Chapter 21

THE EFFECTS OF COLLUSION IN LABORATORY EXPERIMENTS

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1. Introduction

At least since the time of Smith (1976), economists have believed that sellers are likely to discuss common price strategies, but that incentives to defect may be strong enough to break down collusive agreements. Collusion is difficult to study in naturally occurring markets, since sellers will try to hide illegal activities from buyers and from antitrust authorities. Even when a conspiracy can be established, the effective dates, the exact identities of all participants, and the real effects on prices are typically difficult to prove. In particular, price-fixing may result in stable common prices, but it is usually impossible to say what prices would have been without collusion, at least in the absence of precise cost and demand conditions. Even when markets seem to alternate between collusive and non-collusive phases, the price differences are difficult to interpret since a breakdown in collusion may be caused by a demand decrease that would have reduced prices in any case. This makes the laboratory an ideal setting to study factors that facilitate or hinder illegal price fixing.

The main result from the experimental economics literature is that the market trading institutions are crucial in determining whether or not collusion will be successful in raising prices above competitive levels. The initial paper on this topic was Isaac and Plott (1981), who examined the effects of seller discussions between rounds of a continuous double auction. In particular, the sellers were allowed to come together to a corner of one of the rooms and confer after the close of one trading period and before the start of another. Attempts to collude were as ineffective as they were inevitable. The problem is that each seller has a strong private incentive to defect and lower the asking price during the course of the double auction trading (Clauser and Plott, 1993).

In some sense, the Isaac and Plott (1981) result is consistent with Smith's (1981) finding that even a single-seller monopolist could not always find and enforce near-monopoly prices when trading with a number of buyers in a continuous double auction. Smith, however, did observe consistent supra-competitive prices, sometimes approaching monopoly levels, in posted-offer monopolies with the same supply-and-demand design. The posted-offer trading rules preclude price cuts during the course of the trading, which facilitates monopoly pricing. This raises the issue of what would happen in a posted-offer conspiracy with more than one seller. Isaac, Ramey, and Williams (1984)

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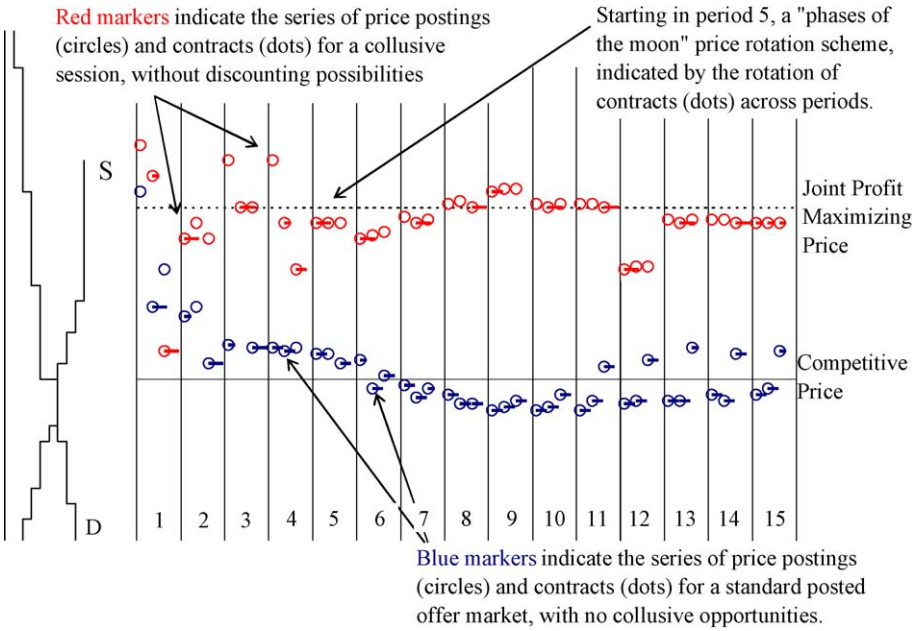

Figure 1.

addressed this issue and found that sellers were much more effective when conspiring about prices that were posted on a take-it-or-leave-it basis.

Many markets of interest to industrial organization economists do not fit exactly into the double-auction or posted-offer category. Sometimes sellers post list prices, for example, and then consider offering discounts if sales are falling behind expectations or if there is other evidence that others are offering secret discounts. The next section summarizes some experiments that illustrate the dramatic effects of opportunities to collude without discounts, and the opportunities to offer secret discounts even if there is collusion. Then the effects of collusion in some other auction and securities market trading institutions are considered in the final section.

2. Collusion with and without Secret Discounts

The dramatic effects of conspiracy in a posted-offer auction are shown in Figure 1, which summarizes two sessions reported in Davis and Holt (1998). There were six subjects in each session, randomly assigned to the three buyer and seller roles. Subjects were visually isolated and interacted over a network of personal computers. The supply and demand arrays are reproduced on the left side of the figure, and the theoretical competitive and joint-profit maximizing prices are indicated by horizontal dashed lines.

First look at the blue series for the standard posted offer market without collusion. The posted prices for the three sellers are indicated by small circles, and contracts (units actually sold) are shown as dots to the right of the corresponding circle. The price data for each period are separated by vertical lines, with the period number (from 1 to 15) shown at the bottom. Within the slot for each period, the price for seller S1 is plotted to the left, the price for S2 in the middle, and the price for seller S3 is on the right. Thus the blue circle for seller 1 in the first period is above the monopoly price (sellers were not given information about the demand curve or others' costs). Seller S2 has the low price in period 1, as shown by the blue circle with the three dots that indicate sale of three units. By the third period, all sellers' prices are nearing competitive levels, and the average price actually falls somewhat below the highest competitive price in periods 6 to 13. As intended, this is a very competitive supply and demand design.

The upper red price sequence in Figure 1 shows a parallel session in which price collusion among sellers was permitted prior to the start of each period. Buyers were taken from the room under the guise of using a random device to assign them to buyer roles, B1, B2, or B3. As buyers entered the hall to return, an experimenter alerted the sellers, who ceased discussions and slid their chairs back into their visually isolated booths before entering their prices for the next period. After some initial bouncing around in early periods, sellers agreed on a common price in period 5, but all three buyers purchased from seller S1, which may be due to the focalness of the "1" key, despite the fact that this seller had been offering higher prices in earlier periods.[1] Seller S1 then suggested a price rotation scheme, with him going first! Incredibly enough, the other sellers agreed, and S1 sold all three units at a price slightly below the others, as indicated by the red dots attached to the left-hand circle in the period 6 slot. This "phases-of-the-Moon" rotation continued, as the sellers experimented with different prices over the next several periods.[2] Prices were raised above the joint monopoly level in period 9, which resulted in only two units sold, and sellers returned to an exact monopoly outcome in period 10. The price reduction experiment in period 12 did not increase sales, so prices returned to near-monopoly levels for the final rounds. The industry cost structure was such that this rotation is very inefficient, since each seller had a low-cost unit, but only one of these would get produced and sold under price rotation. Interestingly, sellers moved to the more profitable equal-division arrangement in period 15, even though they had no way of knowing that was the final period.

The pattern effects of collusion in Figure 1 were replicated and were significant using a non-parametric test applied to the session price averages. A particularly interesting collusion session is plotted by the red sequence at the top of Figure 2. As before, there is some price variation in the initial periods before a common price is established in period 4. Seller S2, however, does not sell anything, and they then agree to limit sales to

[1] Here we see one of the advantages of using human buyers, since simulations may introduce too much uniformity or too much randomness relative to human behavior.

[2] The defendants in the celebrated electrical equipment price-fixing case of the early sixties had used phases of the moon to determine which one would submit the low bid.

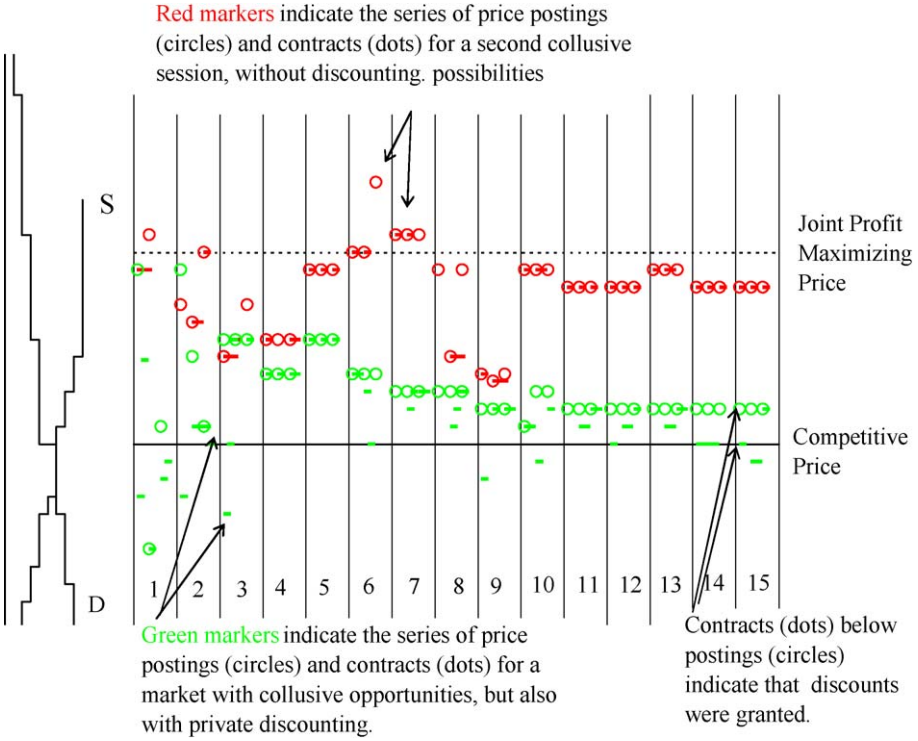

Figure 2.

one unit each in an effort to solve the "random selection problem." This split is honored in the next period, but the agreement breaks down as seller S2 prices aggressively in periods 8 and 9, thereby making all of the sales. In period 10 sellers finally coordinate a uniform, high price. Despite the fact that there was an understanding that each would limit sales to one unit, S2 cheated and sold two units, as indicated by the two dots attached to the middle circle for that period. Seller S3 was "not happy," but S2 covered up the defection by claiming that they should have expected sales to be lower when price is higher. Whether believed or not, this deceptive claim let them to agree on a uniform price reduction, with equal splits being honored in periods 11 and 12. They decided to try another increase in period 13, and seller 2 defected again, and again claimed deceptively that the failure of S3 to sell a unit was due to the demand reduction at a higher price. This only resulted in a slight price decline, with high prices and efficient market splitting the rule in the final two periods.

The next issue is the effect of opportunities to offer secret discounts from list prices that come out of a conspiracy. The setup for these "list-discount" sessions was the same as before, with the buyers being taken from the room while (without their knowledge) sellers discussed prices. The sellers then returned to their personal computers and en-

tered their prices as buyers returned to the room. The main difference between this treatment and the previous conspiracy setup is that buyers could select a seller and direct a discount request to that seller by pressing a specific key. The seller selected would respond by typing in the original price or a lower one. Other sellers could not tell by the number of keystrokes whether the response was a discount or not. A buyer who was not satisfied with the seller's response could switch to another seller, which resulted in a "switching cost" of 5 cents that was deducted from the buyer's earnings for each switch (see Davis and Holt, 1998, for details).[3]

The price data for a typical session with discounting is shown in green in the lower part of Figure 2. When a discount price is accepted, the dot indicating that sale may lies below the green circle directly above, which marks the seller's list price. The opportunity to discount clearly causes a breakdown in the effectiveness of the conspiracy, but the breakdown process is particularly interesting. As in the previously discussed collusion sessions, there is considerable price variation in the initial period before a common price is selected in period 3. Seller S2 sells nothing, however, so they agree to a price reduction at which all sell at least one unit in period 4. This success emboldens them to raise prices. The prospects for high earnings start to fade when seller two discounts from the common list price in periods 6–8. Notice that these are not small discounts, indicating that seller S2 is suspicious that the others may do the same. Seller S1, who sells nothing in periods 7 and 8, offers a deep discount in period 9 and defects from the list price agreement in period 10. This results in persistent discounts for the remaining periods, despite the fact that sellers are able to agree on a common list price. Finally, note that the price fixed in these final periods was only slightly above competitive levels.

The next issue considered was whether providing more information to sellers about market shares may facilitate collusion, even in the presence of discounting. In particular, we ran a parallel series of sessions in which we provided *ex post* sales quantity information to each seller. This information, which is of the type sometimes disseminated by a trade association, makes it possible for sellers to monitor sales quantity agreements. In fact, this type of sales information did result in prices increases: prices in the conspiracy/discounting/sales-information sessions were about halfway between the low prices for the conspiracy/discount treatment and the high prices for the conspiracy/no-discount treatment.

The conclusion emerging from these and other sessions is that seller conspiracies can raise prices to near-monopoly levels, even in environments that yield competitive prices in a standard posted offer market. Second, this success of this price-fixing tends to evaporate when colluding sellers are given the chance offer secret discounts to individual buyers. This research suggests that antitrust hostility to contracts and codes that impede or discourage price discounts is justified. Moreover, it is now known that contracts which reduce sellers' flexibility to offer buyer-specific discounts may have

[3] To ensure comparability across treatments, this switching cost was assessed in each of the other treatments as well.

the effect of raising prices, even in the absence of explicit collusion (Grether and Plott, 1984).

3. Recent Work

One critical issue in the study of collusion is how to infer whether or not it exists. As seen above, successful conspirators may rotate bids (the red markers in Figure 1), or may split the market at fairly constant prices (the red markers in Figure 2). Neither of these pricing patterns, however, is uniquely a result of conspiratorial behavior. Consider, for example, sealed-bid auctions, such as those that are typically used to let construction subcontracts, and in government procurement auctions.[4] In these contexts, sellers may be relatively small, and may face sharp capacity constraints. Under these conditions, competitive bidders may find themselves rotating winning bids, since the bidder who has waited the longest since winning the last contract may have the most idle capacity, and may therefore have the lowest costs. In other contexts, where capacity constraints are less of an issue, competitive sellers may post identical prices, given sufficient excess supply. Davis and Wilson (2002) explore the extent to which collusion can be discerned from competitive behavior through observed bidding patterns in sealed bid procurement auctions. This research also allowed insight into other empirical means of detecting collusion through bidding patterns, such as the conjecture by Porter and Zona (1993) that collusion in sealed bid auctions can be detected by the correlation between losing bids and costs. With collusion, the correlation between bids and costs should break down.

A second direction of the relevant experimental work continues with the theme explored above, of assessing the interrelationship between explicit communications opportunities, and the institutional features of a market. Cason (2000), for example, examines the effects of collusive opportunities among subjects who are put into the position of dealers in asset markets. Cason's market structure was designed to parallel critical features of NASDAQ markets, where the dealer's long-standing convention of setting spreads on "even eighths" led recently to allegations of collusion. (See, for example, Christie and Schultz, 1994a, 1994b.) Cason finds that the combination of explicit discussions by dealers, combined with the capacity to monitor all dealer quotes on a computer screen can substantially increase dealer spreads. Cason also reports that the SEC's response to the alleged collusion by NASDAQ dealers – allowing traders to publicly post limit orders – narrows spreads even when dealers are allowed to communicate. This policy tool, however, is a rather blunt instrument, in that it has the undesirable characteristic of making dealer profits negative. Cason's experimental results suggest

[4] Isaac and Walker (1985) examine the effects of explicit conspiratorial opportunities in sealed bid auctions, and find results very similar to those for the standard posted offer markets illustrated by the red markers in Figures 1 and 2.

that the practice of publishing limit orders may have the undesirable consequence of eliminating liquidity-enhancing market making services.

To this point, our focus has been exclusively on verbal forms of collusion. The rise in the use of computerized auction and sales systems opens up the opportunity for a number of near-collusive types of signals. For example, bidders in the recent Federal Communications Commission bandwidth auctions allegedly used the decimal places in bids to identify zip codes, sparking concerns that such communications generated artificially low bids. In a related incident, several major airlines attached letter combinations (e.g., FU) to fare quotes listed electronically in the Airline Tariff Publishing (ATP) system network that seemed to effectively communicate particular messages to other competitors. This feature, combined with sellers capacity to costlessly and quickly submit non-binding, non-public advance price quotes led to allegations of conspiratorial behavioral in the airline industry. Cason (1995) and Cason and Davis (1995) examine the price-increasing effects of some of the pricing practices used by airlines in the ATP system.[5] In a single-market environment, Cason (1995) finds that extensive non-binding price-signaling opportunities raise prices, but only temporarily. This parallels results observed by Holt and Davis (1990) in an posted-offer environment with less robust communications opportunities: Although price-signaling can temporarily raise prices, it is difficult for sellers to implement stable agreements, absent opportunities for explicit discussion. Cason and Davis (1995) report that high prices were more consistently observed in a multi-market setting with extensive price-signaling opportunities. However, even here it was not the case that sellers were able to communicate successfully with non-binding signals, despite some persistent efforts. Rather, high prices were the result of one seller supporting high prices despite continued defections by the others.[6]

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[5] Many of the questionable practices were prohibited via a 1994 consent decree between the ATP, the major airlines, and the Department of Justice.

[6] Results of these experiments, as well as the capacity of other types of non-binding communications to affect prices are reviewed elsewhere in this Handbook by Timothy Cason.

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