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How Do Cartels Operate?*

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Abstract

This paper distills and organizes facts about cartels from about 20 European Commission decisions over 1999-2004. It describes the properties of a collusive outcome, monitoring and punishment methods for enforcing it, the frequency of meetings, the organizational structure of cartels, and what preceded cartel formation.

1 Introduction

A recent paper reviewed various approaches to detecting collusion using market data (Harrington, 2006). The efficacy of looking for patterns in prices and quantities relies on knowing what to look for. What does cartel behavior look like? How is it distinguishable from competitive behavior? Towards better addressing those questions, this paper delves deeper into cartels and explores how they operate. How a collusive outcome - in terms of price and an allocation of market supply - is determined. How a collusive outcome is monitored and enforced. How often a cartel meets and how a cartel's organizational structure is designed. And, finally, what preceded the cartel's formation. The hope is that such an exercise will produce a better understanding of how cartels operate and generate a richer set of collusive markers based on market data.

This paper does not engage in an empirical analysis as it is normally conceived. Rather, the approach is to glean what one can from about 20 cartels for which there is detailed information.¹ Though we will not be able to draw any definitive (that

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¹It is more in the style of the classic studies by Stocking and Watson (1946, 1948) and Hay and Kelley (1974).

is, statistically significant) conclusions and indeed any claims are necessarily speculative, this is partially offset by being able to offer finer details about cartels which will suggest a richer set of collusive markers. It needs to be emphasized that the case studies are largely confined to providing information during the episode of collusion. Thus, claims about how cartel behavior differs from competitive behavior will either rely on using general knowledge of competitive behavior (rather than knowledge about how this particular industry behaves when firms are not colluding) or reported information about how the colluding firms sought to change their practices.

In addition to making progress on identifying collusive markers, this analysis may also have implications for future directions in the theory of cartels. By identifying empirical regularities and institutional features of hard-core cartels, this information can be used to guide theoretical modelling. The next big step in the theory of collusion is apt to be the construction of models of hard-core cartels that take account of the manner in which firms coordinate and communicate and the realities of dealing with firm asymmetries. As firms run the risk of incurring penalties by engaging in explicit collusion, a simple revealed preference argument tells us that the outcomes under explicit collusion must be different from those under tacit collusion. What is needed are models that are designed for hard-core cartels and this requires using the rich institutional detail that case studies offer.²

The primary source material for this study are European Commission decisions over 1999-2004. These cases comprise cartel activity going back to the 1970s though largely cover activity in the 1980s and 90s. While the Antitrust Division of the U.S. Department of Justice regularly issues Press Releases, these are typical one or two pages in length which provide minimal details as to how cartels actually function. In contrast, the European Commission decisions can range from 30 to over 200 pages and provide vast information on the manner in which firms colluded. In collecting these cases, I sought to use every decision dealing with collusion for which there was extensive material available at two online sources: *Official Journal of the European Union*³ and "Cases" at *DG Competition of the European Commission*.⁴ I am likely to have missed some cases but it is reasonable to suppose that my sampling process was unbiased.

There have been several recent studies that perform a similar exercise to that conducted in this paper. Connor (2001) offers a highly detailed description and analysis of cartel behavior, though his focus is restricted to the citric acid, lysine, and vitamins cartels. Levenstein and Suslow (2001, 2004) provide case studies of bromine, citric acid, graphite electrodes, seamless steel tubes, and vitamins but their analysis is more structural - characterizing industry conditions - with less coverage of cartel operations. Using a large set of European Commission and U. S. Department of

²One might argue that explicit collusion may only entail meeting once to coordinate on behavioral rules that are identical to what would have emerged under tacit collusion. To the contrary, hard-core cartels meet frequently and regularly. Firms are then continually running the risk of discovery and presumably they do so because these meetings generate more profitable outcomes than tacit collusion.

³<<http://europa.eu.int/eur-lex/lex/JOIndex.do>>

⁴<<http://europa.eu.int/comm/competition/antitrust/cases>>

Justice decisions on price-fixing, Grout and Sonderegger (2005) provide a comprehensive examination of cartels. Their analysis focuses on identifying industry traits that result in cartel formation, while my emphasis is on describing cartel behavior. From the perspective of screening for cartels, their study is useful for implementing a structural screening approach - identifying those industries for which a cartel is likely to emerge - while the current study is designed to support a behavioral screening approach - identifying patterns in market data consistent with a cartel operating.

Section 2 reviews the agreements made regarding price and the allocation of the market. Procedures for sustaining that agreement are discussed in Section 3 and this includes monitoring, punishments, and the handling of external disruptions. Section 4 focuses on the frequency of meetings and the organizational structure of the cartel, while Section 5 investigates the circumstances surrounding the formation of a cartel. After a few brief concluding remarks in Section 6, Appendix A offers, by way of background, a brief description of each of the industries - product description, geographic markets, companies, and cartel duration - and Appendix B lists the primary sources used in the study.

2 What are the properties of a collusive outcome?

Of the cartels reviewed, the canonical collusive outcome is characterized by an agreement in both price and the allocation of supply across cartel members. Let me briefly summarize some of the findings of this section. In Section 2.1, I discuss agreement with respect to price. In all cartels, firms had common prices. When the product was homogeneous - such as vitamins or gases - this was a straightforward exercise. When there was a wide array of feasible products, the cartel would either agree to a set of standardized products or use a sophisticated pricing rule that conditioned on the features of the product. Collusion not only meant higher prices but typically fewer prices, with a smaller number of discounts and less variation in prices across customer types. Collusion also extended to prices for ancillary services and non-price dimensions in order to avoid cheating through alternative means. Though, when collusion spanned markets with different currencies, the cartel strived to avoid arbitrage opportunities, this often proved challenging and, as a result, significant differences in prices emerged. The implementation of the collusive price was typically characterized by a gradual change in price with firms making this price change in a staggered manner.

In Section 2.2, the allocation of supply is described. Almost all cartels had a market-sharing scheme that either involved setting sales quotas or allocating customers or territories; a cartel might use one or more of these schemes. In implementing sales quotas, firms would often exchange information to arrive at some shared assessment of market size and then, based on that assessment, set minimum volumes or an allocation of market shares. It was common to freeze market shares at their levels in the one to three years prior to cartel formation. In some cases, there was tremendous stability in market shares over time. Historical precedence was also used in implementing a customer allocation scheme. A reduction in imports was a property of

several cartels as they implemented the home-market principle which specified that a firm should be given preference in supplying its domestic market.

2.1 Price

What it means to "collude in price" varied greatly across the cartels examined. The members of the lysine cartel viewed one market for lysine - the global market - and thereby coordinated on a single price. The citric acid cartel had only two prices - a regular price and a discounted price for select large customers. At the other end of the spectrum, the electrical and mechanical carbon and graphite products cartel instituted a sophisticated pricing rule which, in principle, allowed for many different prices depending on the particular characteristics of the product and the buyer.

One property that was common to all of the cartel examined was that the collusive (though not necessarily actual) prices were the same for all cartel members. A second feature common to several cartels was that they would agree to a "target" (or "recommended") price and a "floor" (or "minimum" or "bottom") price which was lower than the target price:

The cartel pursued four main objectives, namely the allocation of specific sales quotas to each member and their adherence to those quotas; the fixing of target and/or 'floor' prices; the elimination of price discounts; and the exchange of specific customer information. [Citric acid - EC, 80]⁵

In addition to target prices, participants also agreed to "minimum" for each national market (so-called "floor" or "rock bottom" prices). [Methionine - EC, 68]

Table 1 shows the target ("list") and floor ("lowest") prices for vitamin B2 in German Deutschemarks (DEM) for products intended for human consumption (USP) and non-human consumption (Feed),

Table 1: Vitamin B2 Cartel Prices
(Source: Vitamins, EC, 284)

Date	Type	List	Lowest
June 1, 1991	USP	110	106
	Feed	89	84
October 1, 1991	USP	117	112
	Feed	94	89
October 1, 1992	Feed	99	94
April 1, 1993	USP	122	116
	Feed	102	97

⁵[Citric acid - EC, 80] refers to paragraph 80 of the European Commission Decision relating to citric acid. The complete citation is provided in Appendix B. When more than one European Commission Decision is cited for an industry, they are denoted as EC1 or EC2.

and for vitamin B5:

Table 2: Vitamin B5 Cartel Prices
(Source: Vitamins, EC, 304)

Date	List	Lowest
October 1, 1991	29.50	28.50
April 1, 1992	32.50	31.00
April 1, 1993	36.50	35.00

The distinction between a target price and a floor price was never made clear in the case material. One conjecture is that if a firm priced below the floor price, it would then be considered in violation of the agreement. In comparison, a target price would be the price that the cartel believed the market could sustain and firms would be able to sell their agreed-upon quantities.

In two cases, the cartel agreed on the final product price even though some or all of its sales were not to end-users. Carbonless paper was sold in "reels" to retailers and directly to end-users, while "sheets" were sold exclusively to retailers. The firms agreed to a final product price for reels which obviously meant coordinating on a price for reels to merchants so as to support that final product price. Coordinating on the price for end-users was initiated by the sorbates cartel but then discontinued because of the difficulty in implementing it:

From 1989 to 1992, target prices agreed for each EEA country referred to the prices to end user customers. During the 1993 spring joint meeting, however, it was agreed that target prices should in future relate to the price to be charged to dealers, given the difficulties encountered among the Japanese producers in finding information about and controlling prices to end users. [Sorbates - EC2, 100]

2.1.1 Controlling Cheating on Quality, Product Traits, and Ancillary Services

A more challenging matter for the cartel in setting price arises when there are potentially many variants of the product. The relevance of this issue varies across products according to the diversity of consumer preferences and the technological constraints for providing different products. For example, this was an issue with graphite electrodes - an input in the production of steel - but not an issue with vitamins. One approach is for firms to agree on an array of standardized products - which meant cartel members would only supply those products - and assigning a price to each standardized product. Alternatively, firms could coordinate on a pricing formula that would prescribe a price based on a product's characteristics.

In the market for isostatic graphite, it was because of collusion that the industry created its first "product grouping standard."

In order to be able to fix prices according to equivalent categories of products, the parties established an appropriate Product Grouping Standard.

This classification of grades was done in accordance with the product applications: EDM (electro discharge machining), CC/GP (continuous casting/ general purpose) and Semiconductors. Much effort was devoted to obtaining a proper classification (the issue recurrently appeared on the agenda of meetings). [Isostatic Graphite - EC, 99]

The approach of having standardized products was also taken in the graphite electrodes cartel as the firms:

agreed to charge certain premiums on the price of large-size electrodes, namely a surcharge on the price charged for standard 24-inch electrodes (for example, a 10% premium for 28-inch electrodes and a 40% premium for 30-inch electrodes). [Graphite electrodes - EC, 56]

However, cartel member Showa Denko destabilized the arrangement when it introduced a 28.75-inch model and priced it at the 28-inch model. The other cartel members complained as they saw this as a form of cheating, though offering higher quality rather than a lower price. Market leaders SGL and UCAR demanded that Showa Denka either stop selling it or use the price for the 30-inch model. Showa Denka chose to discontinue production.

Standardizing the product may then be important to avoiding cheating through superior quality while maintaining the cartel price. To avoid the type of event that happened in the graphite electrodes cartel, the electrical and mechanical carbon and graphite products (EMCG) cartel specified that upon introducing a "technically new design," a firm must inform the cartel prior to offering a price quotation on it. [EMCG - EC, 130]

Collusive Marker: Increased product standardization.

An alternative approach to having standardized products is for firms to agree to a pricing formula. This was so impressively done in the electrical and mechanical carbon and graphite products cartel that it is worth describing their formula in its entirety:

The most important purpose of the cartel was to agree on the prices to be charged to customers in different countries for the many different varieties of electrical and mechanical carbon and graphite products. For this purpose, the cartel members first agreed on a pricing method which calculated the sales price by reference to a number of factors. The basis of the scheme was the calculation of the price for carbon brushes. These were divided into three groups: industrial brushes, midget brushes and exceptions. Within each of the first two groups, the volume of the carbon or graphite material in question would be determined in cubic centimetre. Depending on the material, each volume corresponded to a "basic material price" figure, which was displayed in identical table format in each company's internal price list. To the basic material would be added

a "standard fittings price", calculated by reference to the sectional area of the material in question in square centimetre. To this figure would be added charges for additional machining, such as the inclusion of screws, plugs, springs, grooves and other items. The total figure thus resulting, plus any additional surcharges, was known by the cartel members as the "scheme price" or "bareme price" in an expression borrowed from the French and often used by cartel members. The bareme price was not a real sales price in any particular currency, but rather a relative value, indicating, for instance, that a complicated large brush should cost x times more than a small simple brush. In this sense, the bareme prices had a certain commercial logic, as they were based on incremental increases in the costs of materials and tooling. Nevertheless, what was in no way commercially inescapable was the level of detail and uniformity in the price calculation method agreed among members of the cartel, the result of which was that, by using the price calculation scheme, each member would arrive in principle at exactly the same price increase, in relative terms, for each additional cubic centimetre of carbon used or for each additional screw or other tooling added. Nor did the cartel stop at that. To move from a relative value to a real sales price, the bareme price was multiplied by two "co-efficients". First, the bareme was multiplied by a "currency co-efficient", which converted the value into a real price in the currency of the country where the brushes were being sold. This figure was then multiplied by a "quantity co-efficient", which gave the buyer a discounted unit price in return for purchasing a higher volume of products. The final figure represented the unit price in local currency, franco domicile. The quantity co-efficient differed depending on the customer. OEM customers received a larger volume rebate than either resellers or end-users. [EMCG - EC2, 91-3]

Note that this pricing rule also allowed for quantity discounts and dealt with currency issues; two issues that will be addressed in Section 2.1.2.

Though controlling "quality cheating" may not be as relevant with commodities such as vitamins and gases, there are similar ways in which firms can cheat. One method is to offer ancillary services at low prices. A second method is to bundle the collusive good with some other goods and price the bundle in such a way that the firm is effectively charging below the collusive price.

As an example of the perceived need to control firms' prices for ancillary services, firms in the industrial and medical gases cartel agreed not only about price but also about "trading conditions". Specifically, this meant agreeing to minimum transport charges and a minimum rate for renting a gas cylinder. The cartel also introduced a drop charge on bulk deliveries and an environmental and safety charge as devices to further raise the effective price. Failure to agree on any of these other charges could have undermined the cartel as firms could then price gas at the agreed-upon level but cheat by offering, say, free transport.

The issue of controlling other dimensions than the price of the primary prod-

uct or service was central to collusion between Christie's and Sotheby's in the fine arts auction houses cartel. The centerpiece of their agreement was a non-negotiable commission schedule for clients (which is provided in Appendix A). (A client would contract an auction house to sell their property at auction in exchange for a commission on the revenue collected.) Prior to that agreement, the auction houses would routinely offer discounts off of the publicly announced commission schedule; even going so far as to offer a zero commission rate (though they also charged a buyer's commission). In addition, there were many other features that an auction house might offer a customer to attract business. The cartel sought to control as many of these as possible.

Going over the various subjects they had discussed in their previous conversations, [Christie's Chairman of the Board Anthony] Tennant summarized the topics they had already agreed upon: From September 1993, neither Christie's nor Sotheby's would give any "straight" guarantees - the kind, where the auction house did not get to share in the proceeds if the winning bid exceeded the guarantee price promised to the consigner. Both firms would also abandon the practice of making advances on single lots, and they would no longer make any loans to sellers below the prime rate, known in England as the London Interbank Offered Rate, or LIBOR. Dealers, or "trade" vendors, would be given a rate of no better than 5%, and they would be obliged to pay their own insurance costs, while trade buyers would be offered no more than ninety days' credit. Furthermore, Tennant noted, it was agreed that the two firms would no longer pay more than 1% in introductory commissions to third parties when the deal in question involved a zero seller's commission. Nor would they make any offers to sellers who were already under contract with the rival auction house, although he insisted that Christie's did not do that anyway. Finally, he noted, Christie's would cease making charitable contributions [on the consigner's behalf] if it saw that Sotheby's had stopped doing so. [Mason (2004), 119]

Given the multiple dimensions in which they competed - not just the commission rate - the auction houses were cognizant of the need to close these potential loopholes by which a firm could cheat. Failure to do so would only cause collusive profits to be dissipated.

Collusive Marker: Increased uniformity across firms in product price, quality, and the prices for ancillary services.

Cheating can also occur with a commodity by bundling it with other goods and implicitly pricing the collusive good below the agreed-upon price. A cartel member claimed that one of the other members used this tactic in the vitamins cartel. One of the uses of vitamins is in animal feed and some of the cartel members sold pre-mix - a blend of vitamins which would then be mixed with animal feed - as well

as straight vitamins. In the case of the folic acid cartel, Takeda accused Hoffmann LaRoche (also referred to as Roche) of pricing pre-mix low so that Roche could put a price squeeze on independent suppliers of pre-mix and thereby drive them out of the market and increase Roche's market-power in the pre-mix market. This required implicitly charging itself a lower price for folic acid than it was charging the independent suppliers (which was at the cartel price). [Vitamins – EC, 370] A similar complaint was made in connection with the vitamin B5 cartel as cartel member Daiichi claimed that BASF and Roche were pricing their pre-mix too low. [Vitamins – EC, 322]

2.1.2 Variation in Prices across Customers

A defining feature of collusion is obviously higher prices. What these cases suggest, however, is that a second defining feature is greater uniformity in price across customers. Subject to the important caveat that data on the non-cartel phase is lacking, the case evidence suggests that firms reduced the number of different prices charged to customers. In particular, they sought to move from a regime characterized by a list price and a series of ad hoc negotiated discounts to either a non-negotiable price list that encompassed discounts (such as with the fine arts auction houses cartel) or an agreed-upon set of discounts to the list price (as with the citric acid cartel).

This increased uniformity in price across customers could have been done for several reasons. It might have been done for simplicity; remember that firms had to discuss and then agree to every price and this was a recurring situation. More prices not only meant more time spent meeting - which raised the chances of discovery by the authorities - but perhaps also more opportunities to reach a disagreement and threaten the collapse of the cartel. A second reason is that fewer prices may have made monitoring easier. With more customer-specific prices, it may become harder to document whether the price charged by a firm was appropriate given the market or customer type.

Though there was clearly a movement to having fewer prices across customers, many cartels still had more than one price. The citric acid cartel sought to have a single price but perceived there to be a necessity to offer a discount to the largest customers:

It was further agreed that no customers would be granted discounts and all would be expected to pay the list price. This was designed to prevent any participant from selling below the agreed prices. An exception was made for the five major consumers of citric acid since it was unrealistic to expect them to pay the published list price. It was accepted that these customers could be offered a discount of up to 3% off the list price. [Citric acid - EC, 83]

A similar discounting strategy was deployed in the plasterboard cartel as discounts were generally eliminated except for large customers: "Firms agreed to raise price and eliminate all special discounts with the exception of those for large retailers." [Plasterboard - EC, 321]

The movement to fewer discounts and more price uniformity across customers was quite common. In the copper plumbing tubes cartel, firms coordinated quite closely with respect to rebate levels in order to maintain collusive margins:

in order to avoid price erosion through large rebates, the suppliers established guidelines on rebate levels. The plumbing tube manufacturers in the respective national markets divided customers into three or four groups according to size, without, however, discussing individual customers. [Copper plumbing tubes - EC, 207]

There may be several motivations for offering some discounts. It may just reflect price discrimination and the higher profit that comes from it. When it was stated in the citric acid case that the major customers would not pay list, it might have been meant that they would resist it by postponing demand and consuming out of inventories. Furthermore, the cartel might be concerned about creating suspicions that there is collusion since offering no discounts off of list would be inexplicable in light of past practice.

In a competitive environment, one could imagine a firm moving to an "everyday low price" by eliminating discounts (or sales) while reducing the list price. This makes the combination of fewer discounts off of list prices along with a *higher* list price suggestive that firms are coordinating their behavior.

Collusive Marker: Higher list prices and reduced variation in prices across customers.

Though there did not appear to be much disagreement among firms over price, there is a well-documented episode of disagreement with regards to discounts. In the isostatic graphite cartel, members disagreed about the 20% discount to machine shops and distributors; the source of the disagreement appeared to be the different composition of cartel members' demands.

Prices for machine shops (MS) in Europe were discussed at length during this meeting. [cartel members] SGL and LCL advocated a strict enforcement of minimum prices while the Japanese suppliers were not in favour of such drastic approach. SGL and LCL favoured eliminating a separate MS price ... and to have a price only for large end users. The Japanese suppliers which depended heavily on selling to independent machine shops disagreed with the arguments of the European producers. The difference in the distribution methods of the respective producers appeared to be the major reason for this disagreement. SGL and LCL distributed its products through own subsidiaries throughout almost all of Europe and often directly to large end users with machining capability. Toyo Tanso distributed its products through subsidiaries in some countries and through distributors/machine shops in countries where they did not have subsidiaries. Tokai Carbon and Ibiden relied on sales to independent distributors and machine shops. No conclusion was reached. [Isostatic graphite - EC, 137]

2.1.3 Variation in Prices across Countries

Many cartels also strived to achieve uniformity of prices across countries. Indeed, a continual concern for a number of global cartels was avoiding arbitrage opportunities due to currency fluctuations and the inability of the cartel to adequately adjust prices. The concern was that resellers would buy the product in a country where the price is low and sell it where the price is high. Such actions would effectively reduce the average transaction price and, furthermore, could cause cartel instability because the burden would fall unequally across firms; firms where the price is low would benefit by selling more while firms where the price is high would suffer because of reduced sales due to imports.

Most global cartels were quite explicit about acting to avoid the creation of arbitrage opportunities and achieving what they called "harmonization" in prices. In the choline chloride cartel:

An agreement was made to increase prices world-wide to identical levels. These identical price levels around the world would not only increase profitability but also help to avoid destabilising exports between regions. [Choline chloride - EC, 68]

Similarly, consider the nucleotides cartel: "The final goal, as expressed by Takeda, was to have one world price ..." [Nucleotides - EC-108]

Some global cartels would use the US dollar (USD) and the German Deutschmark (DEM or DM) as the benchmark currencies (though presumably the Euro has now replaced the latter). This may require regular adjusting of price across countries.

Prices were agreed in DM and were adjusted so that the cross-country difference within Europe was not more than 5-10%. [Graphite electrodes - EC, 60]

One of the main preoccupations of BASF and Roche was to ensure that currency fluctuations did not lead to price differentials between the regions and consequent trans-shipment by dealers. Thus when the US dollar became strong in relation to the Deutschmark, the two European producers were concerned to raise the European prices so as to deter dealers selling from Europe to North America. [Vitamins (B5) - EC, 321]

Prices were established in both USD and DEM terms. In the European market the DEM was used as the benchmark currency and converted into the appropriate national currency when quoting and charging prices to national customers. Given the global character of the citric acid market and the use of the DEM and USD as benchmark currencies, the value of the exchange rate between the two was critical to the establishment of sustainable and competitive prices, particularly to avoid trans-shipments between the two areas. Pricing decisions were taken by the cartel members in the light of this important consideration. The relative strength of the DEM vis-à-vis the USD between mid-1991 and mid-1992 (it appreciated

by almost 20%) meant that citric acid price increases for areas with prices quoted in USD were more frequent and of a higher aggregated amount than in DEM denominated markets, essentially to compensate for the DEM's revaluation. [Citric acid - EC, 82, 93]

In spite of the effort to achieve harmonization, the price gap could become quite considerable as noted in these three episodes.

The wide gap between the target price in Europe (6.20) and the going price in Asia (5.25-5.40) caused concern of Asian sales flowing back to Europe. [Methionine - EC, 145]

The participants considered in particular that the European price at that time was 22% higher than the US price. They were concerned that parallel importers would be attracted if the price differential increased and concluded that it was not possible to increase the European price further at that moment. [Lysine - EC, 82]

SGL states that price harmonisation was sought in Europe as, due to exchange rate distortions, prices in countries such as the United Kingdom and Italy were around 30-40% lower than in Germany. [Isostatic graphite - EC, 134]

In trying to identify an associated collusive marker, the difficulty is that we do not know whether there was more or less price harmonization under collusion. It is clear from the documentary evidence that lack of price harmonization arose under collusion and that cartels sought to eliminate it. One might imagine that without collusion, firms would supply to meet demand in each country and this would allow arbitrage opportunities to be exploited and prices equalized across countries (or the differential between countries' prices to be less than transportation and reselling costs). With collusion, firms were typically restraining supply - as is reviewed in Section 2.2 - and this could allow disparities in price to exist across countries. On the basis of this argument, the following collusive marker is tentatively put forth.

Collusive Marker: Increased variation in prices across countries.

2.1.4 Implementation of Price Changes

Having agreed upon some price change, there is the matter as to how a cartel actually implements it. Two common features were: 1) cartels tend to gradually raise price; and 2) cartel members would sequentially, not simultaneously, implement the new price or price schedule. Let us provide examples documenting both patterns.

Gradual and Periodic Price Changes A number of cartels were quite explicit about gradually raising price. Indeed, most cartel price paths show a gradual increase. This was exhibited for citric acid and lysine (Connor, 2001), several of the vitamins

(Levinstein and Suslow, 2001), and graphite electrodes (Harrington, 2004a). Price may be raised gradually for several reasons. It might be done to avoid buyer resistance whereby they hold off purchases and work down their inventories. Secondly, cartel members might be uncertain as to how high a price would be stable in which case they may prefer to gradually raise it rather than risk a price war by initially setting price at what proves to be an unstable level. Thirdly, a gradual price increase may serve to avoid discovery of collusion by buyers.⁶ Of course, a gradual raising of price may simply be driven by gradual increases in cost that served to increase the optimal collusive price. In some cases - such as the graphite electrodes cartel (Harrington, 2004a) - that can be confidently dismissed.

This intent to gradually raise price is quite apparent when firms, at a point in time, agreed to a series of future price increases. At a meeting of the choline chloride cartel on November 16, 1992, they agreed to the following sequence of global prices for three product variants:

Table 3: Cartel Prices - Choline Chloride
(Source: Choline Chloride - EC,77)

Date of Planned Price Increase	50% Dry	60% Dry	75% Liquid
January 1993	1000	1200	1000
July 1993	1100	1320	1100
January 1994	1100	1320	1200

This was similarly the case in the carbonless paper cartel as "the participants agreed on several consecutive price increases expressed in percentage form for each EEA country." [Carbonless paper - EC, 78] More specifically, "it was agreed that the price would be increased in two stages on 1 July and on 1 September 1994, both times by 5%." [Carbonless paper - EC, 211]

Steady price increases were a trademark of the vitamins cartel. For example, the prices of vitamins A and E were usually raised in increments of 5% [Vitamins - EC, 182] and such a gradual increase was also noted for vitamin B1:

From 1991 until about 1993, the price of vitamin B1 was gradually increased by the cartel. In 1991, the producers raised the market price from below DEM 65 to DEM 68/kg. [Vitamins - EC, 255]

The movement to more uniform prices across customers could also be done gradually. In the district heating pipes cartel: "A common price list was devised; agreed discounts were to be progressively reduced with the declared aim of raising prices 30% in two years."⁷

There is also evidence that price changes were performed with some periodicity when firms were colluding. This was documented for a number of the vitamins cartels. For the vitamins A and E cartel,

⁶ For a theoretical analysis, see Harrington, (2004b, 2005b) and Harrington and Chen (2005).

⁷ *Competition Policy Newsletter*, 1999 February, Number 1, pp. 27-8.

During the 1991 concerted initiative, new prices were initiated each quarter; from the beginning of 1993, prices were increased as a rule once a year, usually on 1 April, with 1 October being kept as a fallback date in addition. [Vitamins - EC, 210]

While for vitamin B5,

During the period of the cartel, the three producers contrived to raise the price of vitamin B5 at regular intervals in a series of concerted price increases. [Vitamins - EC, 317]

Of course, it is quite possible that non-collusive prices reveal the same gradual and periodic nature. Though the documentary evidence in the Commission decisions do not speak to that issue, a recent study by Marshall, Marx, and Raiff (2005) does. It finds that the periodicity of vitamins prices was greater when vitamins manufacturers were colluding. The data is comprised of the announced price increases reported in two weekly trade journals over 1970-2001 for vitamins A (Acetate 650 Feed Grade and Acetate 500 USP), E (Acetate 50% Spray Dried Feed Grade and E Acetate Oil USP), C (Ascorbic Acid 100% USP), Beta Carotene (FS 30%), B2 (Riboflavin 96% Feed Grade and Riboflavin USP), and B5 (Calpan Feed Grade and Calpan USP). This time period included both non-cartel and cartel regimes. A logit model was estimated for the probability that a new price is announced in a given month conditional on the amount of time that has passed since the previous price change and taking account of a several possible cost and demand triggers for a price change. During non-cartel period, they found no statistically significant relationship between *delay* - the time since the last price announcement - and the probability of making a new price announcement. In contrast, during the cartel period, there was a statistically significant positive relationship between *delay* and the probability of making a new price announcement. These results are consistent with the periodicity of price announcements under collusion which may be due to the periodicity of cartel meetings, which is an issue addressed in Section 4.

Staggered Price Changes That a cartel was concerned about detection is evident in the explicit avoidance of making simultaneous price changes. In many cartels, there was a clear orchestration of who would move first and when other firms would follow which could be in days, weeks, or even months. This has been documented for cartels in carbonless paper, electrical and mechanical carbon and graphite products, copper plumbing tubes, fine arts auction houses, and sorbates.

At the general cartel meeting of 2 February 1995 the participants also agreed on a system for launching the price increases according to which AWA would lead the price increases and others would follow. As stated in the minutes: ‘AWA will lead announcement of following increases per market. To follow, Koehler AG, Zanders, Stora, Sappi, Torras’. [Carbonless paper - EC, 233]

For the new prices to take effect, one of the cartel members would circulate its new price list to customers at some time between January and March in the year following the Technical Committee meeting. The other cartel members would follow suit and issue their new price lists over the following weeks or months, thereby trying to create the impression that the companies concerned took their pricing decisions autonomously. The cartel members broadly rotated who would issue their price lists first in each country. Sometimes they also collectively thought up possible explanations they could give to their clients as justification for the price increases. [EMCG - EC, 101]

... pricelists were usually issued once a year (in autumn) by the leader in the respective national market. The market leader generally sent, or otherwise conveyed, the pricelist to certain competitors before its publication, to invite adaptation of their prices. The pricelist was, however, also freely available in the market (for example, from customers). The other producers would then generally issue a similar price list within one to two weeks. [...] other suppliers were expected to adapt their prices to the leader's price list. [Copper plumbing tubes - EC, 204]

On 9 March 1995 Christie's publicly announced that it would be instituting a new sliding scale of rates based on the value of the property sold. It was made clear that under the new policy scale commission would be non-negotiable. The new charges were to apply from 3 April 1995 for property scheduled for auction at Christie's salesrooms world-wide beginning 1 September 1995 when the new auction "season" opened. ... On 13 April 1995 Sotheby's duly followed. [Fine arts auction houses - EC, 109-111]

After each joint meeting, the agreed target prices were announced to agents, distributors and customers. Hoechst was usually the first to announce the new price in Europe, followed by the Japanese producers (for example, two months later). [Sorbrates - EC, 103]

When the cartel was global, the firm that took the lead in changing price could vary across countries. The identity of the leader could also vary over time.

In order to implement the prices agreed between them (and communicated to other producers), SGL and UCAR arranged in advance which of them would act first to announce the increase to customers. Once the price was established, it could not be undercut. Which of the two was designated to 'lead' the price increase in a particular national market in Europe depended on their respective positions in that market. Since SGL had a more important presence in Germany and Scandinavia than UCAR, it had the responsibility for announcing and leading the price increase in those markets. UCAR generally led the price increases in France and United

Kingdom. In the other two major Community markets for electrodes, Italy and Spain, where UCAR and SGL had roughly equal market shares, they decided on each occasion which one of them would ‘publicly’ act as the price leader to get the new price established in the market. Price increases were typically staggered over time across countries. [Graphite electrodes - EC, 66, 69]

If a price increase was decided, Roche usually took the lead and announced first. Apparently however, it occasionally asked BASF to lead the increase publicly. ... The parties normally agreed that one producer should first ‘announce’ the increase, either in a trade journal or in direct communication with major customers. Once the price increase was announced by one cartel member, the others would generally follow suit. In this way the concerted price increases could be passed off, if challenged, as the result of price leadership in an oligopolistic market. [Vitamins (A, E) - EC, 183, 203-4]

Moving sequentially was not without a cost however. During the time between when one firm raises its prices and the other firms follow, the price leader could lose sales. This is not only costly to that firm but it could risk the stability of the cartel if the lost sales are sufficiently great to cause retraction of the price increase or movement to an even lower price in order to regain market share. Indeed, it appeared this almost caused the fine arts auction house cartel to collapse. Christie’s had already announced, as part of the collusive arrangement, a non-negotiable commission schedule. Sotheby’s had not yet followed and, in the meantime, had secured a major consignment by offering a zero-percent seller’s commission.

Having already announced its new nonnegotiable minimum of 2 percent, Christie’s was unable to match Sotheby’s offer. ... Christopher Davidge [CEO of Christie’s] was furious when he learned that Sotheby’s had won the Alghanim consignment because of the delay in matching Christie’s new nonnegotiable rates. He began to fear that Brooks [Sotheby’s CEO] was double-crossing him. [Mason (2004), p. 166]

This was also a serious enough concern for the industrial and medical gases cartel that they agreed to a moratorium on supplying other firm’s customers for a period of two to five months each year while the new price was being implemented. To execute that agreement, cartel members would instruct their sales people to focus on retaining existing customers:

That [cartel member] AGA put the moratorium into effect is shown by the internal instructions it issued on 28 November 1989 ... to focus on implementing the 5% price increase with existing customers and explaining that competitors could be expected to do the same. Were attacks by competitors nevertheless to lead to price concessions, such concessions

should be reported to the management. [Industrial and medical gases - EC1, 161]

Air Liquide submitted an internal note regarding the price increases for 1995 which instructs salesmen to focus on their own clients (with the effect of respecting the moratorium) [Industrial and medical gases - EC1, 180]

2.2 Quantity

Equally important to coordinating on price - and documentary evidence reveals it was more important for many cartels - was coordinating on the allocation of the market. All but a few cartels had an explicit market sharing arrangement. In this section, we'll review the various allocation schemes and how they decided on a particular allocation. Critical to these schemes is the monitoring of each firm's supply to ensure the agreed-upon allocation is implemented. That issue, along with the types of punishment deployed when there was a violation, will be reviewed in Section 3.

There were three forms of allocation schemes: i) sales quotas (which I will use to refer to both an allocation of quantities and of market shares); ii) exclusive territories (and, closely related, the home-market principle); and iii) customer allocation. A cartel could pursue one of them or use them in combination. In some cases, exclusive territories and customer allocation were used to implement a sales quota scheme; the choline chloride cartel used all three methods.

2.2.1 Sales Quotas

The majority of the cartels used sales quotas. This could take the form of a quantity that each firm was assigned to supply - which made be interpreted as a target quantity or a minimum quantity - or of an allocated share of the market. With respect to the latter, it was a share of total demand if the cartel was all-inclusive or a share of the cartel's supply if it was not. Sales quotas could be set at the level of the entire global market (if it was global), region (for example, Europe), and country.

In the citric acid cartel, firms agreed to a global sales quota for each firm and, as they viewed the market to be global, there was no further disaggregation. Two months after specifying a fixed tonnage figure for each member, the cartel met again and converted these volumes into market shares. Specifically, each firm was entitled to a percentage of supply provided by the European Citric Acid Manufacturers Association to which all cartel members belonged.⁸ [Citric acid - EC, 81, 97] The resulting

⁸One speculation as to why they preferred market shares is that it provides an easy way in which to handle market growth.

market shares are shown in Table 4.

Table 4: Allocation of ECAMA Market Shares (1991) - Citric Acid
(Source: Citric Acid, EC)

Company	Market Share
Haarman & Reimer	32.0%
ADM	26.3%
Jungbunzlauer	23.0%
Hoffman LaRoche	13.7%
Cerestar Bioproducts	5.0%

In the lysine cartel, the emphasis was on specifying a *minimum* level of sales for each firm rather than a target. Compliance occurred as long as each firm's sales exceeded its minimum and if that held then a firm was compliant even if it sold above its quota. This was made clear by Terence Wilson, a senior executive for cartel member Archer Daniels Midland (ADM), who was secretly taped at meetings of the lysine cartel.

if I'm assured that I'm gonna get 67,000 tons by the year's end, we're gonna sell it at the prices we agreed to and I frankly don't care what you sell it for. [Video transcript of "The International Lysine Cartel at Work, 3/28/00," U.S. Department of Justice, Antitrust Division.]

The market's bigger than we originally said it was. We just took it. So we're not in violation of nothin. [Eichenwald (2000), p. 134-5]

The lysine cartel chose to specify quotas for both the global market and the European market.

Table 5: Sales Quotas (1992, tons) - Lysine
(Source: Lysine - E, 77)

Company	Global Sales (Market Share)	European Sales (Market Share)
Ajinomoto	73,500 (39.7%)	34,000 (51.9%)
ADM	48,000 (25.9%)	5,000 (7.6%)
Kyowa	37,000 (20.0%)	8,000 (12.2%)
Sewon	20,500 (11.1%)	13,500 (20.6%)
Cheil	6,000 (3.2%)	5,000 (7.6%)

From at least 1978 up until the mid-1990s, the sorbates cartel engaged in volume agreements:

The agreements on volume quotas and target prices were inter-linked. They were intended to enable each party to sell its allocated volume at the highest possible price. The purpose of the quota system was in fact to gradually increase the market price. According to [cartel member] Chisso, the volume quotas prevented the companies from competing for market share, which would have driven prices down. [Sorbates - EC2, 108]

The sorbates cartel colluded in the European market and was comprised of one European company, Hoechst, and four Japanese producers: Chisso, Daicel, Nippon, and Ueno. At the general cartel meeting, sales would be allocated sales between Hoechst and the Japanese producers as a group. The four Japanese producers would then meet and allocate their collective quota amongst themselves. The resulting quotas are provided in Table 6. The entry in a cell is volume in metric tons. For Hoechst and the Japanese firms, the market share is in parentheses, while in parentheses for Chisso, Daicel, Nippon, and Ueno is their share of the allocation to Japanese producers. Notice the tremendous stability to market share over this 15 year period, especially among the four firms out of Japan.

Table 6: Sales Quotas (metric tons (market share)) - Sorbates Cartel
(Source: Sorbates - EC2)

Meeting	Hoechst	Japan. firms	Chisso	Daicel	Nippon	Ueno
Spr 79	1800 (44%)	2300 (56%)	580 (25.2%)	925 (40.2%)	354 (15.4%)	442 (19.2%)
Spring 80	2200 (50%)	2200 (50%)	554 (25.2%)	884 (40.2%)	339 (15.4%)	422 (19.2%)
Aug 80						
Mar 81	2100 (51%)	2000 (49%)				
June 81			504 (25.2%)	804 (40.2%)	308 (15.4%)	384 (19.2%)
Spr 82	2100 (51%)	2000 (49%)	504 (25.2%)	804 (40.2%)	308 (15.4%)	384 (19.2%)
Spr 83	1900 (51%)	1800 (49%)	454 (25.2%)	724 (40.2%)	277 (15.4%)	346 (19.2%)
Fall 83	(51%)	(49%)				
Feb 84	2300 (52%)	2100 (48%)	529 (25.2%)	844 (40.2%)	323 (15.4%)	403 (19.2%)
Feb 85	2400 (52%)	2200 (48%)	554 (25.2%)	884 (40.2%)	339 (15.4%)	423 (19.2%)
Feb 86	2300 (52%)	2100 (48%)	529 (25.2%)	844 (40.2%)	323 (15.4%)	403 (19.2%)
Mar 87	2400 (52%)	2200 (48%)	554 (25.2%)	884 (40.2%)	339 (15.4%)	423 (19.2%)
Jan 88	2320 (52%)	2130 (48%)	537 (25.2%)	856 (40.2%)	328 (15.4%)	409 (19.2%)
June 88	2320 (52%)	2130 (48%)	537 (25.2%)	856 (40.2%)	328 (15.4%)	409 (19.2%)
Feb 89	2520 (52%)	2311 (48%)	582 (25.2%)	929 (40.2%)	356 (15.4%)	444 (19.2%)
Oct 89	2520 (52%)	2311 (48%)	582 (25.2%)	929 (40.2%)	356 (15.4%)	444 (19.2%)
Feb 90	2558 (52%)	2344 (48%)	591 (25.2%)	942 (40.2%)	361 (15.4%)	450 (19.2%)
Sept 90	2558 (52%)	2344 (48%)	591 (25.2%)	942 (40.2%)	361 (15.4%)	450 (19.2%)
Mar 91	2665 (53%)	2350 (47%)	592 (25.2%)	945 (40.2%)	362 (15.4%)	451 (19.2%)
Sept 91	2665 (53%)	2350 (47%)	592 (25.2%)	945 (40.2%)	362 (15.4%)	451 (19.2%)
Feb 92	2665 (53%)	2350 (47%)	592 (25.2%)	945 (40.2%)	362 (15.4%)	451 (19.2%)
Sept 92						
Feb 93	2877 (53%)	2579 (47%)	650 (25.2%)	999 (38.7%)	422 (16.4%)	510 (19.8%)
Sept 93						
Mar 94	2705 (53%)	2399 (47%)				

Given the decision to allocate the market using sales quotas, there is then the matter of settling upon what each firm's sales quota would be. This was generally a two-step process in which, in step one, firms would reach a shared assessment of

market size and then, in step two, agree to some allocation of the market. Determining market size was explicitly noted in many Commission decisions.

Senior executives responsible for vitamin marketing in each company, together with some product managers, identified the size of the market for vitamins A and E and then agreed the allocation between the four producers of the world and regional markets on the basis of their respective achieved sales in 1988. [Vitamins, EC, 163]

At a meeting held in Frankfurt in the autumn of 1987, Nippon Soda, Rhône-Poulenc, Degussa (who chaired the meeting) and Sumitomo exchanged and compared their respective estimates of the total volume of the world market, gave their opinions as to future incremental market growth and how to allocate quotas between producers (the talk was of sharing in proportion to production capacity), disclosed the volume of their sales and production capacity for the previous year and discussed the 'announcement' of new list prices. [Methionine - EC, 88]

A cartel was specifically interested in measuring the size of the *available* market. Given the sizable supply of firms outside of the cartel in both sorbates and vitamin C, it was important to take this into account.

Hoechst and the four Japanese producers agreed on volume allocations for sorbates sales in Europe from at least 1978. The market was allocated in two ways. First, the producers estimated the total demand in Europe, and then subtracted the estimated sales volume of [non-cartel producers] Monsanto and Cheminova. The remaining market was divided between Hoechst and the Japanese producers. [Sorbates - EC, 106]

To set the quotas themselves, the participants first determined the total market on the basis of their sales and estimated sales by the Chinese and East Europeans producers of vitamin C. Expected sales by third parties were deducted, the remainder of the market being defined as the "available market." Volume targets for each producer for the next period were set on the basis of their estimate of the "available market". [Vitamins - EC, 393]

With regards to setting sales quotas, a general though not universal principle was to use historical precedence. In the cartel for copper plumbing tubes: "Participants attempted to stabilise the market by using market shares of a (previous) reference year as a basis for fixing a target for future market shares." [Copper plumbing tubes - EC, 210] More precisely, market shares were frozen at the level achieved in the year(s) prior to the cartel in several cases. The organic peroxides cartel used sales from 1969-70 to set quotas for 1971. [Organic peroxides - EC, 85] The same approach was taken in the collusion of vitamins A and E and of folic acid, respectively.

the underlying objective [of collusion] was to stabilize the world market share of each producer. Market shares were frozen at 1988 levels; 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. [Vitamins - EC, 164]

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. [V-FA, 357]

In contrast, the citric acid cartel used the average of each firm's sales over 1988-90 to set sales quotas in 1991 [Citric acid - EC, 81] and similarly the sorbates and zinc phosphate cartels used a multi-year average:

Hoechst and the four Japanese producers agreed on volume allocations for sorbates sales in Europe from at least 1978. The first volume allocation for 1978 was based on their actual sales volumes in 1977 for each region of the world, as well as current and forecasted demand. The corresponding volume allocation between the Japanese producers was based on the average of their actual sales volumes from 1973 to 1977. [Sorbates - EC, 106]

The cartel engaged in a market sharing agreement (allocation of and adherence to market shares to/by each producer) and, to some extent, the allocation of specific customers. The allocation of sales quotas was the cornerstone of the cartel. 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. Sales quotas were in principle allocated at the European level. It was thought that crucial to cooperation is that each firm could get an accurate assessment of its market share. [Zinc phosphate - EC, 66]

The use of historical precedence in the setting of collusive market shares and then the persistence of this allocation over time leads us to claim that firm market shares are highly stable under collusion. It is important to note that, due to changes in non-cartel supply (in particular, growth as a result of collusion), a cartel member's share of the total market can change over time. What tends to be stable is a cartel member's share of total *cartel* supply.

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

When the cartel is all-inclusive then this leads to the corollary:

Collusive Marker: Market shares are highly stable over time.

Before we jump to the erroneous conclusion that historical precedence is universal, not all firms in all cartels were content with using past market shares to determine the collusive allocation. A notable example is the lysine cartel whose recent history lacked the stability to allow historical precedence to be determining. ADM was a recent entrant into the lysine market and it had built a large state-of-the-art production facility. Prior to its entry, the Asian manufacturers had been colluding so the price of lysine was relatively high. Upon entry, ADM engaged in aggressive pricing to build market share; as a result, the average price in the U.S. fell from \$1.32/pound down to \$0.68/pound.⁹ Once it had increased its sales to around one-third of global sales (and it had come to dominate the U.S. market with a share of 71%), executives for ADM approached the other manufacturers about forming a cartel. At the cartel meeting, ADM demanded parity with the largest supplier, Ajinomoto, and proposed that the market be allocated so that one-third went to ADM, one-third to Ajinomoto, and one-third to Kyowa, Sewon, and Cheil. [Lysine - EC, 73, 76] In retrospect, it appears that ADM's strategy was to build global market share to the level that it desired as a collusive allocation and then propose the formation of a cartel. As shown in Table 5, ADM's proposal was not accepted and it instead agreed to an allocation that gave it around 26% of global sales. However, as part of the compromise, ADM was supposed to receive a disproportionate share of market growth until it reached Ajinomoto's market share; ADM gave it three years for it to happen.

Sewon was also eventually discontent with its allocation. Though having experienced a rise in its allocation to 37,000 tons by 1994, Sewon wanted more. In response to Ajinomoto's proposed that Sewon's sale quota be raised to 39,000 tons for 1995, Sewon instead demanded 50,000 tons. Just as ADM had made a major capacity investment and wanted an allocation that utilized it, Sewon was building a plant in China that would expand its capacity to 50,000 tons. [Lysine - EC, 142] Sewon later reduced its demand to 46,000 tons. Ajinomoto responded by saying that it would accept it if Sewon would sell 6,000 of those 40,000 tons to Ajinomoto; Sewon declined. [Lysine - EC, 152]

A similar dilemma arose in the choline chloride cartel. After building a new plant, Chinook demanded more share and ultimately chose to leave the cartel: "At a meeting in 4/94, firms failed to agree to anything. Chinook, which has recently started a new plant, would not agree to price floors. Chinook declared it would no longer participate." [Choline chloride - EC, 95]

Given the recent capacity investment of ADM and Sewon, historical precedence lacked consensus as a guide to allocating the market for lysine. It is then interesting that, contrary to other cartels, there was a serious effort to exchange information on capacities early in the cartel's life (when allocations were being agreed upon).

⁹Connor (2001), p. 201.

The participants exchanged information on ADM's and Cheil's production capacity and sales volumes. Some days before the meeting Cheil communicated the information on its production capacity and sales volumes to Ajinomoto by telephone. [Lysine - EC, 63]

ADM even went so far as to engage in the unprecedented act of inviting representatives from Ajinomoto, Kyowa, and Sewon to inspect its production plant. Though doing so ran the risk of trade secrets being revealed (in fact, a representative of Ajinomoto attempted to get a sample of the microbe used by ADM in producing lysine), it was important for ADM to reveal the extent of its capacity and its low-cost of production; both towards assuring that the cartel form and, in that event, that ADM would be allocated a sufficiently large sales quota.

The exchange of capacity information is consistent with the use of capacity to determine a market allocation. A number of historical cartels have used such a rule including some German cartels in the 1920s and 1930s (Bloch, 1932)¹⁰ and the Norwegian cement cartel in the mid-20th century (Röller and Steen, 2003).

Though stability of market shares was common, it was not universal. In negotiating in 1992 in the market for vitamin B2, Roche agreed to allow BASF's market share to rise from 35% in 1990 to 38% by 1994. [Vitamins - EC, 273] In the market for beta carotene - for which the two suppliers were again only Roche and BASF - it was agreed in September 1992 that:

BASF should be allowed to increase its 21% market share by 1% a year until 2001 when it would be capped at 30%. Variations in share were permitted from region to region provided the overall quota was not exceeded. [Vitamins - EC, 521]

For reasons unknown, the market share allocation in the vitamin B5 cartel changed significantly over the period of 1991-99.

Table 7: Variation in Market Share Allocation (1991-99) - Vitamin B5
(Source: Vitamins - EC, 301)

Company	Global	Europe
Roche	42-45%	40-48%
BASF	23-25%	19-22%
Daiichi	32-34%	30-39%

One possible reason for changing market share, beyond capacity investment (as in the lysine cartel), was due to unanticipated demand shifts across products.

In 1994 the rapid increase in demand for vitamin E for human consumption necessitated a revision of the quota allocated to Rhône-Poulenc. To maintain its agreed 16% share of the overall market, Rhône-Poulenc had to increase its sales in the animal feed sector. The producers agreed in

¹⁰Cited in Scherer (1980).

August 1994 that the Rhône-Poulenc share of the feed segment be capped at 21%; if the agreed increase in quota in that area did not however give Rhône-Poulenc its full 16% overall, the other two European producers would purchase product from it to compensate for the shortfall. Compensating purchases were made by Roche in 1996 and by Roche and BASF in 1997. [Vitamins - EC, 225]

2.2.2 Exclusive Territories

As mentioned previously, sales quotas were one device for allocating the market. Two other schemes were exclusive territories and customer allocation, which were used both in isolation and as a method for implementing sales quotas. Let us turn to examining the use of exclusive territories.

A common principle to a number of cartels was the "home-market principle" whereby cartel members would reduce supply in each other's home markets. The objective was to move to an arrangement where, ideally, each cartel member would take control of their home market and then share the global demand that was not part of any cartel member's home market. Of course, the size of some markets - such as the U.S. and E.U. - often prevented their supply exclusively by American and European firms, respectively, when there were other firms (often, Asian firms) who had historically supplied those markets.¹¹

The home-market principle is well-exemplified by the choline chloride cartel. [Choline chloride - EC, 77] The cartel was comprised of companies from Europe - Akzo Nobel from the Netherlands, BASF from Germany, and UCB from Belgium - and North America - Bio Products and DuCoa from the U.S. and Chinook from Canada. The plan was for European producers not to export to the North American market and North American producers not to export to the European market. An agreement was reached in a November 1992 meeting which specified that Bio Products and Chinook would be out of Western Europe by mid-1993 and out of Eastern Europe by mid-1994 and European suppliers would exit North America by mid-1993. For Asian markets, Ducoa would reduce supply, the supply of European manufacturers would be unchanged, and Bio Products and Chinook would expand; while in Latin America, BASF would transfer exports from Europe to there and the other cartel members would hold their exports at current levels.

The home-market principle was also at work in the copper plumbing tubes and seamless steel tubes cartels:

the basic goal of the meetings was to protect the main producers' home markets and to freeze the market shares on the basis of the volume figures of previous reference periods. A further objective was to avoid price wars. [Copper plumbing tubes - EC, 239]

¹¹In a 1990 European Commission decision, Solvay and ICI were found to have used the home-market principle to share the market for soda-ash, with Solvay supplying Western Europe and ICI supplying the United Kingdom.

In practice, domestic markets were reserved to the local producers in the first instance. [T]he basic rule of the agreement ... consists in observing the domestic markets of the different producers. The United Kingdom (off-shore) was regarded as semi-protected: a competitor had to contact the local producer of oilfield pipes and tubes before making a bid. The Japanese producers were not supposed to penetrate the European market in these sectors, while European producers were not to deliver to Japan. [Seamless steel tubes - EC, 54, 62-3]

Some firms in the lysine cartel put great emphasis on abiding by the home-market principle:

Kyowa insisted on the home-market principle. The participants agreed to sell, in 1991, within the export quantities of 1990. Ajinomoto and Kyowa requested Sewon to reduce substantially its sales to the USA and Europe on the principle that the local producer should sell as much as possible in its region. [Lysine - EC, 57, 68]

With the methionine industry, the home-market principle was, in fact, the instigating factor for cartel formation.

The cartel originated in the mid-1980s when Rhône-Poulenc and Degussa contacted Nippon Soda and Sumitomo because they felt that the Japanese producers' were encroaching on 'their' home markets. Rhône-Poulenc, Degussa, Nippon Soda and Sumitomo met at divisional level and agreed a scheme to limit Japanese imports. Some time in the 1980s, Rhône-Poulenc and Sumitomo entered into a "gentleman's agreement" whereby the latter would stay out of Europe and the former would stay out of Japan. [Methionine - EC, 82-3, 91]

It also appears that exclusive territories were used in connection with the isostatic graphite cartel.

The three European producers were in frequent telephone contact with each other to discuss their prices and they met at least twice a year. The cooperation mainly included an agreement on prices to be charged in Europe and the allocation of customers. In principle, the German market was reserved for Ringsdorff and Schunk and the French market for LCL. When a customer inquired about the price for a prospective order, the three companies first contacted each other by telephone in order to agree who would obtain that order. [Isostatic graphite - EC, 106]

Implementation of exclusive territories may require inter-firm purchases. That is, to induce a firm to pull out of a market (or greatly reduce its supply), the home-market firm(s) may have to buy some of that reduced supply. In the case of the nucleotides cartel, two Japanese suppliers - Ajinomoto and Takeda - were interested

in getting two Korean suppliers - Cheil and Miwon - to limit their sales in Europe and Japan. The deal was that Cheil and Miwon would not sell to the three largest European buyers and would restrict supply to Japan; and in exchange Ajinomoto and Takeda would purchase supply from them. [Nucleotides - EC, 69]

In a competitive market, one would expect a rise in a firm's price, *ceteris paribus*, to result in more imports. However, an allocation scheme based on the home-market principle would result in the combination of a higher price and *fewer* imports.

Collusive Marker: Price increases and imports decrease.

2.2.3 Customer Allocation

Finally, we turn to the scheme of allocating customers. The choline chloride cartel used this device as well as the home-market principle to implement the collusive allocation:

Price agreements regarding individual clients were implemented by allocating clients to particular producers and by agreeing that the other European producers concerned would offer higher prices than the European producer to whom the client had been allocated. This was done in such a way as to respect the overall market shares in the EEA of the participating producers. Price agreement, client allocation, and market share agreements worked hand in hand. [Choline chloride - EC, 65]

Customer allocation was also instrumental in the copper plumbing tubes cartel:

producers allocated a share of the respective estimated national demand to each ... producer. In certain markets they fixed "extremely precise quantities" to be sold to each distributor. Thus, customers were allocated (like distributors, for example, in the Netherlands). In the case of allocation of customers (distributors), the demand of certain customers was either reserved for one producer or split between several producers. [Copper plumbing tubes - EC, 137]

In a U.S. cartel in linen supply, firms agreed not to compete for each other's customers and actively assisted in ensuring that customers did not switch. If a firm learned that one of its customers was contemplating switching suppliers, it was to notify other cartel members who were to submit intentionally high price quotes or refrain from submitting price quotes.¹²

In the case of the district heating pipes cartel, projects were allocated as part of bid-rigging.

The cartel allocated sales quotas on both a national and European level. ABB's quota was 37%, Løgstør 20%, and the three other producers 10%

¹²U.S. Department of Justice, Antitrust Division, Press Release, 2/28/05.

each. As the market is project-based, bid-rigging was a feature. Sales managers met every 2-3 weeks to deal out contracts. For each project, one producer was nominated "favourite" and it informed the others what it was to bid; the others were to put in higher "protection" offers. A computer program monitored all bids to ensure compliance. [*Competition Policy Newsletter*, 1999 February, Number 1, pp. 27-8.]

There is some sketchy evidence of customer allocation in the fine arts auction house cartel. In that cartel, there were no sales quotas or exclusive territories, and the customer allocation that was done was probably ad hoc or limited to especially large consignments. In this passage, Christopher Davidge and Dede Brooks are the CEOs of Christie's and Sotheby's, respectively, while Stephen Lash and Christopher Burge are employees for Christie's.

Shortly after Davidge's call to Brooks from Pebble Beach, Stephen Lash was apoplectic when Christopher Burge took him aside and asked him which estate consignment Christie's should prefer - Mrs. Hazen or Joanne Cummings? Without going into much further detail, Lash recalled, Burge explained that Davidge was seeking a "consensus." To Lash, the clear implication was that Brooks and Davidge were dividing up clients. As a trusts-and-estates expert who struggled on a daily basis to ensure that major business came to Christie's, not Sotheby's, he was mortified at the thought of the firms' two CEOs divvying up big estates on a one-for-me, one-for-you basis. [Mason (2004), p. 191]

A related activity to customer allocation is for firms to coordinate on sharing a customer. A highly structured mechanism was deployed in the electrical and mechanical carbon and graphite products cartel:

Probably because of the difficulty of implementing uniform prices for large customers throughout Europe, SGL proposed, in a Technical Committee meeting held on 18 April 1996 in Cologne, Germany, a second strategy, namely a policy of account leadership. ... Account leadership would be determined based on the market shares of each of the cartel members for each major customer for the years 1994/1995. The policy was based on the following key principles. i) The current market shares of the cartel members should be frozen at all accounts and per each item sold where applicable. ii) For each major customer an account leader should be agreed, which normally should be the cartel member with the largest share of that customer's purchases. iii) This account leader leads the pricing efforts, that is to say, the other members must follow its advice before quoting a price to the customer in question. iv) The account leader is responsible for achieving sufficient price increases. v) Pricing for new products should be cleared with the account leader. vi) The Summit meeting determines the account leaders. [EMCG - EC, 128]

In settling upon a customer allocation, historical precedence seemed to play a role as was done with the setting of sales quotas. This was noted for the nucleotides cartel where the three largest European buyers were allocated between Ajinomoto and Takeda according to who had historically supplied them. [Nucleotides - EC, 68] This was also used in the vitamin C cartel which furthermore showed how special arrangements could be made to handle large customers such as Coca-Cola.

To underpin their concerted efforts to raise the price for vitamin C in each market, the producers conceived a sophisticated system for handling the 'key accounts', i.e. important individual customers for which a detailed sales plan would be agreed. For each 'key customer' which is identified, the producers estimated its total annual demand and reported the price it was currently paying, ascertained whether this was under a tonnage or fixed-term contract and agreed who would supply what tonnage in 1991. In some cases a producer asserted the right to supply exclusively a particular 'traditional' customer; in others, it demanded that the business of that customer be split according to a particular set formula. One of the largest customers worldwide was Coca Cola whose total requirements of vitamin C are in excess of 1,000 tonnes per year. For this major account, which received special treatment, Coca Cola negotiated a worldwide supply contract with its suppliers, the vitamin producers agreed between themselves how the business would be shared between them and the prices quoted. The cartel also discussed the supply contracts which Roche had with the pharmaceutical company Pfizer. This contract was renewed every two years. Takeda's report of its meeting with Roche in February 1993 read as follows: Roche would like Takeda not to supply Pfizer if they contact Takeda. [Vitamins - EC, 402-12]

In the zinc phosphate cartel, the largest customer in the market - the Finnish company Teknos - was shared among the cartel members by having the contract rotate among them.

in order to avoid a price war over Teknos, it was agreed that Britannia, Heubach, SNCZ, and Waardals would take it in turns to supply this customer. The supplier for the next period was discussed at each meeting. [Zinc phosphate - EC, 97]

It is also noteworthy that the cartel was cognizant that Teknos might suspect that the firms were coordinating.

the companies were aware that Teknos could become suspicious of the collusion ... if a regular rotation was put in place. The cartel participants ... therefore followed a more flexible system, for example, at one stage SNCZ was the Teknos' designated supplier three times in succession. [Zinc phosphate - EC, 100]

2.2.4 Other Allocation Issues

As mentioned earlier, firms did not always agree on the allocation. It is also true that they did not always agree on the allocation *scheme*. In the lysine cartel, Ajinomoto and Sewon argued in favor of exclusive territories and Sewon proposed that the Japanese firm Kyowa be given a monopoly in Japan. (Though Ajinomoto was the largest lysine producer and was Japanese, its primary market was Europe through its division Eurolysine.) ADM preferred sales quotas and, in particular, argued against a customer allocation scheme:

Wilson [of ADM] told the cartel that volume limitations did not mean dividing up the market by captive consumers and refuse to sell to others. A "don't touch [each other's] customers policy" could create suspicions. The cartel had agreed, upon the urging of Wilson, not to permanently assign customers because it would have been too obvious. [Lieber (2000), pp. 184, 238]

Sewon, however, was against having sales quotas as it felt that a firm's allocation should be based on its previous year's sales. (Of course, that is exactly the time of arrangement that would result in firms overproducing.) Eventually, the lysine producers agreed to allocate the global market using sales quotas.

A similar view to that of Sewon was voiced by Japanese suppliers Chisso and Ueno in the sorbates cartel, though Japanese supplier Daicel agreed with Hoechst.

Chisso declared that the volume quotas system should be abolished since it prevented the producers of increasing their sales. Ueno shared Chisso's view. Daicel wanted to maintain the status quo and wanted to prevent members from leaving the group. It supported Hoechst's proposal ... against abolishing the quotas. [Sorbates – EC2, 206]

These disparate views regarding the allocation scheme may be due to honest differences as to what was thought to be the most effective collusive mechanism. There may be different opinions as which scheme is easier to monitor or less likely to create suspicions among buyers that there is collusion. Alternatively, these different views may be strategic and reflect dissatisfaction with the likely allocation that a particular allocation scheme would induce. For example, a firm may argue against sales quotas because it expects that quotas will be set based on sales in preceding years and it may desire a bigger share of the market.

Finally, it needs to be mentioned that not all cartels had an allocation scheme. There is no direct evidence that the methionine cartel had a volume agreement. The European Commission concluded that: "The cartel's three main objectives were to fix target prices, agree [to] concerted price increases and share information on sales volumes and market shares." [Methionine - EC, 64]. Though cartel member Degussa proposed the establishment of a volume agreement, it contends it was never implemented. [Methionine - EC, 75] Furthermore, Degussa believed that such a scheme would not have worked because a major supplier, Monsanto/Novus, was not

a member of the cartel. [Methionine - EC, 149] The methionine cartel focused on coordinating their prices and, in spite of exchanging firm sales volume, apparently did not use this information to implement a market allocation scheme.

Another case in which there was not a market allocation was the lysine cartel in its early years. In fact, this case argues to the importance of agreeing to quantity and not just price. As described earlier, the lysine producers disagreed as to the preferred allocation scheme - some wanted exclusive territories, while others wanted sales quotas - and this disagreement initially resulted in there being no allocation agreement though firms did come to an agreement on price. Starting in November 1992, price initially rose to \$0.98/pound in spite of the lack of an allocation agreement. But by March 1993 the price agreement had unravelled and price was down to \$0.68/pound (Connor, 2001). After this failed start, firms went back to working out an allocation agreement which they did achieve in late 1993. From that point onward, collusion was highly effective.

The importance of a quantity agreement was clearly stated by an executive connected to the copper plumbing tubes cartel. When asked why cartel members chose to fix market shares rather than price, the executive replied: "if there was allocation of volumes, prices would follow." [Copper plumbing tubes - EC, 220]

3 How is a collusive outcome enforced?

Having coordinated on price and/or an allocation of the market, the agreement must then be implemented. In doing so, there is the concern that cartel members may cheat by pricing too low, selling too much, attracting other firms' customers, and committing other violations of the understanding among firms. Towards deterring such cheating, cartel members' behavior was monitored and, if there was a significant deviation from the agreed-upon outcome, the deviator was punished and the harmed firms were possibly compensated.¹³ Issues of monitoring and punishment are reviewed in Sections 3.1 and 3.2, respectively. In addition to internal difficulties associated with implementation, cartels were concerned with external disruptions coming from those not part of the cartel. This will typically mean non-cartel suppliers; either manufacturers of the product who are not part of the cartel or firms who purchase the product from the cartel as an input and resell it or add value to it. There was also an internal source of disruption in the form of employees who are involved in sales activities - typically, sales representatives - but were not privy to the collusion that was taking place. These issues are covered in Section 3.3.

3.1 Monitoring

Collecting information on other firms' prices and sales is a non-trivial exercise. Though price lists were often public information, one of the concerns was that a cartel member may be giving secret discounts off of that list to buyers. Since, in most of these

¹³According to the theory of collusive pricing, punishment not compensation is critical. However, these case studies reveal an importance attached to compensation.

markets, price could be bilaterally set between a seller and a buyer, there is the issue of how a firm learns what other firms are really charging. The matter may be even more difficult when it comes to data on sales. Some information could be retrieved by learning from a customer as to from whom they bought. However, on the whole, cartels relied on the self-reporting of sales data which raises the issue about the incentives to truthfully report. Indeed, there were documented episodes of deception but firms were not naive on the matter and some cartels instituted methods to check the authenticity of the reported numbers.

3.1.1 Monitoring of Price

Though far greater effort was put into monitoring sales, let me begin by discussing the monitoring of price. This is obviously necessary when there is no volume agreement but is also useful when there is one. In the electrical and mechanical carbon and graphite products cartel, it was noted that: "There were exchanges of price information regarding specific bids for tenders. They also exchanged the cartel members' turnover to individual clients along with the price level obtained in those sales." [EMCG – EC2, 142] While the copper plumbing tubes performed "continuous price co-ordination through regular adaptation of price lines (mostly by phone) and agreements on rebates." [Copper plumbing tubes - EC, 212]

Firms were also able to engage in some unilateral monitoring of price and thus avoid relying exclusively on self-reporting. A firm's sales force could be useful for learning about competitors' prices. Some firms in the industrial and medical gases cartel instructed their sale representatives to report any aggressive pricing by competitors. [IMG - EC1, 161] Also, one of the cartel members of the plasterboard cartel noted: "Our sales team give us daily information about our competitors' prices." [Plasterboard - EC, 342] With the sorbates cartel, dealers were a source of information:

Hoechst and the Japanese producers monitored target price adherence through the data regarding competitor pricing which they used to receive through their dealers. When prices fell below the target prices for key customers, the Japanese companies (mainly Daicel) and Hoechst did on occasions telephone each other to try to ensure that such prices were brought closer into line with the targets in the next large contract with the same customer. [Sorbates – EC2, 113]

To show its compliance, a firm may also share with other cartel members the instructions they have given to employees with regards to pricing. This is particularly important for the fine arts auction house cartel since there is limited evidence of a market allocation scheme.

To demonstrate that Sotheby's was "following suit", [an officer of Sotheby's] faxed Christie's with a copy of internal instructions given to staff confirming the strict new practice: all commissions are minimum rates and may

not be waived or reduced. The instructions made clear that the new tariffs would be non-negotiable. [FA - EC, 112]

So as to avoid any mistaken inferences about cheating as well as to deter cheating, Christie's and Sotheby's also shared the list of clients to which they had already signed contracts so that it was understood that the commission rates charged were negotiated prior to the collusive agreement. If the client was not on that list then an auction house was in violation of the agreement if it did not charge the agreed-upon commission rate.

Both press releases of Christie's and Sotheby's made it clear that property already consigned for future planned sales would not be affected by the new sliding commission scales. This obvious exception however opened the door to "cheating" by the two auction houses. In order to ensure that neither took on new business at the old rates or at no commission, the [companies] exchanged lists of "grandfathered" clients. These lists identified the customers with whom conditions had been agreed, prior to the announcement of the new scale. [FA - EC, 117]

3.1.2 Monitoring of Sales

Structure of Reporting To most cartels, more critical than monitoring price was monitoring sales. The level of specificity of sales data collected varied greatly across cartels. Of course, the need for such numbers depended on the allocation scheme. An attraction to a customer allocation scheme is that monitoring is relatively easy since, if a firm was to supply a particular buyer, it would surely know whether that buyer ended up buying from someone else. Monitoring a sales quota scheme was more difficult and indeed most of the information from these cases about monitoring pertains to it.

Perhaps the most sophisticated and well-documented monitoring scheme was that deployed in the vitamins cartel. The "budget" in the vitamins cartel refers to the sales quotas.¹⁴

The collusive arrangements in most of the vitamins concerned employed essentially the same model and followed the same pattern and the same method of operation, namely: the preparation, agreement and implementation and monitoring of an annual 'budget', the exchange of sales, volume and pricing information on a quarterly or monthly basis, the adjustment of actual sales achieved so as to comply with the quotas allocated in the 'budget' exercise, the establishment of formal structure and hierarchy of different levels of management, often with overlapping membership at the most senior levels, the role of Roche as the conduit for collusion with Japanese producers. [Vitamins - EC, 577]

Here is some evidence from specific vitamins cartels:

¹⁴For more details, see Connor (2001).

For the most part, the BASF documents consist of (a) worksheets or support documents used to fix the annual budget for each producer on a country-by-country basis and (b) charts comparing the actual sales of each producer with their respective budgeted volumes., i.e. their quota for each regional and national market both on an annual basis and for interim periods (sales figures in volumes were exchanged on a monthly basis). [Vitamins (A, E) – EC, 191]

The purpose of the quarterly meetings was to monitor achieved market shares against quota and to adjust sales levels to comply with the agreed allocations. A control system along the lines of the vitamin A and E mechanism was developed. [Vitamins (B2) - EC, 276]

Results were to be monitored on a quarterly basis against target quotas ... There were comprehensive spreadsheets and tables showing how the sales quotas were calculated for each year and how actual sales ('result') were compared with quota ('allocation'). [Vitamins (folic acid) – EC, 359]

This was not unique to the vitamins cartel; the overall structure of monitoring was quite common to cartels with an allocation scheme, especially one based on sales quotas. For consider the plasterboard cartel:

At these meetings, the competing undertakings exchanged data on their market shares with a view to reaching agreement on the sharing of the German market. BPB, Knauf and Lafarge regularly exchanged sales volumes data, inter alia on the German market, and that from 1995 onwards, this regular exchange took place on a quarterly basis. The representatives of BPB and Knauf established, as from 1992, information exchange arrangements, to which Lafarge and subsequently Gyproc acceded, relating to their sales volumes on the German, French, UK and Benelux plasterboard markets; the representatives of BPB, Knauf and Lafarge exchanged information, on various occasions, prior to price increases on the UK market. [Plasterboard - EC, 462]

Another highly developed monitoring scheme was that used in the graphite electrodes cartel with the institution of their "Central Monitoring System."

In addition to discussions on pricing and on certain customers, the participants exchanged information on their individual sales volumes covering several years: the previous year, current year and projections for the coming year. Volume data for all areas, including Europe, were updated and revised at each meeting. Information was broken down by country for each firm with the Japanese being one group. For the purpose of formalising the exchange of volume information and making the collection of data more efficient, SGL proposed at the 'Top Guy' meeting in Tokyo in February 1995 the adoption of a 'Central Monitoring System' (CMS).

Tokai was designated by the cartel to collect the data from the Japanese producers, UCAR and SGL. [Graphite electrodes - EC, 55]

Previously we mentioned that the allocation of (European) market shares in the sorbates cartel was set in two stages. At the general cartel meeting, the market was allocated between Hoechst and the four Japanese producers. Afterwards, the Japanese members would meet to divvy up their share amongst themselves. This organization also applied to the monitoring arrangement.

As for volume quotas, before preparatory meetings, Daicel used to collect sales information from each of the Japanese producers and to prepare charts reflecting this information. During the preparatory meetings, the Japanese producers monitored sales results for the year to date and compared them to the agreed volume quotas for the same period. At the joint meeting, the group reviewed sales results and confirmed the volume allocations agreed in the previous joint meeting. [Sorbates - EC, 114]

The lysine cartel was also highly organized.

Kanji Mimoto of Ajinomoto was assigned the task of preparing monthly "scorecards" for the five members of the cartel as a way of tracking adherence to the volume shares agreed upon. Each month, the five companies telephoned or mailed their lysine volumes of sales to Mimoto, who prepared a running spreadsheet that was handed out and discussed at the quarterly maintenance meetings. Sales volumes were calculated for four regions (North America, Latin America, Europe/Middle East/Africa and Asia/Oceania) and for the world. [Connor (2001), p. 207]

Based on this information, the cartel would decide whether or not firms were compliant.

The participants compared the allocated production quotas for 1994 with the actual sales figures realized during the same year. They concluded that the difference between allocated quota and actual sales of each company was not excessive and that therefore the price level could be maintained. Furthermore the participants resolved to allocate sales quotas on the basis of the estimated market size for 1995. [Lysine - EC, 154]

What happens when a firm's sales exceeds its quota and other firms fall short of theirs will be considered in Section 3.2.

Level of Aggregation As reflected in the lysine cartel, there were various levels of aggregation in reporting. It might be at the global level, regional level, country level, or even at the level of specific customers. For example, the vitamins cartel tended to report at the regional level.

Regional product marketing level - These meetings, which were organised by the regional management and involved the heads of marketing for each region, including Europe, were held about four times a year. Discussions included pricing to individual customers. The group was also responsible for: monitoring sales against budget on a regional level and making adjustments if necessary; identifying relevant market developments inside their region; implementing the price increases agreed at the more senior levels. [Vitamins (A, E) - EC, 176]

A document dated 5 June 1991 is headed "Vitamin B1 monitoring 1990" and shows for each region (Northern America, Latin America, Japan, Europe, etc.) the sales in tonnes of Roche, BASF, Takeda and the Chinese producers, the latter presumably estimated for the year 1990. [Vitamins - EC, 249]

The isostatic graphite cartel held meetings at the local level and reported sales at the more disaggregated country level in response to dissatisfaction with the cartel's performance in terms of price increases.

the meeting was convened with the object of improving the implementation of decisions and the communication among manufacturers. Price increases were not showing good progress ... The participants therefore decided to monitor better the sales channels and the prices by taking further control of local agents. Local meetings would thus be held in Germany, France, Italy and Spain, with SGL being appointed as coordinator for Germany, LCL for France and Spain and Tokai for Italy. ... Tokai explains that it was deemed necessary to have meetings where the situation could be assessed on a country-by-country basis because the representatives at the European meetings were not able to obtain sufficient information on specific local circumstances.[Isostatic graphite - EC, 202, 237]

The choline chloride cartel - which used sales quotas, exclusive territories, and customer allocation - exchanged highly disaggregated sales data.

In the EEA, whether the agreed market shares, customer allocations and prices were being achieved in practice was regularly checked by comparing information on sales actually made during the previous period. Starting from CEFIC [trade association] statistics, participants would report their actual sales volumes and sales prices in national markets, including to individual customers. They also discussed their experiences with individual customers. The parties agreed to meet every six months to monitor, discuss and correct any problems. In these follow-up meetings, the parties compared information on sales actually made during the last period. [Choline chloride - EC, 69]

Accuracy of Reported Sales As the cartel largely relied upon firms self-reporting their sales, there is obviously a concern about underreporting. A firm may either intentionally or inadvertently overproduce but in either case it may want to underreport in order to avoid punishment. As the incentive compatibility of truthful reporting is problematic, a central issue is the accuracy of the reported sales.

In cartels such as carbonless paper and lysine, there is evidence that firms acted "as if" these reported numbers were accurate even though firms might suspect underreporting.

Comparison of these figures with information on real sales figures confirms that the sales volume information exchanged at the meeting was accurate. This shows that the carbonless paper producers took the information exchange seriously. Mougeot's statement indicates that the volume information exchanged was used to verify whether there were important changes in market shares, which might be due to a failure to comply with the price increase agreements. [Carbonless paper - EC, 248]

In the Plasterboard cartel, some cartel members were suspicious that its fellow members were underreporting but then an audit was permitted.

According to Gyproc, the time came when Mr [K], [a high level representative], realised that its competitors were not always supplying the consultancy with accurate figures, in order, according to Gyproc, to minimise the volume of their sales on the German market and hence reduce their share of that market. In this way they made their competitors overestimate their own market shares. [Plasterboard - EC, 214]

in the French market meeting ... there was some disagreement between the cartel members on the accuracy of price increase and volume information exchanged in the course of the meeting. In order to verify the figures submitted, [an AWA employee], who doubted the figures supplied by Sarrió (Torraspapel), had asked and received permission to audit the information on Sarrió's sales volumes on Sarrió's premises. [Plasterboard - EC, 106]

The sorbates cartel was rather unique in that Japanese export data provided a check on the sales being reported by the Japanese producers.

the group started noticing the existence of "grey material" - which corresponded to the difference between the self-declared sales results and the published Japanese export data. This "grey material" was due to the fact that the producers did not report all of their sales results to the group. The self-declared figures were not verified and the group assumed that the Japanese export data was accurate [and therefore the discrepancy was due to the producers not reporting their sales accurately]. Hoechst

was always aware of the Japanese export statistics because it was a member of the Chemical Industrial Products Export Co-operative (CIPEC), a Japanese organised export cartel that had no relationship with the conspiracy, and, consequently, had access to the Japanese export statistics. The Japanese producers, however, had no way of checking the Hoechst sales figures since they could not obtain the German official statistical data. [Sorbetes - EC2, 191]

Due to the incentive to misreport, some cartels actively sought independent verification including vitamins, plasterboard, and citric acid.

They again discussed the mechanism needed to obtain and police a sales volume agreement. ADM stated that the way for them to communicate is through a trade association. ADM explained by way of example that ADM reported its citric acid sales every month to a trade association, and every year, Swiss accountants audited those figures." [Lysine - EC, 100]

But even with independent auditing, cartel members might be able to "hide" sales and once again result in underreporting.

A memo from 1/94 revealed that Ajinomoto parked 3,500 tons of lysine out of the cartel's auditors. Another sentence read: "Hide 1,000 tons in Thailand internal business." [Lieber (2000), 172]

Cheil claims that, whenever it submitted data on sales volumes, such data were continuously incorrect as they understated its actual sales. Cheil stresses that in fact it supplied misleading information to the other companies. [Lysine - EC, 375]

At the same time, the lysine cartel seemed to take these numbers seriously, which may suggest that there were perceived to be limits to the extent of misreporting: "The cartel was pleased at its Atlanta meeting in 1/95 because there was only 'a very small difference between what was allocated and what was sold.'" [Lieber (2000), 234]

Some cartels went through a series of reporting procedures with the apparent intent to improve the accuracy of the sales numbers. The copper plumbing tubes cartel went from self-reporting to working through the International Wrought Copper Council (IWCC), which is a trade association, to using the World Bureau of Metal Statistics.

The main part of the cooperation was the exchange of sales volumes data and, on its basis, the allocation of volume quotas. Volumes were first exchanged through the "spreadsheets;" each producer provided Mr. [...] with its volume figures of deliveries on a country-by-country basis on a monthly or quarterly basis and, with these figures, Mr. [...] prepared a "spreadsheet" that contained the collected data. From around 1993, IWCC data was used as a basis for agreeing on volume-targets until at

least mid 1994; sales volume data of each main market was submitted to the market leader, normally on a monthly basis. In 1996, certain data was exchanged directly among the parties to re-intensify cartel activities as they had occurred before. In 1997, participants set up a new data exchange system - initially on a monthly, later on a quarterly, basis through the World Bureau of Metal Statistics. WBMS statistics only contained aggregated figures and no company specific information. [Copper plumbing tubes - EC, 486]

Interestingly, two cartels designed the monitoring scheme in order to protect the privacy of each firm's market share while constructing total market sales for dissemination. In this way, each firm could calculate only its own market share. The isostatic graphite cartel achieved this by playing "pass the calculator," while the plasterboard used a third party.

A common practice in the meeting ... consisted in trying to determine the size of the market by passing around a calculator where each participant entered its company's sales volumes of isostatic products. This ensured that no one saw the individual companies' volumes, but only aggregate sales to the Italian market. [Isostatic graphite - EC, 245]

Four firms set up a system for exchanging information through an independent expert, Mr [U, independent consultant]. The operation was placed under the aegis of the Plasterboard Industry Group. Each producer gave its figure to Mr [U] on a confidential basis and the results were compiled by the latter's office, giving an aggregate figure, which was then sent to the participants. This figure enabled each producer to calculate its own market share, but not that of the others. Every quarter, the participants - Gyproc, Rigips, Knauf/Dano and Lafarge - supplied their respective sales figures (in square metres) to Mr [U], who collated them and then sent each an aggregate figure for the whole market. [Plasterboard - EC, 271]

It is unclear why firms sought to maintain privacy of their market share and to what extent effective enforcement could be achieved without market shares being commonly known among the cartel members.

Frequency of Reporting In addition to the level of disaggregation, another important dimension to monitoring schemes was the frequency with which firms exchanged sales data and assessed compliance. This issue is reviewed in more detail in Section 4 and there it is shown that the frequency of monitoring ranged from weekly communication via phone or fax to semi-annual in face-to-face meetings.

The copper plumbing tubes cartel only appeared to exchange sales data every several months:

For the purpose of stabilising the market shares, the participating companies usually met around October/November to discuss the size of the relevant market and to agree on target volumes. Market shares and volume information were exchanged a few times a year and followed by meetings, usually at the operational level. [Copper plumbing tubes - EC, 200]

The choline chloride cartel reported that it initially was set up to meet semi-annually though actually communicated by phone about every 2-3 weeks to discuss sales in Europe. [Choline chloride - EC, 97] Quite typical was for cartels to meet and share sales data on a quarterly or monthly basis. In the case of the vitamin B5 cartel, firms initially reported sales data on a quarterly basis but later chose to do it on a monthly basis. [Vitamins - EC, 316]

The lysine, zinc phosphate, and citric acid cartels monitored on a regular monthly basis.

In order to monitor the correct implementation of these quotas and avoid, as far as possible, the need for compensation at the end of each year, a regular exchange of monthly sales information was established from March 1991 (37). As Jungbunzlauer declares, 'each of the participants reported the tonnage they had sold in each region (Europe, North America, and the rest of the world) to the secretariat of the ECAMA President by the seventh (day) of each month. In the secretariat these sales figures were assembled and then reported back to the members by telephone, broken down by firm and by region. This made it possible to monitor the relative market shares continuously. The information also formed the basis of the market analysis carried out at the meetings. [Citric acid - EC, 100]

While the vitamins A and E cartel met monthly for monitoring purposes, they communicated weekly by phone.

The managers who attended the European regional meetings had weekly telephone contact in order to monitor the agreements on pricing and sales volumes and to discuss individual customers. Every month they exchanged the volumes of vitamins A and E sold in each national market. Roche provided the others with the monthly sales of Eisai in the European market as a whole rather than for each country. [Vitamins - EC, 188]

Though monitoring might take place weekly or monthly, the punishment for non-compliance was levied annually. By engaging in high-frequency monitoring, a number of these cartels - such as citric acid, lysine, and vitamins A and E - gave firms the opportunity to adjust their sales so as to be compliant at the year's end with respect to sales quotas. This would avoid the need for actually implementing a punishment.

Other Monitoring Issues Some cartels would choose to work through their trade association. In this quotation from the European Commission decision on the zinc phosphate cartel, CEFIC and VdMI refer to trade associations.

In order to ensure that allocated market shares were adhered to, a monitoring system was set up. Each producer sent its sales volumes data on a monthly basis to the CEFIC and later to the VdMI, which compiled the figures and sent them to all the five producers concerned. Being in possession of the exact size of the market, the producers met and provided each other with their individual sales volumes, thereby verifying via this exchange of information their mutual adherence to the agreed market shares. Information about specific customers was also exchanged. On some occasions, this resulted in customer allocation. [Zinc phosphate - EC, 69]

Finally, it is worth noting that firms were not always reliant on other firms self-reporting. In some instances, unilateral monitoring of customers provided information.

Gas suppliers are rather well informed about each other's clients. Because cylinders and gas tanks usually belong to the gas supplier and bear that company's markings, a salesman visiting a customer or a potential customer can easily see who the current supplier is. A supplier can therefore react immediately if a customer with which it has a contract starts buying from a competitor. The larger suppliers of industrial gases certainly maintain lists for each competitor detailing customers they have lost and won. These lists also indicate price concessions they had to accept because of competitive offers made by that particular competitor. [Industrial and medical gases - EC, 83]

3.2 Enforcement

Suppose a firm was found to have priced below the agreed-upon price or sold significantly in excess of their sales quota. What was the punishment that would ensue? The review of these cases reveal two types of reactions to apparent violations. For some of the cartels with allocation schemes, they instituted a well-structured compensation scheme whereby either: i) a firm that sold too much had to buy output from a firm that sold too little; or ii) the next year's sales quotas were adjusted accordingly. A second reaction was to engage in aggressive pricing behavior. There is evidence that this was discussed and threatened but one would need to examine the price data to see if it was ever executed. Typically, though not universally, the threatened aggression would be targeted at the markets and customers of the deviator. It should also be noted that the threat of a price war (or the collapse of collusion) may have served to induce firms to go along with a compensation scheme.

3.2.1 Buy-Backs and Compensation

Some form of compensation was used in the cartels in the markets for choline chloride, citric acid, lysine, organic peroxides, sodium gluconate, sorbates, most vitamins, and zinc phosphate. The scheme was well-developed in the citric acid cartel and is somewhat canonical for this type of punishment/compensation scheme.

A compensation scheme was agreed to as a corollary to the quota agreement and in order to penalise those companies selling above their assigned sales quota and at the same time compensate those that did not reach it. If a company went over its assigned quota in any one year, it would be obliged to purchase product from the company or companies with sales below their quota during the following year. [Citric acid - EC, 88]

At the meeting on 14 November 1991 in Brussels, the first at which sufficient data had been gathered on the progress of sales, it became clear that ADM was falling far short of its sales quota whilst Haarmann & Reimer was ahead of its quota by a similar quantity: 'By the end of 1991, Haarmann & Reimer needed to buy 7,000 tons of citric acid from ADM'. The other two producers were broadly in line with their quotas. At the meeting concern was expressed on this divergence because it had been agreed that one of the aims of the meticulous monitoring of sales was precisely to avoid the need for any compensation at the end of the year. It had been agreed earlier that imbalances of this kind were not to be allowed. [Citric acid - EC, 102]

This form of compensation was also part of the choline chloride cartel's agreement.

it was understood that Akzo Nobel and UCB could claim 35% and 28% respectively, while BASF would have 15%. The principle was accepted that compensation should be provided if these shares were exceeded. [Choline chloride - EC, 99]

It is noteworthy that cartels actively sought to avoid the necessity of buy-backs. As mentioned in Section 3.1, the citric acid and vitamins A and E cartels engaged in "continuous monitoring" to assess how sales matched up with quotas and, where a firm was at a pace to sell too much by the year's end, the firm was expected to slow down their sales.

The information for the whole year was maintained on a cumulative monthly basis to ensure that each party kept to its agreed market share; if one was seen to be selling more than its allocated quota, it would have to "slow down" sales to enable the others to catch up. If at the end of the year a producer was substantially ahead of its quota, it had to purchase vitamins from the others in order to compensate them for the corresponding shortfall in their allocation. [Vitamins (A, E) - EC, 196]

One conjecture for the effort exerted to avoid buy-backs is that firms were uncertain as to whether they would actually be made. If indeed a firm that had oversold did not make compensation, it could cause the cartel to collapse. On this point, recall that, at one point during the citric acid cartel, Haarman & Reimer was to buy 7,000 tons from ADM.

Haarmann & Reimer was reluctant to compensate ADM. Hoffmann-La Roche's World Head of Marketing Vitamins and Fines Chemicals, as Chairman, intervened in the dispute, making it clear that this was an essential part of the agreement and that non-compliance on this point would undermine the trust necessary to maintain the cartel and would therefore be harmful to all participants. Accordingly, he urged Haarmann & Reimer to fulfil its agreement. The representatives of ADM and Haarmann & Reimer were told to work out a solution to this dispute and they discussed the subject at a subsequent bilateral meeting. [Citric acid - EC, 103]

Ultimately, it did make the compensation. [CA, 107] While an executive for Haarman & Reimer claimed that ".. compensation never exceeded 2% of its total global sales." [CA, 111], even 2% of global sales is non-trivial. It could also have been that regular and large inter-firm purchases may have created suspicions about collusion, though such purchases can be done for legitimate purposes as well. For both these reasons, it would make sense for cartel members to strenuously avoid the necessity of having to engage in inter-firm sales.

ADM used this compensation scheme not only in the citric acid cartel but also with the lysine cartel.

Wilson [of ADM] described guaranteed "buy-ins" whereby if one sold more than their quota, it would have to buy product from producers who were below quota. Mimoto [of Ajinomoto] explained it in court: "We had allocation for each company at the end of the year 1994. If some company exceeded the allocated quantity and if some company is behind the allocated quantity, then the exceeding company must buy lysine from the behind-schedule company." The five companies provided sales figures to Mimoto. When ADM's sales fell behind the schedule, the other producers slowed down so that ADM could catch up and meet its quota. [Lieber (2000), 148]

In the organic peroxides cartel, buy-backs were not presented as something compulsory but rather that it was an option to a firm to request it when it sold below quota.

All future sales of initiators in the geographical area will be shared between the parties in accordance with a quota system ... the quota will be maintained by exchanging every quarter the uncertified sales figures

of the past three months . . . If the exchange of figures shows that the sales of a party in any country have exceeded the quota for any category then that party will modify its sales policy in succeeding months with the object of arriving eventually at a tonnage for the whole of the calendar year which does not exceed his percentage quota . . . compensation may be made at the underseller's discretion by the purchase of product/s at prices which reflect the loss of profit suffered by the underseller. [Organic peroxides – EC2, 85]

The organic peroxides cartel was explicit that the buy-back was done for purposes of compensation as it was to reflect the firms' foregone profit. This suggests that compensation may have been a more significant consideration than punishment. Indeed, if a deviating firm is only required to "return excessive sales" than it is not much of a punishment at all. What may then have been the case is that the buy-back scheme was indeed to serve the purpose of compensation and, to ensure that buy-backs were paid, there was the threat of aggressive pricing, which we discuss below.¹⁵

A modification of this buy-back scheme was used in the soda ash cartel though there it was one-sided. Solvay sought to "buy" the cooperation of rival CFK by guaranteeing CFK a minimum supply. If CFK's sales fell below that minimum then Solvay would purchase the difference from CFK. Interestingly, when the market grew faster than expected, CFK expected its minimum sales to rise with it. Thus, the agreement was apparently not in terms of volume but market share.

Originally, CFK's guarantee was set at 179,000 tonnes, a figure apparently based on CFK's achieved sales in Germany during 1986. For both 1987 and 1988, CFK's achieved sales were somewhat over its guaranteed minimum of 179,000 tonnes (183,000 tonnes and 180,000 tonnes respectively). Indeed demand in Germany had started to increase beyond earlier expectations and by the end of 1988 it had become apparent that the total sales for that year would come to some 1,170,000 tonnes, an increase of some 8.3% over the previous year. As a result of the growth in demand, CFK demanded a minimum guarantee for 1988 and 1989 of 194,000 tonnes. Solvay offered maximum compensation for 1988 of 4,000 tonnes instead of the 8,500 tonnes. For 1989, it proposed that the guarantee be ... 190,000 tonnes instead of the 194,000 tonnes which CFK had originally demanded. [Soda ash - EC, 42-48]

A closely related alternative to buy-backs is to adjust the next year's sales quotas based on the relationship between the current year's sales and quotas. In the sodium gluconate cartel, if a firm's sales exceeded its quota then its quota in the ensuing year

¹⁵Such a mechanism is consistent with the theoretical analysis of Harrington and Skrzypacz (2005). There it is shown that when firms only observe other firms' sales but not their prices, the threat of a price war cannot by itself sustain collusion. However, a buy-back scheme supported by the threat of a price war can sustain collusion.

would be reduced.^{16,17}

Though a buy-back scheme was originally instituted in the sorbates cartel, it was then abandoned for unknown reasons.

Among the Japanese producers there was a penalty system in the early years of the agreements. In 1981, for instance, Daicel compelled Chisso to buy 60 to 70 tons from Daicel because Chisso had exceeded its volume quota for 1980. The penalty system was abandoned after 1981, at Chisso's request. [Sorbates - EC2, 116]

An alternative form of compensation for having sold under a quota was to receive a bigger customer allocation. This was used in the zinc phosphate cartel.

The agreement on sales and quotas was in the nature of a 'gentlemen's agreement', in that the members did not put into practice any specific kind of enforcement mechanism. Enforcement of the sales quotas was achieved through pressure brought to bear on the members during cartel meetings. Customer allocation was used as a form of compensation in the event of a company not having achieved its allocated quota. On an annual basis, the real market shares of the five producers closely followed their allocated share. [Zinc phosphate - EC, 72]

Specifically, the large customer Teknos, which regularly rotated among the cartel members, was used as a form of compensation: "SNCZ seemed to have undersold and was 'allocated' Teknos for 6 months." [Zinc phosphate - EC, 139]

3.2.2 Price Wars and Retaliation

Less explicit than the use of buy-backs, many cartels threatened a price war if firms did not behave.

While a compensation scheme and retaliatory mechanism did not exist, a competitor not following the agreed principles could face aggressive market conduct by other tube producers. Whenever a participant made an offer to the client allocated to another producer and/or did not respect the agreed discount scheme, he was immediately called and asked for justification. [Copper plumbing tubes - EC, 224]

In the carbonless paper cartel, cartel member AWA had a market share in Europe of 30-35% and was the largest producer with capacity exceeding twice that of any other firm. [Carbonless paper - EC, 105] It used its dominant position in the market to threaten aggressive pricing if firms did not comply with the collusive agreement. [Carbonless paper - EC, 106]

¹⁶ "Commission Fines Five Companies in Sodium Gluconate Cartel." European Commission Press Release, March 19, 2002.

¹⁷ The dependence of the current market allocation on past realized allocations is a feature of a collusive mechanism characterized in Athey and Bagwell (2001).

Mougeot's account of the meeting of 1 October 1993 indicates that there were sanctions for failure to comply with the agreements: '[an AWA employee] said quite expressly that he would not tolerate any failure to follow this price increase and that he would "personally look after" anyone who did not "play the game"'. When asked to describe the control mechanism and the reasons for the authority of [this AWA employee] and AWA, Mougeot replied: 'As far as we know there were no contracts, documents or legal circumstances which gave AWA any sort of authority. But they had a position of moral and economic leadership on the market. To the old manufacturers [he] was the man who had successfully launched self-copying papier in Europe for AWA, and then secured encouraging results in the United States. AWA's financial and industrial weight enabled him to say that if any of these increases were not passed on AWA would make it its business to push the market right down by applying a price policy that would leave most people high and dry. He showed quite clearly what he was capable of by crushing Binda in Italy'. [Carbonless paper - EC, 104]

In some cases, it was quite explicit that there would be targeted retaliation against apparent deviators rather than a market-wide price war. In the industrial and medical gases market, firms would keep track of where customers were going and this information could be used to retaliate for non-compliance.

The larger suppliers of industrial gases certainly maintain lists for each competitor detailing customers they have lost and won. These lists also indicate price concessions they had to accept because of competitive offers made by that particular competitor. This knowledge, together with lists of that competitor's potentially interesting clients, allows the supplier in question to set up 'hit lists' for a retaliation campaign. In AGA documents this retaliation policy is referred to as the 'balance of terror'. Retaliation campaigns need not be restricted to the same geographic market. Several documents in the Commission's file refer to cross-border retaliation, notably in order to hit an aggressive competitor on its home market, where suitable targets may be easier to find. [Industrial and medical gases, EC1, 83]

In the lysine cartel, the Korean firm Sewon was demanding an increase in its allocation from 37,000 tons to 50,000 tons. If Sewon actually supplied this larger amount, ADM threatened not only to lower the price in the U.S. but also to increase its sales in Sewon's home market of Korea:

Sewon announced it had a target price of \$2.20/kg in the US. ADM said that if Sewon persisted with its 50,000 target that ADM would push the US price down to 1.30/kg and that it would raise its supply in Korea from 1,000 to 5,000. Sewon proposed to continue with price negotiations only.

The other participants rejected this on grounds that price negotiations were meaningless without having a quantity agreement first. [Lysine - EC, 148]

Ajinomoto supported ADM's threat and, through its subsidiary Eurolysine, threatened Sewon with an anti-dumping complaint in Europe if they did not limit their sales to 6,000 tons and maintain a price of 4.25DM. In response to that threat, Sewon complied. [Lysine - EC, 88]

3.3 Disruptions

3.3.1 Non-Cartel Suppliers

Another significant source of cartel instability came from sources of supply that were not fully controlled by the cartel. One source were firms who purchased the product from cartel members and either directly resold it or added value to it and then resold it. In principle, the cartel could control these suppliers by controlling the inputs they sold to them and/or having them join the cartel. Of course, excessive supply by such resellers or value-added sellers could well be due to some cartel members cheating by selling too much input to those firms. Where such alternative suppliers were present, the cartel was aware that they could be a serious disruption if the cartel failed to control their input supply.

In the choline chloride cartel, the resellers were either distributors or what was known as "convertors" who purchased liquid choline chloride and converted it into an alternative form for final use.

To ensure the effectiveness of the agreements regarding market shares, customer allocations and prices, it was important for the producers to control the behaviour of distributors and converters of choline chloride in the market. The control over distributors was pursued by agreeing not to sell at preferential prices to distributors, while the control over converters was pursued either by ensuring that they purchased their raw materials from the cartel members, under the right conditions, or by informing them of the price levels agreed among the three producers, in the hope that they would follow these price levels, or, if necessary, by establishing exclusive corporate ties over them. [Choline chloride - EC, 99]

A similar matter arose in the electrical and mechanical carbon and graphite products cartel. Firms known as "cutters" would purchase carbon blocks from the cartel members and then produce final products that would compete with the cartel's supply. Though this alternative supply could be controlled by properly pricing carbon blocks, it proved difficult to implement.

A European Scheme of September 1990 stipulated that within the EEA, carbon blocks should be sold using the same price calculation as for carbon brushes. This meant that the price for the semi-manufactured product

had to be as high as the price of finished products like brushes. If this rule had been implemented by all members, this would effectively have made competition from cutters within the EEA impossible, at least to the extent that cutters were supplied by members of the cartel. Apparently, however, some of the cartel's members did not want to give up the European cutters' business altogether and continued to supply them at prices below those of brushes. [EMCG - EC, 156]

One cutter in particular was aggressively supplying the German market to the point that the cartel discussed a coordinated response.

A local meeting in Germany on 7 May 1992 records a discussion among cartel members on how best to act against EKL, a competitive East-German cutter that had entered aggressively into the West-German market after unification. 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 undercutting it with all customers, so that it would not be able to sell anywhere. EKL was taken over by SGL in 1997. [EMCG - EC, 157]

The other source of alternative supply, which was more common across cartels, was from firms not belonging to the cartel who possessed production capacity. This might be due to the cartel not being all-inclusive or because of later entry (possibly induced by the high prices created by the cartel). One response to increased non-cartel supply was to have the cartel members purchase the supply. This was used in the vitamin B2 market.

In 1993, the parties realised that a US producer, 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 115 tonnes of vitamin B2 (representing half of Coors'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 - EC, 287]

Or the cartel might take more drastic actions such as disciplining the maverick firm or even trying to drive it out of the market. In the district heating pipes cartel, the Swedish firm Powerpipe chose not to join the cartel and later filed a complaint with the European Commission on the grounds that the colluding firms had acted anti-competitively against it. The decision of the Court of First Instance stated:¹⁸

As a characteristic feature of the cartel, the decision refers in particular to the adoption and implementation of concerted measures to eliminate

¹⁸Judgment of the Court of First Instance (Fourth Chamber) of 20 March 2002. - ABB Asea Brown Boveri Ltd v Commission of the European Communities.13.

Powerpipe, the only major undertaking which was not a member. The Commission states that certain members of the cartel recruited key employees of Powerpipe and gave Powerpipe to understand that it should withdraw from the German market. Following the award to Powerpipe of an important German project, a meeting is said to have taken place in Düsseldorf in March 1995 which was attended by the six major producers and Brugg. According to the Commission, it was decided at that meeting to organise a collective boycott of Powerpipe's customers and suppliers. The boycott was subsequently implemented.

There were other episodes of focused retaliation. Increased supply by Chinese producers proved to be a problem for several cartels. In vitamin B1, expansion in Chinese supply led cartel members to price aggressively in a selective manner to reclaim lost customers. The price cuts were enacted so that prices would "align on the Chinese prices for feed grade to important customers but ... higher pricing should continue for food and pharmaceutical grades." [Vitamins – EC, 258] This was also done in the citric acid cartel though it proved unsuccessful in stabilizing the cartel.

Due to the Chinese, the cartel's share of global output fell from 70% to 52% over 1992-94 and this led to increased tension among cartel members. Cartel members agreed a price war against Chinese suppliers was necessary and customers for regaining were allocated among the members; it became known as the Serbia list. [Citric acid - EC, 188-9]

During the second period, from mid-1993 until the ending of the cartel in May 1995, it became increasingly difficult for the participating companies to sustain the price levels, in no small measure due to a dramatic increase of citric acid imports from China, particularly into the European market. Accusations of cheating on the agreement, especially against Jungbunzlauer, became rife and the level of trust between the cartel members deteriorated. [Citric acid - EC, 91]

A similarly difficult period was faced by the methionine cartel when cartel member Sumitomo discontinued participation and Monsanto entered the market with a liquid version of methionine.

Following these events, prices started to fall dramatically (Rhône-Poulenc ... even speaks of 30% by the summer and autumn of 1989). It appears that at first the remaining participants (Degussa, Rhône-Poulenc and Nippon Soda) were in doubt about the best way to react to the new situation: would they need to focus on regaining market share or would it be more effective to focus on prices? It is apparent from the evidence in the Commission's file that after having held various meetings in 1989 and 1990, the cartel members agreed unanimously (at least by November 1990) to focus their efforts on increasing prices. [Methionine - EC, 80]

Initially, however, the cartel members disagreed as to how to respond as "Degussa wanted to win back market share by dropping price for lost customers and, having done that, trying to raise price. Rhône-Poulenc was more interested in just maintaining price and avoiding a further price decline." [Methionine - EC, 101-4]

Entry and capacity expansion was a serious problem in the market for vitamin C and most likely caused the collapse of the cartel. By early 1993, cartel members began to discuss how to respond to the growing supply and low prices of the Chinese producers.¹⁹ There was disagreement as Roche was in favor of reducing supply so as to maintain and even raise the price, while Takeda was hesitant to reduce supply. Takeda instead proposed to purchase Chinese supply; a proposal that was rejected by the others. The cartel members eventually came to an agreement whereby the sales quotas of the European producers - Roche, BASF, and Merck - were reduced by 2.5% and Takeda's by 2.2%. But Takeda did not follow through and only after the three other firms threatened to discontinue the collusive arrangement did Takeda comply. Nevertheless, Chinese supply continued to expand so that the price had fallen by around one-third by 1995. As early as mid-1995 (as claimed by Roche) or at least by 1996, the vitamin C cartel had collapsed amidst the aggressive pricing and expansion of Chinese producers which was itself likely a response to the higher price resulting from collusion.

A final tactic to forestall entry and growth in non-cartel supply is for the cartel members to coordinate in not sharing the technology required for producing the product. This was apparently done in the graphite electrodes²⁰ and sorbates cartels.

During the joint meetings, there was considerable discussion about new market entrants, particularly the Chinese and the Russians. In the late 1980's and during the 1990's several potential competitors from China requested sorbates technology from the existing producers, but Hoechst and the Japanese producers decided that no technology would be provided to other sorbates producers. [Sorbates – EC2, 117]

3.3.2 Over-zealous Sales Representatives

A final, and rather different, source of disruption arises from employees of the colluding firms who are not themselves aware of the collusive arrangement. This was well-recognized in the fine arts auction house cartel. The non-negotiability of the commission schedule was considered critical and its implementation relied on lower-level employees not deviating from it, nor finding ways around it by offering equivalent benefits to clients (while, all the time, being unaware of the collusive arrangement). But it was soon made clear to the colluding CEOs that employees were wary of the non-negotiable schedule and may look for ways to circumvent it.

The non-negotiability of the new commission structure was strictly implemented. Staff at Sotheby's would sometimes complain about the rigidity

¹⁹The ensuing discussion is based on [Vitamins - EC, 431-57].

²⁰United States. Dept. of Justice. "Japanese Subsidiary Charged with International Conspiracy to Fix Prices for Graphite Electrodes in U.S." Press Release. February 23, 1998.

of the non-negotiable vendor's commission structure. In Amsterdam, the Sotheby's people feared they would (together with Christie's) lose business to other auction houses. There were also fears that Christie's would not adhere to "the agreed commission structure". A proposal to adapt the commissions was firmly rejected by headquarters, despite the alarming messages from the Amsterdam office. Instead, they received instructions to clearly follow the instruction set out by [officer of Sotheby's] on the new vendor's commission. [Fine arts auction houses - EC, 113]

One response by the senior management (engaged in collusion) was to centralize authority.

[An officer of Christie's] identified an unintended risk that could arise if the two auction houses adhered rigidly as agreed to the commission sales with no chance to undercut on price; their department chiefs would vie with each other to get quality business by making excessive estimates of what items would fetch: "If no price competition, pressure to get best stuff will result in overestimating". (If the estimates were excessive, it would increase the risks attached to guarantees and loans). To avoid this problem, [officer of Christie's] suggested a formal procedure for estimates with three signatures required over a certain amount. [Fine arts auction houses - EC, 120-1]

The problem of aggressive sales people was noted as a possible source of non-compliance in the industrial and medical gases cartel as well.

There are a number of instances in which a firm had offered gases at prices and other trading conditions below what had been agreed. Some of these instances may have been acts of retaliation, others may have been carried out by over-zealous salesmen. [Industrial and medical gases - EC1, 345]

This was particularly a concern during the several month period in which firms were, in a staggered manner, implementing new price increases. To deal with this problem, a moratorium was put in place whereby each company's customers were not to be approached; this was expressly conveyed to their sales people.

That [cartel member] AGA put the moratorium into effect is shown by the internal instructions it issued on 28 November 1989 ... to focus on implementing the 5% price increase with existing customers and explaining that competitors could be expected to do the same. [Industrial and medical gases - EC1, 161]

The issue of controlling the sales force was probably most prominent in the lysine cartel. Senior management at ADM saw the sales people as potentially in collusion with buyers and that they were not to be trusted.

[ADM executives] Wilson and Whitacre emphasized it was key that each company controlled its sales force. The sales reps had a tendency to become buyer advocates and to cut price. They told the cartel that, in the previous week, ADM's best salesman had given a customer a price of only \$1.13. The salesman was fired. [Lieber (2000), 151]

The ADM sales force was kept out of the loop. [ADM executive Michael Andreas said:] "The salesman could go off to another company and turn in the top people at ADM and report that there's price-fixing. So, the salesmen couldn't be trusted." [Lieber (2000), 251]

ADM responded to this problem by having pricing centralized "at the highest level" and encouraged the other cartel members to do the same. [Lieber (2000), 170]

In the isostatic graphite cartel, the risk of sales people deviating from the collusive prices was considered serious enough that senior management decided to bring them in on the scheme, in spite of the added risks of collusion being discovered by the antitrust authorities.

UCAR further points out that the participants also stated the prices of isostatic products that they had been quoting to each customer and that there were often disputes over the lowering of prices. At a certain moment, again according to UCAR, the participants agreed to enlarge the meetings to include the salesmen, in an attempt to impress on the sales force the importance of following the pricing directives that they received from their supervisors. [Isostatic graphite - EC, 245]

4 What is the structure and organization of meetings?

Thus far we have discussed the collusive outcome - in terms of price and the allocation of supply - and the manner in which it was enforced. Enforcement deals with monitoring the agreement, punishing for violations, and responding to external sources of disruptions. All of these decisions are handled within the context of communication between the members of the cartel. A potentially important determinant of cartel behavior is then the frequency with which firms communicate. This can determine the frequency and periodicity of observed changes in firm behavior (in particular, price) but can also influence the stability of the cartel.

Though we've spoken of a cartel member as some monolithic entity, in fact it is represented by a firm's employees who are engaged in collusion. This raises the question of how duties in running the cartel are allocated across employees. Who decides on price and the allocation? Who implements the allocation (for example, by allocating customers and projects)? Who monitors the agreement? All of these questions pertain to the organizational structure of the cartel. While it is not clear what are the implication of organizational structure for firm behavior, it does seem relevant and so we report the information here though without an associated analysis.

4.1 Frequency of cartel meetings

A potentially important distinction between a collusive and competitive industry is the frequency with which firms act. In that collusion requires firms first to communicate and coordinate before, say, changing price, it is not difficult to imagine that price changes are less frequent for a cartel and, furthermore, there may be a periodicity to price changes due to the periodicity of meetings. Of course, firms could meet with some regularity, yet agree to future price changes which need not follow the same timing. Nevertheless, there is a cost to agreeing to a price change that is to commence in, say, two months; if cost and demand conditions have changed in two months then this reduces the appropriateness of that price change. For this reason, the timing of meetings is apt to influence when changes in cartel behavior are enacted and, in particular, periodicity of meetings might result in periodicity of changes in market behavior.

In discussing the timing and frequency with which a cartel acts, there are two issues that I'll address. First, the frequency with which firms decide on the allocation, specifically, price and quantity (including sales quotas and allocating customers or projects). Second, the frequency with which firms monitor the agreement by exchanging information and comparing the realized outcome with the agreed-upon outcome.

Table 8: Frequency of Meetings
(Source: Various European Commission Decisions)

Market	Type	Allocation	Monitoring
Choline chloride	SQ, ET, CA	2/year	every 2-3 weeks
Citric acid	SQ	2/year	monthly*
Copper plumbing tubes	SQ	annual	every 1-2 months
District heating pipes	SQ, CA	every 2-3 weeks	?
Elec. mech. carb. graphite	SQ, CA	2/year	weekly/monthly
Graphite electrodes	SQ	1-2/year	2-3/year
Isostatic graphite	ET?	2-3/year	2/year
Lysine	SQ	quarterly	monthly*
Methionine	SQ?	2-4/year	n/a
Nucleotides	CA, ET	2/year	?
Organic peroxides	SQ, CA	2-4/year	quarterly*
Plasterboard	SQ	?	quarterly
Sorbates	SQ	2/year	2/year
Vitamins (A, E)	SQ	2-3/year	weekly/quarterly
Zinc phosphate	SQ	quarterly	monthly

*Buy-backs occurred annually.

Table 8 reports the frequency of meetings for those cartels for which sufficient information was available. "Type" refers to the allocation scheme: sales quota (SQ), exclusive territories (ET), and customer allocation (CA). "Allocation" refers to the frequency with which an allocation was selected; "Monitoring" refers to the frequency

with which monitoring took place.

Generally, meetings to decide on an allocation took place either quarterly or semi-annually. However, the time between meetings could be much shorter when firms are allocating customers. In the case of the district heating pipes cartel, the cartel met every two to three weeks to allocate projects. Here, it is important to distinguish between the meeting to settle upon an allocation of sales quotas - which is typically only twice a year - with meetings to implement that allocation through a divvying up of customers and projects - which has a frequency dictated by the flow of new projects and customers. My reading of the cases leads me to the tentative claim that the frequency of meetings is highest for a customer allocation scheme and lowest for exclusive territories, with a pure sales quota scheme between those two.

Firms met noticeably more frequently to monitor an allocation as opposed to deciding on an allocation. Most cartels exchanged information - generally regarding sales - on a monthly or quarterly basis with some doing it as often as weekly through phone or fax rather than face-to-face meetings. Among the cartels that used buy-backs and their frequency was reported, buy-backs occurred annually. As mentioned earlier, that monitoring occurred on a higher frequency than buy-backs gave cartel members the opportunity to adjust their sales and avoid the need to make compensation at the year's end.

Many cartels chose to time their meetings - typically, allocation meetings - so that it would coincide with a meeting of a trade association. In the carbonless paper cartel, general planning meetings were conducted under the cover of the meetings of the Association of European Manufacturers of Carbonless Paper). [Carbonless paper - EC, 83] With choline chloride, meetings were generally (though not exclusively) scheduled either before or after the meetings of the European Chemical Industry Council. [Choline chloride - EC, 98] The general meetings of the citric acid cartel were scheduled to coincide with those of the general assembly of the European Citric Acid Manufacturers Association (ECAMA); meetings typically took place the evening prior to the official ECAMA meeting. [Citric acid - EC, 87] Coordination with trade association meetings also took place with cartels in copper plumbing tubes [Copper plumbing tubes - EC, 112], industrial and medical gases [Industrial and medical gases - EC, 105], and industrial tubes [Industrial tubes - EC, 10].

Scheduling to convene the cartel at a trade association meeting is obviously convenient - as many of the executives are to be there anyway - but it also serves the purposes of avoiding detection of the cartel. The trade association meeting provides a cover for why executives of competing firms are all at the same venue. For this reason, ADM pushed early on for the formation of a lysine producers' association in order to provide a regular venue to hide their illicit meetings.

From the first contacts made in April 1992 with his Asian rivals, ADM's Terrance Wilson pushed for the formation of a formal lysine association to facilitate the conspiracy. Wilson had in mind two models, the European Citric Acid Manufacturers Association (ECAMA) and the Corn Refiners Association (CRA) in the United States. Both of these organizations held regular meetings to discuss perfectly legal matters of common interest,

and both collected members' sales data. ECAMA collected citric acid sales volumes monthly and shared all that information with each of its members ... The biennial meetings of ECAMA were pretexts for holding secret parallel price-fixing sessions for citric acid. [Connor (2001), p. 220]

The attractiveness of meeting under cover was clearly apparent in an episode with the lysine cartel. Generally, the Japanese producers preferred not to meet in the U.S. because of its stringent antitrust laws. However, later in the cartel's life when concerns about discovery had heightened, the cartel members chose to meet in Atlanta because they could meet under the cover of a poultry conference (as lysine is used to build muscle in chickens). Apparently, the cover that it provided compensated for having to meet in the U.S. as opposed to Europe or Asia. Still, the cartel members recognized that they had to be careful. After meeting in a hotel room at the poultry conference, the cartel members left the room separately because they didn't want customers seeing a group of competitors leaving together. [Lieber (2000), p. 234]

One final anecdote speaks to the determinants of the frequency of meetings. It was reported that the frequency of meetings of the copper plumbing tubes cartel appeared to negatively correlate with the growth rate of demand. The European Commission found that from late 1994 onwards, probably due to the increased demand coming from the German construction boom, there were fewer contacts between cartel members and apparently the cartel did not meet at all in 1995. With the weakening of the German economy in 1996, meetings were re-established. [Copper plumbing tubes - EC, 215]

4.2 Organizational structure of the cartel

One of the more striking features of several cartels is the sophistication of their organizational structure. Some cartels - like the lysine cartel - operated with a single level so that the same set of employees performed all functions. Other cartels organized themselves into both a general group - comprised of all cartel members - and regional sub-groups. The choline chloride cartel had all cartel members meet to coordinate with respect to the global market and, in addition, European suppliers would meet to coordinate with respect to the European market. [Choline chloride - EC, 64] In fact, the global cartel collapsed in mid-1994, while the European cartel persisted until late 1998. In the case of the sorbates cartel, the Japanese producers met as a group prior to and after the general cartel meeting which also included European producer Hoechst. [Sorbates - EC, 83]

Our primary interest here, however, is with describing a hierarchical structure for allocating duties across employees of the cartel participants. Table 9 includes those cartels which used a multi-level structure in performing the tasks of choosing, implementing, monitoring, and enforcing a collusive outcome. The column for "Price" denotes the level(s) at which price was determined; the column for "Quantity" denotes the level(s) at which the market allocation was determined; the column for "Mon." denotes the level(s) at which monitoring was performed; and the column for "Imp." denotes the level(s) at which price and/or the allocation was implemented. The

Table 9: Allocation of Authority
(Source: Various European Commission Decisions)

Market	Level	Price	Quan.	Mon.	Imp.	Employees	Other duties
Carbonless paper	Top	✓	✓			CEOs, directors	
	Regional, national		✓			Sales mgrs	
Citric acid	Top ("Masters")	✓	✓			Senior mgmt	
	Technical ("Sherpa")			✓		Sales mgrs	
Copper plumbing tubes	Top ("Elephants")	✓	✓				
	Operational ("Dung-movers")			✓	✓	Senior mgmt	
District heating pipes	Top ("Directors' club")		✓				
	Operational ("Contact groups")				✓	Local sales mgrs	
Elec. mech. carb. grap.	Top					Senior mgmt	Oversight
	Technical	✓	✓				
	Local	✓		✓			Allocate customers
Graphite electrodes	Top ("Top guy")	✓	✓	✓		CEOs	
	Working level			✓		Sales mgrs	
Isostatic graphite	Top ("Top level")					Senior mgmt	Product grouping
	International working level	✓		✓		Experts	
	Regional/European				✓	Local mgrs	
	Local/national			✓	✓	Local mgrs	
Organic peroxides	Summit ("AC Treuhand")		✓				
	Working group	✓		✓	✓		
Vitamins (A, E)	Summit ("Shareholders")					Senior mgmt	Overall strategy
	Budget	✓	✓			Marketing heads	
	Global product marketing			✓		Operations mgrs	
	Regional product marketing			✓	✓	Reg. mark. heads	

column for "Employees" lists the positions of the employees engaged at that level where "Senior management" refers to CEO, president, director, chairman, and/or general manager.

An important area for future research is to understand how the design of the cartel's organization affects observable behavior in terms of frequency of price changes, the allocation mechanism, time series on market shares, cartel stability, and other relevant variables.

5 What precedes cartel formation?

In reviewing the various cases, the evidence strongly supports the hypothesis that cartels form when conditions are more competitive. Cartel formation was often preceded with a significant decline in price that, in some cases, could be attributed to weakening demand, entry, or capacity expansion (which could arise with growing demand if firms are expanding capacity at a faster rate than the demand growth rate). In some cases, it appeared that a firm inexplicably engaged in a more aggressive pricing strategy. There is no case in which it was documented that a cartel formed amidst rising profit.²¹

Weakening demand conditions and declining prices preceded the formation of cartels in carbonless paper, fine arts auction houses, graphite electrodes, and seamless steel tubes. The carbonless paper cartel is arguably the least convincing of these four cases. In the 1980s, the demand for carbonless copy paper grew rapidly as it replaced one-time carbon paper. Then, with the growing use of electronic means to perform transactions, European demand for carbonless paper slowed. The cartel formed in 1992 and, though demand did not actually fall until 1995, capacity utilization had already hit 65% by that time. Furthermore, one could argue that the future decline in demand was quite predictable in the early 1990s. [Carbonless paper - EC, 24-5]

As in the case of the carbonless paper cartel, technological change was the source of weakening demand in the market for seamless steel tubes.

In the last 25 years seamless pipes and tubes have gradually declined as a proportion of all pipes and tubes produced and consumed, in favour of welded pipes and tubes. In 1960, welded pipes and tubes accounted for 52% of steel pipes and tubes produced worldwide, whereas today they account for 68.5%. A process of substitution has been going on, therefore, which can be explained, inter alia, by the technological progress in the manufacture of welded pipes and tubes, which, with lower production costs, has made it possible to achieve the requirements hitherto met only by seamless pipes and tubes. [Seamless steel tubes - EC, 24]

This declining demand resulted in excess capacity, a collapse of prices, and ultimately the formation of a cartel in 1977.

An equally compelling case concerns collusion between Christie's and Sotheby's which formed amidst a serious recession in the art market.

²¹A similar analysis and set of conclusions is drawn in Grout and Sonderegger (2005).

Both houses suffered financially from the art-market crash, which had been worsened considerably with the worldwide recession that followed the Gulf War. Back in 1989, Sotheby's auction sales had reached an all-time high of \$2.9 billion. In 1992 they dropped to a mere \$1.1 billion. Over the same period, auction revenues, had plunged from \$410 million to \$201.1 million. Equally, earnings per share had dwindled from \$1.96 to a mere 7 cents. In the heyday of 1989, Sotheby's net profit had been a robust \$113 million, but after a precipitous slide to \$13 million in 1991, it was now an abject \$3.9 million - a drop of nearly \$110 million in two years, and a woeful return on 1992's \$1 billion of sales. Since 1990, the firm's stock price had slunk from around \$37 to \$9. [Mason (2004), p. 87]

As a result, "[An officer of Sotheby's] and [an officer of Christie's] agreed to meet to discuss the difficult market situation and to consider how things could be improved." [Fine arts auction houses - EC, 78, 81] Those officers were the chairman of their respective boards and it wasn't long afterwards that their CEOs implemented the agreement.

There is a similar story to tell in the market for graphite electrodes. As graphite electrodes are used in the production of steel, demand is highly cyclical and can suffer from structural change as not all forms of steel production used graphite electrodes. The industry suffered a substantial decline in demand in the 1980s as reflected in a capacity utilization rate under 60%. This led to a restructuring process whereby several plants were closed and, quite importantly, the formation of a cartel in 1992. [Graphite electrodes - EC, 12-3]

A second source of cartel formation is intensified price competition which cannot be obviously traced to an external source such as declining demand. In some of the cases mentioned below, there is likely to be an external factor at work that simply wasn't uncovered. However, it is also possible that prices "spontaneously" declined (that is, without a commensurate change in demand and cost conditions). This could occur for at least two reasons. First, firms may be tacitly colluding and what is witnessed is the collapse of tacit collusion and, with the formation of a cartel, its replacement with explicit collusion. Though some event may have triggered the collapse - such as a temporary negative demand shock - there need not be a persistent change. Second, firms may be uncertain as to what is the best pricing strategy and thus may be learning over time. One might then find a firm decide to switch to more aggressive pricing because it believes that capturing more market share today will reap higher profits due to scale economics or higher future profits due to customer switching costs, learning-by-doing, or some other dynamic force. Relatedly, there could be a change in management and the new management brings with it beliefs that support a more aggressive pricing policy.

Cases in which cartel formation was preceded by a steep price decline include citric acid, commercial explosives, plasterboard, soda ash, and vitamins. The citric acid cartel formed in early 1991 after the European market had experienced a 45% decline price over 1985-90.

Prices at the end of this period were atypically low, a fact attributed in some quarters to the waging of a price war in Germany and the United Kingdom (for which Jungbunzlauer was held mainly responsible) with the objective of capturing extra market share. Jungbunzlauer's conduct on the market place was perceived to be one of the reasons for this decline in prices. In the same period, Jungbunzlauer virtually tripled its production capacity of citric acid. [Citric acid - EC, 72]

The commercial explosives cartel was induced by a "family feud." Prices were heavily depressed because of a price war between two brothers who owned competing companies. After they sold their companies, some of the remaining explosive manufacturers decided to form a cartel in order to raise prices from their currently low levels.²²

From 1988 to 1992, the price of plasterboard fell by 50-75%. [Plasterboard - EC, 71] The European Commission attributed this to European integration: "Since the late 1980s, the market has developed from a collection of 'national' markets, each dominated by the local producer, into a more 'European' market in the sense that the major suppliers are now present in all the national markets." [Plasterboard - EC, 26] This was the background when manufacturers BPB and Knauf met in early 1992 at which time they:

reached the joint conclusion that the fierce competition for market shares which had been prevalent between them, and more generally on the plasterboard market as a whole, for a number of years and which had resulted in price cuts and far-reaching structural changes on the market should end and that, in future, the parties should discourage any over-aggressive competition and that the market should be stabilised at the status quo. [Plasterboard - EC, 70]

The vitamins cartel formed in the late 1980s and early 1990s and, in several vitamins market, this formation was preceded by a decline in prices. Of course, the formation of the cartels in the various vitamins markets were not independent events given that the two main companies - Hoffman La Roche and BASF - were members to all eight cartels. As to why prices fell at that time and collusion arose, Connor (2001, p. 308) conjectures:

One possibility is that decelerating growth rates and standardization of quality standards had caused the vitamin business to evolve from its former specialty-chemical status to one more like a mature, commodity-type industry in which buyers focused solely on price during purchase negotiations. Such an evolution would have squeezed profit margins for the producers, but ironically a movement towards greater homogeneity of quality would have made price fixing easier. Another hypothesis about

²²In re Commercial Explosives Litigation, Civil No. 2:96-MD-1093S. United States District Court, D. Utah, Central Division. October 25, 1996.

the timing of the vitamins cartels may be derived from the general financial conditions facing the prime movers of the conspiracies. Recall what conditions were like in 1989-1991 for the major chemical companies involved (Roche, BASF, Rhône-Poulenc, and Hoechst). In each case, these companies faced a financial crisis in the late 1980s that became public knowledge when their financial results were later reported for fiscal years 1990 to 1994. However, internal projections of sales and profitability would have been known to top managers of the companies in the 1988-1989 period. The poor financial prospects were the result of overstaffing, overcapacity, and unprofitable diversifications, particularly in the companies' core Western European operations. Compounding the companies' woes was the onset of a global recession in 1990, a downturn that lingered for several years longer in Western Europe than in other regions of the world. In Japan too, the miraculous growth that had characterized the post-war period had burst. Japan experienced a nearly zero-growth phase that was to persist throughout the 1990s.

A third class of events that preceded cartel formation was entry and capacity expansion. Of course, these are endogenous events triggered by other changes. Entry and capacity expansion could be due to growing demand but it isn't clear why the combination of the two - for example, demand growth and entry - ought to result in lower prices. However, keep in mind that entry and capacity expansion are lumpy so that, in spite of growing demand, these events could have resulted in more excess capacity at existing prices and this could intensify competition and thereby induce firms to form a cartel.

Entry occurred into the market for industrial and medical gases market in spite of this being a mature market. Not surprisingly, it depressed prices. A cartel was formed in 1993.

The Commission notes that since the late-1980s a number of newcomers have entered the Dutch industrial gases market: Air Liquide, Messer, BOC and Westfalen and, in the CO₂ market, Hydrogas. In a mature market, where there is little prospect for growth over and above that of the economy as a whole, the arrival on the market of new players is likely to enhance competition. ... There was indeed a negative development in the price level of all major industrial gases since 1989, whether supplied in bulk or in cylinders. This development took place for gases facing declining general demand (such as acetylene) as well as for gases in more stable markets. [Industrial and medical gases - EC1, 78-9]

The formation of cartels in isostatic graphite and methionine occurred in response to Japanese producers increasing their presence in Europe and thereby putting pressure on European prices.

Toyo Tanso alleges that the establishment of GTI in France in 1988 as the European sales company of Toyo Tanso and the fact that Ibiden had begun

to sell blocks to European customers were competitive threats to the incumbent European producers. This was because the prices for graphite blocks on the Japanese market were significantly lower than in Europe. [Isostatic graphite - EC, 107]

It has already been mentioned that the formation of the methionine cartel began in early 1986 when European manufacturers Degussa and Rhône Poulenc contacted Japanese suppliers Nippon Soda and Sumitomo because the latter were encroaching on their "home markets."

In sum, these cases show that cartel formation is more likely when market conditions become more competitive as reflected in lower prices, weakening demand, increased excess capacity, and entry.

6 Concluding Remarks

At the same time that one has disdain for these firms that engaged in price-fixing, one cannot help be impressed with the sophistication of their behavior. Firms were meticulous in designing an agreement to minimize opportunities for cheating and in structuring both monitoring and punishment schemes to weaken the incentives to cheat. To implement such a complex arrangement, some cartels created an impressive organizational structure that entailed frequent communication and face-to-face meetings. In spite of all their efforts, collusion was far from perfect. There are episodes of noncompliance by cartel members, deceptive practices when it comes to monitoring, over-zealous sales representatives ignorant of collusion disrupting the agreement, and increased supply from non-cartel firms in response to the high prices of cartel members. Nevertheless, most of these cartels collapsed only because of discovery and prosecution.

The information provided in this study should be useful for both policy and research purposes. From a research perspective, a better understanding of the institutional structure of cartels ought to help in developing better theoretical and empirical models. Of particular interest is contributing to the development of models of hard-core cartels by encompassing those features that distinguish this brand of collusion from the tacit variety. From a policy perspective, better knowledge about collusive practices should assist in improving methods for detecting cartels and for constructing evidence to support a case that firms have violated Article 81 of the Treaty of the European Communities in the European Union or Section 1 of the Sherman Act in the United States.

7 Appendix A - Industries

This study is based on case material - almost entirely from European Commission decisions - for the following industries: carbonless paper, choline chloride, citric acid, commercial explosives, copper plumbing tubes, district heating pipes, electrical and mechanical carbon and graphite products, fine arts auction houses, graphite electrodes, industrial and medical gases, industrial tubes, isostatic graphite, lysine, methionine, nucleotides, organic peroxides, plasterboard, seamless steel tubes, soda ash, sodium gluconate, sorbates, vitamins, and zinc phosphate. For these markets, brief descriptions are provided of the product, geographic markets affected by collusion, companies that participated in the cartel, and the duration of the cartel. Duration typically refers to "official duration" and there may be evidence consistent with a longer duration (typically with collusion starting earlier than the official start date). In some cases, I also provide some other relevant facts. Most of these descriptions are taken verbatim from the relevant European Commission decision (which is cited in Appendix B).

7.1 Carbonless paper

Product description: Carbonless paper, also known as self-copying paper, is used for the multiple duplication of documents and is made from a paper base to which layers of chemical products are applied. The principal clients in the self-copying paper sector are printers who convert carbonless paper to business forms and rolls.

Geographic markets: In the European Economic Area (EEA) the production of carbonless paper is concentrated and mills are located in five Community Member States: Belgium, France, Germany, Spain, and the United Kingdom. Generally speaking, however, producers sell throughout the EEA, and transport costs do not seem to hinder trade inside this area.

Companies: Arjo Wiggins Appleton, Binda, Carrs, Copigraph, Divipa, Koehler, Mougeot Sappi, Stora, Torraspapel, Zanders, Zicuñaga.

Duration: January 1992 to September 1995.

Table A1: Price Increases for Carbonless Paper ("Reels")
(Source: Carbonless paper - EC, 142)

Date of Meeting	Date of Price Change	Price Increase
October 1, 1993	December 1, 1993	10%
January 20, 1994	April 1, 1994	6%
May 31, 1994	July 1, 1994	6%
July 1994 (?)	October 1, 1994	10%

"As the price increases were cumulative, the total increase was to be 36% whereas Mougeot increased its prices for reels by a total of only 29%." [Carbonless paper - EC, 143]

7.2 Choline chloride

Product description: Choline chloride is a member of the B-complex group of water-soluble vitamins (vitamin B4). It is mainly used in the animal feed industry (especially for poultry and swine) as a traditional feed additive to increase growth, reduce mortality rates, increase feed efficiency, increase egg production, and improve meat quality.

Geographic markets: At the start of the period of investigation, choline chloride was produced mainly in Europe and North America (United States and Canada), although there was also production capacity in China, India, Japan, Korea, and Taiwan. The North American producers were exporting to Central and South America, Europe, the Far East, and the South East. The European producers were starting to export to Central and South America, Africa, the South East, and the Far East. European and North American producers also had production facilities in different areas of the world and were expanding local production in order to cut transportation and storage costs and better penetrate local markets.

Companies: Akzo Nobel, BASF, Bioproducts, Chinook, DuCoba, UCB.

Duration: Global, November 1992 to April 1994; European, March 1994 to October 1998.

7.3 Citric acid

Product description: Citric acid is widely distributed throughout nature, occurring in both plants and animals. It is used primarily in the food and beverage industry, where its high solubility, tart flavor, acidity and buffering capabilities make it the most widely adopted acidulent/preservative worldwide. Citric acid is also utilized in household detergents and cleansers, pharmaceuticals and cosmetics, and industrial uses.

Geographic markets: While sales and production tend to be compartmentalized in three major geographical areas - North America, Europe and Asia - significant amounts of product are traded between these zones. In the case of the European Community, imports from China alone account for almost 20% of total consumption, although those imports are made by dozens of small companies. Cartel members made up 60% of global production and 67% of E.U. production.

Companies: Archer Daniels Midland Company, Cerestar Bioproducts, Haarmann & Reimer Corporation, F. Hoffmann-La Roche, Jungbunzlauer.

Duration: March 1991 (first multilateral meeting) to May 1995.

7.4 Commercial explosives

Product description: Commercial explosives, which include dynamite and ANFO (ammonium nitrate mixed with fuel oil), are primarily used in the mining, construction, and oil and gas industries.

Duration: Depending on the particular geographic market, the earliest cartel started in Fall 1988 and the last cartel ended in early 1996. Most of the cartels lasted about four years.

7.5 Copper plumbing tubes

Product description: Copper plumbing tubes (also called sanitary tubes, water tubes, and installation tubes) are used for water, oil, gas, and heating installations in the construction industry. The main customers are distributors, wholesalers, and retailers that sell the plumbing tubes to installers and other end consumers.

Geographic markets: The scope of business of the copper plumbing tube suppliers is essentially Europe, including the Community/EEA. There are limited exports outside Europe. Transportation costs are estimated to be generally below 5% within Europe, and most European suppliers are in a position to supply the entire European market regardless of factory location.

Companies: Boliden, Austria Buntmetall and Buntmetall Amstetten, Halcor, HME Nederland, IMI plc, IMI Kynoch and Yorkshire Copper Tube, KME-group, Mueller Industries, WTC Holding Company, Mueller Europe, DENO Holding Company and DENO Acquisition EURL, Outokumpu Oyj and Outokumpu Copper Products Oy, Wieland Werke.

Duration: June 1988/Sept 1989 to Sept 1999/March 2001. First informal competitor contacts, mostly on a bilateral basis, started as early as 1987.

7.6 District heating pipes

Product description: In district heating systems, water heated in a central site is taken by underground pipes to the premises to be heated. Since the temperature of the water or steam carried in the pipes is very high, the pipes must be insulated in order to ensure an economic, risk-free distribution. The pipes used are pre-insulated and, for that purpose, generally consist of a steel tube surrounded by a plastic tube with a layer of insulating foam between them.

Geographic markets: There is a substantial trade in district heating pipes between Member States. The largest national markets in the E.U. are Germany, with 40% of Community consumption, and Denmark, with 20%. Denmark has 50% of the manufacturing capacity in the E.U. and is the main production center in the Union, supplying all Member States in which district heating is used.

Companies: ABB Asea Brown Boveri, Brugg Rohrsysteme, Dansk Rørindustri, Henss/Isoplus Group, Ke Kelit Kunststoffwerk, Oy KWH Tech, Løgstør Rør; Pan-Isovit, Sigma Tecnologie Di Rivestimento, Tarco Energie.

Duration: Denmark, November/December 1990 to March/April 1996; other European countries, late 1994 to March/April 1996.

7.7 Electrical and mechanical carbon graphite products

Product description: These products are produced from carbon and graphite for ultimate applications in either the electrical or mechanical field. There are thousands of varieties of electrical and mechanical carbon and graphite products. Most often they are customer-designed, and certification of the product's conformity to product requirements is usually necessary before the product can be used.

Geographic markets: The geographic focus of this market is within the EEA. Because products are developed in close cooperation between producers and customers, production takes place as close as possible to customers. As a consequence, a large percentage of products sold were produced in the country in which they were sold.

Companies: C. Conradty Nürnberg, Hoffmann & Co. Elektrokohle, Le Carbone Lorraine, Morgan Crucible Company, Schunk GmbH and Schunk Kohlenstofftechnik, SGL Carbon.

Duration: October 1988 to December 1999. The first evidence of a European-wide cartel among suppliers of electrical and mechanical carbon and graphite products dates back to April 5, 1937. Some time after World War II, the cartel was reconstructed. According to SGL, the cartel was in operation at least as early as the end of the 1970's, but probably before as well.

7.8 Fine arts auction houses

Product description: Auction houses sell fine art objects, antiques, furniture, collectibles and memorabilia as the agent of the consignor, billing the buyer for the goods purchased and remitting to the consignor the monies received after deduction of commission, expenses, and taxes.

Geographic markets: Christie's and Sotheby's are both present in nearly all EEA countries for buying (consigning) property; selling (auctioning) takes place in only few countries within the EEA. Furthermore, buyers at auction in London or other EEA salerooms often are non-EEA residents, while a significant part of items sold originate from non-EEA located sellers. The same applies for auction in New York, Geneva, and other auction locations.

Companies: Christie's, Sotheby's.

Duration: April 1993 to February 2000.

The commission rate is the percentage of the final bid price.

Table A2: Commission Charges for Sellers (Christie's)
 Press Release: March 1995, Effective: September 1, 1995
 (Source: Mason, 2004)

Annual Sales	Commission
Up to \$99,999	As now*
\$100,000-\$249,999	9%
\$250,000-\$499,999	8%
\$500,000-\$999,999	6%
\$1,000,000-\$2,499,999	5%
\$2,500,000-\$4,999,999	4%
\$5,000,000 and above	2%

*10% for most consignments but higher rates for lots selling less than \$75,000.

Table A3: Commission Charges for Sellers (Sotheby's)
 Press Release: April 13, 1995, Effective: September 5, 1995
 (Source: Mason, 2004)

Annual Sales	Private	Dealer	Museum
0-\$99,999	CCR*	CCR	CCR
\$100,000-\$249,999	9%	6%	5%
\$250,000-\$499,999	8%	6%	5%
\$500,000-\$999,999	6%	6%	5%
\$1,000,000-\$2,499,999	5%	5%	3%
\$2,500,000-\$4,999,999	4%	4%	2%
\$5,000,000-\$9,999,999	2%	2%	2%
\$10,000,000-\$24,999,999	**	**	**
\$25,000,000+	***	***	***

*Current commission rates.

**Lower of 2% or 50% of expenses

***Lower of 2% up to \$25,000,000. and 1% on any amount over \$25,000,000. or 50% of expenses.

7.9 Graphite electrodes

Product description: Graphite electrodes are ceramic-molded columns of graphite used primarily in the production of steel in electric arc furnaces, also referred to as 'mini-mills'. Electric arc furnace steelmaking is essentially a recycling process whereby scrap steel is converted into new steel.

Geographic markets: All the Member States of the EEA are producers of electric steel and consumers of graphite electrodes. The two main producers of electrodes have facilities in several Member States - Germany, Italy, France, Spain, Austria and Belgium. The two others both produce in Germany only.

Companies: SGL Carbon, UCAR International, VAW Aluminium, Showa Denko K.K., Tokai Carbon Co., Nippon Carbon Co.

Duration: May 1992 to February/March 1998.

"Ibiden and Tokai recall that during the meeting Mr. [SGL employee] indicated that thanks to the collaboration achieved in the market of graphite electrodes the parties had succeeded in increasing prices by 50 percent." [Isostatic graphite - EC, 129]

"The cartel agreements were implemented by a series of step increases between 1992 and 1996. During this period prices nearly doubled." [Graphite electrodes - EC, 137]

7.10 Industrial and medical gases

Product description: Industrial gases are either derived from air, in air separation tonnage plants (for example, oxygen, nitrogen, argon), or are produced in tonnage

plants through a chemical process (for example, carbon dioxide, hydrogen, acetylene), often as a by-product. Industrial gases are used in most industries and manufacturing processes. Medical gases are used in hospitals, clinics, and in home treatment. The largest volumes of industrial and medical gases are used for producing, cutting, and welding metals and in the chemical industry.

Geographic markets: The geographic market for supplying industrial gases is limited by the costly means of transport and can therefore be defined as local or regional in scope. Production and supply of industrial gases in the European Community is dominated by a few large, multinational groups, which have national subsidiaries in most Member States. These subsidiaries supply bulk gases to local depot holders and to end-customers and cylinder gases to end-customers within that particular Member State only. These subsidiaries also set prices and other commercial conditions for supplies within that Member State.

Companies: AGA, Air Liquide, Air Products Nederland, BOC Group, Messer Nederland, NV Hoek Loos, Westfalen Gassen Nederland.

Duration: September 1993 to December 1997.

7.11 Industrial tubes

Product description: Copper tubes are generally divided into two product groups: plumbing tubes used for water, oil, gas and heating installations, and industrial tubes which are divided into sub-groups based on the end use. The most important of the latter in terms of volume is air-conditioning and refrigeration (ACR) industry, the other industrial applications being mainly fittings, refrigeration, gas heater, filter dryer and telecommunication tubes. Industrial tubes, ACR-tubes in particular, are typically supplied in annealed level wound coils (LWC) in lengths ranging up to several kilometers. LWC's, to which the Decision is confined, were introduced in the 1980's as a substitute for straight length tubes and were specifically developed for automated manufacturing lines of air-conditioning producers. Industrial tubes are normally used by and supplied directly to industrial customers, original equipment manufacturers or part manufacturers.

Geographic markets: The major producers of LWC tubes in Europe are currently KME, Outokumpu, and WielandWerke. These undertakings together accounted for about 75-85% of the total EEA market. Other significant producers within the European market include Feinrohren S.p.A of Italy and Halcor S.A. of Greece.

Companies: Wieland Werke, Outokumpu Copper Products OY, Outokumpu Oyj, KM Europa Metal, Tréfinmétaux, Europa Metalli.

Duration: May 1988 to March 2001.

7.12 Isostatic graphite

Product description: Specialty graphites is the general term widely used in the industry to describe a group of graphite products for diverse applications (other than steel making graphite electrodes, graphite anodes for the chemical industries, and carbon electrodes for the refining of ferrous alloys and cathodes for aluminum reduction

cells). Specialty graphite products are often categorized as either isostatic graphite, extruded graphite, or molded graphite. The prices of each graphite category differ according to their mechanical characteristics and, from the production point of view, a partially different machinery is necessary for each type of production process so there is no supply-side substitutability among the three categories.

Geographic markets: The Commission considers that the market for specialty graphite as a whole, and in particular the markets for isostatic and extruded specialty, are world-wide markets. Transportation costs and tariff barriers might well lead to somewhat higher costs, but they do not prevent the producers from trading on a worldwide basis. This is demonstrated by the fact that the Japanese producers, without having any production sites outside Japan, were able to trade in Europe and to obtain a market share of more than 20% in the market of isostatic specialty graphite in blocks and cut blocks.

Companies: SGL Carbon, Le Carbone-Lorraine, Ibiden Co., Tokai Carbon Co., Toyo Tanso Co., GrafTech International, NSCC Techno Carbon Co., Nippon Steel Chemical Co., Intech EDM.

Duration: July 1993 to February 1998. There is evidence of meetings going back to Fall 1988.

"The cumulative price increase applied by Tokai in the period January 1994 to January 1997 amounts to 52.7%." [Isostatic graphite - EC, 285]

7.13 Lysine

Product description: Lysine is an essential amino acid. Amino acids are building blocks of protein, a major component of body tissues. Animals synthesize body proteins from amino acids released during digestion, but can only synthesize some of the 22 different amino acids that account for all the proteins found in life. The others, designated as essential, must be supplied by the diet, either bound naturally to protein or in a chemically pure form. Feed-grade lysine has been produced commercially for some 30 years and the growth in the use of this amino acid worldwide has been remarkable. Although this rise in consumption is partially attributable to the increase in pig and poultry production that has occurred worldwide, it also reflects an increasing sophistication in the formulation of livestock diets.

Geographic markets: Eurolysine is the sole lysine producer in the EEA. Before 1991, there were only three lysine producers: Ajinomoto/Eurolysine, Kyowa, and Sewon. In 1991, ADM and Cheil entered the lysine market. ADM's plant essentially doubled the world's lysine production capacity.

Companies: Archer Daniels Midland Company, Ajinomoto Co./Eurolysine, Kyowa Hakko Kogyo Co., Daesang Corporation, Cheil Jedang Corporation, Fefana.

Duration: September 1990 to June 1995.

7.14 Methionine

Product description: Methionine is an amino acid that is added to compound animal feeds and premixes for all animal species. The principal application is in poultry

feed, but methionine is also increasingly being added to pig feed and specialty animal feeds.

Geographic markets: Methionine is produced in three Member States (Germany, France, and Spain) and marketed throughout the Community. All but one of the addressees of the Decision had production facilities in the European Community (in certain cases through subsidiaries). Additional sales of methionine in the Community come from other countries such as Japan and the U.S.

Companies: Aventis (formerly Rhône-Poulenc), Aventis Animal, Nippon Soda Company, Degussa.

Duration: February 1986 to February 1999.

7.15 Nucleotides

Product description: Nucleic acid or nucleotide is made from glucose through a process of fermentation, separation, crystallization, and filtration. There are two nucleotides, which are used for food flavor enhancement, namely disodium 5'-inosinate (IMP) and disodium 5'-guanylate (GMP). Both are used by major food manufacturers to add flavor to foods either on their own or, most often, in combination with MSG. They are mainly used to replace beef extracts, to enhance sweet and meaty flavors, to mask "off" flavors in various food formulations, and to overcome bitterness.

Geographic markets: The nucleotides business is essentially a global one. The major producers of nucleotides are large, multinational corporations established in Japan and South Korea. Although production is essentially based in Asia, sales are global with most occurring in North America, Europe and Asia. All nucleotides sold in the EEA are imported from outside the EEA, though there are important flows between the Member States, through sales subsidiaries or distributors established in the Community.

Companies: Ajinomoto Co., Takeda Chemical Industries, Daesang Corporation, Cheil Jedang Corporation.

Duration: End of 1988 to June 1998.

7.16 Organic peroxides

Product description: An organic peroxide is any organic molecule containing a "peroxy" or oxygen-oxygen bond. Organic peroxides serve a critically important role in the plastics and rubber industries where they have three main applications: (1) the polymerization of thermoplastic resins (so-called high polymer or "HP" applications); (2) the curing of unsaturated polyester thermoset resins (so-called "UP" applications); and (3) cross-linking (so-called "XL" applications).

Geographic markets: While transport and security costs as well as national legislation served as certain obstacles to cross-border trade, especially prior to the completion of the single market, the market for organic peroxides can nevertheless be seen as at least EEA-wide.

Companies: Akzo Nobel Chemicals International, Akzo Nobel Polymer Chemicals, Akzo Nobel, Atofina, Degussa UK Holdings Limited, Peroxid Chemie GmbH &

Co., Peroxidos Organicos, AC Treuhand.

Duration: January 1971 to December 1999. The Spanish market (1975-1999), the French market (1971-1991), and the UK market (1971-1991) were subject to specific meetings within the broader framework of the European cartel.

7.17 Plasterboard

Product description: Plasterboard is a manufactured product used as a prefabricated construction material and consisting of a sheet of gypsum plaster sandwiched between two sheets of paper or some other material. Plasterboard is typically used as an internal lining for walls, to form internal partitions inside buildings, as a roof lining, and as a ceiling material for residential, commercial, and administrative premises. The properties which make plasterboard an attractive product for the building industry are its stability, durability, easy application, fire resistance, and low cost.

Geographic markets: Since the late 1980s, the market has developed from a collection of "national" markets, each dominated by the local producer, into a more "European" market in the sense that the major suppliers are now present in all the national markets. Nevertheless, cross-border trade at wholesale or distributor level is limited, despite the substantial price differences. Among the reasons cited by the producers for the relatively low level of cross-border trade are differences in standards, differences in standard board widths between countries, the non-availability in destination countries of the required accessories, and differences in technical language within the building trade.

Companies: BPB, Gebrüder Knauf Westdeutsche Gipswerke, Société Lafarge, Gyproc Benelux.

Duration: Mid 1992 to late 1998.

7.18 Seamless steel tubes

Product description: The steel pipe and tube sector comprises a great variety of pipes and tubes, which are manufactured by different processes for a whole series of uses. A distinction is drawn, according to the manufacturing process, between seamless steel pipes and tubes, which are made from pierced and hot reduced solid products without removing any metal, and welded steel pipes and tubes, which are made from flat products and then shaped and welded. The products concerned in this case are seamless, carbon-steel pipes and tubes, in particular those used by the oil and gas industry, which account for 40-50% of the consumption of seamless pipes and tubes.

Geographic markets: The European Community is the main production area for seamless pipes and tubes in the world. It exports about 45% of its production and is thus the leading world exporter, closely followed by Japan and Latin America. Within the European Community, six countries produce seamless pipes and tubes; Germany, Italy, and France together account for 85% of production.

Companies: Mannesmannröhren-Werke, Vallourec, British Steel Limited, Dalmine, Sumitomo Metal Industries, Nippon Steel Corporation, Kawasaki Steel Corporation, NKK Corporation.

Duration: 1977 to 1995.

7.19 Soda ash

Product description: Soda ash (sodium carbonate) is an alkaline chemical commodity which is mainly used as a raw material in the manufacture of glass. Soda ash is also used in the chemical industry, for making detergents, and in metallurgy.

Geographic markets: The west European market for soda ash in the late 1980's was characterized by separation along national lines. The producers tended to concentrate their sales on those Member States where they possessed production facilities, although from 1981 or 1982 onwards the smaller producers increased sales outside their home markets. In the Member States where Solvay was the sole locally established producer (Italy, Portugal and Spain), it virtually had a monopoly. Solvay's market share was in excess of 80% in Belgium, 55% in France, and 52% in Germany. ICI had over 90% of the UK market, the only alternative sources of supply being the U.S. and Poland.

Companies: Solvay, Imperial Chemical Industries (ICI), Rhône-Poulenc, Akzo, Matthes & Weber, Chemische Fabrik Kalk.

Duration: Sometime in 1987 to at least 1989.

7.20 Sodium gluconate

Product description: Sodium gluconate is an industrial metal and glass cleaner used for bottle washing, food service and utensil cleaning, food process equipment cleaning, and paint removal.

Companies: Akzo Nobel NV (and its subsidiary Akzo Nobel Chemicals BV), AVEBE BA (and its subsidiary Glucona BV), Roquette Freres, Fujisawa Pharmaceutical Co., Ltd., Archer Daniels Midland, Jungbunzlauer.

Duration: U.S., August 1993 to June 1995; Europe, 1987 to June 1995.

7.21 Sorbates

Product description: Sorbates are chemical preservatives (antimicrobial agents) capable of retarding or preventing growth of micro-organisms, such as yeast, bacteria, molds or fungi. Used primarily in food and beverages, their principal mechanisms are to reduce water availability and increase acidity. Sometimes these additives also preserve other important food characteristics such as flavor, color, texture, and nutritional value. In addition to their use as a preservative in food and beverages, sorbates also perform well in the stabilization of other types of products such as pharmaceutical products, cosmetics, pet food, and animal feed.

Geographic markets: During the period considered, the sorbates market was characterized by important trade flows between European Member States, as well as between the Contracting Parties to the EEA Agreement. European sorbates production is concentrated in a small number of sites - there are only two European producers, Hoechst and Cheminova, which have their production facilities in Frankfurt, and in

Harboore, respectively. Although Chisso, Daicel, Nippon and Ueno do not produce sorbates in Europe, they sold their products in almost every Member State both directly to end-users and through a network of independent distributors in the different European countries.

Companies: Chisso Corporation, Daicel Chemical Industries, Hoechst, The Nippon Synthetic Chemical Industry Co., Ueno Fine Chemicals Industry.

Duration: 1978 to November 1996 (except for Nippon who colluded until December 1995).

7.22 Vitamins

Product description: Vitamins are a group of micronutrients of various types of organic compounds required in small amounts in human and animal diet for normal growth, development, and maintenance of life. Their physiological function in the organism and mode of action are diverse. Some vitamins are essential sources of certain coenzymes necessary for metabolism, others are involved in the metabolism of other vitamins. All known vitamins can be synthesized chemically. The products with which this decision is concerned are those bulk synthetic substances which belong to the following groups of vitamins and closely related products: A, E, B1, B2, B5, B6, C, D3, biotin (H), folic acid (M), beta-carotene, and carotinoids.

Geographic markets: The European Commission considers the markets for vitamins A, E, B1, B2, B5, B6, C, D3, H, folic acid, beta-carotene, and carotinoids to be at least EEA-wide (there are several indications that point to worldwide markets for each of the vitamin products). European bulk vitamin production is concentrated at a small number of sites. Most Community/EEA Member States import the totality of their bulk vitamin requirements, with the vast majority of this from production originating in another Member State (Denmark, France, Germany, the United Kingdom).

Companies: F. Hoffmann-La Roche, BASF, Aventis, Lonza, Solvay Pharmaceuticals, Merck KgaA, Daiichi Pharmaceutical Co., Eisai Co., Kongo Chemical, Sumitomo Chemical Co., Sumika Fine Chemicals, Takeda Chemical Industries, Tanabe Seiyaku Co.

Duration: (Europe): A, E: September 1989 to February 1999; B1, January 1991 to June 1994; B2, January 1991 to September 1995; B5, January 1991 to February 1999; B6, January 1991 to June 1994; Folic Acid, January 1991 to June 1994; C, January 1991 to August 1995; D3, January 1994 to June 1998; H, October 1991 to April 1994; Beta-carotene, September 1992 to December 1998; Carotinoids, May 1993 to December 1998.

7.23 Zinc phosphate

Product description: Zinc phosphate is derived from zinc oxide and phosphoric acid. It is a non-toxic product and usually comes in the form of a non-cohesive, micronised white powder. Zinc phosphate is widely used as an anti-corrosion mineral pigment

in protective coating systems. Paint manufacturers use it for the production of anti-corrosive industrial paints such as automotive, aeronautic, and marine paints.

Geographic markets: Zinc phosphate has traditionally been manufactured in Europe. As it became a high performance product for export, five producers located in Western Europe hold virtually the whole of the world market. The rest is produced by two U.S.-based companies and by a few small producers, generally located in Asia.

Companies: Britannia, Heubach, James Brown, SNCZ, Trident, Waardals.

Duration: March 1994 to May 1998.

8 Appendix B - Sources

- Carbonless paper

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 - EC2** Commission Decision of July 24, 2002, Case COMP/E-3/36.700 - Industrial and medical gases.
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 - EC** *Official Journal of the European Union*, L 125/50, 28.4.2004, Case C.38.240 - Industrial tubes, Decision of December 16, 2003.
 - Isostatic graphite
 - EC** Commission of the European Communities, Commission Decision of 17/12/2002 (Case COMP/E-2/37.667 - Specialty Graphite)
 - Lysine
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- Methionine

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- Nucleotides

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