

# Dominant-Firm Conduct by Cartels\*

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## Abstract

Recent cartel cases show that concordant cartels engage in dominant-firm conduct, while discordant cartels do not. We construct a model in which a firm that was not invited to join the cartel or that chose to remain outside the cartel can be eliminated by the cartel if the cartel turns out to be concordant, but not if the cartel turns out to be discordant. This dominant-firm conduct by a cartel can be an incremental source of profits for cartel members beyond the narrow suppression of within-cartel rivalry. We discuss policy implications of our work.

Keywords: antitrust, collusion, monopolization, plus factors, price fixing

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“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 ...”<sup>1</sup>

## 1 Introduction

Agreements that successfully suppress rivalry among firms in an industry are profitable. It is well known that cartels have non-trivial problems to solve en route to higher profits.<sup>2</sup> Because members of a cartel do not have access to the judicial system to enforce the terms of their agreements, cartel members may engage in profitable deviations from the cartel’s proscriptions for their conduct. Some cartels struggle with deviant conduct and confront ongoing challenges in their attempts to suppress within-cartel rivalry. For other cartels, deviations are not a problem, and the cartel functions in a concordant manner.

Concordant cartels may look for additional sources of profits beyond those achieved through the suppression of within-cartel rivalry. A cartel that has suppressed rivalry among its members has the potential to act like a dominant firm.<sup>3</sup> Prior to the formation of the cartel, each individual firm may find the incremental profit to itself from dominant-firm conduct, which benefits multiple firms in the industry, to be less than the incremental cost; however, once the cartel forms, the incremental profit to the cartel as a whole may be positive.<sup>4</sup> One example of such an action is driving small non-cartel firms out of business.<sup>5</sup>

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<sup>1</sup>Case C.38.359 — Electrical and Mechanical Carbon and Graphite Products, Comm’n Decision 167 (Dec. 3, 2003), available at <http://ec.europa.eu/competition/antitrust/cases/decisions/38359/en.pdf>.

<sup>2</sup>See, e.g., Stigler (1964) on the issue of secret price cutting among cartel members. For an overview of factors affecting cartel success, see Levenstein and Suslow (2006).

<sup>3</sup>The analysis of recent explicit cartels provided in Heeb et al. (2009) suggests that colluding firms often coordinate efforts to engage in dominant-firm conduct, including, among other things, the use of exclusive-dealing provisions. Exclusive-dealing provisions may enable a cartel to exclude non-cartel rivals in the same way they may enable a firm to monopolize a market. The seminal papers on this topic include 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).

<sup>4</sup>As described in Jones (1922, pp.261–274), trade associations may coordinate activities typically associated with a dominant firm in order to disadvantage non-member firms. Although Jones’ focus is on trade associations, the examples of activities he provides apply equally well to cartels, regardless of whether a trade association is involved. Jones’ examples include: controlling channels of distribution, organizing boycotts, establishing blacklists or whitelists, cutting non-members’ supply, interfering with non-members’ labor supply or procurement of storage facilities, predatory pricing, malicious litigation, espionage, intimidation and coercion, and misuse of governmental agencies. See Jones (1922, pp.261–274) for discussion, examples, and cites to cases related to each of these.

<sup>5</sup>We are aware of many cartels that engage in predation against non-cartel firms, but we are unaware of predation ever taking the form of market-wide price cuts. Two common types of predation are restricting

The cost of taking actions with cartel-wide benefits can be spread among the cartel members, for example according to their market shares.<sup>6</sup>

In this paper, we review the European Commission’s (EC’s) decisions regarding industrial cartels for the period 2000–2009. For cartels that are concordant in that the suppression of within-cartel rivalry appears to be without internal struggle, we find that the cartel often engages in dominant-firm conduct. For cartels that are discordant in that the suppression of within-cartel rivalry appears to be an ongoing challenge, we find that the cartel does not engage in dominant-firm conduct.

We construct a model of collusive behavior in a three-firm industry. In the model, two firms can form a cartel, and if they do, they can then invite the third firm to join the cartel. If invited, the third firm decides whether to join or not. After the cartel membership is determined, the concordance of the cartel is realized. We model dominant-firm behavior by assuming that when a two-firm cartel turns out to be concordant, it can eliminate the third firm from the market. If the two-firm cartel turns out to be discordant, it lives with competition from the third firm.

The empirical finding and our modeling result that concordant cartels engage in dominant-firm conduct are important for multiple reasons. First, the social harm of cartels often extends beyond the suppression of competition among members. As we observe in the EC decisions and as our model shows, concordant cartels can damage the competitive process

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access to a critical factor input and targeting the specific customers of non-cartel firms. A public statement by the Department of Justice Division for Enforcement of Antitrust Laws released June 27, 1939, states: “Another device is the creation of a fund among a small group to buy competing plants which are troublesome competitors. Upon acquisition, such plants are often shut down and dismantled. Thus, the socially desirable small independent operation is eliminated from the field of competition.” (Temporary National Economic Committee, 1941, Exhibit No. 2176)

<sup>6</sup>As described in the European Commission (EC) decision in *Vitamins* (see Appendix A for the full citations for cited EC decisions), the cost of activities targeting the non-cartel 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 another example, 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 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 Westfälische-Anhaltische Sprengstoff A. G. (Coswig) for restricting its exports.

through dominant-firm conduct.<sup>7</sup> Second, public enforcement authorities treat Sherman Act Section 1 cases as separate and distinct from Sherman Act Section 2 cases, but in light of our finding, Section 1 cases can potentially provide insight into Section 2 cases. The discovery record from a cartel case may contain descriptions of the cartel firms’ deliberations with respect to potential dominant-firm conduct. Public enforcement authorities can use this record to shed light on the nature of dominant-firm conduct in industries with similar characteristics. This suggests that the ‘firewall’ between Section 1 and Section 2 cases that exists within public enforcement agencies should be reexamined.<sup>8</sup> Third, if 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 dominant-firm activities by the cartel may be prevented.

In our model, the third firm, which is capacity constrained, may prefer not to join the cartel so it can take advantage of the price umbrella provided by a potentially discordant cartel. There is a literature that addresses cartel “stability” – firms inside the cartel do not find it desirable to exit and firms outside the cartel do not find it desirable to enter.<sup>9</sup> 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 serves as an umbrella with non-cartel 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.

The paper proceeds as follows. In Section 2, we review the EC decisions for industrial cartel cases in the period 2000–2009 and extract the essential features. In Section 3, we describe the model. In Section 4, we present results consistent with the findings from Section 2. In Section 5, we offer concluding comments.

## 2 Review of EC decisions

In this section, we describe the salient empirical phenomena that emerge from a review of 21 decisions published between 2000 and 2009 regarding industrial cartels prosecuted by

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<sup>7</sup>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.

<sup>8</sup>For related discussion, see Heeb et al. (2009, p.231).

<sup>9</sup>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.

the EC antitrust authorities.<sup>10</sup> Overall, the EC decisions provide an excellent description of many aspects of the market and industry, as well as cartel conduct.<sup>11</sup> In what follows, we refer to the EC decisions by their case names. See Appendix A for the formal references.

As background, most cartels in our sample have a high aggregate market share. Some control the entire market. As shown in Table 1, four of the cartels in our sample have close to or exactly 100% market share, four have a market share around 90%, and the rest have market shares less than 90%.

Table 1: EC Cartel and Price-Fixing Decisions (2000–2009)

Case name	Number of cartel members	Cartel market share	Cartel concordance	Dominant-firm conduct reported
Amino Acids (Lysine)	5	almost 100%	very discordant	no
Carbonless Paper	11	85-90%	concordant	no
Choline Chloride	6	82%	very discordant / very concordant*	no
Citric Acid	5	1991 - 70%, 1993 - 60%, 1994 - 52%	discordant	no
Copper Plumbing Tubes	8	79%	concordant	yes
Electrical and Mechanical Carbon and Graphite Products	6	90%+	very concordant	yes
Flat Glass	4	about 80%	concordant	no
Food Flavour Enhancers	4	almost 100%	discordant	no
Graphite Electrodes	8	almost 100%	concordant	no
Industrial and Medical Gases	7	about 90%	discordant	no
Industrial Tubes	6	60-90%	discordant	no
Methionine	4	60-70%	very concordant	yes
Methylglucamine	2	100%	very concordant	no
Organic Peroxides	5	70-80%	very concordant	yes
Plasterboard	4	90%+	discordant	no
Rubber Chemicals	4	58%	discordant	no
Sorbates	5	70-80%	very concordant	yes
Specialty Graphite (Isostatic)	8	75-90%	very concordant	yes
Vitamins	13	70%+	concordant	yes
Zinc Phosphate	6	90%+	discordant	no

\*According to our criteria, the global Choline Chloride cartel (1992-1994) was very discordant, but the European cartel (1994-1999) was very concordant.

In Table 1, for each cartel in our sample, we report the number of cartel members, the market share of the cartel,<sup>12</sup> our assessment of cartel concordance, which we describe later, and our assessment of whether the EC decision describes dominant-firm conduct.

<sup>10</sup>We have excluded five EC decisions from the period 2000–2009 because they relate to products that are not industrial in nature: *Interbrew (beer)*, *Visa Credit Card Network*, *Bank Cards*, *Professional Videotape*, and *Fine Art Auction Houses*. We have also excluded *Soda Ash* because it is, at its essence, a monopolization case. A detailed review of recent EC cartel cases can be found in Harrington (2006).

<sup>11</sup>We recognize that the EC decisions for these cartel cases, which focus on documenting the suppression of within-cartel rivalry, may have omitted descriptions of dominant-firm conduct by the cartels.

<sup>12</sup>We use the relevant market as defined by the EC. In some cases, the data in the EC decision provides

## 2.1 Large pre-cartel firms do not remain outside a cartel

Firms with relatively large pre-cartel market shares typically join the cartel, while the outsiders, if there are any, are the firms with relatively small pre-cartel market shares.<sup>13</sup> For example, the *Specialty Graphite* cartel consisted of eight members that controlled 75%–90% of the world market throughout the years 1993–1998. Based on the EC decisions, this was an effective cartel. The top-two world producers of specialty graphite products, SGL and LCL, together accounted for about two-thirds of the world market. They were the founders and leaders of the cartel. According to the EC decision, “SGL was the leader and instigator of the infringement in the isostatic specialty market. It was this undertaking which took the initiative to launch the cartel and steered its development throughout the infringement period.”<sup>14</sup> The EC also concludes that “LCL had played a specific leading role in the isostatic specialty cartel.”<sup>15</sup>

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.<sup>16</sup>

In some cases (e.g. *Flat Glass*, *Choline Chloride*), the market shares were fairly evenly distributed across the cartel members, and we cannot identify a clear leader. Nevertheless, in these cases, the large producers joined the cartel at an early stage. In addition to these examples, in all other cartel cases that we have reviewed, the evidence suggests that the largest producers typically do not remain outside of an existing cartel.<sup>17</sup>

## 2.2 Conduct towards small non-cartel firms

Cartel members may threaten relatively small non-cartel firms with predatory conduct in order to coerce participation in the cartel. For example, in the case of *Electrical and Mechanical Carbon and Graphite Products*, one of the cartel members, Hoffmann, was a

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only approximations regarding the cartel’s market share. For example, the table contains entries such as 70–80%, by which we mean that the cartel’s share was described as being in this interval. When exact shares are not available, we approximate the share using statements in the decision such as, “the cartel controlled more than 2/3 of the market” or “top 2 companies accounted for almost one half of the market.” Or sometimes, there are statements like “non-cartel firms’ total share was less than 7%,” allowing us to infer the cartel’s market share. The relevant paragraph numbers in the EC decisions for the market shares are provided in Table B.1 in Appendix B.

<sup>13</sup>Non-cartel firms that were relatively small just prior to the cartel’s formation can become much larger during the cartel period.

<sup>14</sup>*Specialty Graphite (Isostatic)*, paragraph 485.

<sup>15</sup>*Specialty Graphite (Isostatic)*, paragraph 486.

<sup>16</sup>*Vitamins*, paragraphs 160, 244, 271, 196, 330, 354, 388, 459, 484, 520.

<sup>17</sup>The relevant paragraph numbers in the EC decisions regarding our assessment that large pre-cartel firms do not remain outside a cartel are collected in Table B.1 in Appendix B.

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.<sup>18</sup>

There are other cartels in our sample in which smaller members join the cartel after pressure from existing participants. Examples include Gyproc in *Plasterboard*,<sup>19</sup> Sewon and Cheil in *Amino Acids*,<sup>20</sup> smaller Japanese producers in *Graphite Electrodes*,<sup>21</sup> Cheil in *Food Flavor Enhancers*,<sup>22</sup> Gerestar Bioproducts in *Citric Acid*,<sup>23</sup> the five smaller producers in *Industrial and Medical Gases*,<sup>24</sup> several small firms in *Carbonless Paper*,<sup>25</sup> Nippon Soda and Sumitomo in *Methionine*,<sup>26</sup> six small firms in *Specialty Graphite (Isostatic)*,<sup>27</sup> Perosa and Laporte in *Organic Peroxides*,<sup>28</sup> and several small producers in *Copper Plumbing Tubes*.<sup>29</sup>

There are cases where small firms do not join cartels. For example, in *Vitamins* there were small non-cartel fringe players for many of the individual vitamins, including A, E, B1, B2, B5, and B6.<sup>30</sup> The *Vitamins* cartel was recognized by the EC as being effective despite there being numerous non-cartel fringe firms.<sup>31</sup> This is consistent with the US Department of Justice securing criminal fines of \$500 million against Roche and \$225 million against BASF.<sup>32</sup>

*Electrical and Mechanical Carbon and Graphite Products* provides a good illustration of a range of predatory conduct by a cartel. The quote provided at the beginning of this paper describes the cartel's strategy of driving non-cartel firms out of business. A number of examples of implementation of such dominant-firm conduct by the cartel are provided in the decision.<sup>33</sup> The EC concludes that "these different actions took care of virtually all of

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<sup>18</sup> "A degree of uncertainty exists regarding the precise moment when Hoffmann first started to participate in the illegal activities of the cartel. In the early years of the cartel ... there is no evidence of Hoffmann's participation in cartel meetings. In those years, Hoffmann was usually mentioned in agenda's of cartel meetings under the heading of 'Competition' and the participants in the discussion would regularly complain about Hoffmann's behavior in the market." (*Electrical and Mechanical Carbon and Graphite Products*, paragraph 198)

<sup>19</sup> *Plasterboard*, paragraphs 3, 489, 510–512, 565, 570–572.

<sup>20</sup> *Amino Acids*, paragraphs 102, 110, 128, 358–60, 361, 364.

<sup>21</sup> *Graphite Electrodes*, paragraph 46.

<sup>22</sup> *Food Flavour Enhancers*, paragraphs 193–195.

<sup>23</sup> *Citric Acid*, paragraphs 189–192.

<sup>24</sup> *Industrial and Medical Gases*, paragraphs 443–447.

<sup>25</sup> *Carbonless Paper*, paragraphs 105–106.

<sup>26</sup> *Methionine*, paragraph 82.

<sup>27</sup> *Specialty Graphite (Isostatic)*, paragraphs 479–480.

<sup>28</sup> *Organic Peroxides*, paragraphs 415–417, 422.

<sup>29</sup> *Copper Plumbing Tubes*, paragraph 597.

<sup>30</sup> *Vitamins*, paragraph 123.

<sup>31</sup> *Vitamins*, paragraphs 667–672.

<sup>32</sup> See [http://www.justice.gov/atr/public/press\\_releases/1999/2450.htm](http://www.justice.gov/atr/public/press_releases/1999/2450.htm).

<sup>33</sup> *Electrical and Mechanical Carbon and Graphite Products*, paragraphs 168–173.

the ‘outsiders’ active in the EEA market.”<sup>34</sup> That is, the cartel succeeded in monopolizing the entire market by means of its members’ coordinated efforts.

## 2.3 Collusive mechanisms

The majority of the cartels in our sample use a market share allocation scheme. Some cartels use customer allocations or geographic allocations.<sup>35</sup> A few cartels use a combination of these schemes. In Table B.2 in Appendix B, we characterize the market allocation mechanisms used by the cartels in our sample. The references to the relevant paragraph numbers in the EC decisions are provided.

As shown in Table B.2, it is common in our sample for cartels to freeze market shares at their levels during a 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.”<sup>36</sup>

Baseline market shares were also important in folic acid:

“As with all other vitamins, the basis of the collusive arrangements for folic acid was the establishment of a quota scheme. The fundamental principle of the quota allocation scheme was the division of the world market between Roche on the one hand and the three Japanese producers on the other; on the basis of achieved 1990 results, Roche was given 42 %, the Japanese 58 %. The Japanese producers agreed the division amongst themselves of their 58 % quota on the basis of their respective 1990 achieved sales performance. The annual quotas (by region) in volume terms had to maintain the agreed 42:58 division overall, while allowing for natural growth rate.”<sup>37</sup>

The *Organic Peroxides* cartel used sales from 1969–1970 to set sales quotas for 1971.<sup>38</sup> Market shares were also fixed at the level achieved in the year(s) prior to the cartel in: *Car-*

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<sup>34</sup> *Electrical and Mechanical Carbon and Graphite Products*, paragraph 173.

<sup>35</sup> Posner (1976) highlights three cartel organizations: a customer allocation, a geographic allocation, and a market share allocation. Posner states, “If the major firms in a market have maintained identical or nearly identical market shares relative to each other for a substantial period of time, there is good reason to believe that they have divided the market (whether by fixing geographical zones or sales quotas or by an assignment of customers), and thereby eliminated competition, among themselves.” Posner (1976, p.62)

<sup>36</sup> *Vitamins*, paragraph 189.

<sup>37</sup> *Vitamins*, paragraph 357.

<sup>38</sup> *Organic Peroxides*, paragraph 85.

*bonless paper, Specialty Graphite (Isostatic), Electrical and Mechanical Carbon and Graphite Products, Industrial Tubes, Rubber Chemicals, and Graphite Electrodes.*<sup>39</sup>

Instead of pre-cartel market shares in one recent year, some cartels used the average historic market shares of each firm to determine sales quotas. For example, in *Zinc Phosphate*, “respective market shares were initially calculated in 1994 on the basis of the figures for the years 1991 to 1993. Each cartel member had to adhere to its allocated market share.”<sup>40</sup> Similarly, the *Sorbates* cartel used four-year average market shares: “the corresponding volume allocation between the Japanese producers was based on the average of their actual sales volumes from 1973 to 1977.”<sup>41</sup> The *Citric Acid* cartel used the average of each firm’s sales over 1988–1990 to set sales quotas in 1991.<sup>42</sup>

Larger cartel members generally favored maintaining the fixed market share agreement. As the EC notes in the *Sorbates* cartel, “the amount of sales for each company was limited according to the fixed market share: the companies with the greatest market shares benefited most from maintaining the status quo, and were the most insistent on making sure market share levels remained unchanged.”<sup>43</sup> In contrast, there are examples in which smaller members were dissatisfied with their cartel shares and tried to renegotiate their position in the cartel, but the larger firms were reluctant to grant concessions to smaller ones. For example, when the top vitamin producers and the cartel leaders, Roche and BASF, discussed smaller cartel member Takeda’s allocated market share of 13.5%, BASF noted, “If they go higher → war ?”<sup>44</sup>

There are cases in our sample in which the cartel’s inability to reach an agreement over the market shares led members to exit the cartel. One of the members of the *Copper Plumbing Tubes* cartel, Wieland, described the disagreement among the cartel members in a memo to other participants, indicating that several smaller companies attempted to increase their sales beyond their fixed pre-cartel levels. The top member, KME group, insisted on maintaining the prevailing market shares. As Wieland reports, this was “jeopardizing everything we (the cartel) have achieved so far just because of the KME/BCZ WICU dispute and the resulting exit of BCZ.”<sup>45</sup>

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<sup>39</sup>See the references in Table B.2.

<sup>40</sup>*Zinc Phosphate*, paragraph 66.

<sup>41</sup>*Sorbates*, paragraph 106.

<sup>42</sup>*Citric Acid*, paragraph 81.

<sup>43</sup>*Sorbates*, paragraph 109.

<sup>44</sup>*Vitamins*, paragraph 273.

<sup>45</sup>*Copper Plumbing Tubes*, paragraph 350.

## 2.4 Cartel concordance

In a number of the cases in our sample, it appears the cartel unsuccessfully struggled to suppress rivalry among its members, as evidenced by frequent bargaining problems and departures from the collusive mechanism (e.g., the inability to reach an agreement over market shares and prices, violations of agreed market shares or assigned quotas, or undercutting other cartel members).

In order to analyze dominant-firm conduct by cartels, we introduce the notion of cartel concordance. As shown in Table 1, we characterize each cartel according to the following four concordance categories:

- *very discordant*: We find evidence of frequent bargaining problems and deviations by the cartel members, occurring almost throughout the entire cartel period.
- *discordant*: We find evidence of a few bargaining problems and deviations by the cartel members.
- *concordant*: We find almost no actual deviations. The cartel could have experienced some minor bargaining problems, e.g., certain members were dissatisfied with their position in the cartel and/or the agreement over market shares was not reached easily and/or only after several meetings, negotiations and renegotiations.
- *very concordant*: We find no signs of deviations and not even minor bargaining problems.

Cartel concordance, defined this way, measures only the extent of deviations by the cartel members from different aspects of the collusive mechanism. In Table B.3 in Appendix B, we provide the references to the paragraphs in the EC decisions that support our classification. For cartels labelled as very concordant, there are no paragraph references because that label denotes the absence of any reported deviations by the EC.

As an illustration, the *Amino Acids* cartel, which is labeled as very discordant, was confronted by discipline problems throughout the cartel period. Despite regular cartel meetings, most of the price and quantity agreements reached during these meetings were short-lived or not implemented at all. Constant disagreements over sales quotas, as well as frequent deviations and price wars among the members, undermined the concordance of the cartel.<sup>46</sup> The EC found that “the absence of a comprehensive agreement on production quotas was

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<sup>46</sup>The evidence provided in *Amino Acids* paragraphs 66, 69, 73, 77, 87, 89–91, 93, 98, 101–102, 109–110, 118, 134, 143, 145, and 340 confirms that such deviations often took place.

felt to be a destabilizing factor in terms of the relationship between the producers.”<sup>47</sup> As a result of numerous failures to implement cartel policies, the participants “blamed each other for not respecting the price agreements. Consequently, the relationships among the producers deteriorated.”<sup>48</sup>

Deviations by the members also occur in discordant cartels, but they are not as pervasive as in very discordant cartels. For example, in the case of the *Citric Acid* cartel, one of the members, 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 ... the main point of discussion was the lack of discipline on the part of certain members vis-a-vis adherence to the agreement that all customers (except the five largest) were to pay the list price. In particular, ADM and Haarmann & Reimer expressly accused Jungbunzlauer of this lack of discipline.”<sup>49</sup>

In the *Industrial Tubes* cartel, which we classify as discordant, “no punishment mechanism was agreed upon or implemented and deviation occurred frequently. When cheating occurred, the cheated member attempted to gain back lost market shares, for instance, by making competitive offers to the cheater’s customers, which led to ‘price wars’.”<sup>50</sup>

In contrast, the larger members of concordant cartels effectively disciplined the behavior of smaller ones so that deviations never happened or were only occasional. For example, in the *Carbonless Paper* cartel, “it appears that AWA’s threats worked better on the smaller competitors. Mougeot claims that in view of the small scale of their production the sanctions and threats they received were limited to reprimands (‘reproches’), to which they replied by promising to implement any future price increases.”<sup>51</sup>

In the case of the *Vitamins* cartel, despite occasional deviations by the smaller members, the cartel leaders, Roche and BASF, effectively used their joint market power to ensure compliance with the agreements by the smaller cartel members. For example, the EC reports that “Roche and BASF senior executives went (separately) to Japan in order to persuade Takeda to agree to the proposed market allocation in vitamin B2, which it ultimately did by late1991/early 1992.”<sup>52</sup>

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<sup>47</sup> *Amino Acids*, paragraph 87.

<sup>48</sup> *Amino Acids*, paragraph 91.

<sup>49</sup> *Citric Acid*, paragraph 117.

<sup>50</sup> *Industrial Tubes*, paragraph 105.

<sup>51</sup> *Carbonless Paper*, paragraph 106.

<sup>52</sup> *Vitamins*, paragraph 274.

## 2.5 Relation between dominant-firm conduct and cartel concordance

As shown in Table 1, we record for each cartel whether the EC decision reports dominant-firm conduct. For the assessment of whether dominant-firm conduct is reported in the decisions, we rely in part on Table 1 of Heeb et al. (2009), which identifies in the EC decisions the following types of dominant-firm conduct: (i) harming non-cartel rivals directly, (ii) harming non-cartel rivals through buyers by using contracts with cartel buyers or by targeting non-cartel buyers, (iii) harming non-cartel rivals through suppliers by using contracts with cartel suppliers or by targeting non-cartel suppliers, (iv) harming potential entrants, (v) harming substitutes, or (vi) eliminating non-cartel rivals by purchasing them.

Although Heeb et al. (2009) identify the *mention* of dominant-firm conduct in the EC decisions, we use a stricter criterion by additionally requiring that the conduct was actually implemented and harmful to existing non-cartel rivals. In all but two cases, our assessment agrees with that of Heeb et al. (2009). In the case of *Citric Acid*, although Heeb et al. (2009) cite paragraphs mentioning the cartel’s intention to pursue dominant-firm conduct, we find no indication that the conduct was implemented, so we list *Citric Acid* as showing no dominant-firm conduct. In the case of *Graphite Electrodes*, the cartel was essentially all inclusive, so the agreement “not to transfer technology outside the circle of cartel participants” (*Graphite Electrodes*, paragraph 2) does not satisfy our criterion of harm to existing non-cartel rivals.<sup>53</sup> We list this cartel as showing no dominant-firm conduct. Finally, the *Flat Glass* and *Butadiene Rubber and ES Butadiene Rubber* decisions are not included in the analysis of Heeb et al. (2009), so we reviewed those decisions independently, finding no dominant-firm conduct in either case.

The fact that we do not have evidence of dominant-firm conduct based on the EC decision for a cartel does not exclude the possibility that such conduct existed. It means only that the EC did not describe it in its decision. Nevertheless, we find a clear pattern in the cases. We find that the less-than-all-inclusive cartels that were discordant or very discordant did not engage in dominant-firm conduct,<sup>54</sup> while several less-than-all-inclusive cartels that were concordant or very concordant tended to engage in dominant-firm conduct.

As shown in Table 1, the cartels that engaged in dominant-firm conduct were concordant. Also, the concordant cartels often engage in such conduct. This empirical regularity is consistent with the intuition that, “once a cartel controls intra-cartel rivalry, it moves on to

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<sup>53</sup>It may have been harmful to potential non-cartel rivals by creating a barrier to entry.

<sup>54</sup>Discordant and very discordant cartels can be divided into two sub-categories: cartels that intended to predate against the competitors but never implemented their intentions (e.g., *Citric Acid* and *Plasterboard*), and those that, as far as is reported in the EC decision, did not consider predation at all.

implement practices designed to diminish competition from existing and potential non-cartel rivals.” (Heeb et al., 2009, p.223)

## 2.6 Summary

The EC cartel decisions since 2000 reveal the following phenomena:

1. At the time a cartel forms, large firms in the industry are members of the cartel.<sup>55</sup>
2. Cartels typically allocate collusive gains and share cartel costs according to their pre-cartel market shares.
3. If a cartel exists in an industry, small firms may or may not be members of the cartel.
4. Non-cartel firms are left alone, threatened, or eliminated by a cartel.
5. The extent of deviant conduct by cartel members varies between cartels.
6. Cartels that are concordant often engage in dominant-firm conduct, while cartels that are discordant do not engage in such conduct.

## 3 Model

In this section, we propose a model with three firms in an industry. The firms confront the question of whether or not to participate in an explicit cartel. Participation decisions are taken sequentially. If the cartel consists of only two of the three firms, the cartel may or may not be able to exclude the third firm from the market. We define cartel concordance as an exogenous state of the world that determines the cartel’s ability to exclude the non-cartel rival from the market. We model exclusionary behavior by assuming that when a two-firm cartel is concordant, the cartel can eliminate the third firm from the market at cost  $k$ . If a two-firm cartel is discordant, then the cost to eliminate the third firm is prohibitively high. We assume the firms in a concordant cartel 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.

Consistent with the timing as it occurs in practice, we model the cartel participation decision as being prior to the realization of cartel concordance. If cartel concordance was

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<sup>55</sup>As an industry evolves, especially in the presence of a cartel, the size of external firms may increase. For example, by the time the *Vitamins* cartel collapsed, non-cartel firms produced more than 30% of the world market for vitamin C and, in aggregate, were larger than any cartel producer of vitamin C except Roche. (*Vitamins*, paragraph 670)

never in doubt then, for sufficiently low  $k$ , the third firm would always want to join the cartel because it would be eliminated as an outside firm. If it were known that the cartel would never achieve concordance, then the third firm would often want to remain outside the cartel, undercutting the price umbrella provided by the cartel.

### 3.1 Timing

The timing in the model is as follows:

- $t = 1$  (cartel formation): Firms 1 and 2 decide to form a cartel or not. If a cartel of 1 and 2 forms, this is observed by firm 3, and the cartel can offer to include firm 3 in the cartel. We assume firms 1 and 2 must both agree in order to extend the offer to firm 3.<sup>56</sup> If the offer is made, then firm 3 either accepts or rejects the offer.<sup>57</sup>
- $t = 2$  (cartel concordance): The state of the world is realized, either concordant with probability  $\rho$  or discordant with probability  $1 - \rho$ . This state remains in place throughout time.<sup>58</sup>
- $t = 3$  (market outcome): The market outcome is: *noncooperative* if no cartel formed in  $t = 1$ ; *all-inclusive* if a cartel of 1, 2, and 3 formed in  $t = 1$ ; *non-all-inclusive* if a cartel of only 1 and 2 formed in  $t = 1$  and the state realized in  $t = 2$  is discordant or the state is concordant and firms 1 and 2 choose not to incur cost  $k$  to exclude firm 3; and *exclusionary* if only 1 and 2 formed a cartel in  $t = 1$ , the state realized in  $t = 2$  is concordant, and firms 1 and 2 choose to incur cost  $k$  to exclude firm 3.
- $t \geq 4$  : Payoffs are determined.

As we show in Section 4, for a price competition model of oligopoly, there exist parameters for our model such that in equilibrium one of the three firms chooses to remain outside of the cartel and then, with some probability, is able to either (i) profitably free ride on the suppression of rivalry created by the cartel or (ii) is driven from the market. The third firm is driven from the market if the cartel is concordant, but it benefits from the cartel's suppression of rivalry if the cartel is discordant. The advantage of functioning outside the cartel appears to be more substantial for smaller firms. Thus, the model provides a theoretical framework that is consistent with the characterization of cartels described in Section 2 and in the related literature.

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<sup>56</sup>The assumption is not critical. In our model, both cartel members have the same incentive constraint.

<sup>57</sup>As discussed in Sections 2.1 and 2.2, large firms form the foundation of a cartel and then smaller firms are invited to join. In the numerical examples we consider, firms 1 and 2 are at least as large as firm 3.

<sup>58</sup>One can view the state as determining the cost of predation, where it is  $k$  if the cartel is concordant and  $\infty$  if the cartel is discordant.

### 3.2 Equilibrium behavior

We define the payoffs associated with the four possible competition outcomes: *noncooperative*, *all-inclusive*, *non-all-inclusive*, and *exclusionary*. As notation, we let  $\pi_i^{nc}$  denote firm  $i$ 's noncooperative payoff,  $\pi_i^{all}$  denote firm  $i$ 's payoff in the all-inclusive outcome,  $\pi_i^{non-all}$  denote firm  $i$ 's payoff in the non-all-inclusive outcome, and  $\pi_i^{excl}$  denote firm  $i$ 's payoff in the exclusionary outcome, where  $\pi_3^{excl} = 0$ . We break ties in favor of the larger cartel forming.

We assume that for  $i \in \{1, 2\}$ ,  $\pi_i^{excl} > \pi_i^{all}$ , which says that firms 1 and 2 have higher payoffs if they collude and eliminate firm 3, not including the elimination cost  $k$ , than if they collude with firm 3. We also assume that for  $i \in \{1, 2\}$ ,  $\pi_i^{non-all} > \pi_i^{nc}$ , which says that firms 1 and 2 have higher payoffs in the non-all-inclusive cartel outcome than in the noncooperative outcome.

Working backwards, assuming that the cartel of only firms 1 and 2 has formed and that the cartel is concordant, the cartel firms eliminate firm 3 if and only if

$$k < (\pi_1^{excl} + \pi_2^{excl}) - (\pi_1^{non-all} + \pi_2^{non-all}). \quad (1)$$

When (1) holds, we let  $\lambda_i \in \mathbb{R}$  denote the share of cost  $k$  paid by firm  $i$ , with  $\lambda_1 + \lambda_2 = 1$  and for  $i \in \{1, 2\}$ ,

$$\pi_i^{excl} - \lambda_i k > \pi_i^{non-all}.$$

If (1) does not hold, exclusion does not occur in the continuation game and so firms 1 and 2 offer to include firm 3 in the cartel if  $\pi_1^{all} \geq \pi_1^{non-all}$  and  $\pi_2^{all} \geq \pi_2^{non-all}$ .

If (1) holds, then at the time of cartel formation (before cartel concordance is realized), firms 1 and 2 offer to include firm 3 in the cartel if for  $i \in \{1, 2\}$ ,

$$\pi_i^{all} \geq \rho(\pi_i^{excl} - \lambda_i k) + (1 - \rho)\pi_i^{non-all}. \quad (2)$$

Condition (2) together with the assumption that for  $i \in \{1, 2\}$ ,  $\pi_i^{excl} > \pi_i^{all}$ , implies that the cartel does not extend an invitation to firm 3 if  $k$  is sufficiently low and  $\rho$  is sufficiently high.

Firm 3 prefers to join the cartel if and only if its expected payoff from an all-inclusive cartel is weakly greater than its expected payoff from remaining outside the cartel. If (1) does not hold, 3 prefers to join if  $\pi_3^{all} \geq \pi_3^{non-all}$ , and if (1) holds, then 3 prefers to join if

$$\pi_3^{all} \geq (1 - \rho)\pi_3^{non-all}. \quad (3)$$

If conditions are such that the all-inclusive cartel does not form, then firm  $i \in \{1, 2\}$  has expected payoff from forming a cartel of either  $\pi_i^{non-all}$  or  $\rho(\pi_i^{excl} - \lambda_i k) + (1 - \rho)\pi_i^{non-all}$ ,

depending on the size of  $k$ . It follows from the definition of  $\lambda_i$  and the assumption that for  $i \in \{1, 2\}$ ,  $\pi_i^{non-all} > \pi_i^{nc}$  that firms 1 and 2 always prefer cartel formation over the noncooperative outcome, thus the noncooperative outcome never occurs in the equilibrium of this model.

We summarize in Tables 2 and 3 below.

Table 2: Summary of model outcomes if (1) holds

Conditions (2) and (3)	Concordance realization	Market outcome
hold		all-inclusive
do not hold	discordant	non-all-inclusive
do not hold	concordant	exclusionary

Table 3: Summary of model outcomes if (1) does not hold

for $i \in \{1, 2, 3\}$ , $\pi_i^{all} \geq \pi_i^{non-all}$	Concordance realization	Market outcome
holds		all-inclusive
does not hold	concordant or discordant	non-all-inclusive

If conditions (1), (2), and (3) are satisfied, the all-inclusive cartel forms. In addition, if (1) is not satisfied and all firms prefer the all-inclusive cartel over the non-all-inclusive cartel, then the all-inclusive cartel forms. In the remaining cases, the cartel of firms 1 and 2 forms and remains a cartel of just two firms, with firm 3 remaining outside the cartel or being eliminated, depending on the realization of cartel concordance and the elimination cost  $k$ .

**Proposition 1** *If  $k < (\pi_1^{excl} + \pi_2^{excl}) - (\pi_1^{non-all} + \pi_2^{non-all})$  and either  $\rho > \max_{i \in \{1, 2\}} \frac{\pi_i^{all} - \pi_i^{non-all}}{\pi_i^{excl} - \pi_i^{non-all} - \lambda_i k}$  or  $\rho < \frac{\pi_3^{non-all} - \pi_3^{all}}{\pi_3^{non-all}}$ , the all-inclusive cartel does not form, and instead firms 1 and 2 form a cartel, which eliminates firm 3 if and only if the cartel is concordant.*

*Proof.* The proof follows from Table 2 and conditions (2) and (3). Q.E.D.

In Section 4, we describe a model of oligopolistic interaction based on price competition and provide numerical examples showing that for certain parameterizations, the conditions for the formation of an all-inclusive cartel are not satisfied, so the equilibrium outcome is exclusionary or non-all-inclusive, depending on the outcome of cartel concordance.

## 4 Price competition model of oligopoly

There are three firms, 1, 2, and 3, competing in a differentiated products oligopoly. We assume firms have capacities equal to their unconstrained noncooperative outputs. These capacity constraints do not bind on colluding firms, which reduce output as a result of the suppression of rivalry, but can bind on firm 3 when it operates outside the cartel.

We adopt a symmetric version of the model presented in Singh and Vives (1984), although we extend the model to allow three firms. We work with inverse demand functions

$$p_i = 1 - q_i - \sum_{j \neq i} s q_j,$$

where  $s \in (0, 1)$ .<sup>59</sup> As one can see from these demand functions, the market price for firm  $i$ 's product is decreasing in its own quantity. This is a standard downward sloping demand curve. The market price for firm  $i$ 's product is also decreasing in the quantities produced by firm  $i$ 's rivals; however, because  $s$  is less than one, the impact on firm  $i$ 's price of an increase in the rivals' total quantity is less than the impact of an equal increase in firm  $i$ 's own quantity.

We assume firm  $i$  has constant marginal cost  $c_i < 1$  up to its capacity constraint and zero fixed costs. Thus, firm  $i$ 's payoff is equal to its price minus its marginal cost, times the quantity it produces:  $(p_i - c_i)q_i$ .

### 4.1 Payoffs

To define the payoffs, we refer to the findings described in Section 2 and assume that in any market outcome involving a cartel, the cartel firms set their prices to maximize their joint payoff subject to the constraint that the firms' pre-cartel noncooperative relative market shares are maintained. Specifically, we let  $m_i$  denote firm  $i$ 's noncooperative market share, where  $m_i$  is defined as firm  $i$ 's share of the total production in the noncooperative market, i.e.  $m_i \equiv \frac{q_i^{nc}}{q_1^{nc} + q_2^{nc} + q_3^{nc}}$ , where  $q_i^{nc}$  is firm  $i$ 's noncooperative quantity. In the all-inclusive cartel, firms' quantities are constrained to maintain the noncooperative shares. In the non-all-inclusive and exclusionary outcomes, the quantities of firms 1 and 2 are constrained to maintain relative shares  $\frac{m_1}{m_1 + m_2}$  and  $\frac{m_2}{m_1 + m_2}$ .

If the market outcome is noncooperative, the equilibrium price vector  $p^{nc}$  is such that for

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<sup>59</sup>When  $s = 0$ , goods are unrelated and so collusion is meaningless within the context of this framework. The case with  $s = 1$  corresponds to perfect substitutability. We consider examples with an intermediate value for  $s$ .

all  $i$ ,  $p_i^{nc}$  solves

$$p_i^{nc} \in \arg \max_{p_i} (p_i - c_i) q_i(p_i, p_{-i}^{nc}).$$

We restrict attention to parameterizations such that all noncooperative quantities are positive.

If the market outcome is an all-inclusive cartel, then firms 1, 2, and 3 are in a cartel and choose prices to maximize their joint payoff subject to maintaining noncooperative market shares. The price vector  $p^{all}$  solves

$$p^{all} \in \arg \max_{p_1, p_2, p_3} \sum_{i=1}^3 (p_i - c_i) q_i(p) \text{ subject to for all } i, \frac{q_i(p)}{q_1(p) + q_2(p) + q_3(p)} = m_i.$$

If the market outcome is non-all-inclusive, then firms 1 and 2 are in a cartel with firm 3 outside the cartel. In this case, the cartel firms choose their prices to maximize their joint payoff subject to maintaining noncooperative relative market shares while firm 3 reacts to the cartel prices to maximize its payoff. The price vector  $p^{non-all}$  solves

$$p_3^{non-all}(p_1, p_2) \in \arg \max_{p_3} (p_3 - c_3) q_3(p) \text{ subject to } q_3(p) \leq q_3^{nc}$$

and

$$(p_1^{non-all}, p_2^{non-all}) \in \arg \max_{p_1, p_2} \sum_{i=1}^2 (p_i - c_i) q_i(p_1, p_2, p_3^{non-all}(p_1, p_2))$$

$$\text{subject to for all } i \in \{1, 2\}, \frac{q_i(p_1, p_2, p_3^{non-all}(p_1, p_2))}{q_1(p_1, p_2, p_3^{non-all}(p_1, p_2)) + q_2(p_1, p_2, p_3^{non-all}(p_1, p_2))} = \frac{m_i}{m_1 + m_2}.$$

If the market outcome is exclusionary, then firms 1 and 2, who constitute the cartel, incur a one-time cost  $k$ , and coordinate their prices to maximize their payoff, while firm 3 is eliminated from the market. The cartel chooses price  $p_1^{excl}$  and  $p_2^{excl}$  to maximize the cartel payoff, while firm 3 does not operate. In the model, this amounts to assuming that firm 3's price is such that the quantity demanded from it is zero. The price vector  $p^{excl}$  solves

$$p^{excl} \in \arg \max_{p_1, p_2, p_3} \sum_{i=1}^2 (p_i - c_i) q_i(p)$$

$$\text{subject to for all } i \in \{1, 2\}, \frac{q_i(p)}{q_1(p) + q_2(p)} = \frac{m_i}{m_1 + m_2} \text{ and } q_3(p) = 0.$$

## 4.2 Numerical examples

In this section, we provide two numerical examples. In both cases, we assume  $s = 0.6$ , but we make different assumptions about the firms' marginal costs.

The results for Example 1 are shown in Table 4. In this example, firm 1 has the lowest marginal cost and firm 2 has slightly higher marginal cost, while firm 3 has substantially higher marginal cost. As a result, in the noncooperative outcome, firms 1 and 2 have larger shares than firm 3.

As shown in Table 4, for firms 1 and 2, payoffs are increasing as the environment moves from noncooperative to non-all-inclusive, to all-inclusive, to exclusionary. However, as long as firm 3 is not eliminated, it prefers the non-all-inclusive environment over the other two.

Table 4: Example 1

	Firm 1	Firm 2	Firm 3	Total
$c_i$	0	0.05	0.20	
$m_i$	0.42	0.37	0.21	1
$\pi_i^{nc}$	0.0975	0.0747	0.0244	0.1965
$\pi_i^{non-all}$	0.1251	0.1006	0.0570	0.2828
$\pi_i^{all}$	0.1369	0.1112	0.0489	0.2970
$\pi_i^{excl}$	0.1639	0.1338	0	0.2978

Given the profit values in this example, we can calculate values of  $\rho$  and  $k$  such that firms 1 and 2 prefer to invite firm 3 to join the cartel and those such that they do not. They prefer to invite firm 3 when  $\rho$  is sufficiently small and  $k$  is sufficiently large, in which case firms 1 and 2 expect it to be unlikely and costly to eliminate firm 3, so they prefer to invite firm 3 into the cartel. However, when  $\rho$  is sufficiently small, the probability that firm 3 is eliminated is small and so firm 3 declines the invitation and remains outside the cartel. We illustrate this in Figure 1.

Given the parameters for Example 1, an unconstrained all-inclusive cartel can achieve a total payoff of 0.30. However, as shown in Table 4, the constraint that the cartel fix the collusive production shares in proportion to their noncooperative market shares reduces the total payoff below this level. In fact, with the asymmetric firms of this example, the total payoff in the exclusionary environment is greater than the total payoff in the all-inclusive environment. As we will see, this result no longer holds when firms are symmetric.

The results for Example 2 are shown in Table 5. In this example, all firms have marginal cost of zero. As a result, the noncooperative outcome is symmetric. The results for Example 2 are similar to those for Example 1, except that in Example 2, the overall surplus of the firms is maximized in the all-inclusive outcome rather than in the exclusionary outcomes

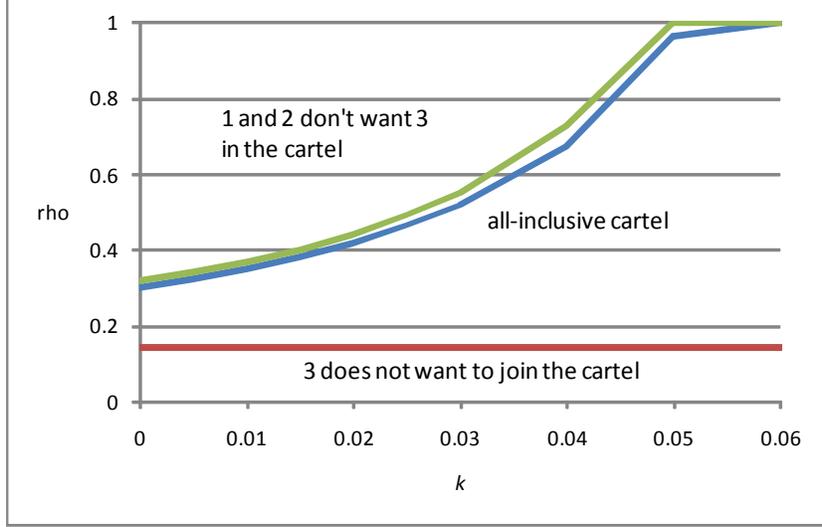


Figure 1: Cartel formation in Example 1

as in Example 1. In Example 2, an unconstrained all-inclusive cartel has total payoff of 0.3409, which is the same as the total for the all-inclusive cartel shown in Table 5 because with symmetric firms the constraint that cartel production be in the same proportions as noncooperative production does not bind.

Table 5: Example 2

	Firm 1	Firm 2	Firm 3	Total
$c_i$	0	0	0	
$m_i$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	1
$\pi_i^{nc}$	0.0727	0.0727	0.0727	0.2182
$\pi_i^{non-all}$	0.0955	0.0955	0.1248	0.3158
$\pi_i^{all}$	0.1136	0.1136	0.1136	0.3409
$\pi_i^{excl}$	0.1563	0.1563	0	0.3125

The figure showing cartel formation for different values of  $k$  and  $\rho$  for Example 2 is similar to that for Example 1, although the region where firm 3 does not want to join the cartel is smaller.

These examples show that if an all-inclusive cartels fails to form, then either colluding firms choose not to invite a third firm to join their cartel, or the excluded firm chooses not to join. Then, if the cartel turns out to be concordant, it may find it optimal to eliminate the non-cartel third firm.

## 5 Conclusion

Firms engaging in a cartel are attempting to increase their profits through an agreement to suppress competition among themselves. In this paper, we document that many cartels, once they have achieved the concordant suppression of within-cartel rivalry, go even further in pursuit of profits by engaging in dominant-firm conduct. The cartels in our sample that are described by the EC as struggling with the suppression of rivalry all have the characteristic that the EC decision does not report meaningful dominant-firm conduct.

There are numerous implications of our finding that concordant cartels engage in dominant-firm conduct to further increase their profits. First, if one observes a subset of firms in an oligopoly engaging in dominant-firm 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."<sup>60</sup> Thus, dominant-firm conduct in the absence of monopolization is a "plus factor" in inferring the existence of a cartel.<sup>61</sup>

Second, anti-competitive dominant-firm 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 dominant-firm conduct when assessing criminal penalties.

Third, we may be able to use the discovery record available in Section 1 cases to inform policy regarding Section 2 matters. An analysis of dominant-firm conduct pursued by cartels may better enable enforcement authorities to assess whether a particular dominant-firm conduct is likely to have harmful effects.<sup>62</sup> Although our review of the EC decisions suggests that the dominant-firm conduct undertaken by cartels is largely anti-competitive, this assessment requires further investigation because it may be that the EC authorities tend to highlight dominant-firm conduct that is of the greatest social concern. The discovery record that is retained by public enforcement authorities, much of which might be confidential, creates an opportunity for in-house research programs regarding dominant-firm conduct. Such analyses

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<sup>60</sup>Posner (2001, p.93) also notes that, "Cartels often have great difficulty coordinating exclusionary conduct, . . ." Posner's meaning with this assertion is unclear. We have found corroboration in that discordant cartels do not engage in exclusionary conduct.

<sup>61</sup>"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."

<sup>62</sup>For more discussion of this point, see Heeb et al. (2009).

could provide insight into dominant-firm conduct in related industries.

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 dominant-firm 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 a concordant cartel.

We conclude by noting an extension of our model. In our model, concordance is handled as an exogenous event. However, a cartel might have a greater incentive to achieve concordance if the payoff from the dominant-firm conduct were higher. The more profitable it is for a cartel to eliminate an outside firm, the more likely it may be that the cartel achieves concordance and eliminates that firm.

## A Appendix – EC decision citations

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## B Appendix – EC decision paragraph references

Table B.1: EC decision paragraph references for cartel market shares, large firms joining the cartel, and smaller cartel members having weaker participation incentives

<b>Cartel case</b>	<b>Cartel market share (global unless otherwise noted)</b>	<b>Major players are always inside a cartel</b>	<b>Smaller cartel members have weaker participation incentives</b>
Amino Acids (Lysine)	48-49, 73, 154, 267,	49-51	102, 110, 128, 358-360, 361, 364, 372-374
Butadiene Rubber and ES Butadiene Rubber*	302 (p.8), 307 (p.9), 312 (p.10), 313(p.11)	295 (p.28), 448-454	445, 496-497, fn (31)
Carbonless Paper*	16, 18, fn (22)	327-328	105-106
Choline Chloride	42	71-73	
Citric Acid	45-46, 97-98, 118	78-79	189-195
Copper Plumbing Tubes*	24-25	104-105, 583	597
Electrical and Mechanical Carbon and Graphite Products *	37	192, 194-195, 197- 198	
Flat Glass*	41	80	
Food Flavour Enhancers	21, 168, 248-249	168, 259	193-195
Graphite Electrodes	15, 21, 30, 71,	44-46	46
Industrial and Medical Gases**	77-80	101, 107	443-447
Industrial Tubes*	52, 327	78	
Methionine	43-44, 79-81, 298- 301, fn (98)	79-81	80, 82, 256
Methylglucamine	7-9	43, 68, 77	
Organic Peroxides	39-47	80, 393-394	415-417, 422
Plasterboard*	24-25, 222-223	2-3, 50	3, 489, 510-512, 565, 570-572
Rubber Chemicals	33	205-206	
Sorbates	64, 211, 339	78-79	
Specialty Graphite (Isostatic)	16-17	106, 485, 490	479-480
Vitamins	10, 27, 123	160, 244, 271, 296, 330, 354, 388, 459, 484, 520	273-274
Zinc Phosphate*	113, 219, 308	65, 102, 207	

\* Shares of the EEA market, \*\* Shares of the Netherlands market

Table B.2: Summary of market allocation mechanisms with relevant EC decision paragraph references

<b>Cartel case</b>	<b>Market allocation mechanism</b>	<b>Paragraph numbers</b>
Amino Acids (Lysine)	Combination of geographic allocation and pre-cartel market share allocation	57, 58, 211
Butadiene Rubber and ES Butadiene Rubber	Combination of customer allocation and pre-cartel market share allocation	93-98, 130
Carbonless Paper	Fix pre-cartel market shares	81
Choline Chloride	Combination of customer allocation and pre-cartel market share allocation	34, 64, 99
Citric Acid	Fix average of the last three pre-cartel years' market shares	81
Copper Plumbing Tubes	Fix pre-cartel market shares	137, 210, 350, 444
Electrical and Mechanical Carbon and Graphite Products	Fix pre-cartel market shares	2, 128, 131, 219
Flat Glass	Fix target and minimum prices, no formal market share agreement	317
Food Flavour Enhancers	Combination of geographic allocation and customer allocation	65, 68
Graphite Electrodes	Fix pre-cartel market shares	2, 71, 50, 110
Industrial and Medical Gases	Fix target and minimum prices, no formal market share agreement	101-102
Industrial Tubes	Fix pre-cartel market shares	79, 103-104, 107, 151, 195
Methionine	Fix target prices, no formal market share agreement	70-73, 213-214
Methylglucamine	Combination of customer allocation and market share allocation	43, 46, 98
Organic Peroxides	Fix pre-cartel market shares	85, 107-109, 135, 353
Plasterboard	Share information on sale volumes, no formal market share agreement	104, 429
Rubber Chemicals	Fix pre-cartel market shares	66-67
Sorbates	Fix average of the last four years' market shares	84, 106-116
Specialty Graphite (Isostatic)	Fix pre-cartel market shares	130, 141, 143, 147
Vitamins	Fix pre-cartel market shares	189-190, 245-247, 272, 300-301, 331, 357, 392, 463
Zinc phosphate	Fix average of the last three years' market shares	2, 66-68

Table B.3: EC decision paragraph references for cartel concordance

<b>Cartel case</b>	<b>Cartel concordance</b>	<b>Paragraph numbers</b>
Amino Acids (Lysine)	very discordant	66, 69, 73, 77, 87, 89-91, 93, 98, 101-102, 109-110, 118, 134, 143, 145, 340
Carbonless Paper	concordant	105, 106, 202, 212, 257
Choline Chloride	very discordant - very concordant*	64-65, 68, 72-74, 86, 89, 95-96
Citric Acid	discordant	90-91, 116-118, 125-128
Copper Plumbing Tubes	concordant	200, 321, 510
Electrical and Mechanical Carbon and Graphite Products	very concordant	
Flat Glass	concordant	361
Food Flavour Enhancers	discordant	94, 96-98, 102, 109, 114, 118, 121, 231, 237, 239, 277-278
Graphite Electrodes	concordant	106-107, 136-137, 211-215
Industrial and Medical Gases	discordant	127, 175, 443-447
Industrial Tubes	discordant	104-105, 314
Methionine	very concordant	278-279, 289, 325
Methylglucamine	very concordant	148, 177
Organic Peroxides	very concordant	
Plasterboard	discordant	229, 230, 257-262, 264-265,
Rubber Chemicals	discordant	210, 212, 234, 288
Sorbates	very concordant	
Specialty Graphite (Isostatic)	very concordant	
Vitamins	concordant	273-274, 449, 713-714, 727, 732
Zinc Phosphate	discordant	122-124, 144-147, 271, 290-297

\*According to our criteria, the global Choline Chloride cartel (1992-1994) was very discordant, but the European cartel (1994-1999) was very concordant.

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