's proposed market. We will also compare these profits to the maximum profits each participant can expect to earn in the most efficient market. When summed across all participants, this difference between what participants earn in the tested market and in the most efficient market measures the "inefficiency" of the tested market. On behalf of Initiative, we will use the experimental data to identify the trading strategies employed by the most profitable market participants in each of the two markets.

5 Comparison of Existing and Siena's Proposed Market for the Trading of Advertising Time: An Experimental Analysis

5.1 Introduction

Siena Holdings, LLC is developing a new and more efficient method by which media buyers and program distributors can buy and sell advertising time. Initiative Worldwide has requested that we provide empirical and objective support for our claim that our new, electronic market will enable Initiative to obtain, on average, better buys, and thus higher profits for its clients, and will enable sellers to obtain, on average, better prices, simultaneously. Below we describe the empirical approach Siena has developed to rigorously and objectively test its claim.

5.2 The Economic Basis for Our Claim

Siena's claim contains two essential elements. The first states that there are instances where buyers and sellers can both benefit from a change in the process by which they conduct trades. The second element is that buyers and sellers would both benefit from moving from the current method of buying and selling advertising time to Siena's new electronic market. Lets consider each in turn.

Markets vary in the degree to which they are efficient. In the most efficient market, no participant leaves "money on the table." That is, in such a market there will be no instance in which the seller could have received a higher price from a different buyer or a buyer could have paid a lower price to a different seller or received a better spot for the same or lower price. According to these conditions, whenever one side of the market leaves money on the table, the other side does as well. That means that the profits of at least one buyer and one seller must not be maximized when the market is less than perfectly efficient. The amount of money participants leave on the table is directly related to the extent to which the market is inefficient.

Market prices assist buyers and sellers in identifying those trading partners with whom the least amount of money will be left on the table. In particular, market prices assist buyers in finding the most willing sellers, while assisting sellers in finding the most willing buyers and, in so doing, the best prices for each. Thus, the degree to which a market is inefficient depends upon whether market forces have established the correct (i.e., "efficient") prices. According to economic theory, market forces will establish such prices when transaction costs are low, gamesmanship is minimal, market prices (i.e., not individual transaction prices) are known by both buyers and sellers, and when market forces reflect the preferences of all the buyers and sellers in the market.2 Because market mechanisms vary in their ability to satisfy these requirements, they vary in their ability to generate efficient prices and, therefore, in their ability to minimize the amount of money market participants leave on the table.

Siena believes that its proposed market is superior to the current trading process because its proposed market satisfies the above conditions much more effectively. Given its centralized and electronic nature, transactions costs are nearly non-existent in Siena's proposed, new market. Because market participants pay the market price, as opposed to their bid or ask price, Siena's proposed market will elicit less gamesmanship than in the current market. Reduced gamesmanship means that buyers and sellers will more likely come to an agreement regarding a trade. In addition, using advanced mathematics, the proposed new market simultaneously evaluates, using all the submitted market information, all the ways in which each market order can be "filled." This ensures that the generated market prices will be more informed than the market prices generated by the current, sequential, bilateral trading process. In addition, to assist participants in determining whether to trade, Siena's proposed market provides participants information on the current market prices.3 While economic theory strongly suggests that Siena's proposed new market will benefit both Initiative (i.e., buyers) and sellers simultaneously, we have developed a method by which to rigorously and objectively test this proposition.

5.3 Test Methodology

Our approach employs "experimental economics," an important and growing branch of economics which involves the study, in a controlled laboratory setting, of how financially motivated humans make decisions in the presence of uncertainty and when confronted with real economic choices. In 2002, a Nobel Prize in Economics was awarded to a founder of this important branch of economics.4 This recognition reflects the increasing use of economic experiments to test the validity of economic theories and shed new light on complex economic situations where theory has little to say. Compared to other empirical-based methodologies, the major advantage of economic experiments is laboratory control, replicability, and a greater ability to establish cause and effect.5 In contrast to pure theory, economic experiments allow one to observe the reactions of real people in situations where they are faced with real uncertainty, market complexity, and economic incentives.

In an economic experiment, human subjects are provided detailed information about an economic environment, assigned a role as a “player” in that economic environment, and are given, after the experiment is completed, a financial payment based on their performance in that environment.6 Our approach will focus on measuring the profits earned by each participant when buying and selling advertising time under the rules of the current market versus under Siena’s proposed new market. For completeness, we will also compare the profits each participant earns in each of the two tested markets with the maximum profits they can expect to earn in the most efficient market.7

5.4 Advertising Market Experiments: Current Market

The experiments begin with the creation of a market that parallels the market in which media buyers currently acquire advertising time from program distributors.8 The following describes the buy and sell sides of the experimental version of the current market, what information each side has that is commonly known, and what information they have that is private.

5.4.1 Sellers of Ad Time and Information Available in the Marketplace

Human subjects that are assigned the role of seller will be assigned a set of assets in the form of blocks of time. Available for three different days, each block of time is 45 seconds in length, and sellers have three blocks to sell each day. Each block can be sold whole or in “units” of 15 seconds, 30 seconds, or 45 seconds to one or more buyers.

Each block attracts three different types of viewers. The actual number of attracted viewers of each type is independent of the length of the sold block. At the time of a market trade, buyers and sellers share the same estimate of the likely number of viewers that will be attracted to the seller’s program. At the close of each trading period buyers and sellers will be told the actual number of attracted viewers. The actual number of attracted viewers will be a random number between 80% and 120% of the estimate.

There are four sellers in the market experiment. Each has the opportunity to sell advertising time either on a “guaranteed” basis or on a “non-guaranteed” basis. If sold on a guaranteed basis, sellers assume the risk that at least the estimated number of viewers will be attracted to the program. Sellers are willing to assume this risk in exchange for a premium over the price of ad time sold on a non-guaranteed basis. In the experiments, sellers vary in their willingness to assume this risk.

With the exception of when a seller sells its time on a guaranteed basis and the actual number of attracted viewers turns out to be less than the number guaranteed, a seller's earnings from a trade are equal to the sale price of the spot (i.e., 15, 30, or 45 seconds). That is:

Seller Trade Earnings = Sales Price of Spot

If the spot is sold on a guaranteed basis and the actual number of viewers is less than the number guaranteed, the seller must "make good" on the difference by buying the necessary viewers from the experimenter at a fixed price per viewer. Under these circumstances, the seller's earnings from a trade are equal to the sale price of the block minus the cost of acquiring the "make good" viewers from the experimenter. That is:

Seller Trade Earnings = Sales Price of Spot − "Make Good" Cost

Finally, sellers are provided information that assists them in keeping track of their current ASKs, completed trades, and remaining unsold avails.

5.4.2 Buyers of Ad Time and Information Available in the Marketplace

There are five buyers in the market experiment. Each buyer is assigned a set of desired spots, a desired block length, and desired viewer type (i.e., demographic), and a resale value for each desired viewer.9 A buyer's resale value for a spot is equal to the buyer's resale value for each viewer times the actual number of viewers attracted to the program in which the spot appears. Buyers vary in their desired spots, their desired block length, their desired demographic, and their resale value for the desired demographic.

Some buyers need to acquire a minimum number of viewers of a certain demographic in order to earn money. In addition, some buyers are limited in the number of spots they can acquire from a single seller and the number of spots they can acquire per day.

A buyer's earnings from a trade are equal to the difference between its resale value for the acquired spot(s) and the purchase price for the spot(s). That is:

Buyer Trade Earnings = Resale Value for Spot − Purchase Price for Spot

Prior to the start of the experiments, buyers are assigned budgets that limit the sum of their expenditures. At some point during the experiments, a buyer's budget may increase. Each buyer's new budget will be a random number between the current budget and 140number. Buyers will be "made whole" if they acquire their desired viewers on a guaranteed basis and if the actual number of attracted viewers is less than the number guaranteed by a seller. Buyers are provided information that assists them in keeping track of their current BIDs, completed trades, and remaining budget.

5.4.3 Information Available in the Marketplace and the Current Trading Process

Buyers and sellers have a common estimate of the number of viewers each program will attract. Buyers and sellers have the opportunity to complete trades through a series of bilateral negotiations. To insure privacy, all negotiations will be conducted electronically. Buyers submit offers to buy (BIDS) to individual sellers, while sellers submit offers to sell (ASKS) to individual buyers. Such BIDS and ASKS are only revealed to the parties to which they are directed. All BIDS and ASKS will be submitted and received electronically. Parties can also communicate verbally to prospective counter-parties using a messaging system.

Buyers create a BID by submitting, into an electronic screen, information identifying the seller to whom the BID is directed, the desired days(s), spot length (i.e., 15, 30, 45 seconds), the number of spots they wish to acquire, whether they wish to acquire their desired spots on a guaranteed versus non-guaranteed basis, and a single BID PRICE. The BID PRICE represents the maximum amount the buyer is willing to pay for a single spot. Each BID can be sent to only one seller. As long as the experiment is open, buyers are allowed to submit as many BIDs as they like, as long as they do not exceed their budget. Prior to a trade, a buyer can either increase its BID Price or withdraw its BID.10

Similarly, sellers create an ASK by submitting, into an electronic screen, information identifying the buyer to whom the ASK is directed, the days(s) in which the spot is available, the spot length (i.e., 15, 30, 45 seconds), the number of spots they wish to sell, whether they wish to sell the spot on a guaranteed versus non-guaranteed basis, and an ASK PRICE. An ASK PRICE represents the minimum amount the seller needs in order to sell a single spot. Each ASK can be sent to only one buyer, and only that buyer will see the ASK. As long as the experiment is open, sellers are allowed to submit as many ASKs as they like, as long as they do not offer to sell more of any asset than they have available. Prior to a trade, a seller can either reduce its ASK Price or withdraw its ASK.

Sellers can sell their respective assets to multiple buyers, but each spot can only be sold to a single buyer. Sellers can trade with each buyer multiple times. Parties are prohibited from revealing to a third-party the sale price of the trade or that a trade has occurred. A trade occurs whenever a buyer accepts a seller's ASK, or a seller accepts a buyer's BID. Each trade occurs at the designated ASK or BID PRICE, depending on whether the buyer or the seller accepts the offer.

5.4.4 Comparing Markets: Measuring Participant Profits

In addition to conducting trades in the experimental version of the current market process, participants will be given the opportunity to conduct trades in an experimental version of Siena's proposed new market. The profits of each participant will be recorded when participating in each market. To ensure that any difference in observed profitability is due to the difference in the market trading process, the economic environment will be identical across the two trading processes. Finally, the controlled laboratory setting allows us to compare the profits made by each participant in each tested market with the profits each can expect to earn in the most efficient market. Subtracting the participant's earnings in the tested market from the amount it can expect to earn in the most efficient market will yield the amount of money the participant has "left on the table" in the tested market. The sum of the monies left on the table across all participants measures the extent to which the tested market is inefficient.

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