

This chapter is excerpted from *The Economics of Collusion: Cartels and Bidding Rings*, by Robert C. Marshall and Leslie M. Marx, published by The MIT Press, 2012.

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# 11 Plus Factors

Plus factors are the body of economic circumstantial evidence of collusion, above and beyond the parallel movement of prices by firms in an industry.<sup>1</sup> Plus factors are the economic criteria that can assist with the diagnosis of collusion.<sup>2</sup> When a plus factor delivers a strong inference of collusion, we refer to that plus factor as a super-plus factor.<sup>3</sup>

## 11.1 Organizing Plus Factors within a Taxonomy of Cartel Structures

We begin by reviewing the structures used by cartels and the observable conduct within these structures that can generate plus factors. In part I, we described nine broad baskets for the conduct of an explicit cartel (see chapter 4.3).<sup>4</sup> We can now use the collusive structures developed in parts II to more clearly articulate this taxonomy.

Cartel conduct that is associated with collusive *pricing structures* includes:

1. *Price elevation*: Raise prices above what they would have been without the conspiracy.
2. *Quantity restriction*: Reduce total industrywide quantity below what it would have been without the conspiracy.
3. *Steps to reduce buyer resistance*: Take steps to reduce resistance by buyers to price increases.
4. *Internal incentive shifts*: Change within-firm incentives so as to inhibit interfirm competition and foster higher prices.

1. ABA Section of Antitrust Law (2007, pp 11–16).

2. See Kovacic et al. (2011) and Harrington (2008).

3. See Kovacic et al. (2011).

4. These are drawn in part from Kovacic et al. (2011).

Cartel conduct that is associated with collusive *allocation structures* includes:

5. *Allocation of collusive gain*: Allocate the collusive gain among members.
6. *Redistributions*: Redistribute gains and losses among members so as to maintain compliance with the agreement.

Cartel conduct that is associated with collusive *enforcement structures* includes:

7. *Communication and monitoring*: Monitor compliance with the agreement and communicate regularly regarding all relevant features of the conspiracy that require discipline, especially production, sales, and market shares.<sup>5</sup>
8. *Enforcement and punishment*: Stand ready to abandon collusive conduct if some cartel members continually engage in substantial noncompliant conduct.

In addition, a cartel that has used collusive structures to successfully suppress rivalry within the cartel may consider incremental actions designed to act on the other forces affecting industry profits. This additional conduct includes:

9. *Dominant-firm conduct*: Once interfirm rivalry has been suppressed successfully, seek additional profits through activities such as dominant-firm conduct.

In chapters 11.2 through 11.5, we discuss in more detail examples of plus factors associated with the cartel conducts listed above. Then in chapter 11.6, we discuss how the mathematics of conditional probabilities can be used to help one think more clearly about, and potentially quantify, the inferences that can be drawn from plus factors. In chapter 11.7, we summarize the super-plus factors identified in chapters 11.2 through 11.5. In chapter 11.8, we briefly discuss cartel and ring reactions to detection based on super-plus factors.

## 11.2 Plus Factors Related to Pricing Structures

We highlight several plus factors and super-plus factors related to pricing structures, and we discuss how plus factors that may be indi-

5. Kuhn (2001) characterizes types of communication likely to facilitate collusion.

vidually weak can potentially be viewed in combination to provide a strong inference of collusion.

### 11.2.1 Price Elevation

Effective collusion by sellers elevates the price that buyers pay relative to noncollusive conduct. If one could account for all material factors that influence price when sellers are not explicitly colluding, then the elevation of price beyond that level would lead to the inference that the sellers were colluding. There is a strong inference of collusion if, for example, a reliable predictive econometric model that accounts for all material noncollusive effects on price, estimated using benchmark data where the conduct was presumed noncollusive,<sup>6</sup> produces predictions of prices that are not consistent with the path of actual prices in the period or region of potential collusion, at a specified confidence level.

If such measurement were readily available, it would be of great value to public enforcement authorities investigating potential collusion, procurers who suspect potential collusion by certain sellers, as well as corporate managers concerned that division managers may be exposing the corporation to antitrust liabilities through collusion with their counterparts at other firms.<sup>7</sup>

#### *Empirical Model\**

In what follows, we describe one approach to modeling and estimating a but-for price. The presentation below assumes a familiarity with basic econometrics. A parent corporation can typically require divisions to provide transaction-level data, along with all data relevant to the underpinnings of pricing, such as factor costs and demand conditions; thus, for a parent corporation, there are fewer barriers to the implementation of the methodology described below than for buyers or public enforcement authorities.

In order to calculate whether prices are elevated relative to noncollusive conduct, one estimates what the price would have been had there not been a cartel.<sup>8</sup> This is often referred to as the but-for price—but-for the existence of a cartel, what would the price have been?

6. The noncollusive benchmark is a period during which firms would be assumed to take into account their mutual interdependence. Thus, changes relative to this benchmark period would be attributed to explicit collusion.

7. On the use of empirical techniques to detect collusion as applied to citric acid and lysine, see Bolotova, Connor, and Miller (2008).

8. See White, Marshall, and Kennedy (2006).

Figure 1.1 contains two calculations of but-for prices for vitamin A acetate 650 feed grade. If the concern is cartel detection, then there would typically not be a plea agreement. This implies the need to search for a noncollusive benchmark, which adds a layer of difficulty to an already demanding problem.

Price variation can arise from many sources. In an attempt to isolate the effect of collusion on price, as one option, we can construct a model that reliably predicts price variation during circumstances where we can be reasonably assured conduct is noncollusive. If the model predicts price movements in this benchmark accurately, then it can be used to predict what prices would have been during the period of collusion. However, this requires an assumption about a period of time, a geographic location, or a product space that is noncollusive and thus can be used as a reliable benchmark. For now, we assume the existence of both a known benchmark time period and a conjectured collusive time period, where each is of reasonable length.

Undergraduate textbooks in econometrics, which form the basis for many conceptual understandings in econometrics, rely to a great extent on the teaching device of an experiment. For example, we might be asked to envision 1,000 one-acre plots that are planted in corn—500 plots receive a treatment of fertilizer, while the others do not. The 1,000 plots are spread across several counties within a state. Temperature, rainfall, soil fertility, hours of sunlight, and humidity all have some degree of variation between the plots. All of these can be measured. Regression analysis can be used to control for these exogenous factors in calculating the marginal effect of the fertilizer application on crop yield.

To apply this teaching device to cartel detection, instead of 1,000 one-acre plots of corn, assume that we have many periods of time in which the product price can be observed. Instead of crop yields, we have price realizations. Instead of temperature, rainfall, soil fertility, hours of sunlight, and humidity, we have factor input prices, demand shifters, inventories, capacity utilizations, exchange rates, and other variables potentially relevant to pricing. Instead of the treatment of fertilizer to some acres, we have a conjectured “treatment” of collusion for a specific period of time.

However, in general, economic environments are not controlled experiments. There are not 1,000 separate island economies, where 500 of the economies receive a cartel treatment and 500 do not. The reality of economic life is that the world is nonexperimental. Thus, the chal-

lenge of detecting a cartel is not a trivial extension of a standard experimental teaching device.

There are no strategic players in the crop experiment, but a cartel is a major strategic player. In an experimental setting, we think nothing of using rainfall to explain crop yields, or controlling for rainfall to understand the impact of fertilizer on crop yields. Rainfall is exogenous. The experimenter cannot change rainfall, and the mere production of crops does not change rainfall. But, there are many factors influencing a product's price that may be affected by the presence of a cartel, or even strategically manipulated by a cartel.

For example, the cartel may actively monitor and change inventory levels and/or capacity utilization as part of its conduct. The inclusion of these variables in the model, where the estimation is conducted over both the benchmark and collusive time periods, is inappropriate because we cannot determine the price but-for the cartel when that determination is based on variables that the cartel directly influences.

Consider inventory levels. Suppose that during the benchmark period, high inventories lead to vigorous competition and that this has a depressing effect on price. In addition, suppose that as prices increase a cartel has leading members agree to build up large inventories as both a threat against smaller cartel members that may deviate and as a threat against potential new entrants. An inventory variable cannot be included in a model to accurately determine the price but-for the cartel when that variable is being altered strategically by the cartel.

This point is important for both estimation and prediction. First, if estimation is conducted over both the benchmark and conjectured collusive period, and inventories are included as a regressor in the model, then the estimated impact of inventories will capture a confluence of the aforementioned effects, where one effect dominates in the benchmark period and another in the conjectured cartel period, despite the fact that the single variable is treated identically by the estimation between the two. Second, even if the estimation is conducted only over the benchmark period, when one uses those estimates to predict but-for prices over the conjectured cartel period, the inventory variable will be poisoned by the strategic use of inventories by the cartel. Specifically, inventories will have a different effect on price during the conjectured cartel period versus either before or after the conjectured cartel period.

Advertising expenditures may be another such variable. If firms were advertising solely to steal market share from one another during the benchmark period, but during the conjectured cartel period they

jointly agreed to advertise to expand demand for their product as a whole, then advertising expenditures cannot be included in an estimation designed to obtain an accurate and reliable but-for price.

It might appear that the prices of factor inputs would be immune from this critique, but this requires thought as well. If the conjectured cartel can use its bargaining power against factor input suppliers to influence the price they pay, then that factor input price is under the influence of the conjectured cartel and cannot be used to produce an accurate and reliable but-for price.

It is the responsibility of the econometrician to understand the industry and product market well enough to know what is and is not a variable that could potentially be under the direct influence of and/or manipulation by the conjectured cartel.

There is an additional issue with a variable such as a factor input price. Suppose that the factor input is a true commodity in the sense that the conjectured cartel is too small relative to the world market for the cartel to have any impact on the factor input's price or availability. The reaction of firms in a noncollusive oligopoly to changes in a factor input price can be entirely different from that of a cartel. Oligopoly pricing may be more sensitive to movements in the factor price than cartel pricing. If possible, one should avoid using data from both the conjectured cartel period and the benchmark period to estimate the effect of variables on price movements.

Within the experimental methodology, factor input prices are typically interacted with the cartel treatment variable, thereby allowing for different effects of factor input prices in the benchmark period versus the conjectured cartel period. For many applications, a preferable methodology is to use the benchmark period, where it is assumed that the conduct is noncollusive, to estimate parameters, and then use these estimates to predict price movements during the conjectured cartel period.

Another issue concerns the use of variables such as exchange rates. Suppose that exchange rates were included because the record indicated that price increases by the colluding sellers were often justified by pointing to changes in exchange rates. However, it may be that the cartel launches price increases when exchange rates change in order to use those changes as "cover," when exchange rates have no real impact on prices in the industry. If this is the case, and exchange rates are included in a model where estimation is conducted over both the benchmark and conjectured cartel period, then the variable may be

found to be important, even though it has no real effect and should have no role in the determination of a but-for price.

Time series variables that have no true underlying economic relationship may appear to be important in the experimental approach for spurious reasons. For example, many economic variables move through time in similar ways because of underlying economic conditions or general growth of the economy. A regression analysis may identify such variables as important for fit, but these variables may have nothing to do with price changes for the product of interest. Appropriate treatment of such variables is needed in the analysis so as to account for their true informational content regarding changes in price.

Some important information may not be available. Omission of important information is always a source of concern. For example, suppose that some freight rates are an important cost and that they are set by long-term contract. Suppose that these prices are unavailable. Then proxies for this important cost should be sought. In this case, there may be a price index available for freight rates that could be used as a candidate regressor.

The objective is to obtain an accurate and reliable estimate of the but-for price during the conjectured cartel period. The model that is estimated over the benchmark period is used to predict but-for prices over the conjectured cartel period.<sup>9</sup>

To ensure that the model produces accurate and reliable predictions, the predictive accuracy of the model is evaluated for the benchmark period. Envision that a candidate set of variables have been selected that can potentially explain price movements, and that these variables are not subject to potential strategic manipulation by the cartel. This could be a long list of variables.

There is only so much data available, and thus only so much information available to evaluate a model. Variables are included based upon their contribution to the predictive accuracy of the model in the benchmark period. Over the benchmark period, blocks of time are withheld (“hold-out periods”) from the estimation of a model. That model is estimated and used to determine how well the model predicts during the hold-out periods. This is done systematically for all the potential models and for a large number of time periods within the benchmark. The best model is the one that predicts best within sample.<sup>10</sup>

9. See Shao (1993), Racine (2000), Bernheim (2002), Inoue and Kilian (2006), and Giacomini and White (2006).

10. See Racine (2000).



The best model contains a specific subset of the candidate variables. When estimated in the benchmark period, that model is then used to predict the price for the conjectured cartel period. That is the but-for price.

Coefficient estimates in the predictive model should not be used to assess the model's reliability or accuracy. The coefficients in a predictive model do not have this kind of structural interpretation. The coefficients are just weights on variables, where those weights are such that they jointly produce the best prediction of the but-for price.

A strict structural interpretation of coefficients is rooted in an ideal experimental world. For example, suppose that we are trying to predict the price of a vitamin product. It is well known that oil is an important factor input. One would expect an increase in the price of oil to cause an increase in the price of the vitamin product, all else held constant. Suppose that the best predictive model produces a "coefficient" on the price of oil that is negative. This does not mean that the model is flawed. The price of oil was selected for inclusion in the model and the coefficient was selected as the best weight for the purposes of prediction. A coefficient in a predictive model should not be viewed as capturing a *ceteris paribus* marginal effect.

Returning to figure 1.1, one can see a large difference between the actual and but-for price during the plea-era period. The difference between the actual and but-for price can be used to determine the harm from a cartel and also used to detect cartel conduct. Specifically, when a significant difference between actual and but-for prices starts to emerge, as is evident in vitamin A acetate 650 feed grade by at least 1992, the inference of collusion is strong.

### 11.2.2 Quantity Restriction

Effective collusion reduces the total industrywide quantity below what it would have been in the absence of collusion. For example, the output restrictions of the OPEC cartel are widely publicized. To the extent that agreements among OPEC countries reduce the output of oil below what it otherwise would be, they increase the market clearing price for oil above what it would have been without the constraints.

As discussed in chapter 6, a class action complaint indicates that the United Potato Growers of America Inc., under the expectation of being covered by the Capper-Volstead Act, allegedly implemented a quantity reduction scheme that involved commitments by members to reduce potato acreage, to be monitored by satellite surveillance and ground inspections.

### 11.2.3 Steps to Reduce Buyer Resistance

As part of the pricing structure in the vitamins cartel, the cartel organized attempts to reduce buyer resistance by publicly announcing price increases, with the announcements reported in leading trade journals. Comparing vitamins price announcements during the admitted cartel period to those in the period prior to 1985, when explicit collusion was less likely, we can characterize collusive price announcements for a range of vitamin products produced by participants in the vitamins cartel as follows:<sup>11</sup>

1. *Collusive price announcements are made relatively more frequently than noncollusive price announcements.* The frequent use of price announcements by cartels reflects the importance of their role as part of a cartel pricing structure.
2. *Collusive price announcements occur at somewhat regular intervals.* The regularity of cartel price announcements reflects the regularity of the cartel meeting schedule. For example, each semi-annual cartel meeting might be followed by a new price announcement, giving a semi-annual structure to the price announcements.<sup>12</sup>
3. *Collusive price announcements are gradual in the sense of involving relatively modest individual price increases.* The gradualism of price increases directly addresses buyer resistance. As described above, cartel members in *Electrical and mechanical carbon and graphite products* faced buyer resistance because of the size of the price increase they announced. In addition, as noted by Harrington (2006), gradual price increases may reduce the probability of detection.
4. *Collusive price announcements are typically "joint announcements," with one firm leading and then others matching with identical announcements soon thereafter.* The use of joint announcements also directly addresses buyer resistance. If buyers observe that all the firms in an industry, or at least an important subset of firms in an industry, have announced identical price increases, then they will be less likely to expect aggressive price negotiations with the firms to be worthwhile. Price announcements by the vitamins cartel typically involved delays between the announcements of cartel members of seven or fewer days (the relevant trade journals are weekly publications).<sup>13</sup> The EC decision in *Vitamins*

11. Price announcement behavior is specific to a product/market/industry, so these characterizations do not necessarily apply beyond the products considered in Marshall, Marx, and Raiff (2008).

12. See Marshall, Marx, and Raiff (2008).

13. See Marshall, Marx, and Raiff (2008).

states that, "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."<sup>14</sup>

5. *Collusive price announcements may be led by a firm other than the market leader.* Noncollusive price announcements will typically be led by the market leader because smaller firms will fear being undercut by larger firms, while a larger firm will have less concern about a smaller firm operating under its price umbrella.<sup>15</sup> Empirically, in the vitamins industry prior to 1985, firms other than the market leader for a vitamin product, typically Roche, rarely led joint announcements, but after 1985, firms other than Roche frequently led joint announcements.<sup>16</sup>

6. *Collusive price announcements typically have long lead times before the new price becomes effective.* Publicly announced prices are sometimes effective immediately and sometime effective at some future date. When announced prices have a future effective date, suppliers may choose to withdraw or alter their announced prices. Lead times for the effective dates of public price announcements allow the cartel to monitor acceptance of the price increase and retract an announced increase that is being heavily resisted by buyers before incurring disruptions in cartel market shares. Approximately 50 percent of the price announcements made by the vitamins cartel were made well prior to the effective dates for the price increases; however, in an earlier benchmark period where explicit collusion was unlikely, only 5 percent of price announcements were made prior to the effective dates for the price increases.<sup>17</sup>

In *Wall Products v. National Gypsum*,<sup>18</sup> the colluding firms announced pricing policies that were all to become effective on the same future date.<sup>19</sup> Because of the role that the pre-announcement of price increases can play in supporting a collusive agreement, competition authorities

14. EC decision in *Vitamins* at paras. 203–204.

15. See Marshall, Marx, and Raiff (2008).

16. For example, in vitamin A acetate 650 feed grade shown in figure 11.1, starting in late 1989, the first six announcements are joint announcements led by first Roche, then BASF, then Rhone Poulenc, then BASF, then Roche, then BASF.

17. See Marshall, Marx, and Raiff (2008).

18. *Wall Products Co. v. National Gypsum Co.* 326 F. Supp. 295, 316 (N.D. Cal. 1971).

19. This is as reported by Clark (1983).

have in certain cases prohibited the announcement of prices prior to their effective date. Such a prohibition was imposed on an association of sugar refiners in 1934,<sup>20</sup> but the Supreme Court reversed that portion of the district court order.<sup>21</sup> More recently, a prohibition on advance price announcements was included in the 1967 consent agreement in *U.S. v. Pennsalt Chem. Corp.*<sup>22</sup> In addition in *Ethyl Corp.*,<sup>23</sup> the U.S. Federal Trade Commission found advance announcement of price changes to have an anti-competitive effect.

To show price announcements in action, we present the price announcement and transaction price data for the vitamins cartel.<sup>24</sup> Data on price announcements come from an exhaustive review of two weekly trade journals, *Feedstuffs* and the *Chemical Marketing Reporter*, for the years 1970 to 2001. This is a complete set of the public price announcements in the United States during this time period for a sample of vitamin products.<sup>25</sup> In figure 11.1 we show the price announcements for vitamin A acetate 650 feed grade, and in appendix A of this chapter, we show the price announcements for Calpan (B5) SD feed grade (figure 11.4), Calpan (B5) USP (figure 11.5), and vitamin E acetate oil USP (figure 11.6).<sup>26</sup>

Figure 11.1 shows the price announcements and prices for vitamin A acetate 650 feed grade. The actual average transaction prices are traced by the thick line, and the announced prices are indicated by filled or open circles, squares, and triangles representing different types of announcements. A joint announcement is defined as one in which one or more cartel members announce the same price within ninety days. Joint announcements are indicated by filled shapes. Single announcements are those not followed by another announcement of the same price and are indicated by open shapes. The shape itself indicates the firm making a single announcement or leading a joint announcement, as stated in the legend. The figure also indicates with vertical bars for each announcement (using the right vertical axis) the

20. *U.S. v. Sugar Inst.*, 15 F. Supp. 817, 830, 908 (S.D.N.Y. 1934).

21. *Sugar Inst. v. U.S.*, 297 U.S. 553, 603 (1936).

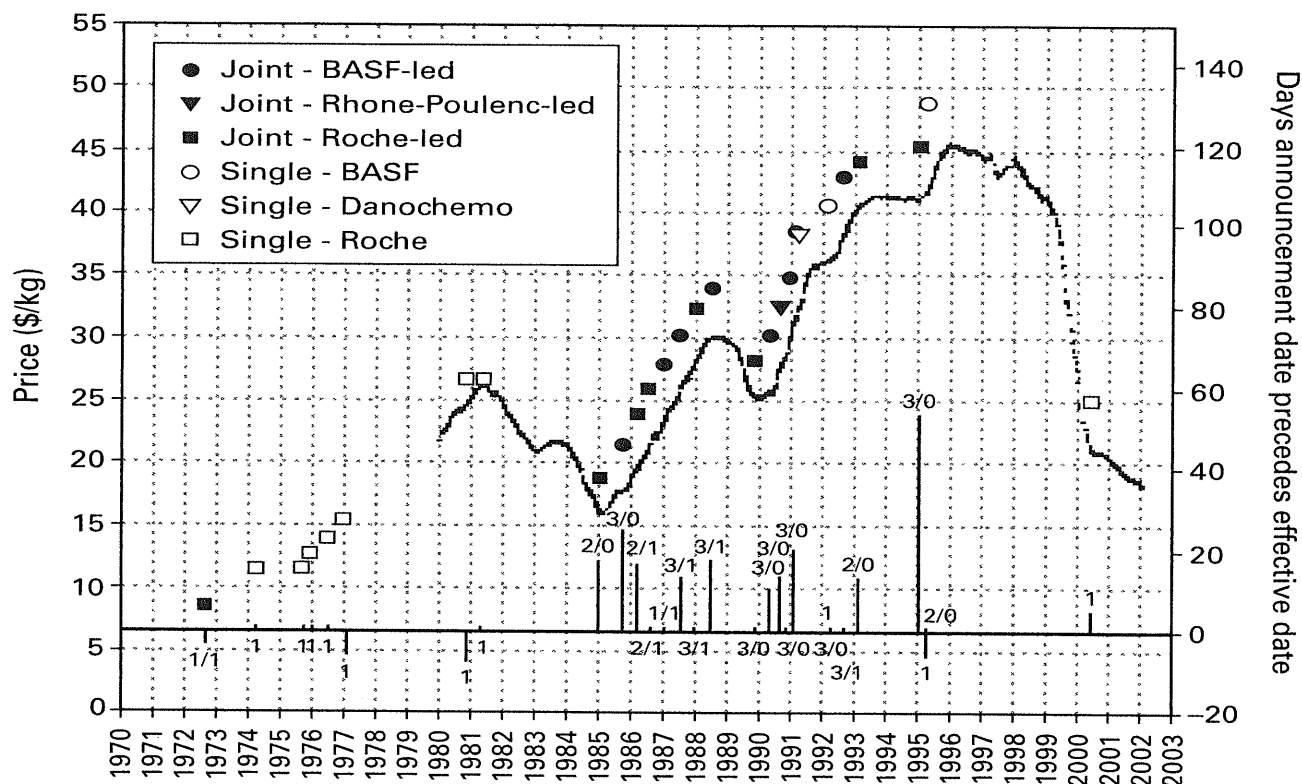
22. *U.S. v. Pennsalt Chem. Corp.*, 1967 Trade Cas. (CCH) P71, 982, at 83,475 (E.D. Pa. 1967).

23. *In re Ethyl Corp.*, 3 Trade Reg. Rep. (CCH) at 22,546 (F.T.C. Mar. 22, 1983).

24. Although the Vitamins Cartel was international in breadth, our empirical analysis relies only on public price announcement data for the U.S.

25. See Marshall, Marx, and Raiff (2008).

26. Data on prices were reverse engineered from the graphs in Bernheim (2002). Section 12 of Bernheim (2002) provides the monthly weighted average unit price in dollars per kilogram from 1980 to 2002, the dates of the plea-period, and the identities of the cartel firms.



**Figure 11.1**

Price announcements and prices for vitamin A acetate 650 feed grade

number of days between the announcement date and the effective date for the price increase. In some cases, the announcement was made after the effective date, so the number of days between is negative. Finally, above the bars indicating the days until the effective date are two numbers, first, the number of cartel members included in the joint announcement and, second (after a "/"), the number of noncartel members included in the joint announcement. For vitamin A acetate 650 feed grade, there were three cartel members: Roche, BASF, and Rhone-Poulenc,<sup>27</sup> so the first number is at most three.

The plea period for vitamin A acetate 650 feed grade was January 1990 to February 1999, although Bernheim (2002) places the start of the conspiracy in January 1985.<sup>28</sup> As can be seen in figure 11.1, January 1985 corresponds to a distinct change in the price announcement behavior and is the beginning of a multi-year run-up in price. Prior to 1985, there are relatively few price announcements, and almost all price announce-

27. See figure 1.1.

28. See Bernheim (2002, p. iii).

ments are single announcements—namely, an announcement by one firm that is not followed by another announcement by another firm at the same price. Also, prior to 1985, announcements tend to be made shortly before or after the effective date for the price change, but after January 1985 announcements tend to be made well in advance of the effective date for the price change. This behavior continues during the conspiracy period. After February 1999, when the conspiracy was identified by antitrust authorities, joint price announcements ceased and the price fell dramatically.

Despite the fact that manufacturers may offer discounts off of their announced price, figure 11.1 suggests that cartel price announcements and actual prices move together.<sup>29</sup>

As shown in figure 11.1, the firms tend to announce price increases, not price declines. The announced prices after January 1985 show a steady rate of increase and lead the actual prices. The prices being announced at any point in time tend to be a similar distance above the current price, except at price peaks after 1985, when the cartel firms continue to announce increasing prices as the transaction prices flatten out or turn down. The figure shows evidence of resistance to further price increases at the price peaks in 1988 and again in 1994.

In the appendix to this chapter, we provide the price announcement graphs for an additional feed grade vitamin and two human vitamins. The characteristics of these figures are remarkably similar to those of figure 11.1.

29. As another example, in the EC decision in *Cartonboard* the announced prices and actual prices were characterized by the EC as follows: "If the purpose of the economic study was simply to show that the cartel was ineffective, it does not fulfil this objective either. The Commission never alleged that the actual prices charged went up by the full amount of the proposed increase to all customers on the first day the new prices became effective and it would be unrealistic to expect that they would (see recitals 101 and 102). The various graphs in the economic study commissioned by the producers (and on which they rely to support the argument that there was no causal connection between 'announced' and 'actual' prices) in fact show a close linear relationship between the two sets of data, both in absolute domestic currencies and converted to ecu in real terms (see recital 21). The net price increases achieved closely tracked the price announcements, albeit with some time lag. The author of the report himself acknowledged during the oral hearing that this was the case for 1988 and 1989. It is only to be expected that when account is taken of individual arrangements, discounts and concessions on timing—and sometimes general customer resistance—the actual net increases achieved should be somewhat lower than those announced. The use of 'average' increases also tends to obscure the fact that in many cases the producers succeeded in making the customer pay the full amount of the announced increase." (EC decision in *Cartonboard* at para. 115).

#### 11.2.4 Internal Incentive Shifts

If a division manager opts to join a cartel, there are internal features of the operation of the division that he or she will need to change. Specifically, as noted in chapter 5, sales staff cannot be incented to strive for increased market share but, instead, it will be necessary for the division manager to change the incentives for the sales force to “price before volume.”<sup>30</sup> In other words, the sales staff will be required to implement the coordinated price increases of the cartel and not engage in the disruptive activity of stealing customer accounts from rivals. The mandate of “price before volume,” or any of the numerous variants, cannot survive in a marketplace where rivals are incenting their sales forces to pursue increased market shares. A firm unilaterally advocating “price before volume” is a sitting duck as rivals undercut its price. It is a sensible change to internal incentives if a large number of other firms simultaneously adopt the change. In an industry in which firms make relatively homogeneous products, a change in the within-firm incentives for a sales force that abruptly shifts from the pursuit of market share to the enforcement of pricing discipline is a super-plus factor.

#### 11.2.5 Economic Evidence in Combination

In some cases, one might observe a constellation of economic evidence, where each individual component is not compelling, that in aggregate constitutes a super-plus factor. For example, there might be conduct that would be consistent with unilateral actions by firms in the face of depressed market demand and separate conduct that would be consistent with unilateral actions by firms in the face of rising demand. However, the simultaneous observation of both types of conduct might be inconsistent with unilateral conduct and lead to the strong inference of collusion.

Suppose that the largest producers are all restricting production. This could happen as a consequence of a negative demand shock. Separately, suppose that prices are relatively high. In isolation, there may be many noncollusive reasons for high prices, such as a positive demand shock. Separately, suppose that profits are relatively high for each of the producers. In isolation, this could also arise for noncollusive reasons, such as a positive demand shock. However, the concurrent occurrence of high profits, high prices, and production restrictions

30. See chapter 2.5.

being implemented by major producers is highly unlikely without collusion. Specifically, if prices and profits are relatively high, then the unilateral response of a producer should be to sell as much as possible to earn the increased profit margin on incremental units. A restriction in production across several firms when the opportunity cost of doing so is extraordinarily high leads to the strong inference of collusion.

When prices are increasing, a buyer is going to invest incremental resources in resisting those increases. Resistance will involve eliciting “special” deals from some suppliers to sell additional volumes to buyers at relatively lower prices. For suppliers to react to such offers from buyers by implementing supply restrictions is contrary to unilateral competitive forces.

As discussed in chapter 11.3, “fixed relative market shares” is a plus factor but, alone, not super plus. There are many noncollusive reasons that market shares may be relatively stable in an industry. But suppose that the firms in the industry undertake many other actions in proportion to their relative market shares. For example, suppose that firms restrict supply in proportion to market share, and that they are doing so at a time when demand is relatively robust. As another example, suppose that a new technology that might compete with current suppliers is bought by a consortium of suppliers where their payments are in proportion to their market shares. These incremental conducts, in addition to the relative fixity of production market shares, constitute a super-plus factor.

### 11.3 Plus Factors Related to Allocation Structures

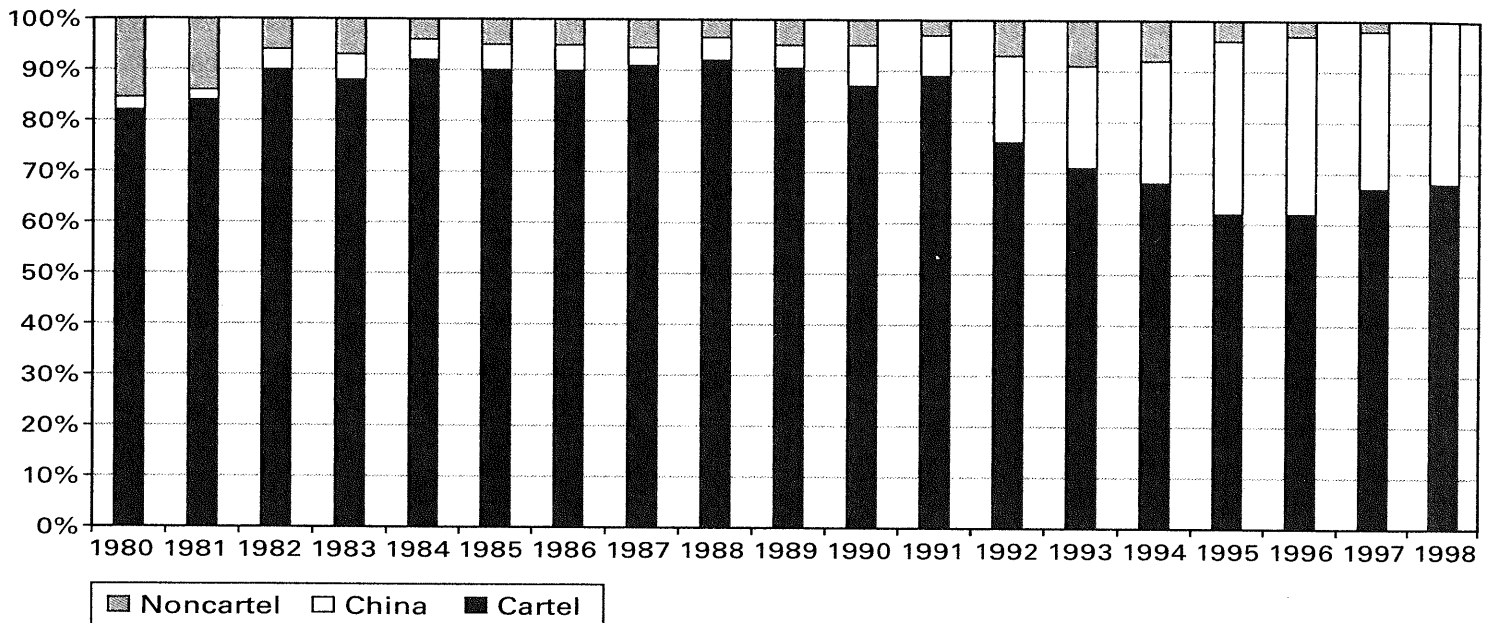
We highlight two plus factors related to allocation structures: the stability of market shares, which might be associated with a cartel’s use of a market share allocation, and the observation of interfirm transfers.

#### 11.3.1 Allocation of Collusive Gain

As discussed in chapter 6.3, many cartels use a market share agreement as a basis for their allocation structure. An implication of a market share agreement is that market shares should remain stable, something that may be observable to those outside the cartel.

Figure 11.2 portrays the worldwide market shares for all producers of vitamin C from 1980 to 1998, where we have grouped the producers into three categories: noncartel firms, cartel firms, and Chinese firms. It is clear from the figure that the Chinese producers made large inroads





**Figure 11.2**

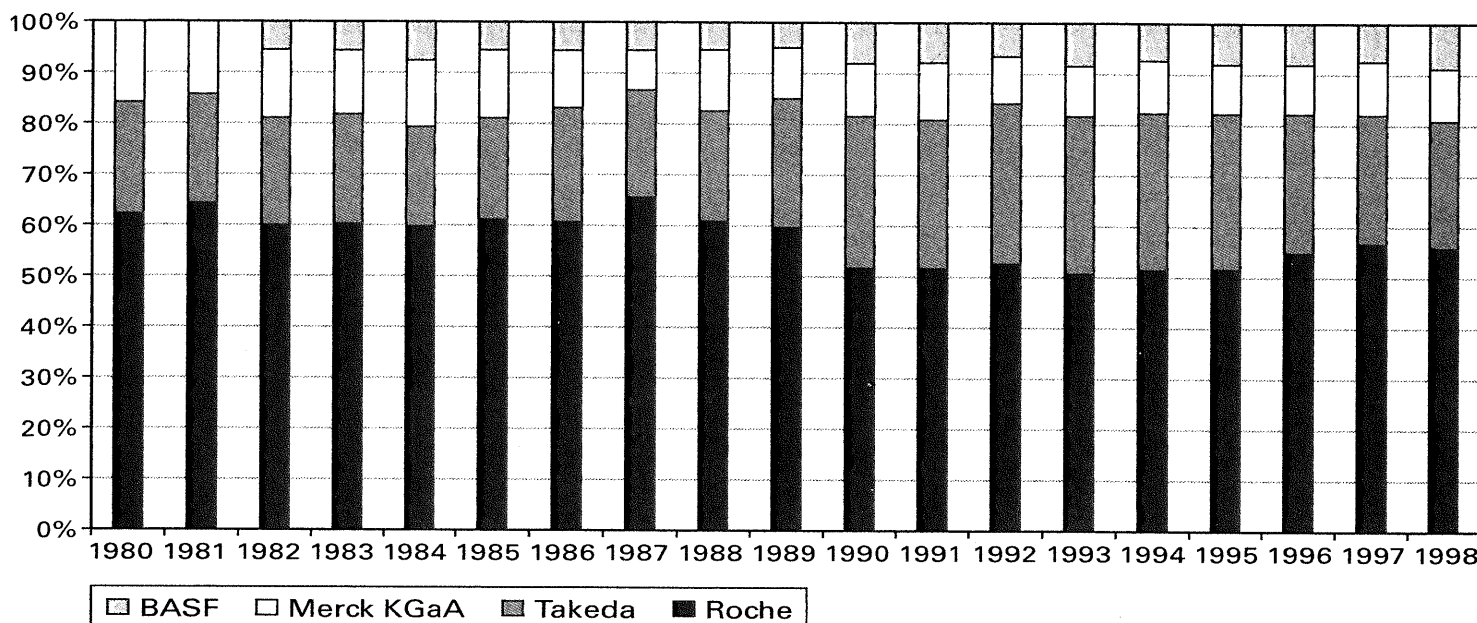
Overall market shares for vitamin C. Source: Bernheim (2002, fig. 8-7).

into the vitamin C market in the early 1980s, suggesting that customer loyalty is not a major factor for this product. It would be difficult to surmise a cartel in vitamin C with a quick visual inspection of this figure.

Figure 11.2 stands in sharp contrast to figure 11.3—the latter depicts the within-cartel market shares for the vitamin C producers. Figure 11.3 shows remarkable market share stability over a prolonged period, especially 1990 to 1994, which is the period where the cartel firms admitted to their participation in a cartel. So, despite the substantial inroads by the Chinese producers into the vitamin C market and a consequent diminishing market share for cartel firms as a whole, the cartel firms were able to maintain the allocation and enforcement structures required to adhere to a within-cartel market share agreement.<sup>31</sup>

In this case, stability of market shares for a subset of firms in the face of substantial entry is a plus factor. But market share stability alone is typically not a super-plus factor because it can arise through unilateral conduct. The same is true for geographic and customer stability. However, market share, geographic, and/or customer stability in conjunction with excess capacity in the industry and prices and profits that

31. See the EC decision in *Vitamins* at para. 394.



**Figure 11.3**

Cartel market shares for vitamin C. Source: Calculated based on Bernheim (2002, fig. 8-7).

are relatively high and increasing constitute a constellation of factors that are jointly a super-plus factor.

### 11.3.2 Redistributions

Cartels may need to engage in redistributions to keep the allocation of the collusive gain among co-conspirators consistent with their agreement.<sup>32</sup> For example, a market share agreement may require that some cartel firms buy product from other cartel firms at cartel prices so that the market share agreement is not violated.<sup>33</sup> Interfirm transfers within a broad class of settings are inconsistent with unilateral conduct and, additionally, not part of tacit collusion by definition. Such transfers are a super-plus factor.

Consider an oligopoly where firms are making a commodity product, and consider the interproducer purchase and/or sale of output by the firms. Such purchases and sales have a quantity and price associated with them. If two firms in an oligopoly that make identical products have excess capacity to make such products, engage in transactions for that product at nonmarket prices, then those transactions are inconsistent with unilateral conduct. Such transactions and transfers cannot be

32. See chapter 2.6.

33. See chapter 2, footnote 48.

part of tacit collusion by definition.<sup>34</sup> These types of transaction are a super-plus factor.

Not all interfirm transactions are interfirm transfers. Consider transactions at market prices. Suppose that two firms in an oligopoly make identical products and each has excess capacity to make such products. Suppose that these two firms engage in transactions for the product at market prices. The firms may offer an efficiency justification for such transactions. For example, perhaps firm A has a customer near firm B's location, and conversely, so to avoid costly shipping the firms provide their product to the other's customer. This conduct facilitates explicit collusion, and if the value/weight ratio of the product is high, such a justification lacks credibility, especially when viewed in conjunction with some consequence of the transaction that has no grounding in unilateral self-interested conduct. That is, if the transaction leads to the same market shares this year for some group of firms as had existed in previous years, then such transactions are a super-plus factor.

Again, the details of such interfirm transfers are often observable by the parent corporation, unlike buyers who may not be able to observe them without litigation-based discovery and/or actions to acquire such evidence by public enforcement authorities from dawn raids (European Commission) or civil investigative directives (U.S. Department of Justice).

## **11.4 Plus Factors Related to Enforcement Structures**

### **11.4.1 Communication and Monitoring**

It is natural for firms in an industry to attempt to learn about the status, intent, and actions of their rivals. Such information can enhance profits. For example, knowing that a rival is functioning near full capacity can enhance the expected profitability for a seller from upcoming buyers' procurements. The flip side of this argument is that a firm should want to guard against its own firm-specific information getting into the hands of rivals. However, a critical component of the operation of a cartel is monitoring the status and conduct of member firms. Thus, firms in a cartel will exchange information with one another in order

34. Tacit collusion requires the absence of communication and transfers. If one firm buys a large volume of the product from a "competitor" at the price of \$1 per pound when the market price at that time is \$10 per pound, then the seller has transferred \$9 times the number of pounds sold to the buyer.

to monitor compliance with the cartel agreement. Specifically, a firm will provide firm-specific information to other cartel members that it would almost never provide when acting noncollusively.

For example, firms in a cartel using a market share agreement may ensure compliance by reporting to one another their production and sales data, with some means by which fellow cartel members can be assured of the accuracy of these reports.<sup>35</sup>

If a firm possesses information about a rival that it could have learned from good market surveillance, then we do not have a super-plus factor. However, if a firm knows something about rivals that is important for monitoring compliance with the collusive agreement, and that information would not be unearthed through reasonable market surveillance, or have been of no interest to a rival if the firms were acting noncollusively, then the knowledge and conveyance of such information constitutes a super-plus factor.

Standard market surveillance might reveal which firms have won recent contracts. After the award decision, buyers may even provide information to losing bidders about winning bids. However, many buyers will not provide such information, and therefore it will not be possible to aggregate and construct accurate firm-specific sale and production numbers from just this kind of market surveillance. If a firm knows the sales and production numbers of individual “competitors,” then this constitutes a super-plus factor. Although any firm would want to know this information, no firm would want to convey this information to “competitors” unilaterally.

Standard market surveillance will not unearth interfirm transactions between other “competitors.” Firm A would not know the details of a transaction between firms B and C unless B and/or C conveyed this information to A. Firm B and/or C would convey such information to A if the transaction was part of the maintenance of a collusive agreement for the cartel consisting of firms A, B, and C. If firms B and C were simply engaged in a noncollusive interfirm transaction, there would be no reason for either to convey the existence or details of the transaction to A.

Information exchange as a super-plus factor is not about the assessment of individual firm guilt but, instead, about the inference of collusion among a set of firms. If firm A knows something about firm B that firm B would not unilaterally reveal, and unilateral information gather-

35. See, for example, chapter 2, footnote 24.

ing efforts by A would almost surely not produce the information, then this is a super-plus factor. Firm A will argue that if information drops in its lap, it is entitled to retain it and use it, and that it cannot be responsible for firm B's confidentiality standards, but this argument is irrelevant. If firm A knows something about firm B that firm B would almost surely never convey to A in a world where the firms were acting noncollusively, then we have a super-plus factor with respect to the inference of collusion between firms A and B.

Unlike buyers that need litigation discovery, dawn raids, or civil investigative directives to uncover such activities, the parent corporation will typically have access to this type of information through information demands of the division managers.

#### **11.4.2 Enforcement and Punishment**

Cartels must stand ready to address secret deviations. If secret deviations are unearthed and any attempts to remedy problems, perhaps through redistributions, fail, then the cartel must respond. As noted in chapter 2 (footnote 57), historically some cartels have had members post bonds as a guarantee against deviations. Evidence of such bond posting is a super-plus factor. Although the posting of bonds can be explicit, as in the cases of the steel, aluminum, and incandescent electric lamp cartels,<sup>36</sup> it can also be more subtle.

For example, aspects of licensing agreements for patents can provide opportunities for cartel firms to exact punishments on one another.<sup>37</sup> Co-ownership of certain assets can also provide such a mechanism. For the case of colluding used machinery dealers as described in Marshall and Meurer (2004, p. 109, n. 99), "A given dealer typically had several machines in inventory that were co-owned with many different dealers. The warehousing dealer had substantial latitude in determining the final transaction price for the machine. The true final transaction prices were not verifiable. This provided dealers with an additional mechanism for punishing deviant ring bidders."

### **11.5 Plus Factors Related to Dominant-Firm Conduct**

Once a cartel has successfully suppressed within-cartel rivalry, it has an incentive to dampen other forces that might depress the profits of firms within the cartel. When there is no dominant firm in an industry

36. See chapter 2, footnote 57.

37. See Priest (1977).

and we observe dominant-firm conduct, it may be possible to infer that firms in the industry are explicitly colluding.

We begin by defining a dominant firm. "A dominant firm is a seller that is able to exercise substantial market power (or, equivalently, monopoly power) unilaterally, without the need for collusive arrangements." (Schmalensee 1985, p. 3)

It follows from this definition that if collusive arrangements are needed for the exercise of substantial market power, then none of the firms in the collusive arrangement is dominant. U.S. enforcement agencies (DoJ and FTC) have offered the assessment that no single firm can act as a dominant firm in an industry with less than a 50 percent market share.<sup>38</sup> It follows that if we observe dominant-firm conduct undertaken by a number of firms in an industry that in aggregate have more than 50 percent of the market, but where no firm has a market share exceeding 50 percent, then it is highly likely that a subset of the firms are acting as a cartel.<sup>39</sup>

This super-plus factor has the advantage that dominant-firm conduct is readily observable by third parties without litigation discovery, dawn raids, or civil investigative directives. No distinction between pro-competitive and anti-competitive dominant-firm conduct is needed to draw the inference of the existence of a cartel when no firm has a market share in excess of 50 percent.

However, caution should be taken if a conduct is observed to be undertaken by only one firm because some dominant firm conducts, such as tying, may occur unilaterally.

## 11.6 Differentiating Plus Factors\*

To the extent that the conduct described above is observed, it may be viewed as a plus factor supporting the inference of collusive behavior. Kovacic et al. (2011) offer a way to assess the strength of plus factors. We review the basics of that approach in this section.

38. "The Department is not aware of any court that has found a defendant to possess monopoly power when its market share was less than 50 percent. As a practical matter, a share greater than 50 percent has been necessary for courts to find the existence of monopoly power." (Barnett and Wellford 2008, pp. 5–6).

39. Posner (2001) identifies certain dominant-firm conduct by firms in an oligopolistic industry as a plus factor. Heeb et al. (2009) note that cartels often engage in dominant-firm conduct. Marshall, Marx, and Samkharadze (2011) note that once cartels have successfully suppressed interfirm rivalry, they move on to seek incremental profits through dominant-firm conduct.

An observed economic conduct is a plus factor, and can be used as an indicator of collusion, if the probability of there being a cartel conditional on observing the plus factor is greater than the unconditional probability of a cartel.

To more clearly state ideas, it is convenient to introduce some mathematical notation. The probability of a cartel conditional on observing a plus factor can be written as  $\Pr[C | F]$ , where the vertical bar is standard notation read as “given,” so the expression is read “probability of  $C$  given  $F$ ,” with  $C$  denoting the event that there is collusion and  $F$  denoting the presence of a plus factor.

We can write the probability of a cartel given a plus factor,  $\Pr[C | F]$ , as depending on other probabilities. In particular, we can write this probability as depending on the probability of observing a plus factor conditional on whether there is or is not a cartel,  $\Pr[F | C]$  and  $\Pr[F | \text{not } C]$ , and on the unconditional probability of a cartel.<sup>40</sup>

$$\Pr[C | F] = \frac{\Pr[F | C] \cdot \Pr[C]}{\Pr[F | C] \cdot \Pr[C] + \Pr[F | \text{not } C] \cdot \Pr[\text{not } C]}. \quad (11.1)$$

This formula is useful because it tells us that when the probability of a specific plus factor given no cartel,  $\Pr[F | \text{not } C]$ , is close to zero, then the probability of a cartel given that plus factor is near one.<sup>41</sup> To see this in equation (11.1), note that when  $\Pr[F | \text{not } C]$  is very close to zero, then the numerator and denominator on the right side of the equation are essentially the same, and so the ratio is very close to 1. The implication is that if we can identify a plus factor that is unlikely to appear when there is no cartel, then the observation of that plus factor indicates that there is a cartel with high probability. We refer to plus factors with this characteristic as super-plus factors. Using the notation, if  $\Pr[F | \text{not } C]$  is near zero, then  $\Pr[C | F]$  is near one, and so  $F$  is a super-plus factor.

For some plus factors, the probability of collusion conditional on observing the plus factor may not be much greater than the uncondi-

40. The formula is often referred to as Bayes' Theorem.

41. As an illustration, suppose that cancer type  $X$  produces a marker that shows up in blood tests. The presence of cancer is analogous to the presence of collusion, and the marker is analogous to a plus factor. If the blood marker is almost never observed when a person does not have cancer, that is, the probability of the marker conditional on no cancer is close to zero, then the probability of a person having cancer, conditional on observing the blood marker, is close to one.

tional probability of collusion. In this case, the observation of the plus factor does not increase the assessed probability of there being collusion by much. For example, the observation of relatively fixed production market shares in the linerboard industry would not by itself be much of a plus factor given the nature of linerboard production (see chapter 6.2.6). However, plus factors that do not individually do much to increase the assessed probability of collusion may, when considered as part of a group of plus factors, lead to the conclusion that the probability of collusion is high.

The strength of a plus factor can be quantified by the ratio of the probabilities of observing the plus factor conditional on collusion and no collusion:<sup>42</sup>

$$S = \frac{\Pr[F | C]}{\Pr[F | \text{not } C]}.$$

Conceptually, the strength of a plus factor,  $S$ , provides a way to rank plus factors, and it can be extended to apply to groupings of plus factors as well.<sup>43</sup>

## 11.7 Super-Plus Factors for Cartels

As described in chapter 11.6, plus factors can be differentiated in terms of their strength. Plus factors or combinations of plus factors that deliver a strong inference of collusion are super-plus factors. Below we summarize the super-plus factors identified in chapters 11.2 through 11.5. Thus, we provide a partial listing of super-plus factors for cartels:

1. *Transaction prices above predicted levels*: A reliable predictive econometric model that accounts for all material noncollusive effects on

42. See Kovacic et al. (2011). To see why  $S$  measures the strength of a plus factor, note that if we let  $O$  denote the baseline odds against a cartel,

$$O = \frac{\Pr[\text{not } C]}{\Pr[C]},$$

then one can show that

$$\Pr[C | F] = \frac{1}{1 + O/S}.$$

Thus, an increase in  $S$  results in an increase in  $\Pr[C | F]$ .

43. See Kovacic et al. (2011) for further development of plus factor strength.



price, estimated using benchmark data where conduct was presumed noncollusive, produces predictions of prices that are not consistent with the path of actual prices in the period or region of potential collusion, at a specified confidence level.<sup>44</sup>

2. *Communication and information sharing*: A firm or subset of firms has extensive knowledge of the details of another firm's transactions, production, sales, and/or inventories where the latter firm would be competitively disadvantaged by conveying that information unilaterally.

3. *Interfirm transfers*: Firms engage in interfirm transactions that are transfers of resources and are largely void of productive noncollusive motivations.

4. *Within-firm incentives*: In an industry where the product made by different firms is largely homogeneous, there is a discrete change in the within-firm incentives of the sales force, across a subset of firms during a given period, that shifts from the pursuit of market share to maintenance of elevated prices (e.g., a shift to "price before volume").

5. *Dominant-firm conduct by nondominant firms*: A subset of firms, with an aggregate market share large enough to have dominant-firm market power, jointly engage in a dominant-firm conduct when no single firm has the market power to act unilaterally as a dominant firm by engaging in that dominant-firm conduct.

6. *Economic evidence in combination*: When prices and profits are relatively high and increasing:

- a. a subset of firms restricts production, or
- b. among a subset of producers, market shares, customer incumbency, or geographic dominance is stable when the firms have excess capacity.

## 11.8 Response to Detection Based on Super-Plus Factors

If collusive firms view super-plus factors as something that will be used by courts to draw a strong inference of explicit collusion, then

44. The higher is the degree of confidence, the stronger is the plus factor. Suppose that the confidence level is 95%. Then the probability of observing the actual price path exiting the confidence bounds (outcome  $F$ ) in the absence of collusion is 5% ( $\Pr(F | \text{not } C) = 0.05$ ). For example, with this confidence level, and with  $\Pr(F | C) = 0.99$  and baseline odds against collusion of 2 (i.e.,  $\Pr(C) = 0.33$ ), we obtain  $\Pr(C | F) = 0.908$ , surpassing the criminal liability threshold.

colluding firms will try to avoid creating super-plus factors.<sup>45</sup> However, avoiding super-plus factors can greatly encumber the profitability and stability of a cartel and may even deter the conspiratorial conduct.

For example, if interfirm transfers are considered super-plus factors by antitrust enforcement authorities, then colluding firms have an incentive to avoid making interfirm transfers or to take additional steps to disguise them. However, avoiding transfers can increase the monitoring burden for a cartel. For example, a market share cartel would need to ensure there were no year-end deviations from the designated cartel market shares.

As another example, if market share stability, in conjunction with other factors, is viewed as a super-plus factor, then colluding firms will have an incentive to artificially manufacture market share volatility. However, this could be destabilizing to a cartel, especially one naturally rooted in a market share agreement.

## **11.9 Appendix: Additional Price Announcement Graphs**

### **1.9.1 Calpan (B5) SD Feed Grade Price Announcements**

Figure 11.4 shows the prices and price announcements for Calpan (B5) SD feed grade. The plea period for this vitamin was January 1991 to February 1999, with Bernheim (2002) dating the start of the conspiracy at January 1985.<sup>46</sup> The cartel firms were Roche, BASF, and Daiichi.<sup>47</sup>

### **11.9.2 Calpan (B5) USP Price Announcements**

Figure 11.5 shows the prices and price announcements for Calpan (B5) USP. The plea period for this vitamin was January 1991 to February 1999, with Bernheim (2002) dating the start of the conspiracy at January 1985.<sup>48</sup> The cartel firms were Roche, BASF, and Daiichi.<sup>49</sup>

45. See Kovacic et al. (2011). See Harrington (2003, 2004a) on potential effects of antitrust laws on cartel behavior. See also Cyrenne (1999).

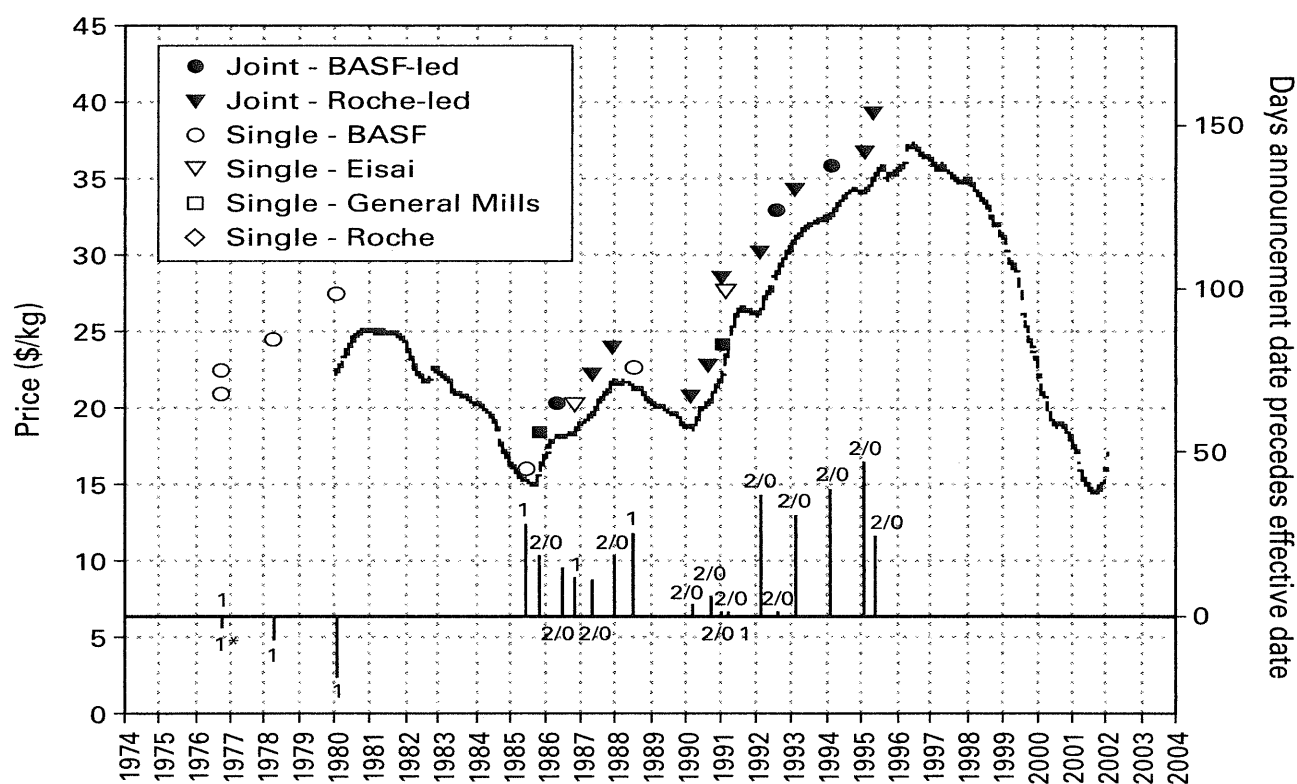
46. See Bernheim (2002, p. iii).

47. See Bernheim (2002, p. 219).

48. See Bernheim (2002, p. iii).

49. See Bernheim (2002, p. 220).





**Figure 11.6**  
Prices and price announcements for E acetate oil USP

### 11.9.3 E Acetate Oil USP

Figure 11.6 shows the prices and price announcements for E acetate oil USP. The plea period for this vitamin was January 1990 to February 1999, with Bernheim (2002) dating the start of the conspiracy at January 1985.<sup>50</sup> The cartel firms were Roche, BASF, and Eisai.<sup>51</sup>

50. See Bernheim (2002, p. iii).

51. See Bernheim (2002, p. 204).