

Transparency and Collusion. Experimental Evidence

Jan Potters
Department of Economics, Tilburg University

First draft. March, 2005

Prepared for the Encore Workshop “Experiments for Antitrust Policies”

Abstract

In this paper we review experimental evidence on the impact of transparency on the competitiveness of markets. Transparency relates to the information available to firms about the conduct and performance of competitors. This information can relate to the past, the present, or the future and it can vary in content and reliability.

1. Introduction

“Competition, free and unfettered, is absolutely destructive to all stability of prices.... Knowledge regarding bids and prices actually made is all that is necessary to keep prices at reasonably stable and normal levels” (Arthur J. Eddy, as quoted in Scherer and Ross, 1990, p. 348) .

In his book *The New Competition* Eddy suggested a policy of “open prices” in which competitors be actively stimulated to communicate and exchange price information or that industries set up trade associations to provide the service for them. Eddy’s proposal fell on fertile ground. In the decades following his recommendation, open price associations formed in several industries. In the 1930s some 400 associations were approved by the National Recovery Administration in the US. The practice of information exchange between competitors is still very much alive today. A significant recent example is the Airline Tariff Publishing Company setup by the major US airlines to exchange detailed information about fares, proposed fare changes, fare restrictions and other marketing data.

Ever since its initiation the open price policy has been under scrutiny of the antitrust authorities. Dissemination of information has met with varying degree of hostility by the courts, in both the US and Europe. Two leading cases in the early 20s testify of the troubled treatment of information exchange by the courts (see Scherer and Ross., 1990, 347-352, for a concise treatment of these and other landmark cases). In 1921 the Supreme Court found the reporting system enacted by the American Hardwood Manufacturers Association to be an illegal conspiracy in restraint of trade. In the Court’s opinion “genuine competitors do not make daily, weekly and monthly reports about their business to their rivals, as the defendants did”. Just two years later the Supreme Court took a more permissive stand toward information exchange. The Mample Flooring Manufacturers Association employed policies that were quite similar to those of the hardwood manufacturers. Now, however, the Court decided that “[p]ersons who unite in gathering and disseminating information ... are not engaged in unlawful conspiracies in restraint of trade merely because the ultimate result of their efforts may be to stabilize prices and limit production through a better understanding of economic laws ..” (quoted in Phillips, 1959, p. 23).

It must be admitted that economic science has been quite equivocal about information exchange as well (Kühn and Vives, 1999). In the model of perfect competition it is assumed that market participants have full information about prices and other relevant market variables. Therefore, some have argued, a system of communication and information exchange that brings a market closer to this ideal state will improve the efficiency of a market. Convergence to competitive prices will be quicker and the probability that extra-marginal units trade will decrease. Moreover, to the extent that buyers also enjoy the increased price transparency, there will be positive effect on competitiveness.

More common among economists, however, is a concern about the potential anti-competitive effects of communication and information exchange among competitors. There are at least two reasons for this. Firstly, communication may make it easier to coordinate and agree on a collusive price. Usually competing firms are not completely symmetric. Products are often differentiated to some degree and production costs may differ across firms. As a result, firms may disagree on what the preferred collusive prices are or on how they should react in case someone deviates from this price. Arriving at some coordinated course of action may be facilitated by direct communication. Secondly, information about the conduct of other firms is needed to monitor adherence to a collusive agreement (whether tacit or explicit). The central problem of any cartel is that participating firms have a constant temptation to cheat on the agreement. The longer it takes the other firms to find out that one firm has cheated, the larger the incentives will be to actually cheat. Moreover, in the absence of reliable information about others' conduct there is also the danger that collusion breaks down because of a false positive. Therefore, the availability of quick and complete information on the conduct of other firms is important for the sustainability of collusion.

Many discussions about competition policy as well actual antitrust cases resolve around these issues of communication and information (Kühn, 2001). As we have just seen it is hard to settle the issue purely on the basis of theoretical arguments. Moreover, empirical studies on the impact of information exchange are scarce. Arguably the strongest evidence on price communication is by Albaek et al. (1997). The Danish anti-trust authority decided to gather and publish firm-specific transaction prices in the ready-mixed concrete industry. The aim was to promote competition by increasing transparency (in particular for buyers). The result of the policy, however,

seemed exactly opposite to the authority's aim. Average prices increased by 15-20 percent within a year following the initial setup. This 'natural experiment' provides quite compelling support for the concern that *open* prices may well be *high* prices. This study is unique in its kind and unfortunately other evidence is much less convincing. This leads Kühn to the assertion that "unfortunately we know very little about how important communication is in practice to establish collusive outcomes".

In this paper I review the experimental literature that deals, directly or indirectly, with the effects of information and communication on market outcomes. I will focus attention on the impact of transparency on market power and collusion, as measured by the level of prices. This means that I will mostly ignore the effects of transparency on other performance measures such as efficiency or convergence. Furthermore, I restrict attention to experiments that have an explicit industrial organization orientation. This implies that I will not discuss the emerging experimental literature that deals with transparency in financial markets which deals with somewhat different issues (such as price efficiency and liquidity) than those of competition policy (see, e.g., Bloomfield and O'Hara, 2000, Flood et al. 1999). Also I will disregard the experimental literature that deals with issues of communication and information in experimental settings other than markets, such as the provision of public goods.

The paper is organized as follows. The next three sections will review the experimental evidence that deals with communication and information about future, present and past actions, respectively. The final section contains a concluding discussion.

2. Transparency about future conduct of competitors

"People of the same trade seldom meet, ... or ..." (Adam Smith)

Explicit price fixing agreements are illegal per se under the Sherman Act and under Article 85 of the European Union. As a consequence, price fixing agreements or other restraints on competition are not contractable, simply because such contracts are not enforceable by a court of law. From this perspective conspiracies are merely talk, no less and no more. Agreements and promises about future conduct can be regarded as

“soft” information. Hence, from an economists point of view the proposition that such information will affect market outcomes is less trivial than it may seem.

Result 2.1 When given the opportunity to communicate, competitors will use it to conspire and come to some form of price fixing agreement.

Friedman (1967) was the first to examine experimental markets in which competitors were allowed to communicate. He set up duopoly markets with price competition and product differentiation. Demand was simulated, and the relation between prices and profits was presented to the subjects in bi-matrix form. Before prices were set, one seller could send a written message to the other seller who could then send one written response. The results indicated that in $\frac{3}{4}$ of the cases a collusive agreement was formed (which was subsequently honored in 90% of the cases).

Unstructured face-to-face communication was allowed in Isaac and Plott (1981), Isaac et al. (1983) and Davis and Holt (1998). Sellers and buyers were in different rooms and they were instructed that they could speak to each other except during brief periods of recess between trading rounds. They could discuss anything they wished except that they could not mention side payments, threats or reveal their private payoff information. Isaac and Plott report that sometimes it could took a few periods but then often quite specific collusive strategies were discussed. The following quote illustrates this: “Let’s try starting \$1 and see if they go for it, and then, keep it between 90c and \$1”. Often the discussions were intertwined with conversations about items of personal interest.

Also when communication is more structured, competitors often manage to come to an agreement. For example, in Andersson and Wengstrom (2004) communication between duopolists is restricted to one subject suggesting “I consider ... to be the appropriate price” and the other subject responding by “I agree” or “I disagree”. They find that in about 50% of the cases the two competitors manage to come to an agreement.

Result 2.2 Direct communication can have a substantial impact on prices

Friedman (1967) is the first paper suggesting that communication between competitors can lead to highly collusive outcomes. Friedman did not run a control treatment without communication, so we cannot attribute the collusion he observed to such communication. Strictly speaking it could also be due to the market structure.

Isaac, Ramey and Williams (1984) is the first study that finds a substantial and significant price increasing effect of seller conspiracies. They implement posted offer markets with 4 seller and 4 buyers, who each can trade up to three units. At the beginning of a trading period the sellers independently post take-it-or-leave prices and the number of units they are prepared to sell at this price. Then buyers are selected in a random order and can decide if and from whom they wish to buy units. Market sessions consisted of somewhere between 15 and 20 periods. Isaac et al run a control treatment in which sellers were not allowed to communicate directly and one conspiracy treatment in which, in between treatment and without the buyers knowing this, sellers were given the opportunity to talk about the market. The results show that in the control treatment prices tended to converge toward the competitive equilibrium price while in the conspiracy treatments average prices were significantly above the competitive price at a level about halfway toward the monopoly price.

Davis and Holt (1998) employed a very similar posted offer design with three sellers and three buyers and treatments with and without conspiracies. Their results are also very similar. In the control treatment average transaction prices were very close to the competitive equilibrium price. In the markets with conspiracies, on the other hand, average prices above the competitive price (39.4 above it to be precise) and approaching the joint profit maximizing price (which was 55 above the competitive price).

Result 2.3 Conspiracies do not always have a (lasting) effect on prices.

Isaac and Plott (1981) study double -auction markets with four sellers and four buyers which are open for 8 periods. They compare a control treatment without conspiracies with treatments in which either the buyers or the sellers are allowed to communicate face-to-face in between periods, as described above. Isaac and Plott find very little effect of the communication possibilities on the average price level. Compared to the control treatment, prices move only about 6% in the direction of the conspiring side.

As we have discussed under Result 2.1, it is not that the traders do not attempt to conspire, it is just that their attempts are not successful.

Holt and Davis (1990) is a study that finds only a transitory effect of communication (see also Cason, 1995; Cason and Davis, 1995). They set up markets in which three sellers simultaneously post prices and demand is simulated. First there are 15 periods without communication and then there are at least 10 periods with price announcement and a random stopping rule after this 10th period. The communication proceeded over the computer and was very structured. At the beginning of a period one of the three sellers was selected at random to make an announcement of the form: '\$... is the appropriate for this period'. The other two sellers could then respond with *A* (agree), *H* (price should be higher) or, *L* (price should be lower). The results indicate that the announcements have a clear initial effect on prices. The effect however is only temporary and by the 10th period prices are almost back at the level were they were before the announcement were introduced.

Result 2.4 Factors found to affect the effectiveness of conspiracies include: (a) the market institution (posted prices versus double auctions), (b) market environment (demand and supply structure), (c) communication format (face-to-face versus impersonal), and (d) cost of communication.

Result (a) follows from a Isaac and Plott (1981) and Isaac, Ramey and Williams (1984). The former studies double auction markets and finds very little effect of conspiracies, while the latter finds that prices are significantly affected by conspiracies in posted-offer markets. Moreover, Isaac et al also conduct a double auction markets with conspiracies and find prices to be lower than in posted offer markets with the same demand and supply configuration. Clauser and Plott (1993) examine the reason for this difference and find evidence for the following explanation. In posted-offer markets sellers can only to price offers at the beginning of a period and cannot revise these offers once the market has opened for trading. In double-auction markets sellers have much more flexibility and can revise their prices continuously. This flexibility makes it the more difficult for conspiring sellers to resist the temptation to renege on an agreement.

Result (b) follows from Holt and Davis (1990); see also Cason (1995). The former paper compares the effect of conspiracies in two different environments: a ‘power design’ and a ‘no power’ design. The former design was expected and found to make conspiracies more effective as it made the joint profit maximizing price more focal and reduced the temptation to cheat (in either case the effect seemed rather transitory as was just discussed).

There is no direct evidence for result (c). Yet, comparing across different studies it is quite noticeable that posted offer studies with face-to-face and free-form contact (Isaac et al., 1983, Davis and Holt, 1998) tend to find a more substantial impact of communication than those with impersonal and very structured communication (Holt and Davis, 1990, Cason, 1995, Andersson and Wengstrom, 2004).

Finally, result (d) follows from an interesting recent study by Andersson and Wengstrom (2004). They study price-setting Bertrand duopolies with structured pre-play communication. Markets were repeated with a random continuation probability and an expected length of 14 periods. As in Holt and Davis (1990), before each period one seller had the opportunity to send a message saying “I think ... is the appropriate price” and the other seller could respond with “I agree” or “I disagree”. In the study the per period cost of sending these messages is systematically varied. In one treatment the cost are zero, in a second treatment the costs are low (about $\frac{1}{4}$ of the stage game monopoly profits, and in a third treatment the costs are high (equal to the stage game monopoly profits). The results indicate that when the cost of communication increase its frequency decreases while its effectiveness increases. The net effect implies that the incidence of collusion goes up dramatically as the cost of conspiring increases. This result suggests that players feel more committed to an agreement if substantial costs had to borne to reach the agreement.¹ One cause for an increase in the costs of conspiring is a more strict enforcement of competition policy. Therefore, the authors argue that such an enforcement may actually be counterproductive.

3. Transparency about current prices

¹ This result is similar to the finding that the likelihood of collusion increases with an increase in entry costs (Offerman and Potters, 2004).

“Prices change with varying frequency, and, unless a market is completely centralized, no one will know all the prices which the various sellers (or buyers) quote at any given time” (Stigler, 1961, p. 213).

In this section we will review the experimental evidence that relates to transparency about current prices. At least two potentially conflicting effects may be at work here. On the one hand, if sellers can immediately and reliably observe each others’ prices, the incentive to undercut prices of competitors may be seriously weakened. Competitors will detect the price cut immediately and in order to prevent a price war, it is perhaps better to refrain from the price cut in the first place. On the other hand, if buyers are better informed about sellers’ current prices they will be better able to make price comparisons, which may make stimulate competition among the sellers. Hence, it is important to distinguish which side of the market gets better information about sellers’ current prices: only the sellers, only the buyers, or both.

Result 3.1 If transparency about current prices is public, i.e., available to both sellers and buyers, then there is no unambiguous negative effect on competition.

A paper which presents some (weak) evidence for a negative effect on competition is Hong and Plott (1982). I discuss it at some length because it is first study to use experiments for an practical question of market regulation. This paper was motivated by a new price setting policy proposed (by the railroads!) for the inland water transportation industry. Rather than using private bilateral negotiations, it was proposed that shippers post their prices with a central agency. The railroads argued that the public information feature of prices would make the market more competitive. The regulator was skeptical about the argument and commissioned an experimental study (see Plott, 1986).

This experimental study is remarkable for a number of reasons (see also Normann and Ricciuti 2004). It consisted of four sessions of 3 hours each with the same 33 subjects, which included engineers, students, secretaries and housewives. Considerable effort was taken to bring the demand and supply parameters of the experimental market in line with those of the waterways barge industry. A price-

posting institution was used for two experimental sessions. At the beginning of a period, sellers posted their prices. These prices were then listed on a piece of paper and photocopied for all traders in the market. When the market opened (“at the sound of a horn”), subjects were free to call another subject and make a purchase or sale at the price posted by the seller. A telephone market was used at the other two days. Buyers and sellers could call each other and negotiate contracts privately. No one but the two traders involved would know about the contract, although subjects were free to discuss or lie about deals made with other subjects.

The results suggest that the scepticism of the administrators was warranted. The posted price policy resulted in higher prices and lower efficiency. In the posted price sessions the prices are from 5 to 9% above those in the telephone markets (and also a little above the competitive price). The price effect seems rather modest in size. Whether it is statistically significant is hard to say. Strictly speaking, the experiment consists of merely one paired observation.

Grether and Plott (1984) is another experimental study commissioned by a government agency. The Federal Trade Commission brought action against four chemical companies and asked them to stop using several marketing practices that the FTC believed to be anti-competitive. One of these practices was that firms publicly announced prices. Another is the use of a most favored customer clause, which effectively rules out private price discounts from the announced prices. The study by Grether and Plott does not allow a clean assessment of the effects of the different practices in isolation. The results reveal that in combination the different practices lead to substantially higher prices. Each practice in isolation did not seem to have a strong anti-competitive effect though.

Both Joyce (1983) and Kirchsteiger et al. (2005) compare double-auction markets and decentralized bargaining markets. In a double auction market, a seller (buyer) can continuously submit price offers to the market which indicate he (she) is prepared to sell (buy) at that price. All offers are public information and at any time a buyer can accept an offer from a seller and vice versa. A decentralized bargaining market is like a “telephone market” in Hong and Plott. Buyers and sellers can contact each other on a bilateral basis and can try to negotiate a mutually acceptable transaction price. No trader other than to two bargaining parties is informed about current price offers. Hence, one can say that in moving from a decentralized bargaining market to a double auction market transparency on price offers increases

for both sides of the market. No effect on the average level of transaction prices is observed in these markets though. At the same time, efficiency usually increases significantly with the increase in transparency.

One might argue that in view of the symmetric role of sellers and buyers in both the double auction and the decentralized bargaining market no effect on average price should be expected. Posted offer markets would be more relevant to examine a potentially negative effect of public information about sellers' prices. Davis and Holt (1994) study just that. In a standard posted offer market, sellers post prices and buyers then decide from whom to buy at these posted prices. No trades can occur at prices other than the ones publicly listed. In particular, sellers cannot grant private discounts to individual buyers. In line with Stigler (1964) one might conjecture that the absence of secret discounts, whether by contract or by industry custom, impedes competition and fosters collusion. To examine this Davis and Holt compare a standard posted offer market with a posted offer market with private discounts. At the beginning of the period sellers post prices publicly and simultaneously. Then buyers are selected in random sequence. In the standard market, the buyer simply decides from whom to buy at posted prices. In the market with discounts, each buyer can buy at the posted price or request for a private discount. Sellers are free to grant such a discount which will be observed by no one but the buyer involved. All the sessions, involve two sellers and three (human) buyers, and markets last for at least 15 periods. The results indicate that the presence of secret discounting increased the variance across different sessions, but no effect on average transaction prices was discernible. The fact that the transaction prices were public information (and not just the "list prices") did not reduce seller competition.

Result 3.2. If price transparency improves only for sellers (and not buyers), or if sellers are involved in an active conspiracy then competitiveness will be restricted.

Davis and Holt (1998) examine markets which are characterized by explicit conspiracies among the three sellers (see also the previous section). In one treatment, after the seller discussions, the market proceed along standard posted-offer trading rules, implying that all trades must be made at the posted prices. In the second treatment, the sellers were given an opportunity to give private secret discounts. Upon

contacting a seller a buyer could request for a discount. The seller could then respond by offering a price below the list price. Like in Davis and Holt (1994) discounts were observed only by the buyer concerned and not by other buyers or sellers.

As we have already seen in the previous section, the posted offer markets with conspiracies and without secret discounts were very collusive. Average prices in the last five periods are 39.4 (with a the competitive price at 0 and the joint profit maximizing price at 55). As soon as the possibility for secret discounts is introduced, however, the posted offer markets with conspiracies generate significantly lower prices with an average of 14.9 in the last five periods. In fact, cartels failed in five of the six markets. This is in spite of the fact that sellers could discuss and conspire not just once but each time before the market opened. Hence, the possibility to offer prices privately and selectively is an important impediment to successful conspiracies.

Kirchsteiger, Niederle and Potters (2005) examine endogenous rather than exogenous information about current prices. They set up two-sided auction markets with six buyers and six sellers, who each can trade at most one unit. When submitting a price offer to the market, sellers can decide whether or not they wish to inform their competitors about this price offer. Kirchsteiger et al. find that high (supra competitive) price offers are more likely to be communicated to competing sellers than low price offers. This suggest that price sharing is at least partly driven by collusive intentions. It is as if sellers want to signal to keep prices at a high level by informing each other about their high price quotes. When posting a relatively low price sellers are less likely to inform their rivals. Price communication also has a discernable effect on transaction prices. Price are higher in periods with relatively frequent information exchange about price offers than in periods with relatively infrequent information exchange. The effect is small in size but statistically significant. At the same time, there is no evidence that increased price communication among sellers reduces price dispersion, speeds up convergence or increases efficiency.

Another interesting result in Kirchsteiger et al. is that price communication tends to have a public good character. As we have just seen, sellers as a group benefit from price communication. Individually, however, sellers are better off to conceal their price offers from competitors as this reduces the probability that an offer will be undercut by a rival. Kirchsteiger et al. find that price communication is very unlikely to arise endogenously when sellers can decide to conceal or reveal price offers

individually and freely. Only when price communication is “sponsored” it is getting of the ground to some extent. This suggests that some (trade) association may be needed to stimulate or organize price communications.

Result 3.3 If price transparency increases for buyers only then there is a positive effect on competition

Here the evidence is strong and unambiguous. If buyers get better information about sellers’ current prices, while sellers’ information is not affected, a downward pressure on prices will be effectuated.

One piece of evidence comes from studies that examine the effect of a reduction in search cost for buyers (Cason and Friedman, 1999, Cason and Friedman, 2002, Cason, Friedman and Milan, 2003, Davis and Holt, 1996). For example, Cason, Friedman and Milan (2003) study customer markets in which a buyer is attached to a certain seller (for example the one that he bought from in the previous period) and can only get a price offer from another seller at a certain switch cost. Cason et al find that prices increase strongly if the buyer switch costs increase. If buyers can get information about the price offers of other sellers more cheaply then seller competition intensifies.

Other studies examine markets in which a certain fraction of the buyers is informed about the price offers by all sellers, while the remaining buyers are captive to a certain sellers (Morgan, Orzen, Sefton, 2004, 2005). These studies show that competition among sellers becomes more fierce if the fraction of fully informed buyers increases, and that prices decrease as a result.

4. Transparency about past conduct of competitors

Several experimental studies are related to this issue of information of competitors conduct. Some studies directly address the antitrust concerns, others speak to the issue in a more indirect manner.

Result 4.1 Reliable information feedback about competitors’ prices fosters the stability of explicit cartels

Several experiments show that conspiracies are less successful and less stable when feedback information about competitors' conduct is lacking. The first piece of evidence is contained in Holcomb and Nelson (1991) who study 20 repeated symmetric quantity-setting duopolies. In the first phase of the experiment firms are allowed to conspire and also they receive perfect information feedback about their competitor's quantity choice. In the second phase of the experiment, information feedback becomes imperfect. In each period, with a 50% probability the feedback received corresponded to the choice made by the competitor, and with a 50% probability the feedback provided was a random draw from the set of possible quantities. The results show that in the first phase with perfect monitoring no less than 17 out of the 20 pairs were perfectly collusive (joint profit maximizing) in at least the last 10 periods of the game. As soon as monitoring became imperfect though, collusion became very instable and 16 of the 17 previously collusive duopolies moved toward the Cournot equilibrium. This result clearly suggests that reliable information feedback about what competitors are doing is essential for the stability of cartels.² Another interesting result of this study is that the cartels did not fail so much because some firms started to defect from the collusive outcome. Rather, the cartels failed due to false positives, that is, firms increasing quantity in reaction to the incorrect information that a competitor had defected.

Davis and Holt (1998) is another paper showing the importance of reliable information feedback about competitors' conduct. As was already discussed in support of the previous result, conspiracies tend to break down when secret discounts off posted prices are possible. One further treatment in Davis and Holt (1998) implements a situation in which secret discounts are still possible but all sellers receive feedback information on each others' sales volume. This situation was intended to parallel the information that is often collected and disseminated by trade associations. Although a competitors' sales volumes are not a perfect signal of any discounts offered, still they appear to be a useful indicator of the degree to which competitors abide by a cartel agreement. The results reveal that average prices increase from 14.9 to 24.8 when feedback information on competitors' sales are

² It much be noted that there is a potential confound here. In the first phase of the experiment the duopolies had perfect information feedback *and* were allowed to communicate to each other directly. From the paper it is not entirely clear whether this communication was still allowed in the second phase of the experiment.

provided. This outcome shows that the availability of this feedback information restores to some degree the stability of collusion that was undermined by the possibility of secret discounts.

Result 4.2 Firm-specific information feedback about competitors' conduct is in some cases found to foster tacit collusion, but these cases are relatively infrequent, particularly so if the information provided includes details about profits, and if the firms compete in quantities rather than in prices.

Here the evidence is quite mixed. Some papers suggest that more detailed or more explicit information feedback on competitors' conduct reduces competition, while several others show that it may actually increase competition.

A first piece of evidence comes from Benson and Feinberg (1988), who examine price setting duopolies with product differentiation. There are two treatments: one in which subjects received information about the rival's price after each of round, and one in which feedback information was restricted to market shares. The results indicate the tacitly collusive outcomes are more frequent with explicit feedback information about rivals prices, but the evidence is not overwhelming.

Strong evidence that detailed information disclosure can facilitate tacit collusion is provided by Dufwenberg and Gneezy (2002). They examine a series of Bertrand duopolies. Two firms simultaneously set a price and the one with the lowest price gets a positive profit which is decreasing in the level of the price, while the firm with the highest price gets no profit.³ In each session of the experiment the game is played 10 times by 12 participants and in each period the participants are random matched in pairs. The experiment uses three feedback information treatments: one in which the participants only learn whether they had the lower price of the two, one in which the participants learn all the low prices of the six duopolies and one in which they learn all prices of all six pairs. The results show a large treatment effect. When participants learn the whole set of prices, the markets are quite collusive with average transaction prices about half way between the competitive price and monopoly price. On the other two treatments prices converge toward the competitive price. The

³ The game can also be interpreted as a symmetric procurement auction with complete information. This interpretation also makes a random matching protocol more realistic.

dissemination of information about the high prices of competitors stimulates participants to charge higher prices as well.

Offerman, Potters and Sonnemans (2002) examine symmetric quantity-setting triopoly markets in which the same three participants interact for 100 periods. In one treatment (Q) information feedback after each period is restricted to own profits and aggregate quantity. In a second treatment (Qq) information is also provided about the individual quantities set by the two competitors. In the third treatment (Qq π) in addition the realized profits of competitors are given. The experimental results reveal that the average levels of outputs are almost identical in the three treatments and very close to the Cournot Nash equilibrium. A closer look at the individual triopolies (11 in each treatment) and at the dynamics over time revealed some remarkable differences, however. In treatment Q the only frequent and stable outcome was the Cournot equilibrium. In treatment Qq apart from the Cournot outcome also the collusive joint profit maximizing outcome was reached quite frequently by some triopolies and turned out to be very stable. In treatment Qq π the results were even more dispersed. The Cournot outcome lost all its drawing power and outcomes were either very competitive or very collusive. So with more detailed information feedback the *range* of outcomes increased dramatically, even though the *average* degree of competition did not.

The fact that the availability of firm-specific information on past conduct and performance can increase competition is most clearly illustrated by Huck et al., (1999, 2000). Comparable results have been obtained by Altavilla et al. (2003) and Davis (2002). Huck et al., set up markets in which four firms compete in quantities and implement two different information treatments; one (BASIC) in which information feedback is restricted to aggregate conduct of competitors and one (EXTRA) in which individualized information about past conduct and profits of competitors is available. Huck et al., find that the availability of more detailed information feedback about competitors actually increases the competitiveness of the markets. In the last half of the 40 periods, average quantity is 74.7 in the BASIC treatment which is very close to the theoretical Cournot Nash equilibrium quantity of 74.5. In the EXTRA treatment the market becomes even more competitive with an average quantity of 83.4 which is even more competitive in the EXTRA treatment. And even though the range of outcomes increases somewhat in the latter treatment, very few are anywhere near the

joint profit maximizing quantity of 49.7. Huck et al., (2000) also conduct similar experiments for markets in which the four firms compete in prices (Bertrand) rather than in quantities (Cournot). Here they find that the degree of competitiveness is about the same for the BASIC and EXTRA treatment and again very close to the non-cooperative equilibrium. So also for the case of price competition they find no evidence that individualized information about past conduct and performance reduces competition. The main theoretical explanation for the competition enhancing effect of the EXTRA treatment is that it allows firms to compare profits. This may stimulate them to imitate the conduct of the more successful competitor in the market. Typically the more successful firm is the one that produces the largest quantity or charges the lowest price. Copying the behavior of this firm then tends to increase quantity and reduce price.

In sum, there is quite conflicting evidence on the effects of firm-specific information feedback. Two opposite forces seem to be at work. On the one hand, detailed information on competitors past conduct allows for signaling of intentions and monitoring of conduct. Both of these may reduce competition. On the other hand, detailed and explicit information about competitors profits allows for an assessment of relative performances, which tends to make markets more competitive. The net effect seems to depend not only on the content of the information (does it include profit information) but also on the type of interaction (price or quantity competition).

5. Concluding Discussion (to be extended)

Looking at the experimental methodology one lesson we learn from the experiments is that there is often a big variance in outcomes; across studies with similar designs and even across repetitions with an identical design (see e.g., the discussion of Results 4.1 and 5.2). This just reiterates the importance of strategic uncertainty. It is not just the controllable variables that exert an impact on outcomes, but also uncontrollable variables. Arguably, the most important among those are the ones that relate to differences between people. Some students are just more clever, more risk averse, more confident, more patient, or more competitive than others. Some may be tempted to see this as a potential drawback of experiments. However, I do not think matters are much different in the real world. Also consumers, shop-

owners, managers and CEOs differ on dimensions that may have an impact on the way they go about their business.

One lesson that can be drawn from the experimental results is that establishing and sustaining collusion is not easy. Tacit collusion in particular is not very frequently observed in experiments, even with relatively few competitors and repeated interaction. And even when competitors have a possibility to conspire collusion is often quite unstable. This holds in particular when talk is, literally and figuratively speaking, “cheap”, that is, when communication bears no cost, occurs frequently, and involves little commitment. If furthermore, the opportunities to defect are frequent, lucrative, and hard to detect, then even explicit conspiracies often tend to be quite unstable. Hence, it seems that some form of explicit communication about future conduct is required as well as reliable and immediate information on present or past conduct.

One of the important issues for competition policy is whether and when information exchange on past conduct should be allowed among competitors. The experimental evidence does not provide unambiguous results on this issue. Result 4.2 suggests that often there is little harm and in some experimental settings it was even found to increase competition somewhat. On the basis of this one might argue (and some have done so) that there is little reason to be hostile against information exchange on past conduct, even if this involves firm-specific information. In my view though this would be quite a naïve conclusion. Result 4.1 indicates that information exchange is important for the support of explicit collusion. Result 4.2 indicates that in a certain fraction of the cases information exchange does in fact stimulate tacit collusion. In the field information exchange is not some exogenous feature of a market (like it is in an experiment). In most cases, firms or associations *choose* to have such an exchange of information. Hence, a natural question to ask is: when is information exchange more or less likely to be set up? In view of Results 4.1 and 4.2 one might even argue that information exchange is most likely to be set in markets which are characterized by some degree of explicit conspiracy. Put bluntly, this suggests that information exchange is more likely to be a consequence of (explicit) collusion than a cause of (implicit) collusion.

References

Ackert, L., Church, B., Sankar, M., (2000), Voluntary Disclosure under Imperfect Competition: Experimental Evidence, *International Journal of Industrial Organization* 37, 81-105.

Albaek, Svend, Peter Møllgaard and Per Overgaard (1997), Government-Assisted Oligopoly Coordination? A Concrete Case, *Journal of Industrial Organization* 65 (December), 429-443.

Altavilla, Carlo, Luini, Luigi, and Sbriglia, Partizia (2003), Information and Learning in Bertrand and Cournot Experimental Duopolies, mimeo University of Siena.

Andersson, Ola, and Erik Wengstrom (2004), Do Antitrust Laws Facilitate Collusion? Experimental Evidence of Costly Communication in Duopolies, mimeo. Lund University.

Benson, B., and Feinberg, R (1988), An Experimental Investigation of Equilibria Impacts of Information, *Southern Economic Journal* 54 (3), 546-561

Bloomfield and O'Hara, 2000

Bosch-Domenech, A., and Vriend, N., (2003), Imitation of Successful Behavior in Cournot Markets, *Economic Journal* 113, 495-524.

Brown-Kruse Cronshaw Schenk (1993), *Ec Inquiry*

Cason, Timothy (1994), The Impact of Information Sharing Opportunities on Market Outcomes: An Experimental Study, *Southern Economic Journal* 60, 18-39.

Cason, Timothy N. (1995), "Cheap talk price signaling in laboratory markets", *Information Economics and Policy* 7, 183-204.

Cason, Timothy, and Davis, Doug, (1995), Price Communications in a Multi-Market Context. An Experimental Investigation, *Review of Industrial Organization* 10, 769-787.

Cason, T., and Friedman, J. (1999), Customer Search and Market Power. Some Laboratory Evidence, *Advances in Applied Microeconomics* 8, 71-99.

Cason, T., and Friedman, J. (2002), A Laboratory Study of Customer Markets, *Advances in Economic Analysis and Policy* 2 (1).

Cason, Friedman, Milan (2003) Bargaining versus Posted Prices in Customer Markets, *International Journal of Industrial Organization* 21 (2), 223-251.

Cason, Timothy. N., and Charles F. Mason (1999), "Information Sharing and Tacit Collusion in Laboratory Duopoly Markets", *Economic Inquiry* 37(2), 258-281.

Clauser, Laura, and Plott, Charles (1993), On the Anatomy of the 'Nonfacilitating' Features of the Double Auction Institution in Conspiratorial Markets," in *The Double Auction Market: Institutions, Theories, and Laboratory Evidence*, edited by D. Friedman and J. Rust, Reading, Mass.: Addison-Wesley, 333-353.

Davis, Douglas D. (2002), "Strategic Interaction, Market Information, and Predicting the Effects of Mergers in Differentiated Product Markets", *International Journal of Industrial Organization* 20, 1277-1312.

Davis, Douglas D., and Charles A. Holt (1994), "The effects of discounting opportunities in laboratory posted-offer markets", *Economics Letters* 44, 249-253.

Davis, Douglas D., and Charles A. Holt (1996), "Consumer Search Costs and Market Performance", *Economic inquiry* 34, 133-151.

Davis, Douglas D., and Charles A. Holt (1998), "Conspiracies and Secret Discounts in Laboratory Markets", *Economic Journal* 108 (May), 736-756.

Davis, Douglas D., Wilson, Bart J. (2002), Experimental Methods and Antitrust Policy, in: Research in Experimental Economics: Experiments Investigating Market Power, Vol. 9, C. Holt and R. M. Isaac (eds.), JAI Press.

Dolbear, F. et al., (1968), Collusion in Oligopoly: An Experiment on the Effects of Numbers and Information, *Quarterly Journal of Economics* 82 (2), 240-259.

Duffy and Feltovich

Dufwenberg Gneezy (2002), Information Disclosure in Auctions: An Experiment, *Journal of Economic Behavior and Organization* 48, 431-444.

Feinberg, R., and Snyder, C. (2002), Collusion with Secret Price Cuts: An Experimental Study, *Economics Bulletin* 3 (6), 1-11.

Flood et al. 1999

Fouraker, L.E., and S. Siegel (1963): *Bargaining Behavior*. New York: McGraw-Hill.

Friedman, James W. (1967), An Experimental Study of Cooperative Duopoly, *Econometrica* 35, 379-397.

Grether, David M., and Plott, Charles R. (1984), The Effects of Market Practices in Oligopolistic Markets: An Experimental Examination of the Ethyl Case, *Economic Inquiry* 22, 479-507.

Harstad, Ronald, Stephen Martin and Hans-Theo Normann (1998), "Intertemporal pricing schemes. Experimental tests of consciously parallel behaviour in oligopoly", in Louis Philips (ed.), *Applied Industrial Economics*, Cambridge: Cambridge University Press.

Hogatt, Austin, Friedman, James, and Gill, Shlomo (1976), Price Signaling in Experimental Oligopoly, *American Economic Review* 261-266.

Holcomb, James, and Paul Nelson (1991), "Cartel Failure: A Mistake or Do They Do It to Each Other on Purpose?", *Journal of Socio-Economics* 20(3), 235-249.

Holt, Charles A., and Davis Douglas (1990), The Effects of Non-binding Price Announcements on Posted-Offer Markets, *Economics Letters* 34, 307-310.

Hong James T., and Plott, Charles R. (1982), Rate Filing Policies for Inland Water Transportation: An Experimental Approach, *Bell Journal of Economics* 13, 1-19.

Huck, S., H.T. Normann, and J. Oechssler (1999): Learning in Cournot Oligopoly - An Experiment, *Economic Journal*, 109, C80-C95.

Huck, S., H.T. Normann, and J. Oechssler (2000): Does Information about Competitors' Actions Increase or Decrease Competition in Experimental Oligopoly Markets?, *International Journal of Industrial Organization* 18, 39-57.

Isaac, R. Mark, Charles R. Plott (1981), "The Opportunity for Conspiracies in Restraint of Trade", *Journal of Economic Behavior and Organization* 2, 1-31.

Isaac, R. Mark, Valerie Ramey and Arlington Williams (1984), "The Effects of Market Organization on Conspiracies in Restraint of Trade", *Journal of Economic Behavior and Organization* 5, 191-222.

Joyce, P. (1983), Information and Behavior in Experimental Markets, *Journal of Economic Behavior and Organization* 4, 411-424.

Kirchsteiger, G., Niederle, M., and Potters, J. (2004), Endogenizing Market Institutions. An Experimental Approach, *European Economic Review*, forthcoming.

Kühn, Karl-Uwe and Vives, Xavier (1999)

Kühn, Karl-Uwe (2001), Fighting Collusion by Regulating Communication Between Firms. *Economic Policy* 16, 169-204.

Morgan, Orzen, Sefton (2004)

Morgan, Orzen, Sefton (2005)

Offerman Potters (2004)

Offerman, T., Potters, J., Sonnemans, J. (2002), Imitation and Belief Learning in an Oligopoly Experiment, *Review of Economic Studies* 69 (4), 973-997.

Phillips (1959)

Plott, Charles (1987), Dimension of Parallelism: Some Policy Application of Experimental Methods, in Roth, A., (ed).

Potters, Rockenbach, Sadrieh, van Damme (2004),

Rassenti, Stephen, Reynolds, Stanley, Smith, Vernon, Szidarovszky (2000), Adaptation and Convergence of Behavior in Repeated Experimental Cournot Markets, *Journal of Economic Behavior and Organization* 41, 117-146.

Scherer and Ross (1990)

Stigler, G. (1961), "The Economics of Information", *Journal of Political Economy* 69, 213-225.

Stigler, G. (1964), "A Theory of Oligopoly", *Journal of Political Economy* 72, 44-61.