Monopolization Conduct by Cartels*

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Abstract

Collusion enhances profits of cartel firms, but collusive profits are reduced by the presence of rival firms outside a cartel. We construct a model in which a firm that was not invited to join, or that chose to remain outside the cartel, can potentially be eliminated through monopolization conduct by the cartel. This conduct increases profits for cartel members due to both the diminished competition and the decreased potential for secret deviations by cartel firms. Because of this latter effect, incentives for monopolization conduct are stronger for cartels that have not fully suppressed within-cartel rivalry relative to those that have. We find empirical support for our theoretical predictions in a sample of cartels prosecuted by the European Commission.

Keywords: antitrust, collusion, dominant-firm conduct, plus factors, price fixing
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1 Introduction

Colluding firms aim to suppress within-cartel rivalry and thereby to elevate prices and profits relative to the absence of explicit collusion. In order to successfully suppress rivalry among members, a cartel has several problems to solve, one of which is monitoring the conduct of members to prevent cheating on the cartel's agreement. Antitrust policy exists to encumber cartel formation and conduct so that market participants can be assured that competitive forces are able to police prices and promote efficient outcomes.

Cartels may look for additional sources of profits beyond those achieved through the suppression of rivalry among cartel members. In particular, a cartel may have the incentive and ability to act like a dominant firm by engaging in monopolization conduct. Posner (2001) noted that exclusionary practices by a cartel can be a plus factor, thus recognizing the possibility of monopolization conduct by a cartel. Kovacic et al. (2011) argue that the observation of monopolization conduct by a subset of firms where no individual firm has the market power to act as a dominant firm, but where collectively the firms do have sufficient market power, provides a strong inference of collusion and so is a super plus factor. Monopolization conduct by cartels includes, among other things, exclusive dealing provisions that enable a cartel to exclude noncartel rivals,[1] targeting the suppliers or customers of noncartel rivals, harm to potential entrants or substitutes, and outright purchases of noncartel rivals. The analysis of Heeb et al. (2009) indicates that such conduct by cartels is not uncommon. For example, cartel firms might restrict access to a critical input or target the customers of noncartel firms, with the cost of taking these actions spread among the cartel members. Indeed, cartels in vitamins, steel, nitrogen, and explosives distributed such costs among their members according to their market shares.[2] The effects of such costs on cartel formation are

[1]On the use of exclusive dealing by a firm to monopolize a market, see, e.g., Aghion and Bolton (1987), Mathewson and Winter (1987), and Rasmusen, Ramseyer, and Wiley (1991). See also Schwartz (1987), Besanko and Perry (1993), O'Brien and Shaffer (1997), Bernheim and Whinston (1998), and Segal and Whinston (2000).

[2]As described in the European Commission (EC) decision in *Vitamins* (see the Appendix for the full citations for cited EC decisions), the cost of activities targeting the noncartel firm Coors were shared among the cartel firms according to their market share allocations: "In 1993 the parties [Roche and BASF] realised that a U.S. producer [of vitamin B2], Coors, had a larger production capacity for vitamin B2 than they had estimated in 1991. In order to prevent Coors from disrupting their arrangements by the export of its production surplus, Roche and BASF agreed that the former would contract to purchase 155 tonnes of vitamin B2 (representing half of Coor's capacity) in 1993. BASF in turn would purchase 43 tonnes from Roche: the burden was thus to be shared in the same 62:38 proportion as their quotas" (*Vitamins*, paragraph 287).

In steel, Article XX of the International Merchant Bar Agreement of 1933 states: "The Management Committee shall, whenever it deems necessary, call upon groups for contributions proportional to their quotas, to provide for or participate in the general expenses or other funds disbursed in the common interest" (Hexner, 1943, p. 317).

As described in Stocking and Watkins (1991, p. 160), the International Nitrogen Cartel collected payments studied by Ganslandt, Persson, and Vasconcelos (2012).

Going back to Stigler (1964), the literature recognizes that cartels may face challenges with the suppression of rivalry. For a more recent treatment, see Bernheim and Madsen (2017). We hypothesize that cartels that struggle to suppress within-cartel rivalry are unlikely to have the unity of purpose and market power necessary to engage in monopolization conduct. However, successful cartels may indeed have that ability. Heeb et al. (2009), offer the conjecture that "once a cartel controls intra-cartel rivalry, it moves on to implement practices designed to diminish competition from existing and potential non-cartel rivals" (p. 223). We provide a theoretical foundation for this hypothesis. Namely, we develop a model that provides a connection between a cartel's success with the suppression within-cartel rivalry and a cartel's predatory conduct against noncartel firms. Part of the usefulness of the model is that it provides insights regarding the kinds of cartels that would produce the greatest social harm from monopolization conduct.

We model collusive behavior in an oligopoly in the spirit of Green and Porter (1984). Several of the firms, which we view as having a sustained historical presence in the market, can form a cartel, and if they do, then they can invite an outside firm to join the cartel. If invited, the outside firm decides whether or not to join. As in Green and Porter (1984), firms engaged in collusion cannot necessarily disentangle random shocks to demand from deviations by co-conspirators, in which case equilibrium behavior is characterized by periods of cooperation and periods of punishment during which firms play according to the static Nash equilibrium. We consider the possibility of monopolization conduct directed at driving noncartel firms from the market, although an interesting question remains of how to think about a cartel's decision whether to "discipline" noncartel firms rather than drive them from the market.

In our model, the incentive and ability for a cartel to engage in monopolization conduct depends on whether the cartel has instituted the collusive structures necessary to overcome the incentive identified by Stigler (1964) for secret deviations by cartel members from a collusive agreement. (For an overview of factors affecting cartel success, see Levenstein and Suslow (2006).) We focus in particular on collusive structures that facilitate the monitoring of cartel firm conduct and that thereby contribute to the cartel's ability to successfully suppress within-cartel rivalry. Within the context of our model, we consider three possibilities for the success of the collusive structures. We define a *concordant* cartel to be one that can always disentangle random shocks to demand from deviations by cartel members. A *semiconcordant*

from its members in proportion to their sales to compensate Belgian producers for restricting their output. Also described in Stocking and Watkins (1991, p. 447), DuPont and ICI contributed in proportion to their shares in the cooperative arrangement Explosives Industries, Ltd. to the compensation made to Westfalische-Anhaltische Sprengstoff A. G. (Coswig) for restricting its exports.

cartel can only disentangle random shocks to demand from deviations by cartel members when there are no firms outside the cartel. A *discordant* cartel can never disentangle the two. The ability of a cartel to monitor the conduct of cartel firms more effectively than that of noncartel firms is consistent with, for example, the conduct in the cartel in Electrical and Mechanical Carbon and Graphite Products (EMCGP), where the cartel used a pricing formula referred to as "bareme pricing" that facilitated the monitoring of cartel firms' prices, but not the prices of noncartel firms (EC Decision in *EMCGP*, section 7.1). In addition, there are multiple examples of cartels engaging a third-party facilitator to perform audits on cartel firms, which would obviously facilitate within-cartel monitoring while not directly helping with the monitoring of noncartel firms.[3]

In this environment, we consider the incentive for a cartel to engage in monopolization conduct that eliminates an outside firm from the market. The understanding of this incentive is particularly relevant given evidence of such conduct. For example, the cartel in Citric Acid developed what it referred to as its "Serbia list," which was a list of noncartel Chinese producers whose customers the cartel targeted for reduced pricing.[4] From the Vitamins Cartel, we have the following example:

> By increasing the prices of the vitamins used in pre-mixes, [cartel firms BASF and Roche] would put a price squeeze on [noncartel firms referred to as pre-mixers], and over time drive the smaller pre-mixers from the market (EC Decision in *Vitamins*, para 322).

And from the cartel in EMCGP, we have records of a "discussion among cartel members on how best to act against [noncartel firm] EKL" (EC Decision in *EMCGP*, para. 157). In that case, "Two strategies were agreed: First, none of the members of the cartel would supply any graphite to EKL. Secondly, EKL would be denied any market share by systematically

[3]The cartel in Organic Peroxides employed the consulting firm AC Treuhand to provide, among other things, "organised the auditing of the data submitted by the parties" (EC Decision in *Organic Peroxides*, para. 92(n)). AC Treuhand (or its predecessor firm Fides) has been found to have been similarly involved in other cartels, including Cartonboard, Fatty Acids, Heat Stabilisers, Monochloroacetic Acid (see EC Decision file properties), Polyethylene, Polypropylene, PVC, and Woodpulp (see the EC Decisions under these cartel names).

[4]For additional detail from the Citric Acid Cartel: "Under cover of their ECAMA [trade association] membership, the undertakings composing the cartel studied the possibility of causing an anti-dumping proceeding to be initiated against the Chinese importers by the European Commission. ... The increasing availability of Chinese production in the European market and the need for a more forceful stance by the cartel members to maintain their level of sales in the light of this were subjects of discussion at the meeting. Participants 'accepted that there would have to be a price war against the competition from China' and that they had to 'try and regain particular accounts [lost to the Chinese producers] at whatever price was necessary with the blessing of the others.'" (EC Decision in *Citric Acid*, paras 116 and 119)

undercutting it with all customers, so that it would not be able to sell anywhere" (EC Decision in *EMCGP*, para 157).[5] Also from EMCGP:

> Another way in which cartel members tried to ensure that the price levels which they had agreed could be maintained in practice in the marketplace was by exchanging information on and jointly acting against competitors. ... The main strategies in this respect were: ... To drive competitors out of business in a coordinated fashion or at least teach them a serious lesson not to cross the cartel ..." (EC Decision in *EMCGP*, para 167).

We show that concordant cartels have a greater incentive to engage in monopolization conduct than discordant cartels. The benefit to a concordant cartel from eliminating the outside firm is twofold. First, the cartel eliminates competition from the outside firm, and, second, the cartel eliminates the equilibrium path punishment periods that come from the monitoring difficulties associated with there being a firm outside the cartel. However, it is also shown that the benefits to monopolization conduct to a semiconcordant cartel are even greater than for a concordant cartel because the monitoring difficulties associated with there being a firm outside the cartel are more severe for a semiconcordant cartel than for a concordant one.

To explore the empirical relevance of our theoretical model, we review a sample of 47 European Commission (EC) cartel case decisions for whether there is evidence consistent with discordance related to the suppression of rivalry and for whether there is evidence consistent with monopolization conduct.[6] While the empirical evidence comes with a number of caveats, it is consistent with the implication of the model that cartels with discordance are less likely to engage in monopolization conduct than other cartels. One caveat is that although monopolization conduct appears with some regularity in EC decisions, monopolization is not the primary focus of these decisions, which are meant to establish an agreement to suppress rivalry. Thus, there is no guarantee that monopolization conduct would be mentioned in a decision even in a case where it occurred. Another caveat is that the assessment of whether there is evidence consistent with discordance is subjective and affected by which details the EC included in a particular decision. Notwithstanding these caveats, we believe that the empirical exercise adds value as it provides empirical validation for the theoretical results. Although the theoretical model distinguishes three categories of cartel based on concordancy, we did not feel that we could reliable distinguish concordant from semiconcordant

[5] The noncartel firm EKL was eventually taken over by cartel firm SGL (EC Decision in *EMCGP*, para. 157).

[6] See Appendix A.1 for the citations for the cases in the sample.

cartels based on the material typically available in EC decisions. Therefore, we categorize cartels simply as showing evidence consistent with discordance or not. We do this by examining cartel decisions for evidence of frequent bargaining problems or of ongoing issues with deviations throughout the cartel period. Based on our classification, we find that few cartels with evidence of discordance engaged in predatory actions against noncartel firms; however, many ot the other cartels engaged in such conduct. This evidence is consistent with our theoretical result that discordant cartels do not engage in predatory conduct, but semiconcordant and concordant cartels do if the costs of undertaking such actions are not too large.

The result that semiconcordant and concordant cartels engage in monopolization conduct is important for multiple reasons. First, the result indicates that the social harm associated with cartels extends beyond the suppression of competition among cartel members because semiconcordant and concordant cartels may further damage the competitive process through monopolization conduct.[7] Second, public enforcement authorities tend to treat Article 81 of the European Community Treaty cases (analogously Sherman Act Section 1 cases) as separate and distinct from Article 82 of the European Community Treaty cases (analogously Sherman Act Section 2 cases). But, in light of our finding, cartel cases can potentially provide insight into monopolization cases. The discovery record from a cartel case may contain descriptions of the cartel firms' deliberations with respect to potential monopolization conduct that provide guidance to competition authorities concerned about monopolization conduct. Third, if antitrust policy or enforcement actions can be taken that lead to cartel discordance, even though the cartel may still function, then an incremental social harm may be mitigated because monopolization conduct by the cartel may be prevented. However, there is a caution here: predatory conduct is not monotonic in concordancy. Specifically, a semiconcordant cartel will engage in monopolization conduct more frequently than a concordant cartel. Thus, antitrust actions that move a concordant cartel only to semiconcordancy can lead to increases in monopolization conduct.

There is a related literature that addresses cartel "stability," meaning that firms inside the cartel do not find it desirable to exit and firms outside the cartel do not find it desirable to enter. Among these papers are Donsimoni (1985), Donsimoni, Economides, and Polemarchakis (1986), Diamantoudi (2005), and Bos and Harrington (2010). In particular, Bos and Harrington (2010) endogenize the cartel formation process, showing that smaller firms are more likely to remain outside the cartel with colluding firms setting a price that

[7]The social harm associated with a concordant cartel in one industry may be less than the social harm associated with a discordant cartel in another industry. In a similar vein, a cartel in an industry with a set of fringe competitors may produce much larger social harm than a cartel in another industry without a set of fringe competitors.

serves as an umbrella with noncartel firms pricing below it and producing at capacity. Their main finding is that a small firm finds it optimal not to join any stable cartel when its capacity is sufficiently low. Levenstein and Suslow (2004) use “stability” to indicate a lack of cheating/deviations by cartel members, which is similar to our notion of concordance. They examine cross-sectional studies of cartels and describe the stylized facts on cartel stability/concordance, duration, and profitability based on that literature.

Our paper is also related to studies on joint predation. Calcagno and Giardino-Karlinger (2019) study collusion between vertically integrated firms using exclusionary contracts and show that joint exclusion is profitable. Closer to our paper is Argenton (2019), which provides a theory of joint predation under perfect information and finds that in a three-firm industry, two firms can induce the exit of a third firm by jointly engaging in predatory pricing. Joint predation arises in equilibrium because the two firms can commit to lower prices after the third firm exits, whereas it is not credible for a monopoly not to raise the price following the exit.

The paper proceeds as follows. In Section 2, we describe the model and the results. In Section 3, we examine empirical evidence for our theoretical results as captured in EC decisions. In Section 4, we offer concluding comments.

2 Model

In this section, we propose a model based on Green and Porter (1984).[8] We assume homogeneous products, demand that is subject to random shocks, and trigger-strategy equilibria characterized by periods of cooperation and periods of punishment, during which firms revert to the static Nash equilibrium. We assume that colluding firms agree on the equilibrium of this type that maximizes the total payoff to the cartel firms. In contrast to Green and Porter (1984), we focus on the case of price competition.

In our model, there are three firms with unlimited capacity and common constant marginal cost of c. Firm 1 and 2 are in a cartel and firm 3 is, at least initially, outside the cartel. Firm i has share s_i in the static Nash equilibrium, where we view firm 1 as the “large” firm in the industry with $s_1 > s_2, s_3$ and $\sum_{i=1}^{3} s_i = 1$.[9] The firms first engage in a

[8]See Tirole (1989, Chapter 6.7.1) for a private monitoring interpretation of Green and Porter (1984).

[9]The EC decisions indicate that firms with relatively large pre-cartel market shares typically join the cartel, whereas the outsiders, if there are any, are the firms with relatively small pre-cartel market shares. For example, the top-two world producers of specialty graphite products, SGL and LCL, together accounted for about two-thirds of the world market and were the founders and leaders of the Specialty Graphite Cartel (EC Decision in *Specialty Graphite*). In the Vitamins Cartel, the world's two largest vitamin producers, Roche and BASF, initiated the creation of cartels in many vitamin products and played a leadership role throughout the existence of the cartels (EC Decision in *Vitamins*).

round of possible cartel expansion, then a round of possible exclusionary behavior, and then compete in prices in each of an infinite number of discrete periods.

We characterize the initial two-firm cartel as being either *concordant, semiconcordant*, or *discordant*. These concepts are motivated by the characterizations from the EC decision of cartels as differing in their success with the suppression of within-cartel rivalry, and they are defined in terms of the cartel's ability to monitor whether members are complying with the cartel agreement. A *concordant* cartel is one that can perfectly monitor its members' compliance with the cartel agreements irrespective of whether the cartel is all-inclusive or there are noncartel firms in the market. A *semiconcordant* cartel, in contrast, can monitor the secret deviations only if the cartel is all-inclusive, but it cannot disentangle potential cartel members' deviations from the behavior by a noncartel firm if the cartel is not all-inclusive. Finally, a *discordant* cartel has no ability to observe secret deviations by the cartel members regardless of whether there is an outside firm or not.

In the first stage of the game, the cartel, which is observed by firm 3, can offer to incorporate firm 3 into the cartel.[10] We assume that firms 1 and 2 must agree in order to extend the offer to firm 3. If the offer is made, then firm 3 either accepts or rejects the offer. We break ties in favor of the larger cartel forming.

In the second stage, cartel concordance is realized: the environment results in a concordant cartel with probability ρ_c, a semiconcordant cartel with probability ρ_s, and a discordant cartel with probability $1 - \rho_c - \rho_s$. Thus, we model the cartel participation decision as being prior to the realization of cartel concordance, which we view as consistent with the timing as it occurs in practice. In particular, the realization of cartel concordance depends in part on the level of buyer resistance faced by the cartel and the disruptiveness of the buyers' strategic responses following the formation of the cartel. Furthermore, when a cartel is initiated, and there is an agreement regarding, for example, the monitoring structures to be put in place, the cartel may not know how well the chosen monitoring structures will work. This may be due to inexperience by the cartel members in operating a cartel or it may be due

[10] For example, in the case of *Electrical and Mechanical Carbon and Graphite Products*, one of the cartel members, Hoffmann, was a small company relative to Carbone Lorraine, Morgan, Schunk, and SGL, which were the largest producers and the initial conspirators. According to the EC decision, Hoffmann joined the cartel under pressure from the existing members. There are other cartels in our sample in which smaller members join the cartel after pressure from existing participants. Examples include Gyproc in *Plasterboard*, Sewon and Cheil in *Amino Acids*, smaller Japanese producers in *Graphite Electrodes*, Cheil in *Food Flavor Enhancers*, Gerestar Bioproducts in *Citric Acid*, the five smaller producers in *Industrial and Medical Gases*, several small firms in *Carbonless Paper*, Nippon Soda and Sumitomo in *Methionine*, six small firms in *Specialty Graphite*, Perosa and Laporte in *Organic Peroxides*, and several small producers in *Copper Plumbing Tubes*. There are cases where small firms do not join cartels. For example, in *Vitamins* there were small noncartel fringe players for many of the individual vitamins, including A, E, B1, B2, B5, and B6. The *Vitamins* cartel was recognized by the EC as being effective despite there being numerous noncartel fringe firms See the corresponding EC decisions for details.

to features of the environment in which the cartel operates that mean that the success of particular monitoring structures are difficult to anticipate at initiation. In part, the differing overcharges produced by different cartels can be related to heterogeneity in the effectiveness of the cartel structures chosen by the cartels.

If firms 1 and 2 have formed a two-firm cartel and firm 3 is not in the cartel, then the cartel firms can engage in conduct that permanently excludes firm 3 from the market at cost k. We assume that the cartel firms are able to negotiate a mutually agreeable division of the cost k, including the possibility of transfer payments, whenever excluding firm 3 increases their joint profit. We recognize that for a discordant cartel, the implementation of exclusionary conduct may be difficult, the cost to a cartel of exclusionary conduct may be high, and the division of the cost may be contentious, and so below we consider the possibility that a discordant cartel may not be able to engage in exclusionary conduct.

Following the cartel formation process, the realization of cartel concordance, and potentially exclusionary conduct by cartel firms against firm 3, the firms participate in an infinite-horizon repeated game. We assume a common discount factor $\delta \in (0, 1)$. In each of the infinite number of discrete periods, a random shock affects demand. Market demand in each period is equal to $D(\min\{p_1, p_2, p_3\})$ with probability ω and equal to zero with probability $1 - \omega$, where the demand shocks are independent across time.

As mentioned above, we focus on trigger-strategy equilibria characterized by the firms' payoffs in cooperation periods, the probability of reversion to the static Nash outcome, and the length of the punishment period. We assume that the outcome of collusive behavior is the trigger-strategy equilibrium that maximizes the cartel's expected payoff. We assume that colluding firms allocate the total cartel payoff according to their static Nash market shares.[11] To simplify this, we assume that if firms choose equal prices in a period, then quantities are allocated to the firms according to their noncooperative market shares. Thus, a cartel achieves the static Nash market share allocation when cartel firms set a common price. As long as total cartel profits are not diminished, we assume that colluding firms allocate cartel profits in this way rather than, for example, having only one firm operate and making transfer payments to the others, where this latter arrangement only arises given our stylized assumptions of unlimited capacity and common constant marginal cost.

As stated below, we assume that a profitable collusive equilibrium exists. Later we

[11]It is common for cartels to use a market share allocation and to fix member market shares at levels that were realized in some period prior to the cartel's formation. For many cartels, maintaining the status-quo market shares was the cornerstone of the collusive mechanism. In the case of cartels in vitamins A and E, "the fundamental idea underlying the cartel was to freeze market shares in both products at the 1988 level. As the market expanded, each company could increase its sales only in accordance with its agreed quota and in line with market growth and not at the expense of a competitor" (EC Decision in *Vitamins*, para 189).

provide a specific model of oligopolistic competition and provide conditions on parameters that ensure that Assumption 1 holds.

Assumption 1. *We assume an environment with imperfect monitoring such that there exists a trigger-strategy equilibrium for a cartel including all* 3 *firms in which (i) all firms have expected payoffs in cooperation periods that exceed their static Nash payoffs and (ii) punishment periods occur with positive probability on the equilibrium path.*

In order to describe punishment phases, it will be useful to note that the firms' payoffs in the static Nash equilibrium are zero and that punishment periods are triggered whenever demand is zero. Letting π^m be the monopoly profit in the positive demand state, the expected payoff to a firm with market share s in the trigger-strategy equilibrium, starting in a cooperation period, with monopoly pricing in cooperation periods and length of punishment T is

$$V(s,T) \equiv \frac{s\pi^m\omega}{1-\omega\delta-(1-\omega)\delta^{T+1}}.$$

To see this, note that one can write $V = \omega\left(s\pi^m + \delta V\right) + (1-\omega)\delta^{T+1}V$, which says that the firm's expected payoff is ω times the current period cooperation payoff in the high demand state of $s\pi^m$ plus the expected payoff from cooperation starting next period, plus $1-\omega$ times a current period payoff of zero, T periods of zero payoff as punishment starting next period, followed by a return to cooperation. Solving this expression for V gives the result.

There exists a trigger-strategy equilibrium of the repeated game with punishment length T in which all three firms set monopoly prices if T is such that for all i,

$$V(s_i,T) \geq \omega\pi^m + \delta^{T+1}V(s_i,T).$$

Assuming that $1-\omega\delta < \min\{s_1,s_2,s_3\}$, we can write this as for all i,

$$T \geq \ln\left(\frac{s_i-1+\omega\delta}{s_i-1+\omega}\right)\frac{1}{\ln(\delta)} - 1. \tag{1}$$

Because the right side in the expression above is decreasing in s_i, the minimum punishment length that supports monopoly prices is determined by the firm with the smallest market share. Let $T^*(s_i)$ be defined to be the smallest integer value of T such that (1) holds for firm i when firm i has market share s_i.

In order to analyze payoffs in the remainder of this section, it will be useful to have the following lemma.

Lemma 1. *If firm* 3 *is outside the cartel, then in equilibrium all firms choose the same price in each period.*

Proof. In punishment periods, all firms choose a price equal to the common marginal cost. In cooperation periods, in a trigger-strategy equilibrium in which payoffs exceed static Nash payoffs, firms 1 and 2 choose price $p > c$. It is not a best reply for firm 3 to choose a higher price or a price less than or equal to c because then firm 3's payoff is zero or negative, which is less than firm 3's payoff if it chooses price p. Suppose that in equilibrium in cooperation periods firm 3 chooses a price less than p but greater than c. Then the cartel firms have zero payoff and can profitably deviate by undercutting firm 3's price, which contradicts the supposition of equilibrium. It follows that all firms choose the same price in cooperation periods. Q.E.D.

2.1 Payoffs in the repeated game

Consider a concordant cartel. If firm 3 is absent, then there are no equilibrium path punishments. Each of the cartel firms has a payoff that is equal to its market share of the monopoly payoff. Firm 3's payoff is zero. If firm 3 is present but is outside the concordant cartel, then deviations by firm 3 must be deterred through punishment periods with length at least $T^*(s_3)$ that are triggered whenever the other firms observe zero demand and no deviations on their part, which in equilibrium occurs only in the low-demand state. We can view this case as a trigger-strategy equilibrium in which there are two firms with shares $s_1 + s_2$ and s_3. The minimum length of the punishment period that supports monopoly pricing in cooperation periods is $T^*(s_3)$. If firm 3 is present but inside the cartel, then once again the concordance of the cartel means that there are no equilibrium path punishments, assuming that all incentive compatibility constraints are satisfied. Each firm has payoff equal to its static Nash market share of the monopoly payoff. (See Table 1 below.)

For a semiconcordant cartel, similar to the case of a concordant cartel, there are no equilibrium path punishments when firm 3 is inside the cartel or absent from the market. However, when firm 3 is present but outside the cartel, the semiconcordant cartel needs to deter deviations by firm 3 as well as the cartel members through punishment periods with length at least $T^*(\min\{s_2, s_3\})$, which occur on the equilibrium path.

For a discordant cartel, even if firm 3 is absent, the equilibrium still involves punishment phases, where the required length of the punishment phase is determined by the smallest cartel firm. When the cartel is discordant, if firm 3 is outside the cartel, then if $s_3 < s_2$, the equilibrium is the same as for a concordant cartel with one firm outside the cartel. However, if $s_2 < s_3$, then the payoffs in the case of a discordant cartel are lower because the punishment length is then determined by the smallest cartel firm, which is smaller than the outside firm.

We can now identify the payoffs for the case of a discordant cartel with firm 3 inside the cartel. Regardless of whether firm 3 is inside or outside the cartel, one can view the cartel as choosing all three prices subject to the incentive compatibility constraints of the firms.

Proposition 1. *For a discordant cartel, the equilibrium outcome with firm* 3 *inside the cartel is the same as with firm* 3 *outside the cartel.*

Proof. For a discordant cartel with firm 3 outside the cartel, by Lemma 1, firm 3 chooses the same price as the cartel firms in each period. It follows that profit shares for the firms are the same as their static Nash market shares. Thus, the trigger-strategy equilibrium that maximizes the profits of firms 1 and 2 is the same as the one that maximizes the profits of all three firms, which corresponds to a discordant cartel with firm 3 inside the cartel. Q.E.D.

We summarize the results of this proposition in Table 1. As shown there, the expected discounted payoff if there is not punishment is simply $\frac{1}{1-\delta}$ times the expected cooperation payoff. If there are equilibrium punishments of length T, then the expected discounted payoff for firm i is $V(s_i, T)$ if all three firms are present and $V(\frac{s_i}{s_1+s_2}, T)$ if only firms 1 and 2 are present.

Table 1: Expected cooperation payoffs for firms 1, 2, and 3

Status of firm 3	Concordancy	Expected cooperation payoff firms $i \in \{1,2\}$	Expected cooperation payoff firm 3	Length of punishment
absent	concordant	$\frac{s_i}{s_1+s_2}\pi^m\omega$	–	–
absent	semiconcordant	$\frac{s_i}{s_1+s_2}\pi^m\omega$	–	–
absent	discordant	$\frac{s_i}{s_1+s_2}\pi^m\omega$	–	$T^*(\frac{s_2}{s_1+s_2})$
inside cartel	concordant	$s_i\pi^m\omega$	$s_3\pi^m\omega$	–
inside cartel	semiconcordant	$s_i\pi^m\omega$	$s_3\pi^m\omega$	–
inside cartel	discordant	$s_i\pi^m\omega$	$s_3\pi^m\omega$	$T^*(\min\{s_2, s_3\})$
outside cartel	concordant	$s_i\pi^m\omega$	$s_3\pi^m\omega$	$T^*(s_3)$
outside cartel	semiconcordant	$s_i\pi^m\omega$	$s_3\pi^m\omega$	$T^*(\min\{s_2, s_3\})$
outside cartel	discordant	$s_i\pi^m\omega$	$s_3\pi^m\omega$	$T^*(\min\{s_2, s_3\})$

Given the results summarized in Table 1, the equilibria for a discordant cartel involve equilibrium punishments in all cases, and the length of the equilibrium punishment potentially differs for concordant and semiconcordant cartels when firm 3 is outside the cartel.

2.2 Incentives for exclusionary conduct

Working backwards and assuming that firm 3 remains outside the cartel, the benefit for a concordant cartel to engage in monopolization conduct that eliminates firm 3 can be quantified by the difference between the payoff for firms 1 and 2 as a concordant cartel with firm 3 absent and the payoff as a concordant cartel with firm 3 outside the cartel. Thus, a concordant cartel has an incentive to engage in monopolization conduct when $k < k''$, where

$$k'' \equiv \sum_{i=1}^{2} \left(\frac{s_i}{s_1 + s_2} \frac{\pi^m \omega}{1 - \delta} - V(s_i, T^*(s_3)) \right).$$

In contrast, a semiconcordant cartel has an incentive to engage in monopolization conduct when $k < k'''$, where

$$k''' \equiv \sum_{i=1}^{2} \left(\frac{s_i}{s_1 + s_2} \frac{\pi^m \omega}{1 - \delta} - V(s_i, T^*(\min\{s_2, s_3\})) \right),$$

and a discordant cartel has an incentive to engage in monopolization conduct when $k < k'$, where

$$k' \equiv \sum_{i=1}^{2} \left(V(\frac{s_i}{s_1 + s_2}, T^*(\frac{s_2}{s_1 + s_2})) - V(s_i, T^*(\min\{s_2, s_3\})) \right).$$

It is easy to see that the incentive for monopolization conduct is strongest for a semiconcordant cartel. To see this, note that $V(s_i, T^*(s_3)) \geq V(s_i, T^*(\min\{s_2, s_3\}))$ and $\frac{s_i}{s_1+s_2} \frac{\pi^m \omega}{1-\delta} > V(\frac{s_i}{s_1+s_2}, T^*(\frac{s_2}{s_1+s_2}))$ as long as $T^*(\frac{s_2}{s_1+s_2}) > 0$, which holds by Assumption 1. If $s_2 \geq s_3$, a concordant cartel has a greater incentive for monopolization conduct than a discordant cartel.[12] However, if $s_2 < s_3$, then because this implies $V(s_i, T^*(s_3)) \geq V(s_i, T^*(\min\{s_2, s_3\}))$, the relation between k'' and k' may be reversed. The greater incentive for monopolization conduct by a concordant cartel is reinforced by the likely greater ability of a cartel to engage in monopolization conduct when it is concordant.

Proposition 2. *A semiconcordant cartel has the greatest incentive to engage in monopolization conduct. If $s_2 \geq s_3$, a concordant cartel has a greater incentive to engage in monopolization conduct than a discordant cartel.*

Consider the incentive for firm 3 to accept an offer to join the cartel should such an offer be made. Suppose that parameters are such that the cartel will eliminate firm 3 if the cartel is concordant or semiconcordant, but not if it is discordant. If firm 3 accepts the offer and the cartel turns out to be concordant or semiconcordant, then firm 3's payoff is $s_3 \pi^m \omega$ rather than zero, so firm 3 gains from accepting the offer. If the cartel turns out to be discordant, then firms 3's payoff is $V(s_3, T^*(\min\{s_2, s_3\}))$ regardless of whether it joins. Thus, firm 3 prefers to join the cartel if asked.

[12]Note also that if $s_2 \geq s_3$, then a concordant cartel has the same incentives as a semiconcordant cartel, i.e. $k''' = k''$.

To see whether firms 1 and 2 would want to extend the invitation to firm 3, note that firms 1 and 2 would consider the following calculation. If they are concordant or semiconcordant, they can pay cost k and eliminate firm 3, achieving a cartel payoff of $\frac{\pi^m \omega}{1-\delta} - k$. If they are discordant, then they have payoff $\sum_{i=1}^{2} V(s_i, T^*(\min\{s_2, s_3\}))$ regardless of whether they invite firm 3 to join. Assuming intermediate values for k, i.e., $k \in (k', k'')$ or $k \in (k'', k''')$, firms 1 and 2 have expected payoff from inviting firm 3 to join the cartel of

$$(\rho_c + \rho_s)(1 - s_3)\frac{\pi^m \omega}{1-\delta} + (1 - \rho_c - \rho_s)\sum_{i=1}^{2} V(s_i, T^*(\min\{s_2, s_3\})),$$

whereas the expected payoff from not inviting firm 3 for $k \in (k', k'')$ is

$$(\rho_c + \rho_s)\left(\frac{\pi^m \omega}{1-\delta} - k\right) + (1 - \rho_c - \rho_s)\sum_{i=1}^{2} V(s_i, T^*(\min\{s_2, s_3\})).$$

and for $k \in (k'', k''')$ is

$$\rho_c(1 - s_3)\frac{\pi^m \omega}{1-\delta} + \rho_s\left(\frac{\pi^m \omega}{1-\delta} - k\right) + (1 - \rho_c - \rho_s)\sum_{i=1}^{2} V(s_i, T^*(\min\{s_2, s_3\})).$$

Thus, the cartel prefers to invite firm 3 if

$$k > s_3 \frac{\pi^m \omega}{1-\delta}$$

and not to invite firm 3 if the opposite inequality holds.

When firm 3 is not invited to join the cartel, then there is a chance that firm 3 will be eliminated, leaving firms 1 and 2 as the only firms in the industry. If they invite firm 3 to join the cartel, profits are affected by the type of cartel concordance, but it is always the case that there will be three firms in the industry. As a result, firms 1 and 2 prefer not to invite firm 3 to join the cartel when k is sufficiently small. The incentive not to invite firm 3 would presumably be reinforced by concerns that firm 3 might reveal the presence of an illegal cartel to authorities. The same result obtains even if k is less than k' if a discordant cartel does not have the ability to eliminate an outside firm.

If k is larger than k''', then the cartel never finds it optimal to eliminate firm 3, so the payoff to firms 1 and 2 from inviting firm 3 is still

$$(\rho_c + \rho_s)(1 - s_3)\frac{\pi^m \omega}{1-\delta} + (1 - \rho_c - \rho_s)\sum_{i=1}^{2} V(s_i, T^*(\min\{s_2, s_3\})),$$

but the payoff from not inviting firm 3 is

$$(\rho_c + \rho_s) \sum_{i=1}^{2} V(s_i, T^*(s_3)) + (1 - \rho_c - \rho_s) \sum_{i=1}^{2} V(s_i, T^*(\min\{s_2, s_3\})),$$

which is lower. Thus, in this case, the cartel invites firm 3 and firm 3 accepts. If k is less than k''', then again the payoff to firms 1 and 2 from inviting firm 3 to join the cartel is unchanged, but the payoff from not inviting firm 3 is

$$\left((\rho_c + \rho_s) \frac{\pi^m \omega}{1 - \delta} + (1 - \rho_c - \rho_s) \sum_{i=1}^{2} V(s_i, T^*(s_2)) \right) - k.$$

Because $s_3 > 0$ and $V(s_i, T^*(s_2)) \geq V(s_i, T^*(\min\{s_2, s_3\}))$, the payoff from not inviting firm 3 is larger as long as k is sufficiently small. One can show that the condition for the cartel not to invite firm 3 to join is always satisfied in this case, where k is less than k'.

We summarize these results in the following proposition.

Proposition 3. *The cartel invites firm* 3 *to join if and only if* $k > \min\left\{s_3 \frac{\pi^m \omega}{1-\delta},\ k'''\right\}$. *Firm* 3 *accepts an invitation to join when invited. If firm* 3 *is not invited to join the cartel, then the cartel eliminates firm* 3 *if (i) the cartel is concordant and* $k < k''$, *or (ii) the cartel is semiconcordant and* $k < k'''$, *or (iii) the cartel is discordant and* $k < k'$.

One can visualize the results of Proposition 3 as in Figure 1.

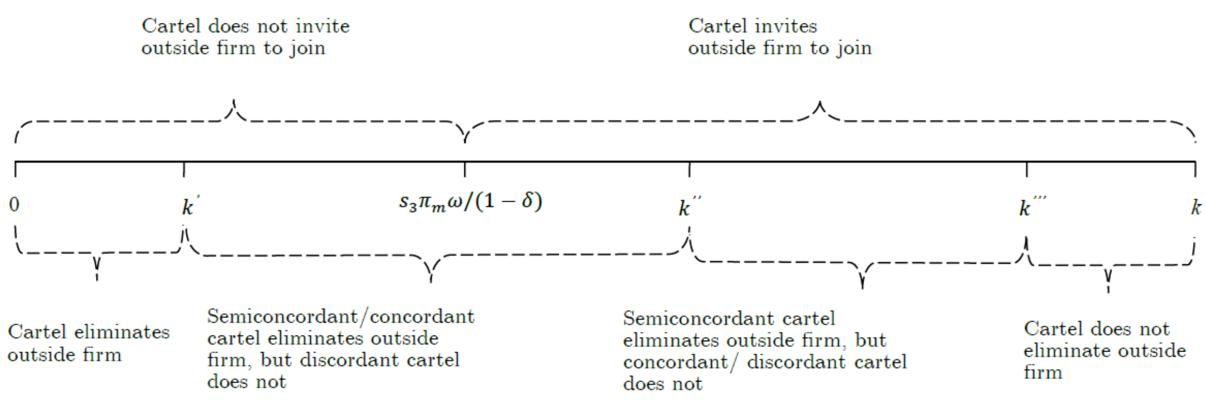

Figure 1: Effect of the cost k for the cartel to eliminate firm 3 on the incentives for the cartel to invite firm 3 to join the cartel and eliminate firm 3 if it does not join. Assumes that $k' < s_3 \frac{\pi_m \omega}{1-\delta} < k''$.

As shown in Figure 1, which illustrates the case with $k' < s_3 \frac{\pi_m \omega}{1-\delta} < k''$, the equilibrium outcome when $k < s_3 \frac{\pi^m \omega}{1-\delta}$ involves firm 3 not being invited to join the cartel and then being eliminated, at least when the cartel is concordant or semiconcordant. The result that firm

3 is not invited and then eliminated when $k < s_3\frac{\pi^m\omega}{1-\delta}$, at least for some types of cartel, continues to hold as long as $s_3\frac{\pi^m\omega}{1-\delta} < k'''$. If $k''' < s_3\frac{\pi^m\omega}{1-\delta}$, then for $k \in (k''', s_3\frac{\pi^m\omega}{1-\delta})$, the outside firm is not invited to join the cartel and then is not eliminated. For values of k greater than $s_3\frac{\pi^m\omega}{1-\delta}$, it is always the case that the cartel invites the outside firm to join.

2.3 Numerical Example

In what follows we provide an implementation using a particular model of oligopolistic price competition. We establish parameters under which firms 1 and 2 prefer not to include firm 3, but then firm 3 is eliminated through monopolization conduct when the cartel is concordant or semiconcordant, but not otherwise.

We base our model on the repeated price competition model of Tirole (1989, Chapter 6.7.1), but adjusted to allow for three firms. All firms are assumed to have a common, constant marginal cost c. Demand in period t is affected by the shock $\alpha_t \in \{0, 1\}$, where $\Pr(\alpha_t = 1) = \omega$ and $\Pr(\alpha_t = 0) = 1 - \omega$.

The realization of α_t is not observed by the firms. Following the cartel formation process and realization of cartel concordance, the firms participate in a repeated price competition game. Each firm observes its own price and quantity, but not those of the other firms unless they are part of a concordant or a semiconcordant cartel with no outside firms.

In each period, firms set prices. Total demand is fixed at Q as long as there is a firm offering a price that is less than or equal to $\bar{p}$. Demand is zero at prices above $\bar{p}$. Demand for firm ℓ's product in period t is, for $i, j, k \neq \ell$,

$$\alpha_t D_\ell(p_1, p_2, p_3) = \begin{cases} 0 & \text{if } \min\{p_i, p_j\} < p_\ell, \\ s_\ell Q & \text{if } p_\ell = p_i = p_j \leq \bar{p}, \\ \frac{s_\ell}{s_\ell + s_i} Q & \text{if } p_\ell = p_i < p_j,\ p_\ell = p_i \leq \bar{p}, \\ Q & \text{if } p_\ell < \min\{p_i, p_j\}\ \ p_\ell \leq \bar{p}, \end{cases}$$

and similarly for the other firms. Thus, in period t, firm i's payoff as a function of the three prices is $(p_i - c_i)\alpha_t D_i(p_1, p_2, p_3)$.

The monopoly payoff in the positive demand state is $\pi^m = (\bar{p} - c)Q$. Because we consider a model of homogeneous products with price competition and common constant marginal costs, the punishment payoffs are equal to zero.

To provide a numerical example, we normalize Q to be 1 and $\bar{p}$ to be 1. We let $c = 0$, $\omega = 0.95$, and $\delta = 0.9$. Then the expressions in Table 1 can be evaluated as shown in Table 2.

The expected cooperation period profit of firms 1 and 2 increases with their shares, e.g.,

Table 2: Numerical example with three firms and market shares as indicated below. Assumes $Q = 1$, $\bar{p} = 1$, $c = 0$, $\omega = 0.95$, and $\delta = 0.9$.

(a) Market shares: $s_1 = 0.4$, $s_2 = 0.4$, and $s_3 = 0.2$

		Cooperation payoff				Discounted payoff		
Firm 3 status	Concordancy	firm 1	firm 2	firm 3	Punishment	firm 1	firm 2	firm 3
absent	concordant	0.48	0.48	–	–	4.75	4.75	–
absent	semiconcordant	0.48	0.48	–	–	4.75	4.75	–
absent	discordant	0.48	0.48	–	2	4.38	4.38	–
inside cartel	concordant	0.38	0.38	0.19	–	3.80	3.80	1.90
inside cartel	semiconcordant	0.38	0.38	0.19	–	3.80	3.80	1.90
inside cartel	discordant	0.38	0.38	0.19	9	2.98	2.98	1.49
outside cartel	concordant	0.38	0.38	0.19	9	2.98	2.98	1.49
outside cartel	semiconcordant	0.38	0.38	0.19	9	2.98	2.98	1.49
outside cartel	discordant	0.38	0.38	0.19	9	2.98	2.98	1.49

$k' = 3$, $k'' = 3.5$, $k''' = 3.5$

(b) Market shares: $s_1 = 0.6$, $s_2 = 0.15$, and $s_3 = 0.25$

		Cooperation payoff				Discounted payoff		
Firm 3 status	Concordancy	firm 1	firm 2	firm 3	Punishment	firm 1	firm 2	firm 3
absent	concordant	0.76	0.19	–	–	7.60	1.90	–
absent	semiconcordant	0.76	0.19	–	–	7.60	1.90	–
absent	discordant	0.76	0.19	–	9	5.96	1.49	–
inside cartel	concordant	0.57	0.14	0.24	–	5.70	1.43	2.38
inside cartel	semiconcordant	0.57	0.14	0.24	–	5.70	1.43	2.38
inside cartel	discordant	0.57	0.14	0.24	28	4.00	1.00	1.66
outside cartel	concordant	0.57	0.14	0.24	6	4.71	1.18	1.96
outside cartel	semiconcordant	0.57	0.14	0.24	28	4.00	1.00	1.66
outside cartel	discordant	0.57	0.14	0.24	28	4.00	1.00	1.66

$k' = 2.5$, $k'' = 3.5$, $k''' = 4.5$

panel (a) shows for firm 1 with firm 3 an expected cooperation payoff of 0.48, but in panel (b) the corresponding payoff is higher at 0.76. But the total expected discounted payoff decreases with the combined shares of firms 1 and 2 in certain cases (e.g., cases where the panel (a) punishment is longer) because of the need to increase punishment lengths to deter deviations by the other firm, whose shares are decreasing and so incentive for deviation is increasing.

2.4 Comparison with a dominant firm

We have considered the case in which two firms have formed a cartel. But for comparison, we can also consider the case in which the two firms have merged to form a dominant firm in the market. Assume that the merged entity operates as would a concordant cartel and faces the same market conditions as would a concordant cartel. Furthermore, abstract from the possibility that buyers might have a different strategic response to a dominant firm than to what under a cartel structure might appear to them as separate competing firms. Then it is clear from the analysis above that a cartel may have a stronger incentive for monopolization conduct than a merged entity.

3 Empirical results

The theoretical model of Section 2 produces the empirically testable hypothesis that cartels experiencing discordance with respect to the suppression of rivalry will be less likely to engage in monopolization conduct than other cartels. In this section, we examine the case discussions for a sample of prosecuted cartels to probe whether these high-level theoretical results are consistent with this data.

We begin this section by offering caveats and cautions related to our empirical exercise. As mention above, we rely on EC decisions in cartel cases for information on cartel functioning.[13] However, the information regarding cartel conduct in the EC decisions is not uniform. From our perspective, it would be useful to have detailed descriptions of pricing, allocation, and enforcement structures for each cartel, as well as any monopolization conduct by the cartel (see, e.g., Marshall and Marx, 2012, Chapter 6). The EC decision in *Vitamins* is an excellent example of a detailed and extensive description of the cartel's self-enforcing agreement. However, many other decisions contain far less detail. For example, the EC decision in *Power Transformers* provides little information other than that the agreement was to refrain from selling in other cartel members' home markets (para. 2).[14] To understand why some decisions have only minimal descriptions of cartel conduct, we note that defense counsel may argue for as little information as possible in a decision because additional information may hurt their clients in follow-on litigation. Related to this, defense counsel may offer higher fines to enforcement authorities in exchange for less detail in the decisions (and shorter plea durations (Marshall et al., 2020)).

The implication for our research is that the EC decisions may lack detailed information about cartel conduct. In addition, it is difficult to categorize each cartel into one of the three categories: concordant, semi-concordant, or discordant. Some decisions recite evidence consistent with discordance in the cartel's attempts to suppress rivalry. However, there is typically insufficient information to parse between semi-concordant and concordant cartels. Moreover, cartel structures and conduct can vary over time, meaning that a cartel could, for example, be discordant in early periods and then evolve into a concordant cartel.

[13] While EC decisions are a valuable source of information, they are informationally inferior to what would typically be revealed through an antitrust discovery process.

[14] The section on "Description of the events" spans paragraphs 75–106, but all but 5 paragraphs are fully redacted, and the 5 included paragraphs have significant redactions themselves.

Given these challenges, we focus our review of cases on identifying whether the EC Decision contains evidence consistent with discordance regarding the suppression of rivalry. We do not attempt to make a distinction between concordance and semi-concordance. Our results are limited by the extent to which relevant details are included in the EC decisions. For example, monopolization conduct may not be mentioned even when it occurs, and indications of discordance may not be mentioned even when they are present. Given these limitations, and to simplify the admittedly subjective classification of cartels, we limit ourselves to distinguishing whether there is evidence of monopolization conduct or not and whether we find evidence consistent with discordance or not. We note that the presence of evidence consistent with discordance does not mean that the cartel was not effective.

Our sample of cases consists of the 47 English-language EC cartel decisions dated 2000–2010 for industrial products (i.e., excluding financial and agricultural products and services) as listed on the European Commission's "Cartels" website.[15] For a additional discussion of these and other cases, see Harrington (2006), Levenstein and Suslow (2006), and Connor (2008). It is worth noting that more recent EC decisions tend to have markedly less detail on the inner workings of the cartels, so we content ourselves with the sample from 2000–2010.[16]

The results of our investigation are shown in Table 3. The number of cartel members is the count of the list of "addressees" given at the beginning of the decision. In the "All inclusive" column, we note cases in which the decision indicates that the cartel market share is 100% or approximately 100%. This is relevant because in those cases, monopolization conduct may be unlikely simply because of the absence of noncartel firms for the cartel to target. Data on cartel market shares is not consistently provided in the decisions, but, setting aside the all-inclusive cartels, we did not detect any relation between the cartel market share and whether monopolization conduct is reported. We provide paragraph references related to the classifications in Table 3 in Appendix A.3.

As shown in Table 3, the cases in our sample reveal that there is evidence consistent with discordance for some cartels, but not for others, and there is evidence that some cartels engage in monopolization conduct, whereas for others we find no such evidence.

[15] We derive our sample from http://ec.europa.eu/competition/cartels/cases/cases.html. For a list of excluded cases, and the reason for exclusion, see Appendix A.2. While the EC website only provides cases going back to 2001, we also include in the sample the two year-2000 cartel cases of which we are aware: 36545-Amino Acids and 33133-B Soda-ash. (Two other year-2000 soda-ash cases are abuse of dominance cases under Article 81, not cartel cases.)

[16] Monopolization conduct for the cases from 2000–2005 was analyzed in Heeb et al. (2009).

Table 3: Discordance and monopolization conduct in European Commission industrial cartel decisions (2000 through 2010)

Case	**# Members**	**All inclusive**	**Evidence of discordance**	**Monopolization**
		2000		
Amino Acids	6	yes	yes	
Soda Ash	2		yes	
		2001		
Carbonless Paper	11			
Graphite Electrodes	8			yes
Zinc Phosphate	6		yes	
Citric Acid	5		yes	yes
Vitamins	13			yes
		2002		
Industrial and Medical Gases	7		yes	
Methyglucamine	3	yes		
Plasterboard	4		yes	
Specialty Graphite	10			yes
Food Flavour Enhancers	4	yes	yes	
Methionine	4			yes
		2003		
Electrical and Mechanical Carbon and Graphite Products	6			yes
Industrial Tubes	6		yes	
Organic Peroxides	8			yes
Sorbates	5			yes
		2004		
Choline Chloride	6		yes	
Copper Plumbing Tubes	9			yes
Needles	6			
		2005		
Industrial Bags	15			
Monochloroacetic Acid	12			yes
Rubber Chemicals	8		yes	
		2006		
Synthetic rubber (BR/ESBR)	13			
Fittings	14			yes
Bitumen Nederland	14		yes	yes
Methacrylates	14		yes	
Hydrogen peroxide	17		yes	
		2007		

Case	# Members	All inclusive	Evidence of discordance	Monopolization
Chloroprene rubber	12			yes
Flat glass	9			
Professional videotapes	3			
Bitumen Spain	13	yes		
Hard haberdashery	7		yes	
Elevators and escalators	5			
Gas insulated switchgear	20		yes	yes
2008				
Carglass	18			
Candle waxes	10		yes	
Aluminium Fluoride	4		yes	
Sodium Chlorate	6+		yes	
Synthetic rubber (NBR)	4		yes	
2009				
Heat stabilisers	23			
Power transformers	9			
Calcium carbide and magnesium based reagents	15			
Marine hoses	11		yes	yes
2010				
LCD	6		yes	
Pre-stressing steel	18		yes	
DRAM	10		yes	

Keeping in mind the caveats mentioned above, particularly the issues that the EC may not have described monopolization conduct in its decision because it stayed narrowly focused on the issue of rivalry suppression among cartel members and that the identification of evidence consistent with discordance is subjective, Table 3 shows patterns consistent with our theoretical results. We summarize these results in Table 4, where we exclude the four all-inclusive cartels because for those cartels, the absence of noncartel firms leaves little opportunity for monopolization conduct. As we see in Table 4, of the less-than-all-inclusive cartels for which we found evidence consistent with discordance, only four engaged in monopolization conduct whereas, half of the less-than-all-inclusive cartels for which we did not identify evidence consistent with discordance engaged in monopolization conduct. In addition, monopolization conduct occurs in 35% of the less-than-all-inclusive cartel cases, as summarized in Table 4. This highlights that monopolization conduct by cartels is substantial, although it is a largely unrecognized part of the potential social harm from a cartel.

Table 4: Relation between monopolization conduct and the suppression of within-cartel rivalry

Rivalry suppression evidence	Monopolization conduct		Share with monopoli -zation conduct
	No	Yes	
not consistent with discordance	11	11	50%
consistent with discordance	17	4	19%
Total	28	15	35%

Notes: Sample is cartel cases in Table 3, excluding the four all-inclusive cartels.

The cartels that we examine here are not just handshake agreements by rivals to suppress competition, but rather they involve collusive structures that allow the cartels to implement and enforce their agreements. Deficiencies in the ability to monitor the conduct of cartel members can be one factor that causes discordance related to the suppression of within-cartel rivalry. The ability of a cartel to monitor its members' compliance with the cartel agreement can depend on a number of factors. Some cartels may know that member firms are complying with the agreement even when there are noncartel firms competing against the cartel in the market. Other cartels may avoid discordance when the cartel is all-inclusive but not be able to monitor if members are complying with the agreement when there are noncartel firms competing against the cartel. There is an obvious direct anticompetitive motivation for monopolization conduct whether a cartel is confronting an internal monitoring issue or not because eliminating an outside firm results in a direct reduction in competition. But there can be a second motivation that stems from the monitoring issue. By eliminating noncartel firms, a cartel may be able to avoid foregoing profits from the possibility of cheating by members whose deviations cannot be distinguished from actions by noncartel firms. It may be the case that by eliminating noncartel firms the cartel can then successfully monitor compliance with the cartel agreement.

For example, the benefits to a cartel from eliminating noncartel firms in terms of monitoring the cartel agreement are reflected in the Vitamins Cartel, where for vitamin C the cartel faced the challenge of disentangling the effects of noncartel producers in China from the possibility of cheating by a cartel firm.[17] Similar indications that the conduct of noncartel

[17] "The [noncartel] Chinese producers continued to sell at prices which threatened the stability of the cartel. According to [cartel firm] BASF, the price for vitamin C had as a result fallen by around one third by 1995. ... BASF states that the quarterly European meetings were marked by increasing tensions between [cartel firms] Roche and Takeda; Roche accused [Takeda] of cheating by misstating its real sales" (EC Decision in *Vitamins,* paras 448 and 449).

firms exacerbate cheating within the cartel appear in the Citric Acid cartel.[18]

4 Conclusion

Firms engaging in a cartel are attempting to increase their profits through an agreement to suppress competition among themselves and, in many cases, also engaging in monopolization conduct. Our finding that semiconcordant and concordant cartels are more likely to engage in monopolization conduct to further increase their profits is consistent with the descriptions from the EC decisions as reviewed in Section 3. There are a number of implications of these results.

First, if one observes a subset of firms in an oligopoly engaging in monopolization conduct, but no single firm appears to have sufficient market share to undertake such conduct unilaterally, then this suggests the presence of a cartel. This observation is not new. Posner (2001, p. 93) notes, "... the existence of a cartel might be inferred from proof of exclusionary practices plus the fact that the market was not monopolized by a single firm." Thus, monopolization conduct in the absence of monopolization is a "plus factor" in inferring the existence of a cartel.[19] Posner (2001, p. 93) also notes that, "Cartels often have great difficulty coordinating exclusionary conduct, ..." Posner's meaning with this assertion is unclear; however, as we show, discordant cartels would not be expected to engage in exclusionary conduct.

Second, anticompetitive monopolization conduct by a cartel increases the social cost of a cartel beyond that associated with the suppression of rivalry among cartel members. Public enforcement authorities should consider any incremental damage from monopolization conduct when assessing criminal penalties.

Third, we may be able to use the discovery record available in Article 81 or Section 1 cases to inform policy regarding Article 82 or Section 2 matters. An analysis of monopolization conduct pursued by cartels may better enable enforcement authorities to assess whether a particular monopolization conduct is likely to have harmful effects. The discovery record

[18] "In the meantime, the cartel members had been targeting individual customers of the [noncartel] Chinese producers in order to undermine their market position. ... One result of this was that by 1993 difficulties between some of the cartel members were beginning to surface. In the first quarter of 1993, [cartel member] Jungbunzlauer was seen to be 'causing problems' in the group because it did not strictly adhere to the agreement at all times and was perceived to be 'badly disciplined' by the other participants" (EC Decision in *Citric Acid,* paras 116 and 117).

[19] "Courts generally have held that 'conscious parallelism' or oligopolistic interdependence, without more, does not permit an inference of conspiracy. Courts typically require plaintiffs who rely on parallel conduct to introduce additional facts, often termed 'plus factors', to justify an inference of agreement" (Gellhorn and Kovacic, 1994, p. 237). For discussion of the evaluation of the probative value of plus factors and "super plus factors," see Kovacic et al. (2011), who argue that dominant-firm conduct in the absence of a dominant firm is often a "super-plus factor."

that is retained by public enforcement authorities, much of which might be confidential, creates an opportunity for in-house research programs regarding monopolization conduct.

Fourth, when horizontal mergers are evaluated by public authorities, there is attention given to the possibility of post-merger coordinated conduct, but this concern focuses on the suppression of rivalry and does not extend to the possibility of monopolization conduct by firms engaged in the coordinated conduct. This omission is odd given that the same guidelines emphasize the importance of a "maverick" firm, which in our context is the firm that opts not to join the cartel in order to profit from the suppression of rivalry among the colluding firms, but that may be the target of predatory conduct by the cartel.

Fifth, our finding that semiconcordant cartels engage in monopolization conduct more frequently than concordant cartels has the interpretation that semiconcordant cartels may create greater long-run social harm than concordant cartels.

A Appendix: Sample of EC decisions

A.1 Citations

1. *Aluminium Fluoride:* Case COMP/39.180 — Aluminium Fluoride, Comm'n Decision (June 25, 2008).
2. *Amino Acids:* Case COMP/36.545/F3 — Amino Acids, Comm'n Decision (June 7, 2000).
3. *Bitumen NL:* Case COMP/38.456 — Bitumen - NL, Comm'n Decision (Sept. 13, 2006).
4. *Bitumen Spain:* Case COMP/38710 — Bitumen Spain, Comm'n Decision (Oct. 3, 2007).
5. *Calcium Carbide and Magnseium Based Reagents:* Case COMP/39.396 — Calcium carbide and magnesium based reagents for the steel and gas industries, Comm'n Decision (July 22, 2009).
6. *Candle Waxes:* Case COMP/39181 — Candle Waxes, Comm'n Decision (Oct. 1, 2008).
7. *Carbonless Paper:* Case COMP/E-1/36.212 — Carbonless Paper, Comm'n Decision, (Dec. 20, 2001).
8. *Carglass:* Case COMP/39.125 — Carglass, Comm'n Decision (Nov. 12, 2008).
9. *Chloroprene Rubber:* Case COMP/38629 — Chloroprene Rubber, Comm n Decision (Dec. 5, 2007).
10. *Choline Chloride:* Case COMP/E-2/37.533 — Choline Chloride, Comm'n Decision (Sept. 12, 2004).
11. *Citric Acid:* Case COMP/E-1/36.604 — Citric Acid, Comm'n Decision (Dec. 5, 2001).
12. *Copper Plumbing Tubes:* Case COMP/E-1/38.069 — Copper Plumbing Tubes, Comm'n Decision (Sept. 3, 2004).
13. *DRAM:* Case COMP/38511 — DRAMs, Comm'n Decision (May 19, 2010).
14. *Electrical and Mechanical Carbon and Graphite Products:* Case C.38.359 — Electrical and Mechanical Carbon and Graphite Products, Comm'n Decision (Dec. 3, 2003).
15. *Elevators and Escalators:* Case COMP/E-1/38.823 — PO/Elevators and Escalators, Comm'n Decision (Feb. 21, 2007).
16. *Fittings:* Case COMP/F-1/38.121 — Fittings, Comm'n Decision (Sept. 20, 2006).
17. *Flat Glass:* Case COMP/39165 — Flat glass, Comm'n Decision (Nov. 28, 2007).
18. *Food Flavor Enhancers:* Case COMP/C.37.671 — Flood Flavour Enhancers, Comm'n Decision (Dec. 17, 2002).
19. *Gas Insulated Switchgear:* Case COMP/F/38.899 — Gas Insulated Switchgear, Comm'n Decision (Jan. 24, 2007).

20. *Graphite Electrodes:* Case COMP/E-1/36.490 — Graphite electrodes, Comm'n Decision (July 18, 2001).
21. *Hard Haberdashery:* Case COMP/E-1/39.168 — PO/Hard Haberdashery: Fasteners, Comm'n Decision (Sept. 19, 2007).
22. *Heat Stabilisers:* COMP/38589 — Heat Stabilisers, Comm'n Decision (Nov. 11, 2009).
23. *Hydrogen Peroxide and Perborate:* Case COMP/F/38.620 — Hydrogen Peroxide and Perborate, Comm'n Decision (May 3, 2006).
24. *Industrial and Medical Gases:* Case COMP/E-3/36.700 — Industrial and medical gases, Comm'n Decision (July 24, 2002).
25. *Industrial Bags:* Case COMP/38354 — Industrial bags, Comm'n Decision (Nov. 30, 2005).
26. *Industrial Tubes:* Case COMP/E-1/38.240 — Industrial Tubes, Comm'n Decision (Dec. 16, 2003).
27. *LCD:* Case COMP/39.309 — LCD - Liquid Crystal Displays, Comm'n Decision (Dec. 8, 2010).
28. *Marine Hoses:* Case COMP/39406 — Marine Hoses, Comm'n Decision (Jan. 28, 2009).
29. *Methacrylates:* Case COMP/F/38.645 — Methacrylates, Comm'n Decision (May 31, 2006).
30. *Methionine:* Case C.37.519 — Methionine, Comm'n Decision, (July 2, 2002).
31. *Methyglucamine:* Case COMP/E-2/37.978 — Methylglucamine, Comm'n Decision (Nov. 27, 2002).
32. *Monochloroacetic Acid*: Case COMP/E-1/.37.773 — MCAA, Comm'n Decision (Jan. 19, 2005).
33. *Needles*: Case F-1/38.338 — PO/Needles, Comm'n Decision (Oct. 26, 2004).
34. *Organic Peroxides:* Case COMP/E-2/37.857 — Organic Peroxides, Comm'n Decision (Dec. 10, 2003).
35. *Plasterboard:* Case COMP/E-1/37.152 — Plasterboard, Comm'n Decision (Nov. 27, 2002).
36. *Power Transformers:* Case COMP/39.129 — Power Transformers, Comm'n Decision (Oct. 7, 2009).
37. *Prestressing Steel:* Case COMP/38.344 – Prestressing Steel, Comm'n Decision (June 30, 2010).
38. *Professional Videotape:* Case COMP/38.432 — Professional Videotape, Comm'n Decision (Nov. 20, 2007).
39. *Rubber Chemicals:* Case COMP/F/38.443 — Rubber Chemicals, Comm'n Decision (Dec. 21, 2005).

40. *Soda-ash:* Case COMP/33.133-B — Soda-ash—Solvay, CFK, Comm'n Decision (Dec. 13, 2000)
41. *Sodium Chlorate:* Case COMP/38.695 — Sodium Chlorate, Comm'n Decision (June 11, 2008).
42. *Sorbates:* Case COMP/E-1/37.370 — Sorbates, Comm'n Decision (Oct. 1, 2003).
43. *Specialty Graphite:* Case COMP/E-2/37.667 — Specialty Graphite, Comm'n Decision (Dec. 17, 2002).
44. *Synthetic Rubber (BR/ESBR):* Case COMP/F/38.638 — Butadiene Rubber and Emulsion Styrene Butadiene Rubber, Comm'n Decision (Nov. 29, 2006).
45. *Synthetic Rubber (NBR):* Case COMP/38.628 — Nitrile Butadiene Rubber, Comm'n Decision (Jan. 23, 2008).
46. *Vitamins:* Case COMP/E-1/37.512— Vitamins, Comm'n Decision (Nov. 21, 2001).
47. *Zinc Phosphate:* Case COMP/E-1/37.027 — Zinc phosphate, Comm'n Decision (Dec. 11, 2001).

A.2 Excluded decisions

Case	Reason for Exclusion
37919 - Bank charges - Germany	Not industrial product
37614 - Belgian beer market	Not industrial product
37800 - Luxembourg brewing industry	Not industrial product
36756 - Sodium gluconate I	English version of decision not available
37444 - SAS/Maersk Air	Not industrial product
37956 - Concrete reinforcing bar	Decision not available
37784 - Fine art Auction Houses	Not industrial product
36571 - Austrian banks	Not industrial product
38279 - French beef	Not industrial product
38238 - Spanish Raw Tobacco	Not industrial product
37750 - French beer market	Not industrial product
36756 - Sodium gluconate II	English version of decision not available
38281 - Italian raw tobacco	Not industrial product
38337 - Thread	English version of decision not available
39234 - Alloy surcharge re-adoption	Not industrial product
39283 - SRAM	Case administratively closed
38907 - Steel beams	Decision not available
37766 - Netherlands beer market	Not industrial product
39188 - Bananas	Not industrial product
39565 - Grains and oilseeds	Not industrial product
38624 - Maritime transport of bulk liquids (deep sea)	Not industrial product
38543 - International removal services	Not industrial product
39419 - International airline passenger services	Not industrial product
37956 - Concrete reinforcing bar	English version of decision not available
39401 - E.ON - GdF collusion	Not industrial product
39258 - Airfreight	Not industrial product
38866 - Animal Feed Phosphates	English version of decision not available
39092 - Bathroom fittings & fixtures	Decision not available
39776 - Agricultural film	Case administratively closed
39459 - Electrical equipment	Case administratively closed

A.3 Citations for Table 3 classifications

Table 5: Paragraph references for classifications in Table 3 related to European Commission industrial cartel decisions (2000 through 2010). Blank entries indicate that we did not identify relevant material in the EC decision.

Case	# Members	All inclusive	Evidence regarding discordance	Monopolization
		2000		
36545 - Amino Acids	2–20	29–35	66, 69, 73, 77, 87, 89–91, 93, 98, 101–102, 109–110, 118, 134, 143, 145, 340	
33133-B - Soda-ash	1		45–47	
		2001		
36212 - Carbonless Paper	1		105, 106, 202, 212, 257	
36490 - Graphite Electrodes	1		106–107, 136–137, 211–215	2, 106
37027 - Zinc Phosphate	1		122–124, 144–147, 271, 290–297	
36604 - Citric Acid	1		90–91, 116–118, 125–128	116, 166, 119
37512 - Vitamins	1		273–274, 449, 713–714, 727, 732	714, 257, 322, 288
		2002		
36700 - Industrial and Medical Gases	1		127, 175, 443–447	
37978 - Methyglucamine	L38/20	32	148, 177	
37152 - Plasterboard	1		229, 230, 257–262, 264–265	
37667 - Specialty Graphite	1			305, 29, 178
37671 - Food Flavour Enhancers	1	21	94, 96–98, 102, 109, 114, 118, 121, 231, 237, 239, 277–278	
37519 - Methionine	1		278–279, 289, 325	141, 146
		2003		
38359 - Electrical and Mechanical Carbon and Graphite Products	1			167, 2, 157, 167, 171, 241, 154
38240 - Industrial Tubes	1		104–105, 314	
37857 - Organic Peroxides	1			271
37370 - Sorbates	1			117, 118, 281
		2004		
37533 - Choline Chloride	1		64–65, 68, 72–74, 86, 89, 95–96	
38069 - Copper Plumbing Tubes	1		200, 321, 510	116, 137
38338 - Needles	3–8		65–67, 114, 125, 189, 194, 200–201	
		2005		
38354 - Industrial Bags	1		224–227, 280–281, 287–288, 342, 352, 357, 364–365, 372, 392	

Case	# Members	All inclusive	Evidence regarding discordance	Monopolization
37773 - Monochloroacetic Acid	1		69, 75, 98, 131–135, 146, 152, 154, 158, 161, 206, 285	71-73, 96-97
38443 - Rubber Chemicals	1		210, 212, 234, 288	
		2006		
38638 - Synthetic rubber (BR/ESBR)	248		297	
38121 - Fittings	1		135, 141	161
38456 - Bitumen Nederland	1		82–86, 134, 359	157
38645 - Methacrylates	1		107, 328, 375	
38620 - Hydrogen peroxide	1		105–106, 130, 149, 166, 205, 225, 249	
		2007		
38629 - Chloroprene rubber	1			142, 155–156, 161, 164, 208, 336
39165 - Flat glass	1		251	
38432 - Professional videotapes	1		59–87	
38710 - Bitumen Spain	1	8, 67, 116–120	130–132, 143, 150–173, 174–189	
39168 - Hard haberdashery	1		98, 105, 126, 566	
38823 - Elevators and escalators	1		198, 200, 255	
38899 - Gas insulated switchgear	1		167–169	2, 156, 160, 281
		2008		
39125 - Carglass	1		110, 112, 116, 117	
39181 - Candle waxes	1		113, 692	
39180 - Aluminium Fluoride	6 – 30		153, 155, 159, 177, 185, 246–247	
38695 - Sodium Chlorate	3–37		519, 532	
38628 - Synthetic rubber (NBR)	1		112, 132	
		2009		
38589 - Heat stabilisers	2		115–120, 129, 233–234	
39129 - Power transformers	1			
39396 - Calcium carbide and magnesium based reagents	2		60, 117, 317, 319	
39406 - Marine hoses	1		148, 156–157, 178, 185, 187, 304, 307, 414	496
		2010		
39309 - LCD	55–38		104–105, 107, 141, 147, 182	

Case	# Members	All inclusive	Evidence regarding discordance	Monopolization
38344 - Pre-stressing steel	7–92		174, 185, 200, 207, 375, 553, 863, 950, 952, 1017–1018	
38511 - DRAM	2		36, 109	

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