Joseph E. Harrington, Jr.

Johns Hopkins University – Baltimore, USA

Behavioral Screening and the Detection of Cartels

Behavioral Screening and the Detection of Cartels[*]

by *Joseph E. Harrington, Jr.*[1]

A.   Introduction

Effectively fighting cartels requires that cartels be discovered, discovered cartels be successfully prosecuted, and successfully prosecuted cartels be penalized. Operating effectively in all three stages - detection, prosecution, and penalization - is crucial to disrupting existing cartels and deterring new ones from forming.

Let us consider the role of economic and econometric analysis in each of these three stages.[2]   Historically, the biggest role of economic analysis lies in the penalization stage. To determine the damage inflicted by a cartel, one must estimate what the price would have been had collusion not occurred. Economic analysis has been essential in estimating the but for price and using it to measure damages. This is directly relevant to penalization in the US - as customer damages are significant - and is (or ought to be) relevant in determining the appropriate government fine, especially if fines are intended to deter cartel formation.[3]

Economic analysis plays a significantly weaker role in the prosecution stage.[4] In the US, economic evidence is generally insufficient to prove a violation of Section 1 of the Sherman Act. There needs to be evidence of explicit coordination (or, as Werden (2004) prefers, "of a spoken agreement") among the suspected cartel members. Economic analysis can play a supportive role, however. For example, in the case of the Ohio school milk case, economic analysis showed how prices were *lower* when (transportation) costs were *higher* which is inconsistent with competition but quite consistent with a particular collusive scheme (Porter and Zona, 1999). Nevertheless, since economic theory generally doesn't distinguish between tacit and explicit collusion - and it is explicit collusion that is illegal in most countries - it is difficult for economic analysis to deliver definitive evidence that observed behavior is consistent only with the presence of a hard-core cartel.

And finally we come to the issue of the detection of collusion. It is here that economic analysis has been least significant. Cartels are discovered in many ways but, with some rare exceptions, economic analysis is not one of them. In this paper, I intend to argue that economic analysis can play a more significant role in the

---

[1] Department of Economics, Johns Hopkins University, Baltimore, MD 21218 410-516-7615, -7600 (Fax),

e-mail: joe.harrington@jhu.edu, site: www.econ.jhu.edu/People/Harrington.

[2] From hereon, when I refer to "economic analysis", I will be referring to the use of either economic theory and/or econometric methods.

[3] For a recent review of economic methods for calculating damages, see Clark, Hughes, and Wirth (2004).

[4] For a review of this issue for the US, see Werden (2004).

detection of cartels, with the intent of spurring policy discussions and scholarly research.

Screening refers to a process whereby industries are identified for which the existence of a cartel is likely. An industry that is picked up by a screen is one that warrants not prosecution but rather a more intense investigation which directly contrasts collusion and competition as competing explanations of market behavior.[5] Screening is then the first phase of a multi-stage process which may or may not end with prosecution.

Before moving on, I do want to admit that screening for cartels may be difficult, *given our current methods*. But my intent is largely to promote research into methods of screening by economists in academia, think tanks, consulting firms, and government. That there is some reason to hope that this process may ultimately result in a workable and effective screening program is suggested by success in analogous programs for other forms of illegal activity. Screening programs are in place to identify credit card fraud, insider trading, and tax evasion. Admittedly, those applications are rich in data but then there are some industries in which data is available. We should not forsake the possibility that screening for cartels can achieve some of the success that has occurred in screening for other illegal activities.

B.   Screening approaches

Broadly speaking, methods of cartel detection using economic analysis can be partitioned into those that are structural and those that are behavioral. A structural approach identifies markets with traits conducive to cartel formation. For example, it has been shown that collusion is more likely with fewer firms, more homogeneous products, and more stable demand.[6]   Grout and Sonderegger (2005, p. 15) is representative of this approach:

> "[...] the fundamental background reduces to three core issues - product, volatility, and company criteria. The first core question is whether the industry has a homogeneous product or not. Cartels are far more likely if the product is fairly homogeneous between companies in the market. ... Second, does the industry display volatile turnover over a sustained period of time? Cartels are more likely if output and market conditions are normally stable. [...] Finally, are the leading players in the market large and relatively constant? If there are significant changes in the market shares or regular exits and entrants then cartels are less likely."

One could imagine investigating industries that score high on these relevant traits with the hope of finding evidence of a cartel. I have been told that the Dutch competition authority has deployed structural methods with some success including, for example, uncovering collusion in the shrimp industry.[7]

---

[5] For a review of some of the methods for comparing competition and collusion as alternative explanations of the data, see Harrington (2006a). I would also recommend reading Porter (2005).

[6] For some industry traits associated with collusion, see Symeonedis (2003), Motta (2004), and Grout and Sonderegger (2005).

[7] This information is based on private communication with Peter A. G. van Bergeijk of the Nederlandse Mededingingsautoriteit (December 16, 2004.)

In spite of that success, I am pessimistic as to the efficacy of structural methods. Their weakness lies in that, in most economies, there is a high chance of false positives - the indicators suggest collusion is likely but in fact there is no cartel. To see why this could be the case, imagine the "ideal" market for collusion: two firms, homogeneous products, stable demand, no large buyers, excess capacity, and so forth. Even though such a market would surely be flagged by a structural investigative tool, my own prior belief is that a very high fraction of those markets are not cartelized. Based on what we know (which, admittedly, is only discovered cartels), the frequency of collusion in most economies is rather low. Hence, given a low prior probability of collusion, the posterior probability - conditional on all those structural variables taking values conducive to collusion - is still probably quite low. At the heart of this problem are omitted variables. There are multiple equilibria - some involving collusion, some not - and non-observed variables can influence whether firms settle upon a collusive equilibrium.

A structural approach is based on data about an industry which makes it more likely that a cartel *will form*. This is to be contrasted with a behavioral approach which uses data that is itself evidence that a cartel *has formed*. A *behavioral* approach focuses on the market impact of that coordination; suspicions may emanate from the pattern of firms' prices or quantities or some other aspect of market behavior. Buyers could become suspicious because of a parallel movement in prices or an inexplicable increase in prices. A sales representative for a colluding firm may become suspicious because she is instructed not to bid for the business of certain potential customers (as part of a customer allocation scheme) or not to offer reasonable price concessions when business might be lost to competitors. For example, the European Commission investigated the stainless steel industry (and found collusion) because buyers complained to the Commission about a sharp increase in prices.[8] Though we do not know the specifics of their complaints, reportedly the cartels in graphite electrodes[9] and thermal facsimile paper[10] were also begun because of buyer complaints.

The focus of this paper is on a behavioral approach to screening. In trying to detect a cartel, it is useful to think about two phases. To illustrate them, the price path for the citric acid cartel is reproduced from Connor (1998). The path labelled "contract" is a more accurate reporting of actual transaction prices. As one can see, the cartel significantly though gradually raised price starting in mid 1991 until late 1992 at which point price became somewhat flat over time until it started to fall with the cartel's collapse.

Figure 1: Citric Acid Cartel Price Path (Connor, 1998)

---

[8] "The industry was investigated for cartel activity after buyers complained to the European Commission about the rapid increase in prices." Graham Hind, "English Cutlers `Hit by Cartel'," *The Times* (London), August 21, 1994; cited in Levenstein, Suslow, and Oswald (2004).

[9] Ferromin International Trade Corporation, et. al. vs. UCAR, et. al., In the United States District Court for the Eastern District of Pennsylvania, Second amended complaint, filed May 1, 1999, at paragraph 50.

[10] John Clifford and Bill Rowley, "Tackling Cross-Border Conspiracy*," International Corporate Law*, May 1995.
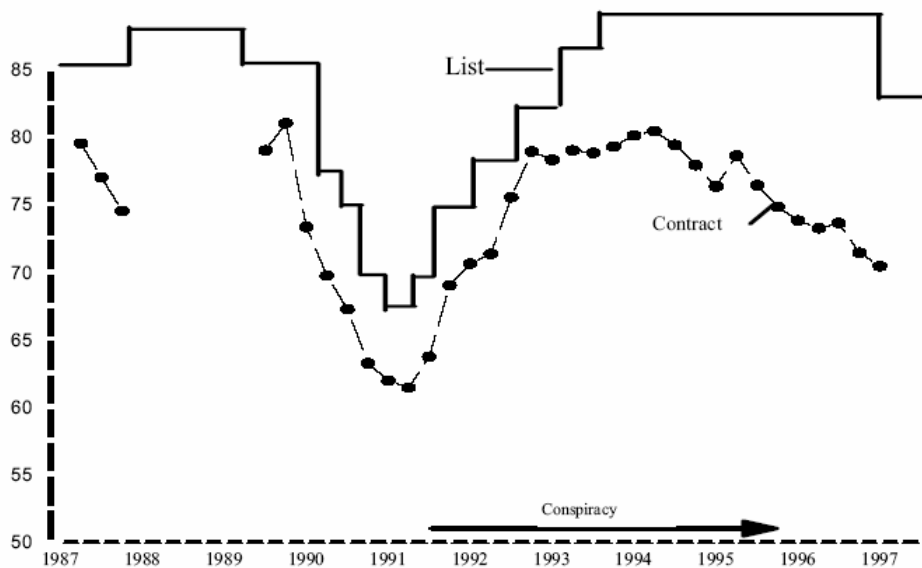
The only point I want to make here is that one could imagine screening methods designed to pick up the transition from non-collusion to collusion - looking for a radical change in firm behavior - or the stationary collusive phase - finding differences in behavior from when firms compete. Finding evidence of collusion is apt to be easiest during the transition and the method to do so is to find evidence of a structural break in the data-generating process, whether it is a firm's price, quantity, allocation of market shares, or some other relevant variables. With either approach, it is important to know what to look for; an issue I turn to in the next section.

C.   Collusive markers

To provide economic evidence of collusion, one needs to know what behavioral patterns are indicative of collusion. An important line of work is that which provides markers that serve to distinguish collusion from competition. In this section, I will review some of what theory and actual cartels have to offer. The discussion will focus on patterns in prices and quantities because a screening approach should be based on easily available data. While the theories might generate predictions consistent with some of the noted empirical evidence on cartels, I do not claim that those theories explain that evidence, nor that my discussion is comprehensive. My objective is simply to catalog a few tentative collusive markers based on theory and evidence.

Before embarking on this review, an important disclaimer is that evidence supporting collusion need not imply evidence against competition. When we find evidence of collusion, there is always the possibility that there actually is no collusion and the problem is we've misspecified the non-collusive model. Similarly, failure to find evidence of collusion may be due to misspecifying the collusive model; for example, we've focused on the wrong collusive equilibrium. At best, collusive markers can serve to screen industries to determine whether they are worthy of more intense investigation.

1.   Theory of collusion

The basic logic whereby collusion is sustainable as an equilibrium in a repeated game model is predicated upon rewards and punishments. A Nash equilibrium for the static game is one in which each firm's behavior (which is typically a price, a bid, or a quantity) is optimal given the (correctly anticipated) behavior of other firms. Firms collude for the purpose of raising price above the static Nash equilibrium (or non-collusive) level so as to yield higher profits. This necessarily means that a firm's behavior doesn't maximize current profit; a firm's collusive quantity is below that which maximizes current profit or its collusive price exceeds that which maximizes current profit. As cheating on the collusive outcome raises current profit, firms can only be deterred from doing so if they experience some punishment. This punishment is typically in the form of future foregone profits due to an intensification of competition. More specifically, if firms set the collusive price then they continue colluding but if a firm cheats then firms revert to some low-profit punishment path. This may mean going to the static Nash equilibrium for some length of time or an outcome with even lower profits (perhaps pricing below cost) or an asymmetric equilibrium which is particularly detrimental to the firm that deviated (perhaps requiring that the firm produce very little).

It follows from this argument that a firm which considers deviating from a collusive outcome realizes it would raise current profit but lower its future profit stream. The equilibrium condition requires that the foregone future profit stream is at least as great as the gain in current profit from deviating. When the punishment is reversion to the non-collusive outcome for T periods, the condition is of the form:

$$\delta\left(\pi^c - \pi^{nc}\right) + \delta^2\left(\pi^c - \pi^{nc}\right) + \cdots + \delta^T\left(\pi^c - \pi^{nc}\right) \ge \pi^d - \pi^c ,$$

where π^c, π^{nc}, and π^d is the collusive profit, non-collusive profit, and the (maximal) profit from deviating, respectively. $\delta \in (0,1)$ is the common discount factor across firms. In this simple case, the model is stationary and the solution is symmetric. Deviation yields higher current profit of $\pi^d - \pi^c$ but lower future profit of $\pi^c - \pi^{nc}$ over the next T periods (with firms returning to the collusive outcome thereafter). Equilibrium requires this condition to hold so that abiding by the collusive agreement is optimal for all firms. Since $\pi^c - \pi^{nc}$, this will hold when T is sufficiently high and δ is sufficiently close to one so that firms sufficiently value future profits.

2.   Price markers

A defining feature of collusion is obviously higher prices and, therefore, the most obvious marker is price increases. However, it is not necessarily a very effective one since price can rise for many reasons unrelated to collusion. What a number of European Commission cases suggest is that price increases occur simultaneously with more uniformity in price across customers.[11] Cartels often reduce the number of distinct prices charged to customers. For example, it is common to move from a regime characterized by a list price and a series of *ad hoc* negotiated discounts to

---

[11] Unless otherwise noted, references to actual cartels are based on Harrington (2006c).

either a non-negotiable price list (such as with the fine arts auction houses cartel) or an agreed-upon set of discounts to the list price (as with the citric acid cartel). This increased uniformity in price across customers could have been done for several reasons. It might have been done for simplicity; remember that collusion requires firms to discuss and agree to every price and this is a recurring situation. A second reason is that fewer prices may have made monitoring easier. With more customer-specific prices, it may become difficult to determine whether the price charged was appropriate given the market or customer type.

While in a competitive environment one could imagine a firm moving to an "everyday low price" by eliminating discounts, this seems to be done along with reducing, not raising, the list or regular price. This makes the combination of fewer discounts off of a list price along with a *higher* list price suggestive that firms are coordinating their behavior.

> **Collusive Marker:** A higher list (or regular) price and reduced variation in prices across customers.

It has also been documented that cartel formation is often preceded by large price declines which, in some cases, were due to weakening demand and/or excess capacity. Notable examples include carbonless paper, citric acid, commercial explosives, fine arts auction houses, graphite electrodes, plasterboard, seamless steel tubes, soda ash, and vitamins. Unless the market is characterized by some cyclical factors such as seasonal demand or supply movements, it would be unlikely for competition to result in significant price declines and then a steadily rising price over the span of a few years.

> **Collusive Marker:** A series of steady price increases is preceded by steep price declines.

A common feature to implementing a collusive allocation is the "home-market principle" whereby cartel members reduce supply in each other's home markets. The objective is to move to an arrangement where, ideally, each cartel member takes control of their home market and then share the global demand that was not part of any cartel member's home market. The home-market principle was associated with collusion in the markets for choline chloride, copper plumbing tubes, isostatic graphite, lysine, methionine, and seamless steel tubes. In a competitive market, one would expect a rise in a firm's price to result in more imports, *ceteris paribus*. However, an allocation scheme based on the home-market principle would result in the suspicious combination of a higher price and fewer imports.

> **Collusive Marker:** Price rises and imports decline.

The preceding markers pertain to movement in a firm's price. There are also markers that focus on the relationship among firms' prices. That parallel pricing behavior is a possible feature of collusion has long been noted. One problem with it as a marker is that non-colluding firms' prices will also tend to move together if they are responding to common demand shocks or highly correlated cost shocks (such as a change in a common input price). Still, it is possible that there is a stronger correlation in colluding firms' prices. It has also been pointed out that some bid rigging cartels have engaged in identical or near-identical bidding. This leads to a second problem which

is that it would appear easy for colluding firms to avoid the appearance of collusion by simply having the members of a bidding ring scale up competitive bids and thus make the relationship between their bids consistent with competition (and firms having different valuations or costs.). This would suggest that parallel pricing behavior may not be effective as a marker, at least in the auction setting.

Interestingly, it does not appear that bidding rings use such an easy detection-avoidance procedure (Bajari and Summers, 2002). One possible reason is due to constraints imposed by maintaining cartel stability. This possibility has been shown in Marshall and Marx (2004). The setting is a first-price sealed bid auction in which no *ex post* information is provided regarding the identity of the winning bidder and their bid (an assumption, however, that is not typically applicable). It is also assumed that the cartel is less than all-inclusive - some bidders are not members of the cartel. Suppose the cartel meets beforehand to decide on what each bidder should bid (and who should be the high bidder). The situation is one of imperfect monitoring; the cartel member who was designated to submit the highest bid cannot distinguish failing to win the item because a non-cartel member outbid it or another cartel member cheated and outbid it. In order to ensure that cartel members want to bid as prescribed, two cartel members' bids may need to be clustered.

Using the (truthful) reports of their valuations at the pre-auction meeting, the cartel selects the bidder with the highest report - let us refer to him as the cartel representative (at the auction) - to bid at a certain level with all other cartel members told to bid less. Absent concerns about cheating, the cartel representative would bid optimally in light of its valuation and the distribution on non-cartel members' bids. The problem, however, is that if it bids too low, another cartel member may cheat by outbidding the cartel representative's bid. To destroy that incentive to cheat, the cartel representative sets a higher bid so that the other cartel members don't want to outbid it and are content to set a lesser bid. But now suppose these other cartel members all set very low bids. The problem that emerges is that the cartel representative would have an incentive to bid lower since the only reason to bid so high was to discourage cheating. In order to keep that from happening, one of the other cartel members must set a bid a little below the cartel representative's bid; it'll keep the cartel representative from cheating without affecting whether the cartel representative wins. That bids are clustered in this way is unique to when bidders collude.

Collusive Marker: Firms' prices are strongly positively correlated.

Going beyond the auction setting, it is indeed a common feature of cartels that firms charge the same price. As mentioned, this could be quite consistent with competition. What makes one more suspicious that there is collusion is when uniformity extends to many other dimensions such as the prices of ancillary services. For example, in the industrial and medical gases cartel, the cartel not only set a common price for gas but also a common transport charge and a common rate for renting a gas cylinder. Failure to agree on any of these other charges could have undermined the cartel as firms could then price gas at the agreed-upon level but cheat by offering, say, free transport. Controlling other dimensions upon which firms can compete was also strikingly clear in the fine arts auction houses cartel. Christie's and Sotheby's didn't just agree to identical commission schedules but also with respect to at least six other contractual features.

Collusive Marker: A high degree of uniformity across firms in product price and other dimensions including the prices for ancillary services.

Properties relating to the variability of a firm's price may also indicate collusion. Two papers taking very different approaches show that prices can be less responsive to cost when firms collude. Athey, Bagwell, and Sanchirico (2004) argue that fixed prices may be part of an optimal collusive scheme. Consider a setting in which firms choose price and each firm's cost varies over time and across firms and is private information. In each period, colluding firms exchange messages about their costs and then choose price. In characterizing an optimal collusive mechanism, there is a tension between efficiency and the amount of collusion. Given firms have homogeneous products, the unconstrained joint profit-maximizing scheme is to have the firm with the lowest cost produce all output at its monopoly price. The problem is inducing firms to truthfully reveal their cost since a firm with high cost may want to signal it has low cost in order to be able to have a positive sales quota. When firms are sufficiently patient, the incentive to mislead is sufficiently great that the best collusive scheme is to have price and (equal) market shares fixed over time and thus messages between firms are made irrelevant. When firms are moderately patient, there is partially rigid pricing so the price function is a step function of cost in which case price is often unchanged but then experiences a large change. This also serves to distinguish collusion from competition.

The argument for stable prices in Harrington and Chen (2006) comes from the cartel wanting to avoid buyers detecting collusion because of suspicious price changes.[12] It is not assumed that buyers know how a cartel prices, nor are consciously looking for collusion, but rather that buyers become suspicious when the observed price series is sufficiently anomalous or inexplicable when compared to the history of prices. More specifically, buyers have beliefs on the current price change based on the history of price changes. When the realized price change is sufficiently unlikely in light of their beliefs, detection is said to occur. The cartel is aware of how its price path affects beliefs and thereby the probability of detection. Upon cartel formation, firms inherit the non-collusive price and buyers' beliefs which are predicated upon price changes when firms were not colluding. In a sense, detection occurs when buyers pick up the "break" in the pricing function associated with cartel formation. Ideally, a cartel would like to raise price fast and have it adjust quickly to cost shocks but it must temper any such price movements in light of the prospect of detection.

The optimal cartel price path is found to have a transition phase - in which price rises largely irrespective of cost - and a stationary phase - in which price is responsive to cost. A simulated price path is shown in Figure 2 where the dashed path is the non-collusive price path, which moves around because (constant) marginal cost follows a random walk (that is, unit cost in period t equals unit cost in period t-1 plus a random shock that is independently and identically distributed). Starting with cartel formation in period 40, the solid line is the cartel price path. (The non-collusive price path is provided after period 40 for purposes of comparison.) While price is sensitive to cost in the stationary phase, note that it is much less variable than the non-collusive price. Intuitively, though the cartel might want to raise price a lot in response to a series of large positive cost shocks, such a price series may be perceived as unlikely by buyers and thus induce suspicions. Therefore, the cartel doesn't respond commensurately to large cost shocks. Relative to non-collusive pricing, the impact of

---

[12] In most price-fixing cases, these are industrial buyers.

cost shocks on price is muted and takes a longer time to pass through. Thus, the variance of price is lower with collusion.

Figure 2: Simulated Cartel Price Path (Harrington and Chen, 2006)
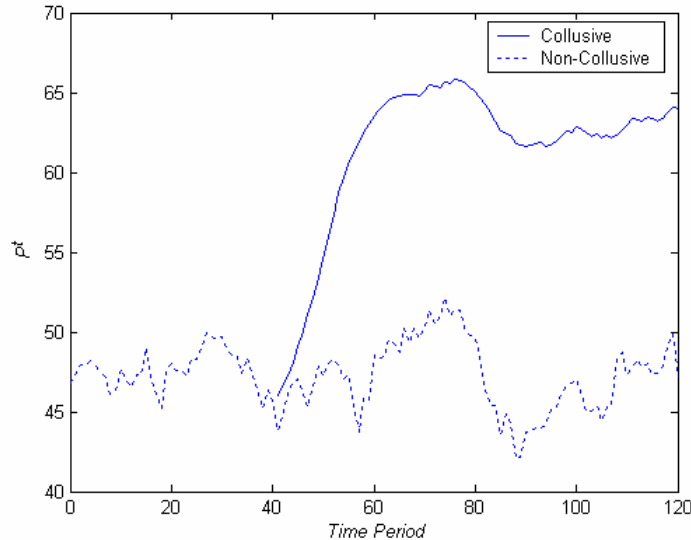
There is some limited evidence showing that price variance is indeed lower under collusion. Examining collusion at auctions of frozen perch, Abrantes-Metz, Froeb, Geweke, and Taylor (2005) find that the price variance during collusion is indeed distinctly lower then what is observed after the cartel was discovered (excluding the transition from collusion to non-collusion); see Figure 3 below. Mixed evidence is provided by Bolotova, Connor, and Miller (2005) who find a lower price variance under collusion for lysine but a higher price variance for citric acid.

Collusive Marker: Low price variance.

Another marker pertaining to price variability also serves as a caveat to the previous marker. Consider a setting in which collusion is imperfectly monitored (Green and Porter, 1984). In each period, firms choose quantities and then observe price. Price depends on firms' quantities and an unobserved demand shock. As a firm's quantity is never observed by other firms, a deviation cannot be directly observed. However, price is observed and, in expectation, a higher quantity results in a lower price. Of course, since price depends on an unobserved demand shock, a low price could be due to a low demand shock rather than some firm cheating by producing above their collusive quota. In this setting, a mechanism that will work to sustain collusion is one in which if the realized price is ever too low then firms switch to a punishment phase which is competitive behavior for T periods, after which they return to the collusive phase.[13] Equilibrium then entails stochastic regime switches where a one-time low demand shock triggers a movement from the collusive phase to the punishment phase - associated with it is a fall in the average price - and, after some length of time, there

---

[13] Alternatively, the punishment phase could be an intense price war for some stochastic length of time (Abreu, Pearce, and Stachetti, 1986).

is a regime switch back to the collusive phase - with a rise in the average price. One then observes abrupt changes in average price which cannot be explained by contemporaneous demand and cost movements.

Collusive Marker: Price is subject to regime switches.

3. Quantity markers

The markers relating to quantity show how collusion imposes intertermporal structure on market share. To establish this point, let us return to the price game when firms' costs are stochastic and private information. Cartel members can convey messages about their costs prior to setting price and quantity. As mentioned earlier, an optimal equilibrium can have firms keeping prices and market shares fixed so there are indeed stable market shares. This was mentioned for when cost shocks are independent across firms and over time but it also holds when firms' costs are persistent over time (Athey and Bagwell, 2004). More generally, firms settle on a collusive outcome with stable market shares when cost persistence is sufficiently high relative to firms' patience.

This result is due to the following logic. When cost persistence increases, it becomes more valuable to a firm to convince its fellow cartel members that it has low cost as it influences not only current beliefs (and potentially the current collusive output quotas) but also future beliefs on cost and thus can enhance a firm's future quota. Given this augmented incentive for a firm to report its cost is low (even when its cost is actually high), inducing truthful revelation either requires firms to be more patient - so they are content to wait for higher market share in the more distant future when they may truly have low cost - or to set lower prices (thus reducing the gain in current profit to a high cost firm from reporting it is low cost). When firms are not very patient, the preference is to forego efficiency in order to support higher collusive prices, which means market shares do not respond to cost shocks.

A number of cartels chose to freeze market shares at their pre-cartel levels which can produce stability in actual market shares. The previous year's market shares were used in the cartels for copper plumbing tubes, organic peroxides, and several vitamins (A, E, and folic acid, in particular), while the average of several years were used in the cartels for citric acid, sorbates, and zinc phosphate.

Collusive Marker: Market shares are highly stable over time.

Market share stability may only be observed when one uses the right measure. If the cartel is not all-inclusive then a cartel member's market share may fluctuate because non-cartel supply is changing (often increasing due to the high prices of cartel members) but, at the same time, it's share of cartel supply is stable. Then there are cases like the sorbates cartel. Collusion occurred in the European market and was comprised of one European company, Hoechst, and four Japanese producers: Chisso, Daicel, Nippon, and Ueno. At the general cartel meeting, sales were allocated between Hoechst and the Japanese producers as a group. The four Japanese producers would then meet and allocate their collective quota amongst themselves. From 1979 to 1994, the allocated market share of Hoechst had little variation as it ranged from 51

to 53%. Even more striking, each Japanese company's allocated share of *Japanese* supply never varied over those 15 years.[14]

> **Collusive Marker:** There is a subset of firms for which each firm's share of total supply for that subset of firms is highly stable over time.

Returning to the previous theoretical model, when instead patience is high relative to persistence, the best collusive equilibrium may have market shares moving over time as firms achieve a more efficient mechanism in which a firm with lower cost has a higher market share (Athey and Bagwell, 2001, 2004). This is shown in a simple situation where cost is high or low. The way the mechanism works is to engage in intertemporal market share favors. A firm that announces low cost and receives a high market share in the current period can expect a lower market share in the next period. This induces the firm to truthfully reveal. For if it is high cost and announces low cost, it sacrifices future market share when indeed it might truly be low cost. (Note that market share is especially valuable to a firm when it has low cost.) Thus, market shares are predicted to change over time (with firms' costs) and, furthermore, a firm's market share is negatively correlated over time. In the absence of collusion, market share would vary over time but would not be negatively correlated.

Similar results of intertemporal market sharing arise in models of repeated auctions which, contrary to the preceding model, do not allow messages to be sent and assume prices are private information. The solution is a history-dependent bid rotation scheme; the probability of winning is decreasing in the frequency with which a bidder has won in the past. Thus, firms are favored who have tended to lose recent auctions (Blume and Heidhues, 2003; Skrzypacz and Hopenhayn, 2004). In a non-auction setting, this may take the form of cartel members engaging in a buy-back scheme whereby firms that sold over its quota have to buy output from firms that sold under their quota. For example, in the lysine cartel, Haarman & Reimer was required to buy 7,000 tons from Archer Daniels Midland for exactly this reason. The attractiveness to punishing with a buy-back scheme rather than a price war is established in Harrington and Skrzypacz (2005) and was used in several recent price-fixing cartels including citric acid and vitamins A and E as well as lysine.

> **Collusive Marker:** A firm's market share is negatively correlated over time.

D.   Screening in action

In this section I would like to illustrate how screening might operate. Let me first consider applying screening to the stationary phase. In examining collusion at auctions of frozen perch, Abrantes-Metz et al (2005) find that the price variance was much lower during the cartel regime compared to the post-cartel phase (excluding the transition from collusion to non-collusion). This is shown in Figure 3 which is reproduced from their paper. The cartel price path (which occurs over 1/6/87-7/9/88) is less sensitive to cost than the (post-transition) non-collusive price path (which occurs over 9/20/88-9/26/89). In practice, a screen could monitor the price variance and assess whether it is low relative to some benchmark.

---

[14] Data was not available to determine whether actual market shares had the intended stability.

In fact, this research was done with the objective of developing a screen in terms of the price variance. Furthermore, one of the co-authors - Luke Froeb - was, at the time, Director of the Bureau of Economics at the U. S. Federal Trade Commission. Dr. Froeb is not the only FTC official to explore the prospect of screening. Former Director Jonathan Baker used price increases after an industry-specific trough in demand to identify the exercise of market power and did so with some success (*FTC History*, 2003, pp. 108-110).

Figure 3: Collusion and the Variance of Price (Abrantes-Metz et al, 2005)

Frozen Perch Prices and Costs: 1/6/87 - 9/26/89
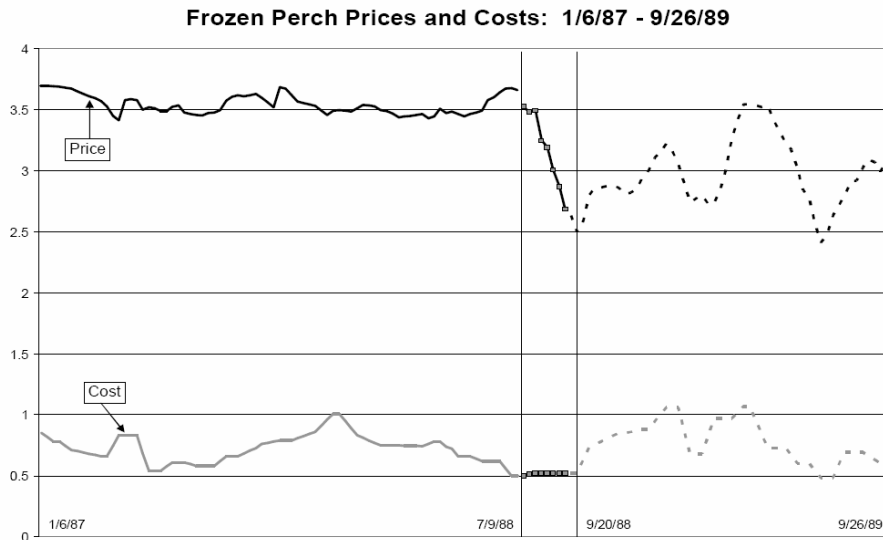
An alternative approach is to identify the transition from non-collusion to collusion or from collusion to non-collusion (as in the case in Figure 3). Cartel formation necessarily entails a change in the price-generating process - and possibly in the market share-generating process - or otherwise it wouldn't be profitable. Furthermore, the change could be abrupt and thereby detectable. Has average price changed? Has the relationship between a firm's price and cost changed? Has the relationship among firms' prices changed? Has the variance of price and market share changed?

To argue the implementability of a screen based on finding a structural break, consider the recent episode of collusion in some Nasdaq security markets. In those markets, collusion took the form of avoiding the quoting of odd-eighths so that a market maker would post a bid price of, say, $10 or 10 1/4 but not 10 1/8. This resulted in a minimum bid-ask spread of 1/4. Figure 4 (which is based on a figure from Christie and Schultz, 1999) shows that there is a sharp change in the dollar spread - which effectively measures the price-cost margin - surrounding the switch from quoting all eighths to largely avoiding odd-eighths. Screening for a structural change in the spread-generating process would have probably picked up the advent of collusion.

Figure 4: Collusion and Bid-Ask Spreads (Christie and Schultz, 1999)
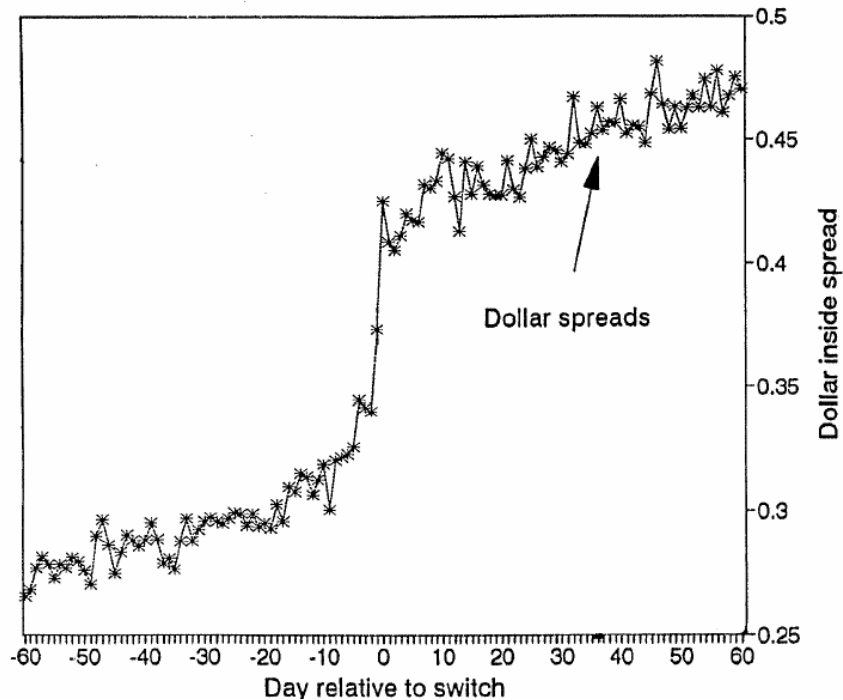
E.   Screening and leniency programs

In light of the impact of leniency programs in the US, E.U. and elsewhere, one possible reaction to a proposal to actively screen for cartels is that it isn't really necessary given that they are being discovered through leniency programs. In response, I want to make two points. First, it is an open question - at least to me - as to how effective leniency programs have been in discovering cartels. I am convinced by their role in prosecution as the evidence is much stronger when it is provided by one of the cartel members. And there clearly are cases, some which I mention below, in which a leniency program was responsible for the discovery of a heretofore unknown cartel. Still, the extent to which leniency programs adequately discover cartels remains an open question. The second point I intend to make is that the presence of an active leniency program makes the case for screening more, not less, compelling because they are complements.

In assessing the impact of leniency programs, the evidence is rather solid that they make a difference. The redesign of the US program in 1993 and the redesign of the E.U.'s program in 2002 were both followed by a very large increase in leniency applications. Of course, one cannot draw inferences about discovery from leniency applications. Even if leniency was awarded prior to an investigation, this is not to say that there was not some knowledge or suspicion about a cartel operating. Indeed, a cursory review of the evidence can be quite misleading, as evidenced by the sorbates cartel case. Chisso received amnesty (under Section A) from the European Commission and paid no fines. In its decision, the European Commission stated:

> "On 29 September 1998, Chisso informed the Commission about the sorbates cartel in which it participated. At that time, the Commission had not undertaken an investigation, ordered by decision, of the enterprises involved, and did not have any information to establish the existence of the alleged cartel."

[Commission of the European Communities, Commission Decision of 1.10.2003 (Case COMP/E-1/37.370 - Sorbates) - paragraph 426]

Before one concludes that the leniency program can be credited with detection, let us travel across the Atlantic. Literally the day after Chisso came forward to the European Commission, the U. S. Department of Justice announced that one of the manufacturers of sorbates had agreed to plead guilty to engaging in a global cartel.[15] The E.U. leniency program was not responsible for the discovery of the European sorbates cartel.

The point of this example is not to argue that leniency programs do not discover cartels but only that there is some misinformation about the role of leniency programs in the discovery process. To pursue this matter a bit more rigorously, let us consider the incentives to use the leniency program. Consider a cartel that formed after the advent of a leniency program and has been operating effectively, such as the dRAM cartel. The question is: What will now induce one of the cartel members to come forward and apply for leniency? What has caused it to forsake collusive profit and knowingly suffer at least some penalties?[16] There must have been some change somewhere to cause a firm to stop colluding and apply for leniency. Let us consider what some of those changes might have been.

The most obvious change is that information about collusion has leaked out and this has raised the prospects of prosecution. However, the focus here is on conditions that induce spontaneous reporting - a firm applies for leniency when there is no knowledge about collusion. One possibility is that there is a change in management and the new management disagrees with the corporate strategy of price-fixing.[17] An example is the monochloroacetic acid cartel. Upon acquiring the Hoechst chemicals business, the management of Clariant discovered that the business was engaging in collusion. The new management chose to inform the European and American authorities and apply for leniency.[18] A second source of change that might induce a firm to come forward is the steady accumulation of penalties. It is possible that penalties might reach a level that a firm prefers to come forward rather than risk having to pay them. That choice becomes even more compelling if collusion has actually collapsed since applying for leniency does not reduce future profits; non-collusive profits will be earned whether or not a firm applies for leniency.

The US has capitalized on an accentuated chance of discovery to induce spontaneous reporting. The context is one in which a firm has been caught colluding in one market and the issue is whether they choose to reveal information about collusion in other markets for which there is currently no evidence. Cartels have been discovered this way through the Omnibus Question and, in conjunction, the Amnesty Plus and Penalty Plus programs. A firm that is currently being prosecuted can, under the Amnesty Plus program, receive full amnesty by reporting collusion in separate markets and receive reduced penalties in the markets for which it is already being prosecuted. Furthermore, if they do not report this other collusion and it is ultimately

---

[15] U. S. Department of Justice, "Eastman Chemical Company Agrees to Plead Guilty to Price Fixing Charges and Pay $11 Million Criminal Fine." Press Release. September 30, 1998.

[16] Until there are rewards, leniency cannot ever truly be full. This is obviously the case in the US as a firm is still liable for single customer damages, but it is true more broadly as the employees involved in the conspiracy are likely to suffer some punishment by the company and those penalties are not waived.

[17] A career concerns perspective is that the new management finds this hidden liability of the previous management - the penalties that would have to be paid if caught - and wants to ensure that this liability is not attributed to them.

[18] "The Week: June 12, 2002," *Chemical Week*, 6/12/2002, Vol. 164, Issue 24.

found, the Penalty Plus program enhances the severity of penalties. The incentives to apply for leniency are stronger because: i) given that the firm is currently being prosecuted for collusion, it is reasonable to attach higher probability that its collusion in these other markets will ultimately be discovered; and ii) the expected penalty is larger for not coming forward.

Information about collusion in other markets can come out during the Omnibus Question phase. At the conclusion of a witness interview under the leniency program, the U. S. Department of Justice asks: "Do you have any information whatsoever, direct or indirect, relating to price-fixing, bid rigging, etc. with respect to other products in this industry or in any other industry?" Failure to answer the question truthfully means a loss of amnesty and possible prosecution for perjury. I believe the power of the Omnibus Question rests largely with the incentives it creates for the individual manager rather than the corporation. Though revealing the company is colluding in some other markets may cause additional financial harm to the company (though, as argued above, the Amnesty Plus and Penalty Plus may actually mean the firm is benefited), this employee is apt to be more concerned with jeopardizing the amnesty they've received from prison sentences and individual fines. Having already revealed their part in collusion, I suspect there is a strong incentive to avoid perjury and tell all to the authorities. The Omnibus Question can be a meaningful tool for cartel detection.

There have clearly been cases discovered through these programs and the Omnibus Question. (A clear documentation of how many would be useful.) That a leniency program can use one cartel prosecution to spur the discovery of other cartels is exemplified with this sequence of events:[19]

> "[...] the investigation and prosecution of the international citric acid cartel led to the investigation and prosecution of the international sodium gluconate cartel, which resulted in the investigation and prosecution of the international sodium erythorbate cartel, which, in turn, led to the investigation and prosecution of the maltol cartel."

As just argued, there are cases in which it is reasonable to conclude that a leniency program discovered previously unknown cartels. Nevertheless, it is an open question regarding to what extent leniency programs take advantage of some knowledge or suspicion about collusion - inducing cartel members to come forward due to the heightened concern about prosecution because of that knowledge or suspicion - and to what extent they cause spontaneous reporting and thereby truly detect cartels. I am unconvinced that leniency programs in and of themselves are sufficiently effective in discovering cartels that we ought to forsake other avenues. That statement is sufficiently weak that most people will agree with it. My proposal is to take it seriously by suggesting we pursue screening.

The most compelling reason for working towards the creation of a screening program at this time is that its efficacy has been enhanced by the presence of an effective leniency program. A firm is more apt to stop colluding and come forward and apply for leniency when the chances of prosecution are greater. An antitrust authority that identifies an industry for further scrutiny through some form of screening and conveys these suspicions to the suspected firms could well induce one

---

[19] Deputy Assistant Attorney General Scott Hammond (Criminal Enforcement, Antitrust Division, US Department of Justice), "Cornerstones of an Effective Leniency Program", ICN Workshop on Leniency Programs, Sydney, Australia, November 22-23, 2004.

or more cartel members to come forward and apply leniency. Hence, the development of a leniency program makes the case for screening more compelling.

In a recent speech, Deputy Assistant Attorney General Scott Hammond claimed:[20] "You can't catch a thief with an economist." That may well be true. But with an active screening program, you may be able to *scare* a thief with an economist and that could be enough to induce them to report their crimes.

References

Abrantes-Metz R., Froeb L, Geweke J. and Taylor C. (2005): *A Variance Screen for Collusion*, FTC Bureau of Economics Working Paper No. 275.

Abreu D., Pearce D. and Stacchetti E. (1986): "Optimal Cartel Equilibria with Imperfect Monitoring", 39 *Journal of Economic Theory* 251.

Athey S. and Bagwell K. (2004): *Collusion with Persistent Cost Shocks*, Standford and Columbia Universities (unpublished).

Athey S. and Bagwell K. (2001): "Optimal Collusion with Private Information", 32 *RAND Journal of Economics* 428.

Athey S., Bagwell K. and Sanchirico C. (2004): "Collusion and Price Rigidity", 71 *Review of Economic Studies* 317.

Bajari P. and Summers G. (2002): "Detecting Collusion in Procurement Auctions", 70 *Antitrust Law Journal* 143.

Bolotova Y., Connor J. and Miller D. (2005): *The Impact of Collusion on Price Behavior: Empirical Results from Two Recent Cases*, Department of Agricultural Economics, Purdue University.

Blume A. and Heidhues P. (2003): *Modeling Tacit Collusion in Auctions*, University of Pittsburgh and WZB, Berlin.

Christie W. and Schultz P. (1999): "The Initiation and Withdrawal of Odd-Eighth Quotes Among Nasdaq Stocks: An Empirical Analysis", 71 *Journal of Financial Economics* 317.

Clark E., Hughest M. and Wirth D. (2004): "Analysis of Economics Models for the Calculation of Damages", in Ashurst's *Study on the Conditions of Claims for Damages in Case of Infringement of EC Competition Rules*, DG Competition, European Commission, Brussels, text available at http://ec.europa.eu/comm/competition/antitrust/others/actions_for_damages/economic_clean_en.pdf#search=%22Analysis%20of%20Economics%20Models%20for%20the%20Calculation%20of%20Damages%22%22.

Connor J. (1998): *What Can We Learn from the ADM Global Price Conspiracies?* Purdue University, Department of Agricultural Economics, Staff Paper #98-14.

FTC History: Bureau of Economics Contributions to Law Enforcement, Reseach, and Economic Knowledge and Policy (2003), Transcript of a Roundtable with Former Directors of the Bureau of Economics, http://www.ftc.gov/be/workshops/directorsconference/index.htm.

---

[20] "Ten Strategies for Winning the Fight Against Hardcore Cartels", OECD Competition Committee, Paris, France, October 18, 2005.

Grout P. and Sonderegger P. (2005): *Predicting Cartels*, Office of Fair Trading, Economic discussion paper of March 2005, text available at http://www.oft.gov.uk.

Harrington J. (2006a): "Detecting Cartels," in Buccirossi P., ed., *Handbook in Antitrust Economics*, MIT Press, Massachussets.

Harrington J. (2006b): *Corporate Leniency Programs and the Role of the Antitrust Authority in Detecting Collusion*, Johns Hopkins University, (commissioned for a symposium entitled "Towards an Effective Implementation of New Competition Policy," organized by the Competition Policy Research Center of the Fair Trade Commission of Japan).

Harrington J. (2006c): *How Do Cartels Operate?,* Johns Hopkins University, Boston, Maryland.

Harrington J. and Chen J. (2006): "Cartel Pricing Dynamics with Cost Variability and Endogenous Buyer Detection", 21 *International Journal of Industrial Organization* 347.

Harrington J. and Skrzypacz A. (2006): "Collusion with Monitoring of Sales," forthcoming in *RAND Journal of Economics*.

Levenstein M., Suslow V. and Oswald L. (2004): "Contemporary International Cartels and Developing Countries: Economic Effects and Implications for Competition Policy", 71 *Antitrust Law Journal* 801.

Marshall R. and Marx L. (2005): *Bidder Collusion,* Penn State University (mimeo).

Motta M. (2004): *Competition Policy: Theory and Practice*, Cambridge University Press, Cambridge.

Porter R. (2005): "Detecting Collusion", 26 *Review of Industrial Organization* 147.

Porter R. and Zona J. (1999): "Ohio School Milk Markets: An Analysis of Bidding", 30 *RAND Journal of Economics* 263.

Skrzypacz A. and Hopenhayn A. (2004): "Tacit Collusion in Repeated Auctions", 114 *Journal of Economic Theory* 153.

Symeonidis G. (2003): "In Which Industries is Collusion More Likely? Evidence from the UK", 48 *Journal of Industrial Economics* 1.

Werden G. (2004): "Economic Evidence on the Existence of Collusion: Reconciling Antitrust Law with Oligopoly Theory", 71 *Antitrust Law Journal* 719.