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MARKETS WITH POSTED PRICES: RECENT RESULTS FROM THE LABORATORY*

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This paper reviews our recent research on markets with posted-prices. Unlike more competitive market institutions, such as the double auction trading rules used in many financial exchanges, we show that posted-price markets are prominently affected by structural and environmental conditions typically considered problematic in industrial organization theory. The sensitivity of posted-price markets to market power, price-fixing conspiracies, search costs and cyclical demand shocks corrects a mistaken impression that laboratory markets are uniformly efficient and competitive.

1. Introduction

In many markets, it is common for prices to be set by the traders on the thin side of the market. Sellers, for example, typically post prices in retail markets. For this reason, theoretical (Bertrand) models are often structured around an assumption that prices are listed simultaneously at the beginning of each «period». Using laboratory experiments, it is possible to make controlled comparisons between markets with posted prices and more symmetric institutions such as the «double auction», where both buyers and sellers post bids and asks in an interactive setting that resembles a centralized stock market. Laboratory double auctions yield efficient, competitive outcomes in a surprisingly wide variety of settings, sometimes even in a monopoly[1]. Although markets with posted prices do not track competitive predictions as well as double auctions, the traditional view was that resulting inefficiencies were only part of the price convergence process. Aside from the initial-period inefficiencies, the primary difference between posted-price and double-auction markets was thought to be that in posted-

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[1] This literature is surveyed in Davis and Holt (1993, chapter 3).

price markets, a higher share of the surplus went to traders on the posting side of the market in the price convergence process [2].

This traditional view is contradicted by our recent research and by the related research of others [3]. Posted-price markets respond sluggishly to demand shocks and can yield consistent supracompetitive prices when sellers possess market power. Price-fixing conspiracies are much more pernicious when subjects post prices on a take-it-or-leave-it basis. More recent experiments relax some of the standard assumptions of the Bertrand model, by introducing costly search, the possibility of buyer-specific discounts, and binding advance-production decisions. These experiments document some interesting anomalies and rigidities that have major implications for new theoretical work in industrial organization and macroeconomics.

The purpose of this paper is to survey this research. The presentation is divided into two main parts. Sections 3-5 review recent research on posted-offer market performance under adverse environmental or structural conditions: Section 3 discusses the effects of unanticipated demand shocks; Section 4 pertains to tacit cooperation among sellers, which is facilitated by the existence of market power; and Section 5 reviews experimental research dealing with explicit collusion (price-fixing). Sections 6-8 summarize some experiments designed to evaluate modifications to the standard posted-offer trading rules: Section 6 considers non-public discounts; Section 7 pertains to search costs; and Section 8 discusses advance-production decisions. Prior to considering either adverse environmental conditions or institutional modifications, it is necessary to briefly describe how laboratory markets are created, and to review some of the empirical regularities pertaining to posted-offer markets that have been observed. This is the project of Section 2, below.

2. Trading Institutions and Market Performance

A market experiment normally consists of a series of trading periods. At the start of each period, sellers are given a capacity, i.e., a listing of units and the corresponding unit costs. The cost is only incurred if the unit is sold, in which case the seller earns the difference between the sale price and the cost. For example, a seller identified as S1 could be given a capacity of 2 units, a first unit with a cost of $1.30, and a second with a cost of $1.40. This

[2] Smith (1982b, p. 951) concludes: «If sellers post offers convergence is from above the C.E. price». In the first major survey of experimental work on industrial organization issues, Plott (1982) summarizes: «Two generalizations seem possible at this time. First, posted-offer (bid) markets tend to have higher (lower) prices than do oral double auction markets in that the adjustment to equilibrium tends to be from above (below) and either converges to equilibrium more slowly or does not converge at all». This statement is qualified in the Plott (1989) update of this survey: «Two aspects of the results are of interest. First, with repetition under fixed conditions, the market prices are near those predicted by the model, and efficiencies approach 90-100 percent. Second, prices tend to be higher for posted-price markets than for oral double auctions (about 10 cents higher in these markets) and efficiencies are lower».

[3] As noted below, some of the contradictions are provided by the work of Vernon Smith and Charles Plott, who are quoted in the previous footnote.

seller would then be willing to sell 0 units at a price below $1.30, 1 unit at a price between $1.30 and $1.40, and 2 units at any prices above $1.40. Thus, S1's supply function would have «steps» at $1.30 and $1.40.

Just as sellers are given the capacity to produce at specified costs, buyers are given the capacity to purchase a number of units with specified monetary values, contingent on purchase. A buyer B1, for instance, could have 2 units with values of $1.40, with the understanding that the buyer earns the difference between the value of each unit purchased and the price paid. This would yield a «rectangular» demand function with a step at $1.40. Earnings are calculated in each period, and accumulated earnings are paid in cash at the end of the market session. The value and cost structures for all traders determine the aggregate supply and demand functions, and hence, the theoretical competitive equilibrium price. For example, the supply and demand curves in Figure 1 are constructed by aggregating the values and costs for six buyers and six sellers; this structure results in a range of competitive prices from $1.30 to $1.40.

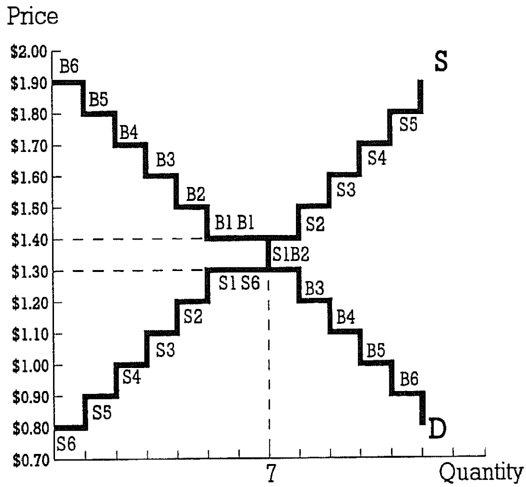

Figure 1
Supply and Demand Structure for a Market Experiment.

The identifiers B1 to B6 printed above the market demand curve **D** indicate unit values for six individual buyers, and the identifiers S1 to S6 printed below the market supply curve **S** indicate unit costs for six individual sellers. As indicated by the dashed horizontal lines, the equilibrium price range is between $1.30 and $1.40. Similarly, as indicated by the dashed vertical line, the equilibrium quantity is 7 units.

Most market experiments involve comparisons of market performance under two or more treatments that may, for example, correspond to alternative trading rules or antitrust policies. When the treatments use the same supply and demand structure, it is natural to consider which treatment yields more gains from trade. Just as the individual buyer's values and seller's costs determine the aggregate demand and supply functions, they also determine the possible trading surplus, the area between the induced supply and demand curves. This surplus is the maximum sum of all buyers' and sellers' earnings in a period. Efficiency is measured as the sum of subjects' actual earnings, expressed as a percentage of the maximum possible[4] Thus efficiency in a theoretical competitive equilibrium is 100%.

Of course, the standard prediction from any introductory price theory course is that the efficient, competitive outcome will be observed. If there is any discussion of the trading rules that give rise to this prediction, recourse would likely be made to the efforts of the fictional Walrasian auctioneer operating in a market of passive price takers. But in truth, price decisions are negotiated by strategic traders who operate under institutional rules that determine the timing and source of price offers and counteroffers. As intimated above, these rules can have a dramatic effect on market performance. Before beginning, the experimenter must decide on an appropriate trading institution.

Although most consumer purchases are made without negotiation at prices posted by sellers, there is a rich variety of alternative trading institutions in which prices are negotiable. Prices on the New York Stock Exchange, for example, are determined through a specialist on the «floor». This centralized

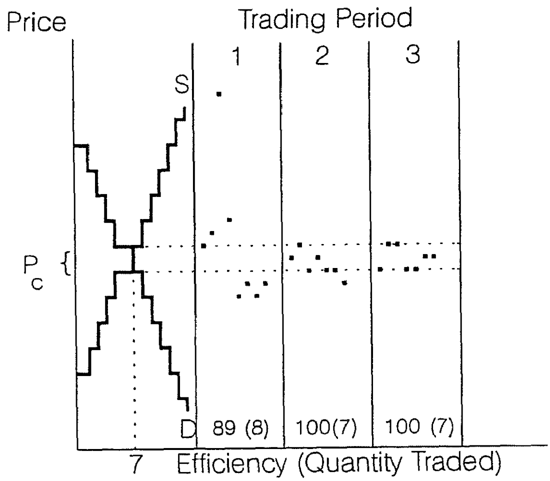

Figure 2
Price Sequence for a Double Auction.

(Key: ▪ contracts.) In trading period 1, illustrated in the leftmost vertical strip after the supply and demand arrays, none of the eight completed contracts were struck within competitive price range, demarked by the horizontal dotted lines, and 89% of the possible gains from trade were realized. In period 2, however, six of the seven contracts completed were stuck within the competitive price range, and 100% of the possible gains from trade were extracted.

[4] See Plott (1989) and Davis and Holt (1993) for a discussion of the limitations of this and other measures of performance used in laboratory experiments.

trading process is implemented in the laboratory by allowing bids and asks to be submitted and displayed publicly, subject to an improvement rule: a seller must improve (lower) the current ask, and a buyer must raise the current bid. Thus ask prices fall and bid prices rise in a «double auction», and trade occurs when someone accepts another's proposal. Consider the contract sequence on the right side of Figure 2, where the supply and demand structure is reproduced on the left. The eight dots in the vertical slot for period 1 represent the transaction prices for the eight units that were sold; these dots are listed in the order in which trades occurred. Only 7 units were traded in periods 2 and 3, and by period 3 all transactions prices were in the competitive price range.

The convergence results in Figure 2 are quite typical. Although double-auction experiments do not even come close to satisfying the perfect-information and large-numbers assumptions that go with textbook treatments of perfect competition, laboratory trading reliably converges to efficient, competitive outcomes (Smith, 1982a). Indeed, the contrast between the clarity of the data and the implausibility of the Walrasian assumptions could not be more dramatic, which makes this institution a very effective teaching device. This convergence to the competitive price has been observed for such a wide variety of supply and demand configurations that structural variables seem to be almost irrelevant [5].

Since the strong convergence characteristics of double auctions are typically cited most prominently in surveys of laboratory market research, the general perception is that market experiments provide reassurance for those who believe in Adam Smith's «invisible hand», and surprises for those who do not. This perception is reinforced by the tendency of textbooks to focus on competitive, Walrasian results of market experiments. Kreps (1991, p. 198), for example, notes that

> «These experiments do not quite get to the level of generality of a Walrasian equilibrium for a general equilibrium with many interdependent markets. But the repertory of experiments is growing quickly and, except for a few special cases, those experiments that have been run are consistent with the notion of Walrasian equilibrium. All in all, they make Walrasian equilibrium look quite good».

Although Kreps seems to be referring to the double auction results, the general equilibrium implications are unjustified if many or most markets in an economy are not organized as double auctions [6].

In fact, many markets are characterized by prices that are advertised or posted for significant time intervals. This price-posting process is implemented in the laboratory by letting each seller choose a price and a maximum quantity to

[5] Some small effects of market power on double auction prices are reported in Holt, Langan and Villamil (1986) and in Davis and Williams (1991). The presence of significant fixed costs can also degrade performance in double auctions (Van Boening and Wilcox, 1996).

[6] There have been some experiments in which double auctions are used in several related markets, and general equilibrium predictions are surprisingly accurate, e.g., Williams, Smith, and Ledyard (1986), Goodfellow and Plott (1990), and (discussed below) Lian and Plott (1993).

offer at that price. After all sellers have confirmed their choices for the period, the prices are communicated to all buyers and sellers. Then buyers are selected one at a time, in a random order, to shop from one of the sellers who is not out of stock. Thus all sales are made at the posted prices, which cannot change until the beginning of the next period. Some experiments are conducted with human buyers, and others use simulated (demand-revealing) buyers that are programmed to purchase all profitable units. If buyers reveal demand, this posted-offer institution corresponds to a theoretical Bertrand price-setting model with capacity constraints and with a «rationing rule» determined by random buyer selection.

The asymmetry and rigidity of the price negotiations have the effect of providing a bargaining advantage to sellers. Figure 3 shows the price sequence for a posted-offer market that was conducted with the same supply and demand conditions discussed above[7]. Only 4 units sold in the first period, as indicated by the small boxes (▪); the prices of unsold units are indicated by plus signs (+). This market shows a common tendency for posted prices to hang above competitive levels, which raises sellers' earnings relative to those of buyers. Overall efficiency measures, shown in Figure 3 below the contract dots for each period, are about ten to twenty percent lower than for comparable periods in the double auction in Figure 2. This

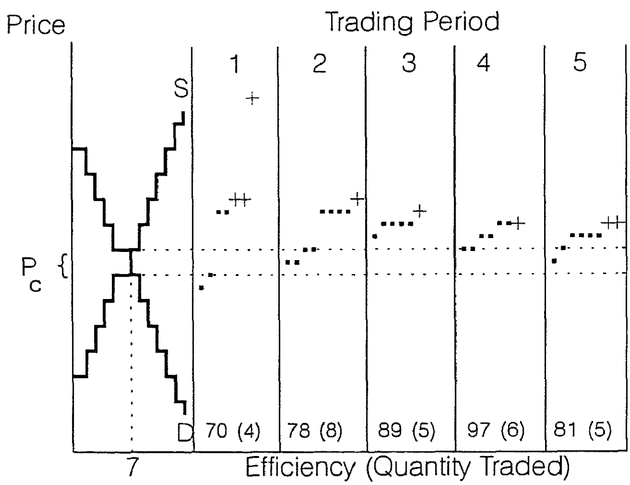

Figure 3
Price Sequence for a Posted-Offer Auction.

(Key: + posted prices, ▪ units sold.) In trading period 1 only one of the four contracts completed was struck within the competitive price range, demarked by the horizontal dotted lines. In this period, three sellers failed to sell any units, and only 70% of the total possible gains from exchange were extracted. In period 2 the sales quantity increased to eight units, with four of the contracts being struck in the competitive price range. 78% of the possible gains from trade were extracted in period 2.

[7] The calculation of Nash equilibrium prices for designs like that in Figure 3 is discussed in Section 4 below.

session is typical; compared to double auctions, laboratory posted-offer markets converge to competitive predictions more slowly (Ketcham, Smith and Williams, 1984) and less completely (Plott, 1986, 1989). Even in non-monopolized designs with stationary supply and demand functions, traders in a posted-offer market generally forego about 10% of the possible gains from trade over the first eight to ten trading periods, whereas traders in a double auction routinely extract 95-98% of the total available surplus over the same trading period interval (Davis and Holt, 1993, chapters 3 and 4).

Other differences between double auctions and posted-offer auctions have been carefully documented. In double auctions, competitive outcomes are consistently observed with very thin markets and even with price-fixing conspiracies (Isaac and Plott, 1981; Clauser and Plott, 1991). The effects of monopoly and significant market power are also surprisingly small (Smith and Williams, 1988, Holt, Langan and Villamil, 1986, and Davis and Williams, 1991). The research reviewed below indicates that none of these conclusions apply to posted-offer trading.

These well-known differences lead naturally to a consideration of the effects of adverse conditions that are quite common in naturally occurring markets. In particular, if posted-offer markets converge to competitive outcomes slowly, what will happen when the competitive price is shifting in response to demand or supply shocks? And what would be the effect of price-fixing conspiracies or of capacity constraints that produce concentration measures that are not unusual for producer goods markets?

A number of important policy issues arise from the parallels between the laboratory posted-offer institution and many retail markets. Factors that affect the success of conspiracies, for example, are of obvious interest to antitrust economists. In macroeconomics contexts, a sluggish response of posted prices to unanticipated demand and supply shocks could produce disruptions with interesting Keynesian implications.

Drawing general conclusions from laboratory posted-offer experiments must be done with caution, as there are many differences between laboratory and natural markets. These differences do not arise because laboratory data are a consequence of an experiment, but because they are the result of the wrong experiment. Successful conspiracies in laboratory posted-offer markets, for example, may say little about behavior in naturally occurring markets in which sellers can offer discounts from their posted prices. Similarly, many natural markets differ from the standard posted-offer implementation in that shopping is not costless. Consumer search costs potentially give sellers some market power over buyers, and may generate higher prices, holding constant other structural conditions.

Perhaps the greatest difference between the laboratory and the economy is complexity. The relative simplicity of a laboratory economy can limit the usefulness of experimental methods. In some respects, however, this limitation is no more condemning that the fact that theory is also a simplification. We can compare the predictive power of alternative theories under ideal «best shot» laboratory conditions and under conditions that stress the theoretical assumptions in limited and carefully chosen dimensions. In such cases, simplicity is a desirable property of an experiment. Relatively more complexity is essential in other cases. For example, the poor response of posted-offer markets to demand shocks suggests Keynesian price rigidities, but an experimental analysis of such rigidities would require a multi-market setup.

These modifications of the posted-offer institution can be accomplished in controlled experiments. Indeed, analysis of discounting and search costs is ideally suited to experimentation, since it is nearly impossible to find two markets outside the laboratory that are identical except for these institutional details. Although there have been few if any multi-market experiments with posted prices, there are an increasing number of multi-market double auction studies (see note 6 above). But in any event, we wish to stress that the primary value of experimentation in economics rests in theory evaluation and refinement: The status of a theory as a basis for policy becomes questionable if it is difficult or impossible to create an environment where the predictions of the theory are observed. Similarly, a theory's status as a basis for policy increases when predictions observed in very specific context can be shown to hold under much richer conditions.

As a final preliminary comment, it is instructive to define explicitly some frequently-used terms, whose precise meaning may not be obvious to the reader unfamiliar with the experimental literature. As mentioned at the beginning of this section, the basic unit of a market experiment is a trading period. A session or market is a set of trading periods using the same cohort, or collection of subjects, in a single day. A treatment condition specifies relevant environmental, and institutional characteristics. A sequence is a subset of a market conducted under a particular treatment condition. Markets consist of one or more sequences. A treatment cell is collection of sessions or session-sequences conducted in the same treatment condition. Finally, an experiment is a collection of markets, organized in one or more treatment cells conducted to evaluate a particular proposition.

3. Demand shocks

Since prices in posted-offer markets tend to converge slowly and from above when the demand and supply structure is stationary, it is natural to consider the adjustment path when structural conditions shift from period to period. In the setup in Figure 4, five units trade in the equilibrium for periods 1 and 2, for a price of $2.45. Demand shifts in subsequent periods raise the equilibrium price by 20 cent increments, until a price of $3.65 is reached in periods 8 and 9. This is followed by inward demand shifts in the final 6 periods. This generates the «hill-shaped» equilibrium price paths shown by the stepped solid lines in Figure 5. In experiments conducted with similar designs, all value and cost information is private, so that sellers get no direct information about the demand shifts.

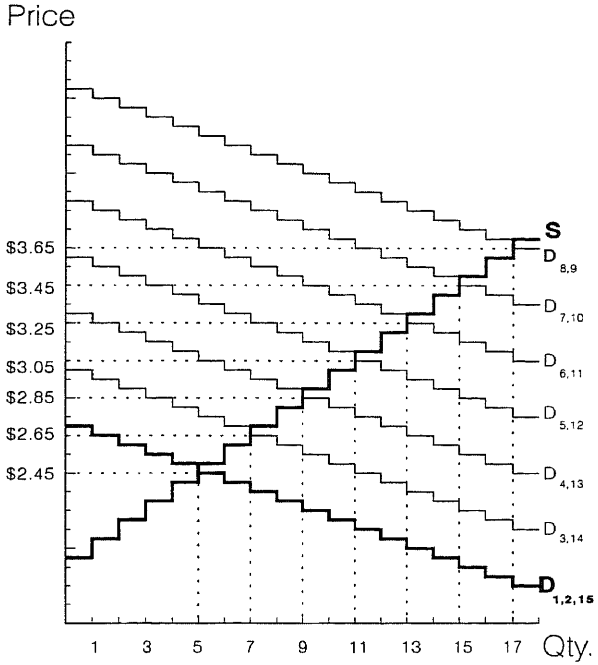

Figure 4
Supply and Demand Arrays for a Trend-Demand Design.

Bolded supply array **S**, and bolded demand array $\mathbf{D}_{1,2,15}$ are in effect for periods 1 and 2. In the competitive outcome, five units trade, at a price of $2.45. In period 3 the demand schedule shifts up vertically to array $\mathbf{D}_{3,14}$, increasing the competitive quantity to seven units, and the competitive price to $2.65. Similar upward shifts occur in periods 4 to 8, with quantity and price predictions peaking at 17 units, and $3.65, respectively. The pattern is reversed in periods 9 to 15, with a series of downward demand shifts.

Davis, Harrison, and Williams (1993) report data for posted-offer and double auction markets in this trend demand design. The difference in performance across institutions is evident from comparison of the curvilinear average price paths for the four posted-offer markets, shown in the left panel of Figure 5, with price paths for the three double-auction markets in the right panel. Although price response in the double-auction sessions is not flawless, mean prices generally move with the underlying equilibrium predictions. In contrast, the posted-offer prices tend to start low and drift slowly upward until they cross the underlying equilibrium, at which time sales quantity falls, or drys up altogether as indicated by the breaks in the contract-price curves. These posted-offer markets only extract about half of the possible trading surplus (48% on average), as compared with the nearly full extraction in the comparable double-auction markets (98% on average)[8].

[8] The poor response of posted-offer markets to a single, unanticipated demand shift was first noticed by Hong and Plott (1982).

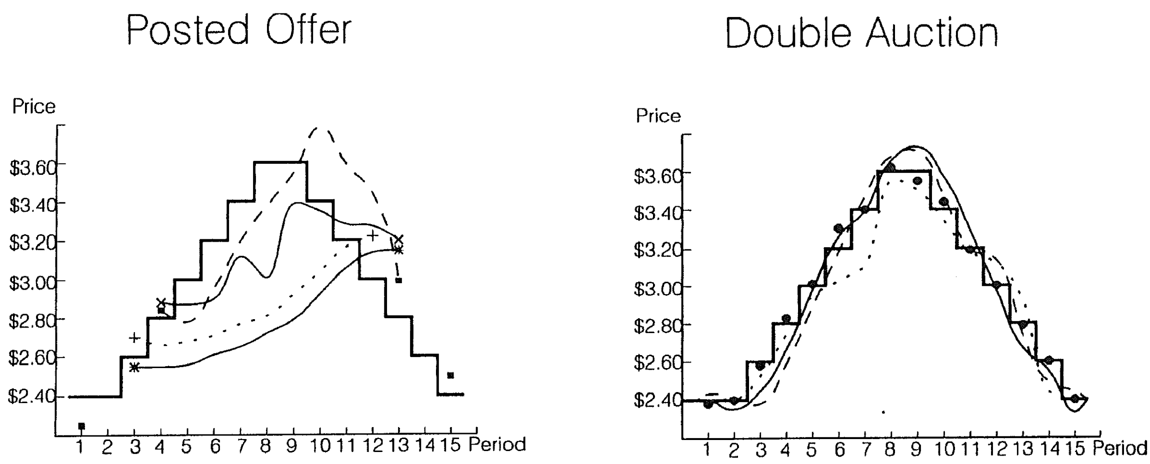

Figure 5
Mean Contract Price Paths in a Trend-Demand Design.

In each panel, the steps indicate the competitive equilibrium price path and curved lines indicate mean contract prices for individual sessions. In the posted-offer sessions, shown in the left panel, the patterns of individual contract prices tend to drift slowly upward, missing altogether the patterns of movements in the underlying equilibria. In contrast, mean contract prices in the double auction markets shown in the right panel track the underlying equilibria much more closely. Particularly accurate predictors of the underlying equilibrium in the double auction markets are the mean closing prices, shown as bolded dots.

The posted-offer auction differs from the double auction in two main ways: the price posting process is one-sided, and there is less price flexibility. Davis and Holt (1996b) report a series of treatments that incorporate aspects of price flexibility that can be found in many markets. The large efficiency losses from posted pricing in the trend demand design are not eliminated by introducing by allowing buyer-specific discounts (discussed below in section VI) or «clearance sales» at prices below the posted levels. In particular, the clearance sale treatment gave sellers a chance to move unsold inventories with a second price posting in each period[9]. These modifications produced modest improvements in price-tracking, and efficiency increased from about 50% to about 66% in each treatment. Nevertheless, market prices still largely failed to track underlying equilibrium price alterations.

A possible problem with computerized posted-offer auctions is that sellers have difficulty gauging the depth of excess demand at the posted prices. It is not unreasonable, however, for a seller who stocks out at an advertised price to be able to observe some or all of the frustrated buyers. Davis and Holt (1996b) also report a treatment in which the posted-offer procedure is modified to provide sellers with an exact count of unfilled orders, using the shifting demand structure of Figure 4. Like the discounting modifications discussed above, this excess-demand information only resulted in modest improvements in price tracking and efficiency; trading dried up completely in the last several periods of all three sessions.

To summarize, unanticipated demand shocks produce a sluggish price response in posted-offer markets, and in particular, negative demand shocks can cause market trading to collapse as prices do not fall rapidly enough. This collapse is suggestive of the type of microeconomic inflexibilities that cause macroeconomic disruptions. There are few experiments motivated by macroeconomic phenomena, and these do not produce severe business cycle fluctuations[10]. For example, Lian and Plott (1993) set up an ambitious experiment with labor and goods markets that were subjected to monetary shocks. They report that prices in their markets moved toward Walrasian competitive levels, without severe disruptions. Since all markets were double auctions, this raises the question of whether behavior changes when prices are posted. The poor response of posted-price markets to demand shocks could provide a simple justification for the price rigidities that are central to Keynesian predictions. We are currently investigating this issue.

4. Tacit collusion and the exercise of market power

A monopolist has the market power to raise price profitably above the competitive level, and single sellers are able to exercise this power much

[9] The clearance sale treatment was approximately the same at that used in the stationary demand-and-supply markets reported by Mestelman and Welland (1994).

[10] Rustichini and Villamil (1992), however, construct a theoretical model in which «sticky» equilibrium prices arise as a result of correlated demand shocks.

more effectively in laboratory posted-offer markets than in comparable double-auction markets (Smith, 1981). This section surveys work on the effects of market power in non-monopolized markets with posted prices. Market power can be defined to be the unilateral incentive of one or more sellers to raise price above a common competitive level[11]. Holt (1989) suggested that the presence or absence of market power may explain why posted-offer prices sometimes lock onto competitive predictions and sometimes hang above those predictions. Intuitively, it can be profitable for a seller to raise price when other sellers' capacities are sufficiently limited; in this case, the effect of the price increase can more than offset the loss of sales quantity, especially if the lost sales are for relatively high-cost units. Note that the existence of market power depends critically on the capacities and costs of the various sellers; a seller with a large number of marginally profitable, high-cost units is more likely to be willing to withhold quantity than a competitor who has a very limited capacity. A reallocation of units from one seller to another can create or destroy market power. Thus, we were not surprised that Mestelman and Welland report that a reallocation of units, holding the aggregate supply function constant, can alter the average prices in posted-offer auctions[12, 13].

This observation that capacity reallocations can affect prices led us to consider a design in which a reallocation changed the Nash equilibrium price from the competitive price (Bertrand result) to higher (randomized) prices over the range spanned by the «Edgeworth cycle». Consider Design 1 on the left side of Figure 6. As indicated by the seller numbers below each unit, sellers S1-S3 each have 3 units, and S4 and S5 each have a single unit. The demand curve has a vertical intercept of r and intersects supply at a range of prices from the highest competitive price, p_c to the level of the highest cost step, c. Also in this design, rather than using «live» buyers, an automated full-demand revealing buyer is used. In the event of a price tie among two or more of the sellers, sales are rotated among the sellers posting the same price.

No seller has market power in this design, since a unilateral price increase above a common price p_c will result in no sales. Suppose, for example, that all sellers but S1 post a price of p_c and that S1 posts p_c+1. Then sellers S2 and S3

[11] Holt (1989) also discusses a related notion of «equilibrium market power», wich exists when the noncooperative equilibrium for the single-stage market pricing game results in prices that exceed competitive levels.

[12] The experiment is described in Mestelman and Welland (1994). The effect of the reallocation of units was reported at a presentation of the Economic Science Association meetings in October 1992.

[13] Moreover, market power can be insidious. For example, when organized under posted-offer rules, seller S1 in the Figure 1 design has market power in the following sense: In a single-period game, buyers have no incentive to withhold profitable purchases after prices are posted. If all sellers choose a common price of 1.40, seller S1 is earning nothing if the second unit sells. A careful count of buyers' units shows that a unilateral price increase of 10 cents will still allow seller S1's first unit to sell, unless buyer B1 is chosen to shop last, an event that occurs with probability 1/6. Thus this seller's expected profit goes up if price is increased above the highest competitive price. Although it is often straightforward to demonstrate the existence of market power, the asymmetry of agents in many designs prohibits identification of a Nash equilibrium. This led us to construct the designs in Figure 6, discussed below.

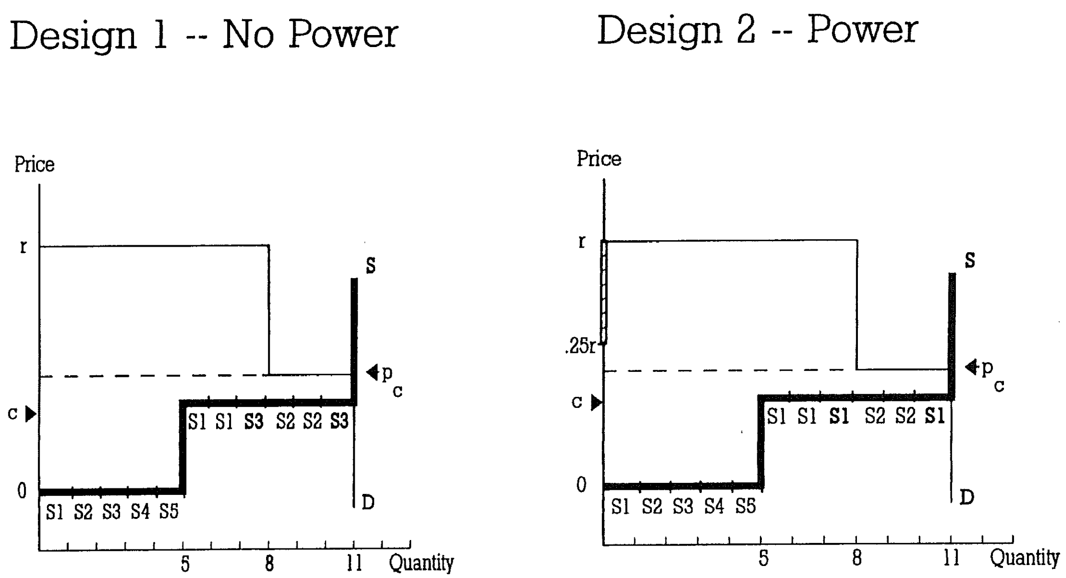

Figure 6

Supply and Demand Arrays for a No-Power Design.

In the no power treatment, shown in the left panel, units are distributed among the sellers in such a way that a unilateral deviation by any seller from the common price p_c will reduce sales for the deviating seller to 0. Market power is created in the right panel by reallocating seller S3's two high-cost units to sellers S1 and S2. With the reallocation, both S1 or S2 find profitable a unilateral increase from the common price p_c to the limit price r.

would each sell 3 rather than 2 units, and S1 would sell nothing. Similarly for any other seller. Market power is created by giving seller S3's two high-cost units to S1 and S2, as shown in Design 2 on the right side of Figure 6. Now each of the large sellers, S1 and S2, has 4 units. If one of these sellers were to raise price unilaterally to the demand intercept, r, one of their 4 units would sell since the other four sellers only have enough capacity to sell 7 of the 8 units that are demanded at prices above the competitive level. By making the demand intercept high relative to the high-cost step, we make such deviations profitable for the two large sellers, thereby creating market power. In this case, it is possible to calculate the price distributions in the mixed-strategy equilibrium, by equating sellers' expected payoffs to a constant (since a seller would only be willing to randomize if expected payoffs are independent of price on some range)[14]. For Design 2, the range of randomization is shown as the darkened region on the vertical axis (see Davis and Holt, 1994b, for details). By holding the number of sellers and the aggregate supply and demand arrays constant across the two designs, we are able to attribute price differences to the creation of market power and not to other factors such as a small number of sellers or a low excess supply at supra-competitive prices.

Figure 7 shows the results of a session in which 30 periods with the Power design were followed by 30 periods of the No-Power design. The period numbers and treatments are shown at the bottom of the figure. The supply and demand functions are reproduced on the left side (on a different scale from Figure 6) to indicate the relative positions of the key price prediction: the competitive price is 309. Demand was determined by a passive, price-taking simulated buyer, and sellers were told the number of periods and all aspects of the demand and supply structure. In each period, S1's posted price is plotted an ×, S2's price is plotted as a +, and the other three small sellers' prices are plotted as dots.

In all but one of the first nine periods of this session, seller S2 (+) stays at the demand intercept price, 589, selling the residual demand of 1 unit. This action lured the other sellers up, and seller S1 (×) reached the demand intercept price in period 9. Then × price cut in period 10 started a general price decline, which was stopped as + goes back up to 539 for four periods. The final 12 periods of this treatment contain two relatively tight price cycles. Overall, prices stay above competitive levels, which produces inefficiencies[15].

[14] The calculation of mixed-strategy equilibria is further complicated by the step-function nature of supply and demand in market experiments. Holt and Solís-Soberon (1992) show how the equilibrium price distributions can be calculated in the presence of the discontinuities that result for the trade of discrete units in the laboratory. Holt (1994) shows that the mixed strategy equilibrium is the limit of the Bayesian/Nash equilibria in pure strategies for games with incomplete information as the random payoff differences collapse to a point in the limit. This paper extends the «purification» argument to market games with payoff discontinuities that result from the profit advantage of having the lowest price.

[15] When all sellers randomize in the Edgeworth-cycle range, market efficiency is reduced because consumers are unable to obtain units with values on the lower demand step, even though the consumers' values for these units exceed the sellers' costs of producing the three units at the margin.

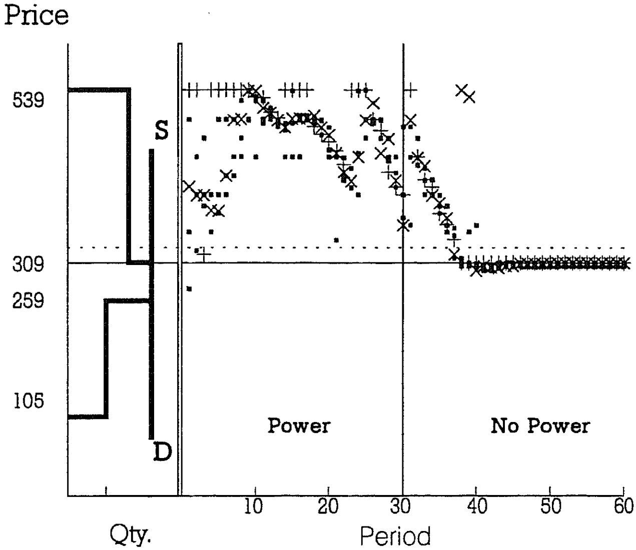

Figure 7
Price Series for a Power/No-Power Sequence.

(Key: S1's prices are indicated by ×s, S2's prices by +s, and the other prices by dots). Early in the Power Sequence, seller S2 raises market prices by repeatedly posting the limit price *r*. Later in the sequence a pair of price cycles are generated, as S2 tries to undercut his competitors. In the No-Power sequence, prices for all sellers quickly collapse to the competitive prediction.

Units are reallocated after period 30 to take away market power. The high price by S2 (+) results in no sales, and the aggressive competition that follows drives prices to the competitive (and now Nash) levels. This market efficiently exploits all gains from trade in the absence of market power[16]. Market power also resulted in large price increases in five other sessions, holding constant the number of sellers and the aggregate supply and demand structure. In fact, the price-increasing effect of market power was considerably greater than the difference between the Nash/Bertrand price in the No-Power treatment and the mean of the mixed price distribution in the Power treatment. Since explicit communications between sellers were not permitted, we use the term «tacit collusion» to describe this ability of sellers to raise prices above the levels determined by a noncooperative equilibrium. To summarize, market power has a double impact: it raises the noncooperative mean price prediction, and it facilitates tacit collusion that raises prices above the noncooperative levels.

[16] Notice that convergence to the competitive equilibrium was not immediate in the second half of the session shown in Figure 7, so being able to do a total of 60 periods (30 per treatment) with a computer network produced a much more convincing outcome than would have been the case with half as many periods. Many variations, such as letting buyers request secret discounts, are even more time consuming, and computerization is even more useful in such environments.

5. Explicit collusion

Ever since Adam Smith, economists have believed that sellers often conspire to raise price, and that such conspiracies fall apart if some sellers defect [17]. Price-fixing is difficult to study since it is usually illegal and the participants do their best to hide the evidence. Without good data on participants and their costs, it is difficult to evaluate the nature and success of collusion, and the causes of breakdowns in pricing discipline. Such data problems do not exist in the laboratory, and controlled opportunities for conspiracy can be allowed, holding constant other structural and institutional elements that may facilitate price fixing.

Isaac and Plott (1981) allowed sellers in double auctions to discuss prices between trading periods. These conspiracies, however, were not very effective in actually raising transactions prices in the fast-paced competition of a double auction. Isaac, Ramey, and Williams (1984) later showed that price-fixing conspiracies can be much more effective in posted-offer auctions, since sellers do not have the temptation to shade prices once they are posted.

The effects of seller collusion in posted-offer markets reported by Davis and Holt (1996c) can be seen by comparing price sequences for representative sessions without collusion (Figure 8a) and with collusion (Figure 8b). The underlying supply-and-demand structure for each session is shown on the left, where the three buyers' reservation values and the three sellers' marginal costs are measured as deviations from the highest competitive price in the range of overlapping demand and supply. There was no collusion for the session shown in Figure 8a, and both posted prices (indicated by + marks) and transactions prices (indicated by the small boxes) quickly fall to the competitive range, which is bounded from above by the lower dotted line.

Procedures for the collusion session shown in Figure 8b were identical, but sellers were allowed to discuss prices, quantities, etc. at the beginning of each period while buyers were taken from the room (under the pretext of assigning buyer demand incentives) [18]. Sellers could not discuss private information about their costs or previous transactions, and after colluding, they returned to their visually isolated booths before entering prices independently via their keyboards. Despite the competitive nature of the market structure and Bertrand pricing rules, sellers were able to fix and maintain prices near the joint-maximizing level, which is \$0.55 above the competitive level and is indicated by the upper dotted line [19]. The price crosses for sellers S1, S2 and

[17] In fact, Smith's oft-quoted warning about the likelihood of price fixing is followed by an important qualification: «In a free trade an effectual combination cannot be established but by the unanimous consent of every single trader, and it cannot last longer than every single trader continues of the same mind. The majority of a corporation can enact a bye-law with proper penalties, which will limit the competition more effectually and more durably than any voluntary combination whatever». (Smith, 1776, p. 144).

[18] Buyers were taken out of the room in exactly the same way in both sessions, but seller collusion was only permitted in the session shown in Figure 8b.

[19] The joint maximizing price is a nickel below the demand step at \$0.60, because buyers were required to pay a nickel shopping cost each time that they approached a seller.

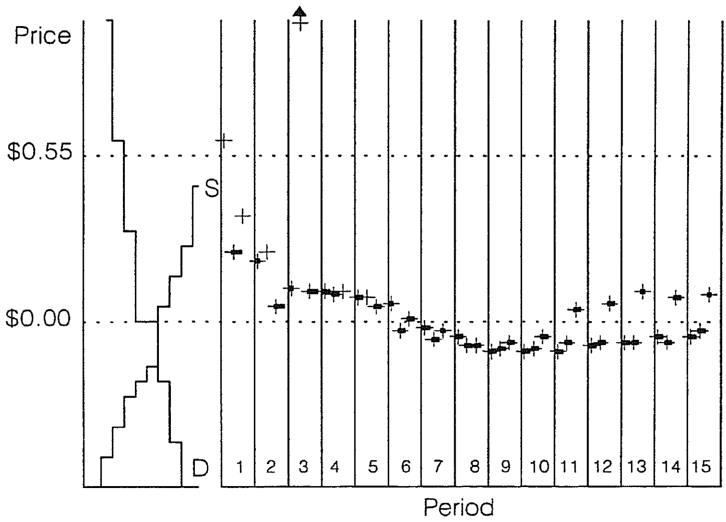

Figure 8A
A session with No Seller Conspiracy and No Discounts.

(Key: + posted prices, ▪ units sold.) In this baseline market, prices fall to the competitive prediction.

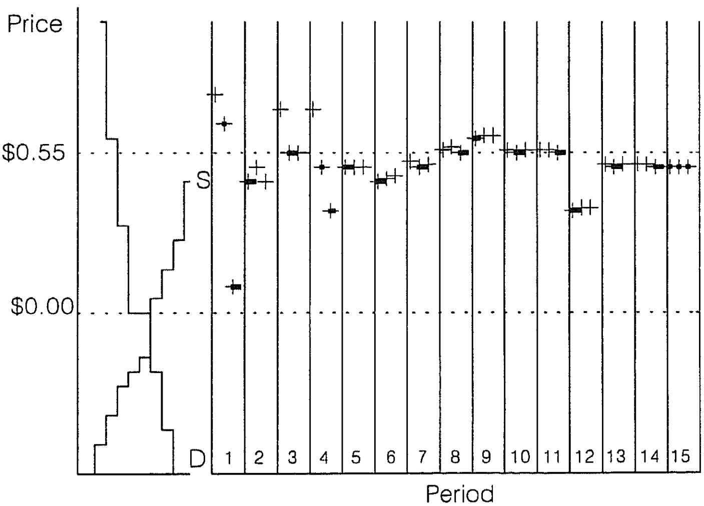

Figure 8B
A session with Seller Conspiracy and No Discounts.

(Key: + list prices, ▪ units sold.) As indicated by rotation of the lowest price from the left, to the middle, then to the rightmost cross in each period 5 to 14, colluding sellers adopted a «phases-of-the-moon» price-rotation scheme in this session.

S3 are listed in order in the vertical stripe for each period, which reveals a «phases of the moon» bid rotation, with S1 bidding low in period 6, S2 in period 7, etc. Aggregate consumers' and producers' surplus was about 30% lower for the session in Figure 8b than for the very efficient outcome in Figure 8a. These are results for are typical for posted-offer conspiracies. For example, we observed substantially elevated, and stable prices in five of the six posted-offer conspiracy sessions we conducted in this design, and competitive outcomes in each of the three sessions we conducted under comparable conditions, but without conspiratorial opportunities (Davis and Holt, 1996c). See also Isaac, Ramey and Williams (1984).

6. Discounts

Markets for major purchases typically differ from the standard posted-offer institution in that sellers can offer private discounts from the «list» prices. The effectiveness of conspiracies in such markets is important for antitrust policy, since many of the celebrated price-fixing cases, like the electrical equipment bidding conspiracy of the late 1950's, involve producer goods. Moreover, sales contracts and practices that may deter discounts have been the target of antitrust litigation, as in the Federal Trade Commission's *Ethyl* case [20].

Davis and Holt (1996c) conclude that opportunities to offer secret discounts to specific buyers can break down price-fixing conspiracies among sellers. The session shown in Figure 9 used the same procedures as in the conspiracy session in Figure 8b, except that buyers could subsequently request discounts from particular sellers (by pressing a discount-request key). A seller could respond by typing in the original list price (no discount) or by typing in a lower discount price, which was not observed by any other buyer or seller. After some initial adjustments, sellers agreed on a common list price in period 3 and in all but one subsequent period. In periods 7 and 8, seller 2 began secret discounting, as indicated by the dots below the middle + sign. These discounts caused S1 to have no sales in these periods, and S1 responded with a deep discount in period 9 and a lower list price in period 10. After this point, discounts were pervasive, and the outcome was relatively competitive. This type of competitive outcome was observed in five out of six sessions with discounting [21].

If secret discounts hamper conspiracies by reducing verifiable price information, institutional features that increase the monitorability of price agreements may have the opposite effect. In particular, the ex post reporting of sales information to a trade association may facilitate

[20] This case is summarized by Grether and Plott (1984), who report laboratory experiments in which the practices raise prices above benchmark competitive levels. A theoretical explanation of the Grether and Plott results is provided by Holt and Scheffman (1987).

[21] Davis and Holt (1994c) report that discounting opportunities do not necessarily result in lower prices when sellers are not able to communicate.

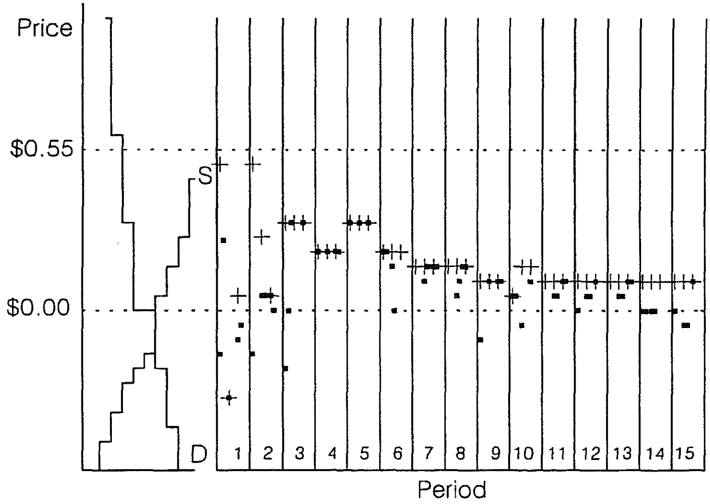

Figure 9
A Session with Seller Conspiracy and Secret Discounts.

(Key: + posted prices, ▪ unit transactions prices.) Despite agreeing on a common list price in each period after the second, transactions prices collapse on the competitive prediction in this session where unobservable discounts were permited.

collusion, even when substantial discounting opportunities are available[22]. Clearly, the publication of sales information may not directly reveal discounting, since price concessions can often be hidden in reduced delivery and service fees, and sellers who defect from an illegal agreement will not report their defections. Nevertheless, the public revelation of large sales changes may signal aggressive discounting, and may therefore temper discounting behavior (Stigler, 1964).

The results in Davis and Holt (1996c) provide some mixed support for the anti-competitive effect of the ex post provision of sales information. The treatment involves seller conspiracies with the possibility of secret discounts, as discussed above. But additionally, sales quantity information was publicly revealed to all sellers at the end of each trading period. In three of the six sessions conducted under these conditions, the ex post sales information was not sufficient to allow sellers to resolve the monitorability problems created by secret discounts. Nevertheless, in the remaining three sessions, relatively monopolistic prices were observed.

The difficulty of observing illegal activity makes laboratory experiments a particularly appealing method for investigating factors that affect the

[22] The link between trade associations and conspiracy has been a matter of continuing concern to antitrust authorities. For example, in their review of Department of Justice horizontal price-fixing cases between 1963 and 1972, Hay and Kelley (1974) found that trade associations were present in almost all cases with fifteen or more conspirators.

likelihood and success of collusive efforts. An area of research closely related to the effectiveness of induced explicit conspiracies pertains to the price-increasing effects of interfirm communications outside the «smoky room». As a practical matter, competitors communicate nearly continuously in the normal course of trade. Indeed, the advertising that promotes aggressive price competition is an important form of indirect interfirm communication. A persistent and important focus of concern to U.S. antitrust authorities regards determining what kinds of communications are sufficient to allow a conspiratorial «meeting of the minds». For example, in addition to price advertising, publicly communications about intended price adjustments, such as through trade press communications, has typically been considered innocuous. This conclusion is supported by results of an posted-offer experiment where three sellers were allowed to make nonbinding price communications prior to posting binding pricing decisions (Holt and Davis, 1990). The nonbinding price communications exerted only a transitory effect: Sellers typically indicated an intention to raise prices, but then uniformly shaded on their revealed intentions. Prices quickly collapsed to competitive levels as the indicated intentions came to be viewed as meaningless.

But the combination of new communications technologies and novel market structures, particularly those evolving in recently deregulated markets, challenges the conclusion that nonbinding price communications should be regarded as uniformly innocuous. For example, prices that substantially exceed competitive levels were observed in some posted-offer sessions reported by Cason and Davis (1995), where sellers simultaneously competed in multiple markets, and where the sellers could engage in repeated nonbinding price communications prior to making binding price commitments. The experiment design used by Cason and Davis parallels important elements of price competition in the U.S. Airline industry prior to settlement of a recent matter involving pricing practices (*United States v. Airline Tariff Publishing Company et al.*, Civil Action No. 92-2854). These results are consistent with the perception of the U.S. antitrust enforcement authorities that a combination of multimarket contact, and extensive nonbinding communications can facilitate collusive behavior.

Yet another related area for further research regards the effectiveness of efforts to detect bid rigging. As shown by Lang and Rosenthal (1991), outcomes commonly thought to be indicators of bid rigging, such as uniform bids, or the cycling of winning bids among competitors, can in fact be quite consistent with competitive behavior, depending on the competitors' underlying cost structures. Alternatively, more reliable information may come from the structure of losing bids. As suggested by Porter and Zona (1993) in an analysis of highway construction bidding, losing bids may be less correlated with costs in a conspiracy than would be the case with independent bidding. One project for future investigation regards the effectiveness collusion detection policies in light of various costs structures.

7. Search costs

The absence of buyers' shopping costs in standard posted-offer experiments is notable in view of the dramatic effects that such costs can have in theoretical models. Diamond (1971), for example, concludes that, in the absence of publicly posted price information, the existence of even a small search cost could lead to monopoly pricing. The intuition is straightforward: No buyer with one price quote would want to search for a second, unless the new quote is expected to be lower by at least the amount of the search cost. Then each seller has an incentive to price slightly above any common price, and the noncooperative equilibrium in a single-stage game is that price be raised to a monopoly level. This result is viewed as a paradox, since a «small» search cost produces high prices, but a zero search cost would produce the usual Bertrand incentives that drive prices to competitive levels, in the absence of capacity constraints and other imperfections. Given the difficulty of controlling and measuring information flows in natural markets, the laboratory is an ideal place to evaluate the Diamond paradox and its proposed resolutions.

Davis and Holt (1996a) report an experiment designed to determine whether prices in an otherwise competitive environment will rise to monopoly levels with the introduction of search costs that are not infinitesimally small. The supply and demand arrays for these sessions are shown on the left side of Figure 10. The identity of the buyer associated with each value step is printed above the demand curve. The three buyers are symmetric, each with units valued 70 and 30 cents above the competitive prediction. In a parallel fashion, costs for the three sellers are printed below the supply curve. Each seller has one low-cost unit and 3 units at the competitive price P_c, normalized to zero for this discussion. The relatively large excess supply at any price above P_c makes the market very competitive[23].

Six 40-period sessions were conducted. Half the periods in each session were conducted under standard-posted offer trading rules, except that buyers had to pay a 15-cent fee each time that they approached a seller. Other than reducing buyer earnings, the approach fee should have little effect on outcomes when prices are publicly displayed. However, in the remaining 20 periods of each session, sellers' prices were not displayed. In these no-information «search» periods, the 15-cent approach fee becomes a search cost. Upon paying the fee to see a price, a buyer could either make a purchase (by pressing «*p*» on the keyboard) or shop elsewhere (by pressing «*s*»). To control for possible order-of-sequence effects, the order of the search and posted-offer treatments were alternated across sessions.

[23] The market design differs from standard search models in that sellers' marginal costs and buyers' reservation values are not constant. The high-value and low-costs steps were added to give both competitive and monopoly predictions a realistic chance, since it is rare to observe stable outcomes in which one side of the market earns nothing. We anchored our design on a minimun earnings of 25 cents per trader per period. For this reason, the cost step for the first unit is 25 cents below the competitive price. Symmetrically, a buyer's value step at 40 cents above the monopoly price guarantees each buyer a minimum earnings of 25 cents at the monopoly outcome, after netting out the 15 cent shopping cost (discussed below).

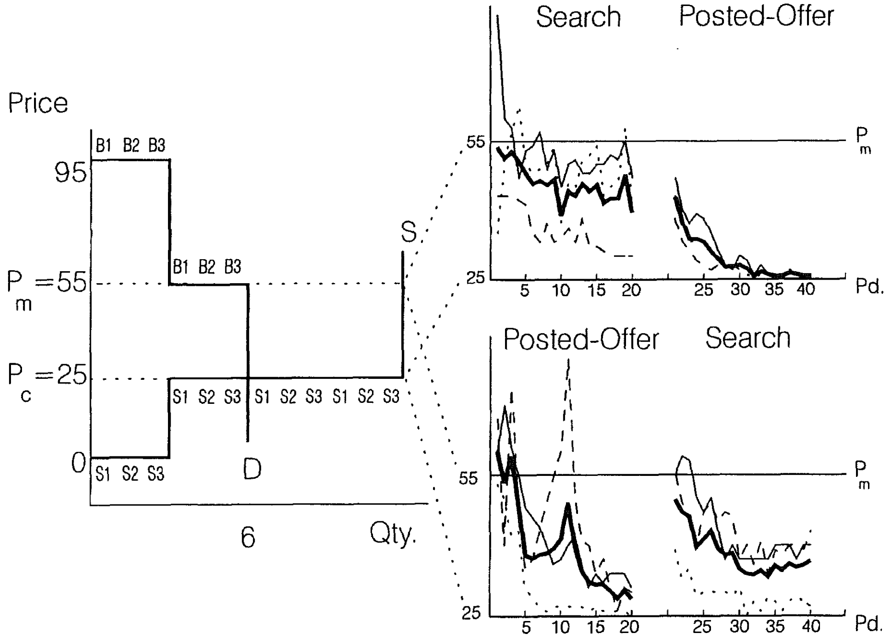

Figure 10
Mean Price Data for Six Sessions, with and without Search Costs.

(Key: The thin, dotted, and dashed lines in the upper and lower panels on the right side represent mean contract prices for individual sessions, while the thick line illustrates the overall mean price.) The upper right panel summarizes results of three sessions where a search sequence precedes the posted offer sequence, while the lower right panel shows results of three sessions where a search sequence follows a posted-offer sequence. Notice that regardless of the order of treatments, prices in the last several periods of the posted-offer sequences are closer to the competitive prediction than prices in the last several periods of the search sequences.

The period-by-period paths of mean contract prices are shown on the right side of Figure 10, where separate sessions are distinguished by the thin dotted, dashed and solid lines. The thick line represents average prices, pooled across sessions. Two observations are readily apparent. First, information makes a difference. Regardless of the order of presentation, prices at the end of the search treatment are higher than prices at the end of the corresponding posted-offer treatment. Second, the Diamond result is not observed. Despite the significant order-of-treatment effect, prices do not cluster about the monopoly price P_m, even in the sessions in the upper panel where the search condition came first.

We were somewhat surprised by the failure of relatively large search costs to yield uniform monopoly outcomes. Moreover, the results are puzzling given that Grether, Schwartz and Wilde (1988) observe monopoly prices in 3 out of 4 sessions, in a very different search-cost design[24]. One possible explanation is that they implement the standard assumption that buyers see the entire list of actual price postings in each period before making a search decision; all sellers' posted prices are listed on a blackboard, without seller identifications. In one treatment, a buyer can pay a search cost to obtain a sample of the prices of two or more randomly selected sellers, so that a purchase can be made at a lower price. A buyer who does not pay the search cost is provided the seller identity of a single randomly selected seller, and any purchase must be made from that seller. In contrast, we decided not to reveal any prices to buyers unless they paid a search cost in a sequential search setup[25]. We were motivated in part by Stahl's (1989, p. 700) argument against «... the dubious assumption that consumers can 'see' deviations by firms before they actually search.»

A second possible motivation for the below-monopoly prices observed in our sessions may be due to the fact that the market was indefinitely repeated (we did not announce the final period in any session). Bagwell and Ramey (1992) model an infinitely repeated price-search game in which buyers can elicit lower equilibrium prices by returning to check the prices of sellers who have given low prices in the past[26]. The equilibrium price predictions vary continuously between monopoly and competitive levels, depending on the size of the

[24] Grether, Schwartz and Wilde also observe qualitative conformity between theoretical predictions and data for two additional informational technologies: a nonsequential search model where a subset of consumers is given a sample from the population of price realizations (Wilde and Schwartz, 1979); and a model in which buyers have either high or low costs of purchasing a complete list of sellers' prices (Salop and Stiglitz, 1977). In these models, it is the proportion of more informed agents (with low sampling costs or with a larger sample) that determines whether the outcomes are competitive, monopolistic, or something in between.

[25] There are a number of other procedural and design differences between our sessions and those reported by Grether, Schwartz and Wilde. In particular, we used different participants in each session, whereas Grether, Schwartz and Wilde used the same participants in all 12 sessions «to the extent possible». They also used more sellers (5-8), and sellers were allowed to exit to avoid a fixed cost.

[26] In the simpler context of a repeated seller-selection game, Davis and Holt (1994a) find that buyers quite naturally select strategies similar to a loyalty-boycott rule, and that such strategies are quite successful in eliciting cooperation from sellers.

consumer search cost. As a first effort to evaluate the role of reputations as a means of generating lower prices, we conducted an added series of three sessions where the identities of the sellers are disguised, and randomly reassigned at the beginning of each trading period (Davis and Holt, 1996a)[27]. Again, surprisingly, outcomes were virtually identical to those in the baseline «no-reputation» sessions, suggesting that reputations do not play a particularly important role in tempering price increases. The inability of costly search conditions to raise prices even when seller reputations are hidden suggests that sellers fail to understand the recursive «price-plus-search-cost» reasoning underlying the Diamond result. Sizable price increases were observed in a fourth treatment condition, where search costs were doubled (to 30 cents per approach). The apparent importance of high search costs rather than privacy suggests that in this kind of environment, price increases may be more attributable to the cost of shopping rather the privacy of information[28].

8. Advance Production Decisions

The extensive interest in posted-offer type markets as a subject of laboratory investigation is a least partially attributable to the plausibility of the price-based competitive interactions generated in posted-offer trading. Most economists conceive of the competitive process between firms as principally involving price competition. Yet in the theoretical industrial organization literature, the more prevalent assumption is that firms engage in Cournot-type quantity-competition. The popularity of institutionally artificial Cournot-type quantity interactions derives from the comparative plausibility of Cournot predictions: Unlike homogenous-product Bertrand models, where competitive outcomes are predicted even when the number of sellers is reduced to two, market structure is critically important in Cournot competition, with the predicted price-cost margin varying inversely with the number of sellers.

In what is undoubtedly the most-commonly referenced resolution to this dilemma, Kreps and Scheinkman (1983) show that Cournot outcomes can be the basis of price competition, if sellers are required to make binding advance production decisions prior to posting prices. Given the centrality of the Kreps and Scheinkman model as a justification for using a Cournot specification, the behavioral relevance of the model's predictions is an important open question.

To evaluate the effects of binding advance production decisions on market performance, an experiment consisting of twelve triopolies was conducted (Davis, 1996). Half of the sessions were conducted under standard posted-offer

[27] Although this treatment may be expected to cast some light on the importance of reputations to pricing outcomes in a costly search context, it should not be regarded as a test of the Bagwell/Ramey model. Several assumptions of the model were not met. In particular, sellers did not have full information regarding underlying costs and values. Additionally, sellers did not know how long the session would last.

[28] The theoretical implications of costly search given full price information have been developed in the switching cost literature, surveyed nicely by Klempere (1995).

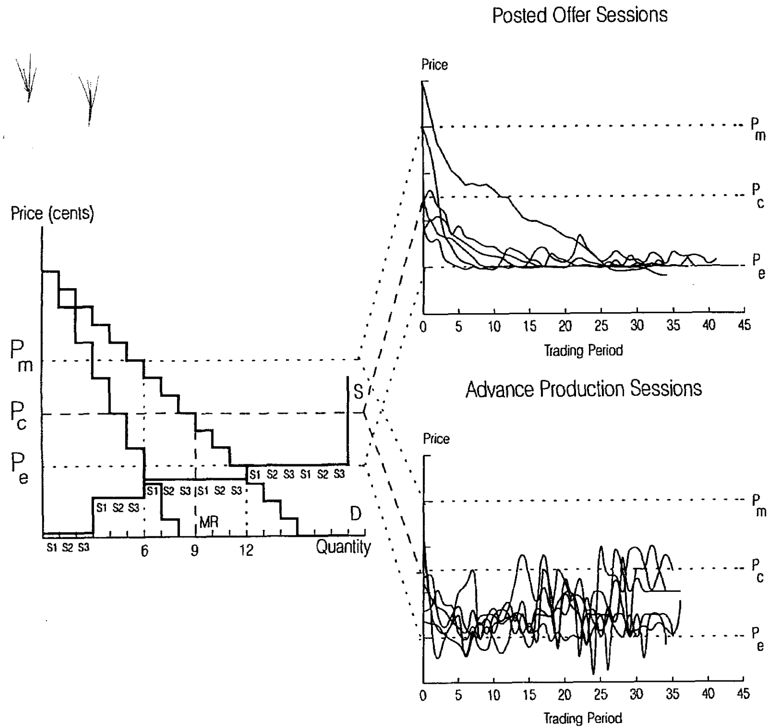

Figure 11.
Mean Price Data for Six Baseline Posted Offer Sessions, and for Six Advance-Production Sessions.

(Key: Curved lines in the right panels illustrate mean contract price paths for individual sessions.) The 6 posted-offer markets, shown in the upper panel, uniformly tend to competitive price prediction P_e. In the advance-production sessions, illustrated in the lower panel, prices are comparatively higher. Nevertheless prices in these sessions are volatile, and tend to remain considerably below Cournot prediction P_c.

rules. In the remaining six markets, sellers were required to make a binding advance production decision prior to posting prices. Each market consisted of a minimum of 35 trading periods, and was terminated with a probabilistic stopping rule. Sellers competed under conditions of full information regarding the cost and value incentives illustrated by the supply and demand arrays on the left side of Figure 11. Results of the twelve sessions are summarized by the mean contract price paths shown on the right side of the figure.

As suggested by the uniform collapse of prices to the competitive prediction P_e in the baseline markets shown in the upper right panel, Nash predictions have considerable drawing power in a Bertrand pricing game in this design. (By construction, the competitive equilibrium is a unique Nash equilibrium for the stage game.) In marked contrast, the advance production decisions generated less competitive outcomes: Prices were uniformly higher and quantities lower. Nevertheless, as is also clear from the figure, sellers were not drawn to the Cournot equilibrium prediction (at price P_c) in the advance production sessions. Rather prices are, on average, lower and much more volatile.

Results of this experiment suggest that although endogenous quantity constraints create market power, as suggested by Kreps and Scheinkman (1983), they create somewhat less market power than predicted by the relevant static Nash (Cournot) equilibrium. The extreme volatility of outcomes are consistent with results of other experiments conducted in a Cournot framework (see e.g., Fouraker and Seigel, 1963; Holt, 1985, Rassenti, Reynolds and Smith, 1996) and suggest further that even under conditions that are institutionally plausible, Cournot predictions do not organize outcomes particularly well.

Understanding the persistent instability of Cournot markets remains an important open question. One obvious candidate explanation is that the markets are an illustration of the general instability result by Theocharis (1960) and Fisher (1961). However, sellers show little tendency to make either the best response, or partial-adjustment responses necessary to support such a result[29]. One possible alternative explanation is that the assumptions of the Nash equilibrium are too strong in this context. Weaker concepts have some behavioral appeal. In particular, toward the end of sessions, seller choices in the advance-production sessions tended to conform to the notion of rationalizability by Bernhiem (1984) and Pearce (1984). Roughly speaking, the set of strategies consistent with rationalizability are the strategies consistent with some rational belief about the choices of others. The set of rationalizable strategies are those that survive iterated strict dominance[30]. Interestingly, in the posted-offer market, the competitive outcome is also the only rationalizable outcome.

[29] See Rassenti, Reynolds and Smith (1996) for a recent study of adaptive behavior in experimental Cournot games.

[30] This is a bit imprecise. In games with more than 2 players, correlated rationalizable strategies are those that survive iterated strict dominance.

9. Conclusion and Directions for Future Work

Many, if not most, markets of interest to industrial organization economists are not organized like the centralized (double) auctions that reliably produce efficient, competitive outcomes in a wide variety of laboratory experiments. When prices are posted on a take-it-or-leave-it basis, market competitiveness and efficiency are much more sensitive to factors such as unanticipated demand shifts, market power, and price-fixing. This section summarizes these and other effects, and outlines some directions for our current research.

Unanticipated decreases in demand can cause posted-offer trading to fall off dramatically as sellers fail to reduce prices quickly. These periods of stagnation are not eliminated by the introduction of discounts, clearance sales, and information about excess demand. We are currently working on experiments that sort out the macroeconomic implications of the rigidities inherent in the posted-offer institution.

The creation of market power in posted-offer markets can cause large, consistent increases in prices, even though other factors such as the numbers of sellers and the aggregate demand-and-supply conditions are held constant across treatments. Market power can arise naturally from capacity constraints in markets with (Bertrand) price competition, and appears to arise to some extent even in markets where capacity choice is endogenous, as suggested by Kreps and Scheinkman (1983).

As is the case with market power, the effects of price-fixing conspiracies can be dramatic in laboratory markets with posted prices. Our research also shows that conspiracies break down if sellers have the ability to offer secret, buyer-specific discounts from the posted list price. The pro-competitive effects of discounting, however, are mitigated if a «trade association» provides sellers with ex post information about each others' sales quantities. These experimental results support the current antitrust hostility to contracts and industry practices that limit opportunities for secret price negotiations.

Market power can also be created by informational imperfections. Instead of the usual Bertrand incentives to shade on one anothers' prices, sellers have an incentive to raise price in markets where buyers must pay a shopping cost to obtain a price quote. Shopping costs do raise transactions prices significantly in laboratory experiments, but not to the monopoly levels predicted by the theoretical «Diamond paradox.» To the extent that moderate shopping costs do not produce monopoly prices, the laboratory results provide indirect support for theoretical resolutions of this paradox. Our current research is directed at distinguishing between some of these resolutions, and in particular, those based on the development of sellers' price reputations.

Despite the inefficiencies and rigidities that characterize posted pricing, this institution offers some important advantages. It became prevalent in the nineteenth century, when the growth of retail establishments made it more difficult for owners to monitor sales clerks. The posting of prices on a take-it-or-leave-it basis also reduces transactions and negotiation costs. In addition, posted prices are easier to advertise, and buyers may prefer a situation in which they know that they are obtaining the best available price from the seller (especially in producer goods markets). For whatever reason, posted price markets are common, and laboratory experiments can be used to evaluate the effects of adverse conditions and imperfections on the performance of such markets.

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Resumen

Este trabajo resume nuestras recientes investigaciones de laboratorio sobre mercados en los que los vendedores fijan los precios. A diferencia de instituciones de mercado más competitivas, como por ejemplo las subastas dobles que se utilizan en muchos mercados financieros, este tipo de mercados se ve muy afectado por aquellas condiciones estructurales que típicamente se consideran problemáticas en la teoría de la organización industrial, tales como el poder de mercado, los acuerdos para fijar precios, los costes de búsqueda y los *shocks* cíclicos de demanda. Los resultados demuestran que la suposición de que los mercados de laboratorio son uniformemente eficientes y competitivos es equivocada.

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