

CHAPTER 8

*The Economics of Tacit Collusion: Implications for Merger Control*¹

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8.1. Introduction

Tacit collusion refers to a group of oligopolists' ability to coordinate, even in the absence of explicit agreement,² to raise price or more generally increase profit at the detriment of consumers. It has been treated under the notion of collective dominance in a number of important European Court decisions and under the "coordinated effects" label in the US. The present chapter focuses on the economic analysis of the impact of mergers on collusion and its consequences for anti-trust policy.³

The legal treatment of collusion depends on the form it takes: explicit, tacit, or any combination of the two. Explicit collusion or cartel agreements are usually banned under antitrust laws, such as Section 8.1 of the US Sherman Act or Article 81 of the European Treaty. The treatment of tacit collusion has however been subject to more controversy than that of cartels, due the absence of a formal agreement or explicit coordination.⁴ For this reason the use of the concept of tacit collusion has almost exclusively been used in merger control policy. Moreover the European Commission has relied more heavily on it than the US anti-trust authorities. This can be attributed mostly to the difference in the legal procedures. While the Clayton Act prohibits a merger the effect of which "may substantially lessen competition", until recently, the European merger regulation allowed the Commission to declare incompatible with the EC treaties mergers that "create or strengthen a dominant position as a result of which effective

¹ This chapter is based on a report on collective dominance for the European Commission (Ivaldi et al., 2003). We thank Vivek Ghosal and John Martin for comments and references.

² "Tacit collusion" need not involve any "collusion" in the legal sense, and in particular need involve no communication between the parties. A better term from a legal perspective might be "tacit coordination".

³ See our report (Ivaldi et al., 2003) for a more complete analysis.

⁴ See in particular the US Supreme Court opinion in *Brooke Group, Ltd. v. Brown & Williamson Tobacco Corp* (1993) or the appeal decision in *Williamson Oil Co. v. Philip Morris USA* (Eleventh District, 2003). For the European Community, see the annulment by the Court of Justice of the Commission Decision 85/202/EEC (the *Woodpulp* case).

competition would be significantly impeded”, where dominance can be single or collective. While the treatment of mergers in the US has mostly focused on unilateral effects, with a minor role for coordinated effects, due to lack of clarity in the interpretation of collective dominance, the European Commission has in the past preferred to address issues of tacit collusion when dealing with collective dominance with no structural links.⁵ Only recently has the new Merger regulation⁶ of 2004 allowed the commission to address unilateral effects in a more systematic way, by prohibiting a concentration which would “significantly impede effective competition”.⁷

In this chapter, we review the main industry characteristics that affect collusion. We then draw some implications for merger policy. Section 8.2 introduces the concept of tacit collusion, while the factors that are relevant for collusion are discussed in Section 8.3. Section 8.4 proposes a mathematical illustration. Section 8.5 discusses non-price collusion. Finally Section 8.6 focuses on the implications for the practice of merger control.

8.2. The economics of tacit collusion

Tacit collusion can arise when firms interact repeatedly. They may then be able to maintain high prices through the threat that any deviation from the collusive path would trigger some retaliation. To be sustainable, retaliation must be sufficiently likely and costly to outweigh the short-term benefits from “cheating” on the collusive path. These short-term benefits, as well as the magnitude and likelihood of retaliation, depend in turn on the characteristics of the industry.

Retaliation refers to the firms’ reaction to a deviation from the collusive path. A simple form of retaliation consists in the breakdown of collusion and the restoration of “normal” competition and profits. Firms anticipate that if one attempts to reap short-term profits, they will be no more collusion in the future. Firms may then abide to the current collusive prices in order to keep the collusion going, in which case collusion is self-sustaining. This form of collusion has a simple interpretation: firms trust each other to maintain collusive prices; but if one of them deviates, trust vanishes and all firms start acting in their short-term interest. However, there may be more sophisticated forms of retaliation that may inflict tougher punishments, thereby allowing sustaining higher collusive prices. Another reason why returning forever to “normal competition” may

⁵ Leading cases for EU are Gencor/Lonrho (M.619), Nestlé/Perrier (M.190) or Airtours/First Choice (M.1524). In the US, the FTC has recently and unsuccessfully attempted to challenge a merger on the ground of coordinated effects (FTC v. Arch Coal, 2004).

⁶ Council Regulation (EC) No 139/2004 of 20 January 2004 on the control of concentrations between undertakings (the EC Merger Regulation), *Official Journal*, L 24, 29.01.2004, pages 1–22.

⁷ Another difference between the US and the EU concerns the proceedings: in the US a merger can only be challenged before a court, whereas in the EU the procedure is internal to the European Commission; the separation between investigation and decision is thus less clear in that case, despite the scrutiny of the member States and the fact that the final decision is made by the Commissioners.

not be a good collusion scheme is the unobservability of rivals' moves. When for example rivals' prices are unobservable, firms must infer aggressive moves by competitors from their own performance on the market; if furthermore demand is random, price wars may then be triggered by low demand rather than deviations.⁸ Temporary price wars then make more sense than long-lasting wars. Finally, retaliation may include targeted price wars. For example, in *Compagnie Maritime Belge* (case C-395/96P), it was argued that shipping companies chartered "fighting ships" that were specifically designed to compete head to head against the ships of a targeted company. The common feature of retaliation mechanisms is however that:

- (i) The profit loss imposed on a deviant firm by retaliation must be sufficiently large to prevent deviations;
- (ii) It must be in the firms' best interest to carry on the retaliation once a deviation has occurred.

The second condition can be difficult to assess, because retaliation is itself an equilibrium phenomenon.

To evaluate the impact of a structural change such as a merger on collusion, it is then necessary to have a clear picture of how industry characteristics affect both the short-term benefits and the retaliation possibilities.

8.3. Relevant factors for collusion

Many characteristics can affect the sustainability of collusion. First, there are some basic structural variables, such as the number of competitors, entry barriers, how frequently firms interact, and market transparency. Second, there are characteristics about the demand side: is the market growing, stagnating, or declining? Are there significant fluctuations or business cycles? Third, there are characteristics about the supply side: Is the market driven by technology and innovation, or is it a mature industry with stable technologies? Are firms in a symmetric situation, with similar costs and production capacities, or are there significant differences across firms? Do firms offer similar products, or is there substantial vertical or horizontal differentiation? This section reviews the impact of these various industry characteristics.⁹

⁸ See for instance the work of Porter (1983) on the Joint Executive Committee for the rail-roads industry in the 1880s.

⁹ While there is little empirical evidence on tacit collusion, there are several studies on cartels, following the initial work of Posner (1970) and Hay and Kelley (1974). Cartels are different due to explicit coordination, exchange of information and greater ability to adjust to specific conditions, but they face many common features since firms must have proper incentives. These studies are surveyed by Levenstein and Suslow (2004) who emphasise their disparity. They however provide support to the importance of some structural factors discussed here, in particular the role of the number of firms, of entry barriers, and of market stability.

8.3.1. Collusion is sustainable if and only if firms put sufficient weight on future profits

As already stressed, collusion arises from dynamic interaction. Collusion emerges when firms conjecture that any attempt to undercut the collusive price will be followed by tough retaliation from competitors. Since retaliation arises in the future while deviations generate immediate profits, the ability to collude depends in turn on the relative importance of current profits compared to future profits in the firms' objective.

8.3.2. Collusion is more difficult when there are more competitors

First, coordination is more difficult, the larger the number of parties involved.¹⁰ Second, and beyond the issue raised by the difficulty of reaching a consensus, deviations from it are more tempting in the presence of many competitors: Since firms must share the collusive profit, as the number of firms increases each firm gets a lower share of the pie. This implies that the short-run gain from deviation increases, while at the same time the long-run benefit of maintaining collusion is reduced. It is thus more difficult to prevent firms from deviating.¹¹

8.3.3. Do symmetric market shares facilitate collusion?

It is often asserted that more symmetric market shares facilitate collusion. At first glance, this may seem justified since the firm with the lowest market share has more to gain from a deviation, and less to lose from retaliation. However, market shares are largely endogenous. *While it may not constitute the main relevant factor for a correct analysis of an industry, market share asymmetry may reflect more profound and relevant asymmetries that tend to make collusion more difficult to sustain.* But then, the relevant question becomes the impact of these more profound asymmetries in cost or product range or quality.

8.3.4. Entry barriers facilitate collusion

It should be clear that collusion is difficult to sustain if there are low barriers to entry. First, in the absence of entry barriers any attempt to maintain supra-competitive prices would trigger entry (e.g., short-term or "hit-and-run" entry strategies), which would erode the profitability of collusion. Second, the prospect of future entry tends to reduce the scope for retaliation. This is a well understood factor that is routinely discussed in the cases.

¹⁰ The idea that coordination is more difficult in larger groups is intuitive but there is little economic literature on this issue. See nevertheless Compte and Jehiel (2002).

¹¹ This insight is valid when holding all other factors constant. The number of firms is however endogenous and reflects other structural factors such as barriers to entry and product differentiation.

8.3.5. Frequent interaction and frequent price adjustments facilitate collusion

As already mentioned, there is more scope for collusion when the same firms compete repeatedly. Relatedly, firms find it easier to sustain collusion when they interact more frequently. The reason is that firms can then react more quickly to a deviation by one of them. Therefore, retaliation can come sooner when firms interact more frequently.

To see this clearly, note first that firms could not tacitly collude if they did not anticipate interacting again in the future. Similarly, collusion is unlikely when firms interact only infrequently, since the short-term gains from undercutting a collusive price could then be “punished” only in a far future.¹²

This idea can be illustrated by the US government’s practice of buying vaccines in bulk in order to undo collusion.¹³ By buying in bulk, the government both increases the stakes of each procurement auction and makes these auctions less frequent, thereby limiting the interaction between the bidders. A similar idea applies to the frequency of price adjustments. When prices adjust more frequently, retaliation will again come sooner; and in addition, a cheating firm will not be able to take advantage for as long a time as before of its cheating behaviour. Both factors contribute to hinder collusion. Examples of frequent interactions include for instance financial security markets (see in particular the NASDAQ Market Makers case), or daily spot markets.

8.3.6. Market transparency facilitates collusion

Quick retaliation when one market participant undercuts the others requires that such deviation be identified by the other participants. As a result, collusion can be difficult to sustain when individual prices are not readily observable and cannot be easily inferred from readily available market data. This observability problem has first been stressed by Stigler (1964)’s classic paper, and formally analysed by Green and Porter (1984) and Abreu et al. (1985). It can be noted that market stability can play a role, since inferring deviations from collusive conduct is easier and requires less market data when the market is stable.¹⁴

The delay necessary to obtain reliable data on prices and quantities matters, as well as its nature. For example, professional associations sometimes publish information on prices, productions or capacity utilisation rates. It first matters whether this information is about aggregate or individual data, since in the latter case it is easier to identify a deviant firm.¹⁵ The time lag elapsed between

¹² Of course, other factors such as market transparency, which is discussed below, also affect the length of time before retaliation effectively occurs. But the point here is that retaliation will not even be feasible in the absence of frequent interaction.

¹³ See Scherer (1980).

¹⁴ See for instance the analysis of transparency in UPM-Kymmene/Haindl (M. 2498).

¹⁵ See for example Kühn (2001).

the pricing period and the publication period is also important. Even detailed information may not help to sustain collusion if it is available only after a long delay.

Finally, we should note that there is a link between the circumstances that make collusion difficult to enforce, and those that may make it difficult to coordinate on a collusive outcome in the first place. The harder it is to obtain data on prices and quantities, the harder it may be for the firms to work out, without explicit collusion, what would constitute a monopoly price. However, this equivalence is not precise. For instance, if the technology in the industry is fairly standard and the goods produced fairly homogeneous, the monopoly price may be easy to work out even if there is no transparency about individual production levels. So collusion could be easy to coordinate upon but hard to enforce. Conversely, even in the presence of high transparency about individual production levels, when products are differentiated it may be difficult for the parties to be sure what counts as “not upsetting your competitors”: does this just mean “avoiding price cuts” or also “avoiding quality improvements”? Does a Christmas promotion in a consumer goods industry fall within the spirit of tacit collusion? And so on. Thus collusion could be relatively easy to enforce once agreed but hard to coordinate upon. Overall, these considerations suggest that, as with the number of firms in an industry, the lack of transparency that makes collusion hard to enforce *may* also make it hard to agree upon—but this is an intuitive conclusion on which there is little convincing scientific literature.

8.3.7. Demand growth

As stressed above, collusion is easier to sustain when short-term gains from a deviation are small compared with the cost of future retaliation. This implies that:

For a fixed number of market participants, collusion is easier to sustain in growing markets, where today's profits are small compared with tomorrow's ones.

Conversely, collusion is more difficult to sustain in declining markets, where tomorrow's profits (with or without retaliation) will be small anyway.

This conclusion appears somewhat at odds with some case courts and opinions expressed by the European Commission in guidelines. Indeed demand growth is in practice often interpreted as a factor hindering collusion. One possible reason for this apparent discrepancy is that the above reasoning assumes that the number of market participants remains fixed despite market growth, while in practice, entry may be easier in growing markets (see for instance *Gencor v Commission*, T-102/96).¹⁶ As discussed above, the prospect of future entry then hinders the ability to collude. In this way, *market growth may be associated with market characteristics detrimental to collusion*. However, it may be useful to

¹⁶ Market growth may also be the sign of a lack of maturity, or of a highly innovative market.

disentangle the intrinsic effect of market growth discussed above from the impact of entry and other factors, so as to assess their relative strengths. In markets with low entry barriers, market growth is indeed likely to generate entry, and the overall impact may well be detrimental to collusion. However, in those markets where entry barriers are high (e.g., because of needed patents), the intrinsic impact of market growth may prevail and facilitate collusion.

8.3.8. Business cycles and demand fluctuations hinder collusion

A corollary of the impact of growth and decline is that collusion is less sustainable in markets that are subject to demand fluctuations (see *FTC v. Arch Coal*). The idea, formally captured by Rotemberg and Saloner (1986) and Haltiwanger and Harrington (1991), is that when the market is at a peak, short-term gains from a deviation are maximal while the potential cost of retaliation is at a minimum. Hence, *demand fluctuations hinder collusion, and more so when fluctuations are deterministic (as in the case of seasonal cycles) rather than random.*

8.3.9. Collusion is more difficult in innovative markets

Innovation makes collusion on prices less easy to sustain. The reason is that innovation, particularly drastic ones, may allow one firm to gain a significant advantage over its rivals. This prospect reduces both the value of future collusion and the amount of harm that rivals will be able to inflict if the need arises.

Consider for example an industry where, in the absence of any innovative activity, the incumbents would benefit from a secure, stable situation. They would then hesitate before cheating on a collusive conduct, which would trigger a price war and dissipate their future rents. Suppose now that, with some probability, one incumbent makes a drastic innovation, which drives its rival out of the market. If the probability of successful innovation is substantial, the incumbents then anticipate that their market position is short-lived (at least in expected terms); they thus put less emphasis on the cost of future retaliation and are more tempted to cheat on collusion.

8.3.10. Cost asymmetries hinder collusion

The presence of such cost asymmetry has several implications.¹⁷ First, firms may find it difficult to agree to a common pricing policy. Indeed, firms with a lower marginal cost will insist on lower prices than what high-cost firms would wish to sustain. More generally, the heterogeneity in cost structures may rule out any “focal point” in pricing policies and so exacerbate coordination problems.

¹⁷ See Bain (1948) for an early discussion and Gertner (1994).

In addition, technical efficiency would require allocating market share to low-cost firms, but this would clearly be difficult to sustain in the absence of explicit agreements and side-transfers.¹⁸

Second, even if firms agree on a given collusive price, low-cost firms are more difficult to discipline, both because they may gain more from undercutting their rivals and because they have less to fear from a possible retaliation by high-cost firms.¹⁹

To better induce the low-cost firm to stick to the collusive conduct, firms may tacitly grant a larger share of the market to the low-cost firm. However, *compared to the case of symmetric cost structure, there is less scope for collusion with an asymmetric cost structure, and the most effective collusive conducts induce asymmetric market shares, reflecting firms' costs.*

The intuition that "it is easier to collude among equals" may also explain the informal discussions about the role of so-called "mavericks". A maverick firm can be interpreted as a firm with a drastically different cost structure, which is thus unwilling to participate to a collusive action. Of course, this "asymmetry" can be along other dimensions (see below).

8.3.11. Asymmetries in capacity constraints hinder collusion

The previous reasoning extends to other forms of differences in the cost structure, including differences in production capacities. Capacity constraints potentially affect the sustainability of collusion in two ways. First, a capacity-constrained firm has less to gain from undercutting its rivals. Second, capacity constraints limit firms' retaliatory power. At first glance, capacity constraints thus appear to have an ambiguous effect on collusion, since they reduce both the incentives to deviate and the ability to punish such deviations. And indeed, studies that have focused on symmetric capacities²⁰ have confirmed this apparent ambiguity.

What is less ambiguous, however, is the impact of an asymmetry in capacities. Compared with a situation where all firms face the same capacity constraints, increasing the capacity of one firm at the expense of the others both increases the first firm's incentive to undercut the others and limits these other firms' retaliatory power. Overall, therefore, introducing such asymmetry hinders collusion. This insight has been hinted at by several studies.²¹ It has recently been explored in more detail by Compte et al. (2002), who show that the introduction of asymmetric capacities indeed makes collusion more difficult to sustain when the aggregate capacity is limited, and discuss the Nestlé/Perrier case (M.190).

¹⁸ Side-transfers need not be monetary, however. For a discussion of these issues, see Osborne and Pitchik (1983) and Schmalensee (1987).

¹⁹ Mason et al. (1992) note in experimental duopoly games that cooperation is more likely when players face symmetric production costs.

²⁰ See, e.g., Abreu (1986) for a symmetric Cournot context and Brock and Scheinkman (1985) for a first analysis of a symmetric Bertrand context, later extended by Lambson (1987).

²¹ Lambson (1994, 1995), Davidson and Deneckere (1984, 1990) and Pénard (1997).

8.3.12. Product differentiation

We have so far assumed that all firms were offering the same product (homogeneous good market). In practice, firms often try to differentiate their offerings, and can do so in different ways.

One possibility is for a firm to develop a “better product”; this is what economists refer to as “vertical differentiation.” In essence, firms are then in an asymmetric situation and the analysis is thus similar to that of asymmetric costs of production. A firm that has a better quality (possibly adjusted for the cost) is in a situation somewhat similar to that of a firm that would offer the same quality as the others, but at a lower cost. This firm has more to gain from cheating on a collusive path (put another way, it may favour a different “net” price, even adjusting for the quality differential), and it has less to fear from a possible retaliation from the other firms.

When firms are differentiated in quality, collusion is more difficult, the larger the competitive advantage of the high-quality firm.

Another and quite different form of product differentiation consists for the firms in offering different combinations of characteristics, possibly at comparable prices but targeted at different types of customers; this corresponds to the case of so-called horizontal differentiation. Such differentiation aims at segmenting customers, and at gaining market power over specific customer segments by creating customer loyalty. Indeed, a customer may then be reluctant to switch away from his favourite brand, even if he would benefit from a small price reduction by turning to an alternative brand. This segmentation strategy affects the scope for collusion in two ways. First, it limits the short-term gains from undercutting rivals, since it becomes more difficult to attract their customers. Second, it also limits the severity of price wars and thus the firms’ ability to punish a potential deviation.

Overall, the impact of horizontal differentiation appears quite ambiguous.

And indeed, the economics literature on this issue has shown that collusion may become easier or more difficult, depending on the exact nature of the competitive situation (e.g., competition in prices versus competition in quantity).²² Raith (1996) however notes that *product differentiation may exacerbate informational problems in non-transparent markets.*

8.3.13. Multi-market contact

It is well recognised that firms can sustain collusion more easily when they are present on several markets.²³ First, multi-market contact increases the frequency of the interaction between the firms. Second, it may allow softening asymmetries

²² See for example Ross (1992) and Martin (1993).

²³ The classic reference is Bernheim and Whinston (1990). See also Parker and Röller (1997) and Evans and Kessides (1994) for empirical evidence.

that arise in individual markets. For example, one firm may have a competitive advantage in one market and its rival its own competitive advantage in another market. While a market-level analysis may then suggest that collusion is difficult to sustain, multi-market contact restores in such a case an overall symmetry that facilitates collusion. Third, multi-market contact may allow the firms to sustain collusion in markets where the industry characteristics alone would not allow such collusion.

International cartels such as the vitamins cartel provide good examples of (explicit) collusion with multi-market contacts.

8.3.14. Other factors

We have so far discussed the factors that have been identified in the economics literature as exercising a key influence on sustainability of collusion. In practice, other factors have been considered by competition authorities; demand elasticity, customers' buying power, and so forth. We now briefly discuss these factors.

Demand elasticity

It is often perceived that low demand elasticity should exacerbate collusion concerns. While the above analysis stresses that the elasticity of the demand has no clear impact on the *sustainability* of collusive prices, it is however the case that collusion can be more profitable when demand elasticity is low. *For a given market size, the firms have more to gain from sustaining the monopoly price when demand elasticity is low.* In that sense, demand elasticity may constitute a relevant factor, although of a different nature than the factors listed above.²⁴ In addition, collusion is a larger concern for consumers when demand is inelastic than when it is elastic. This is both because the potential for a large profitable increase in prices above the "normal" level decreases when demand becomes less elastic, and because consumers are hurt more by a given price increase when they have little alternatives.²⁵

Buying power

A related factor concerns the countervailing buying power of the customers. If buyers are powerful, even a complete monopolist may find it difficult to im-

²⁴ The profitability of collusion can in turn influence the firms' willingness to design and implement practices that facilitate the implementation of a collusive action. It can also induce firms to engage in more explicit collusion, at the risk of being caught by antitrust enforcement. More generally, to the extent that "transactions costs" may affect the ease of identifying and coordinating upon tacitly collusive outcomes, as well as the ease of enforcing them, the profitability of the outcome is likely to increase the probability that the parties will find a way to reach it. Nevertheless, this remains an intuitive argument rather than one for which there exists any formal model.

²⁵ The potential harm to consumers is thus larger, the less elastic the demand. The impact on total welfare, however, is more ambiguous, since price increases generate less distortion when demand is inelastic (see, e.g., Tirole, 1988, for a discussion of this issue).

pose high prices. The profitability of collusion is similarly reduced. In addition, Snyder (1996) note that large buyers can design procurement schemes that reduce the scope for collusion.²⁶

Structural links

Structural links can facilitate collusion among firms. For example, cross-ownership reduces the gains derived from undercutting the other firm. Joint venture agreements can also enlarge the scope for retaliation—a firm can then for example punish a deviating partner by investing less in the venture.²⁷ For these reasons, collusion is more likely to emerge in markets where competitors are tied through structural links.

Cooperative and other contractual agreements

Even in the absence of structural links, simple cooperative agreements can contribute to foster collusion. As in the case of joint ventures, these cooperative agreements can for example enlarge the scope for retaliation, thereby enhancing the ability to punish deviating partners.

This may be particularly relevant for industries such as the telecommunications industry, where competitors need to reach interconnection agreements in order to offer widespread connectivity. These agreements do not only enlarge the scope for retaliation, they also have a direct impact on the operators' pricing strategies.²⁸ Competitors may then design these interconnection agreements so as to facilitate collusion.

More generally, firms may alter their contractual agreements, either between themselves or with third parties, so as to facilitate collusion. Marketing agreements can be employed to that effect. Jullien and Rey (2002) show for example that producers of consumer goods can resort to Resale Price Maintenance to impose more uniform prices across local retail markets, thereby making it easier to detect deviations from a collusive price. Record companies have been accused to market their offerings according to simple pricing grids (with only a few categories, instead of personalised prices for each author or title) for a similar purpose.

The existence of a "maverick" firm

It is sometimes asserted that a particular firm acts as a "maverick" that discourages any attempt to sustain collusion. As already mentioned, this is in line

²⁶ A good example is the treatment of Enso/Stora (M. 1225) in which the commission concluded that "Tetra Pak has countervailing buyer power to such an extent that it will neutralise the potential increase in market power of the merger between Stora and Enso."

²⁷ Martin (1995) provides a detailed analysis of this issue.

²⁸ For example, telecom operators that compete in linear prices could give each other incentives to maintain high prices, even in the absence of repeated interaction, by agreeing on a high reciprocal access charge—see, e.g., Armstrong (1998) and Laffont et al. (1998).

with the economic intuition according to which “it is easier to collude among equals.” The notion of maverick must however be defined properly. Consider for example a firm that has a drastically different cost structure, production capacity or product quality, or that is affected by different factors than the other market participants. Very often such a firm will exhibit a market conduct that differs from others, reflecting its different supply conditions. This firm may then be unwilling to be part to a collusive conduct—put another way, it would do so only under terms that would not be acceptable or sustainable for the other firms. Alternatively, a firm may have a stronger preference for the short-term and be therefore more tempted to undercut the rivals.²⁹ The existence of such a “maverick” clearly tends to make collusion difficult if not impossible to sustain. It is however necessary to identify carefully the origin of the “maverick” character, in order to determine whether it is an inherent, long-lasting characteristic, or only reflects a transitory situation.

Club and network effects

Some markets are subject to club or network effects, where consumers benefit from being in the same “club”: using the same software, typing on the same keyboard pattern, subscribing to the same operator, and so forth.³⁰ Club effects have several relevant implications. They tilt the market in favour of a single participant, thereby creating a “winner-take-all” type of competition which is not prone to collusion. In addition, club effects create lock-ins effects that reinforce the position of the market leader and thus increase the benefits derived from such a position. Club effects therefore contribute to make collusion less likely.

8.4. A mathematical illustration

We illustrate some effects with a model of Bertrand competition. Suppose that n firms produce the same good with the same unit variable cost c . Short run price competition would then lead these firms to price at cost ($p = c$) and dissipate any profits. When these firms compete repeatedly they are able to sustain a “collusive” price $p^C > c$, sharing the profit $\pi^C = (p^C - c)D(p^C)$ equally, by reaching a tacit understanding that any deviation from this price would lead the firms to revert to the competitive price $p = c$ in all future periods.³¹ If the firms have the same discount factor δ , by sticking to the collusive price, each earns

$$\frac{\pi^C}{n} + \delta \frac{\pi^C}{n} + \delta^2 \frac{\pi^C}{n} + \dots = \frac{\pi^C}{n} (1 + \delta + \delta^2 + \dots) = \frac{\pi^C}{n} \frac{1}{1 - \delta}.$$

²⁹ See Harrington (1989) for an analysis of collusion between firms that have different discount factors, and FTC v. Arch Coal where the court rejected the alleged presence of a maverick.

³⁰ One important issue concerns the “compatibility” of rival clubs or networks.

³¹ See Friedman (1971).

If instead one firm slightly undercuts the other, it captures the entire market and thus the entire collusive profit π^C , but the ensuing price war will eliminate any future profit. Each firm is thus willing to stick to the collusive price if

$$\frac{\pi^C}{n}(1 + \delta + \delta^2 + \dots) \leq \pi^C + \delta \times 0,$$

that is, if

$$\delta \geq \delta^*(n) \equiv 1 - \frac{1}{n}.$$

The critical threshold for the discount factor, δ^* depends on the number of firms: the more competitors there are, and the higher this threshold, meaning that collusion is less and less sustainable.

From now on we assume that $n = 2$.

Frequency of interactions

Assume now that firms compete only every T periods. That is, firms compete in periods 1, $T + 1$, $2T + 1$, and so forth. Then, collusion is sustainable if

$$\frac{\pi^C}{2}(1 + \delta^T + \delta^{2T} + \dots) \geq \pi^C + \delta^T \times 0,$$

that is, if $\delta \geq \delta^*(T) \equiv \frac{1}{2^{1/T}}$. When firms interact less often, the perceived cost of future retaliation is smaller, and thus collusion is more difficult to sustain.

Price sluggishness

In a similar vein, suppose that firms “compete” in each period but fix their prices for T periods. Collusion is then sustainable if

$$\frac{\pi^C}{2}(1 + \delta + \delta^2 + \dots) \geq \pi^C(1 + \delta + \delta^2 + \dots + \delta^{T-1}) + \delta^T \times 0,$$

where the right-hand side reflects the fact that a cheating firm can benefit from undercutting its rivals for T periods before they react to its deviation. This condition yields the same threshold as above.

Entry

To illustrate the effects of barriers to entry, suppose that with some probability μ a firm enters the market for one period and charges the competitive price, $p = c$, and then exits.³² To maximise the scope for collusion, the best scheme consists,

³² This is a short-cut to reflect the competitive pressure exerted by entrants.

when entry does not occur, in: (i) charging a collusive price p^C and dividing the profit π^C equally, and (ii) reverting to the competitive price after an incumbent deviates. Such collusion is sustainable if

$$\frac{\pi^C}{2} + (1 - \mu) \frac{\delta}{1 - \delta} \frac{\pi^C}{2} \geq \pi^C + \delta \times 0,$$

that is, if $\delta \geq \delta^*(\mu) \equiv \frac{1}{2-\mu}$. The threshold δ^* thus now increases with μ : the more likely entry is, the more difficult it is to sustain collusion.

Innovation

Similarly, suppose that with probability ρ an outside innovator enters the market and “wipes out” the current incumbents. The incumbents thus survive in each period with probability $1 - \rho$. By sustaining a collusive price p^C , as long they survive the two incumbents get an expected rent given by

$$V = \frac{\pi^C}{2} + \delta(1 - \rho) \frac{\pi^C}{2} + \delta^2(1 - \rho)^2 \frac{\pi^C}{2} + \dots = \frac{1}{1 - (1 - \rho)\delta} \frac{\pi^C}{2}.$$

Collusion is then sustainable when this rent exceeds the short-term profit from undercutting the rival, π^C , leading to $\delta \geq \delta^*(\rho) = \frac{1}{2(1-\rho)}$, which is more difficult to satisfy when the probability of innovation increases. The same conclusion holds if the innovation is due to one incumbent, provided that the innovation probability is exogenous.

Market growth

Let us consider now the effect of demand. Suppose first that demand “grows” steadily at a rate g . By agreeing on a collusive price p^C , each firm gets in each period t a profit $(1 + g)^t \pi^C / 2$, with $\pi^C = (p^C - c)D(p^C)$. Collusion is sustainable if

$$\frac{\pi^C}{2} + \delta(1 + g) \frac{\pi^C}{2} + \delta^2(1 + g)^2 \frac{\pi^C}{2} + \dots \geq \pi^C + \delta(1 + g) \times 0,$$

that is, if $\delta \geq \delta^*(g) = \frac{1}{2(1+g)}$. Thus the threshold decreases with the rate of growth.

Demand uncertainty

Suppose now that $g = 0$ but demand is random: with equal probability, demand is either low and given by $(1 - \varepsilon)D(p)$, or high and given by $(1 + \varepsilon)D(p)$ (Note that the expected monopoly profit is not affected by the demand uncertainty). By sustaining a collusive price p^C , each firm gets an expected discounted profit

$$V = \frac{\pi^C}{2} (1 + \delta + \dots) = \frac{1}{1 - \delta} \frac{\pi^C}{2}.$$

Collusion is sustainable when the short-term gain from stealing the rival's market share is lower than the cost of the future price war. The short-term gains from a deviation are clearly higher when demand is high; collusion is therefore sustainable if:

$$\delta V = \frac{\delta}{1-\delta} \frac{\pi^C}{2} \geq (1+\varepsilon) \frac{\pi^C}{2},$$

that is, if $\delta \geq \delta^*(\varepsilon) = \frac{1+\varepsilon}{2+\varepsilon}$. The threshold δ^* increases with the magnitude of demand fluctuations, measured here by ε .

Business cycles

Consider now a "cycle" where demand is alternatively low, given by $(1-\varepsilon)D(p)$, and high, given by $(1+\varepsilon)D(p)$. If firms sustain a collusive price p^C the expected discounted values of profits, evaluated when demand is high and when it is low, are respectively given by

$$V^+ = (1+\varepsilon) \frac{\pi^C}{2} + \delta V^-, \quad V^- = (1-\varepsilon) \frac{\pi^C}{2} + \delta V^+,$$

which implies $V^+ > V > V^-$. Collusion is again sustainable if it is so when demand is currently high:

$$\delta V^- \geq (1+\varepsilon) \frac{\pi^C}{2}.$$

This condition is more stringent than the condition obtained in the previous example of random fluctuations.

Lack of transparency

Trickier is the effect of imperfect information.³³ Following Tirole (1988) and Green and Porter (1984), suppose that demand is random and can take value $D(p)$ or 0. Suppose moreover that a firm can only observe its sales. Then when observing 0 sales a firm cannot infer whether this is due to a demand shock or to undercutting by the other firm. The equilibrium cannot support a constant price p^C , because this would imply that firms don't react to no sale, which would undermine the incentives not to undercut the collusive price. The collusive price then involves a price war following any instance where one firm doesn't sale:³⁴

³³ Notice that if firms observe their sales and prices every T periods, then the situation is formally equivalent to the case where prices are fixed for T periods described above. An analysis of imperfect information with patient firms is presented in Fudenberg and Maskin (1986).

³⁴ With this set-up, both firms agree on when to start a price war. The strategy of each firm is to set a price equal to cost for T periods after a zero sale or after undercutting (implying zero sale of the other firm). With this both firms starts the price war at the same time and end at the same time.

for T periods firms set $p = c$, then they revert to collusion. Denoting by μ the probability of a demand shock, the expected discounted profit V generated by such a conduct is given by:

$$V = (1 - \mu) \left(\frac{\pi^C}{2} + \delta V \right) + \mu \delta^{T+1} V = \frac{1 - \mu}{1 - \delta(1 - \mu + \mu \delta^T)} \frac{\pi^C}{2},$$

where the two terms correspond respectively to what happens without and with a shock on demand. Collusion is sustainable if

$$V \geq (1 - \mu) \pi^C + \delta^{T+1} V,$$

which is equivalent to $\delta(1 - \delta^T)V \geq \frac{\pi^C}{2}$, and thus (since the left-hand side decreases when T increases) requires price wars to be long enough. An infinite price war would effectively “maintain” collusion if $\delta \geq \frac{1}{2(1-\mu)}$.

Cost asymmetry

To illustrate the effect of cost asymmetries, suppose that firms have different marginal costs $c_H > c_L$. If they insist on equal market shares, it is easy to verify that the high-cost firm will sustain collusion if $\delta > \frac{1}{2}$. But the low-cost firm will be willing to sustain collusion if only if

$$(p^C - c_L) \frac{D(p^C)}{2} (1 + \delta + \dots) \geq (p^C - c_L) D(p^C) + \delta P_L,$$

where P_L is the discounted profit of the low-cost firm after a punishment. This condition is clearly more stringent than with symmetric costs whenever $P_L > 0$. More generally, it may be difficult for a high-cost firm to cancel the profit of the low-cost firm without incurring a loss. This is for instance the case if the punishment is to revert to short-run price competition, in which the low cost firm sells at price c_H .³⁵ Granting a larger market share to the low-cost firm facilitates its participation to the scheme, but it affects negatively the other firm’s incentive constraint. The market split that maximises the scope for collusion thus consists in giving “as much as possible” to the low-cost firm while satisfying the other firm’s incentive constraint.

Difference in impatience

Suppose there are three firms, the first two with a discount factor $\delta > 2/3$ and the remaining one (the “maverick”) with a discount factor $\delta' < 2/3$.³⁶ Because

³⁵ Note however that the upper bound on possible punishments, the so-called minmax profits, is symmetric and might be achieved through sophisticated strategies. See Thal (2005) for a discussion and a formal analysis.

³⁶ For expositional commodity, we thus simply posit here that firms rely on different discount factors; this hypothetical scenario can be interpreted as a short-cut for deeper sources of asymmetry,

of the presence of the maverick, a collusive path with equal market shares cannot be sustained: the maverick would deviate and undercut the others, since $\delta' < 2/3$ implies $\pi^C > \frac{1}{3} \frac{\pi^C}{1-\delta'}$. The minimal market share α that can be allocated to the first two firms must satisfy $\alpha \frac{\pi^C}{1-\delta} \geq \pi^C + \delta \times 0$, and is thus $\alpha = 1 - \delta$. The maximal market share that can be granted to the maverick is thus $1 - 2\alpha = 2\delta - 1$, which is higher than $1/3$ but lower than 1 . Therefore, collusion cannot be sustained if the maverick is sufficiently short-termist: this is the case when $\pi^C + \delta' \times 0 > (2\delta - 1) \frac{\pi^C}{1-\delta'}$, that is, when the discount factor of the maverick is lower than $2(1 - \delta)$.

8.5. Collusion in other dimensions than prices

Quantity competition

The conclusions derived above apply as well to situations where firms compete in quantity. In this case, retaliation is triggered if one firm attempts at increasing its market share by raising its production. A typical retaliation will have competitors react by raising their outputs.

Under quantity competition there is less temptation to increase one's production level to deviate from a tacitly collusive level, since prices adjust to sell out the competitors' output. On its own this would make collusion easier to sustain. However, retaliation is somewhat more difficult under quantity competition since the firm that is the object of retaliation can always soften the blow (as compared with a situation of price competition) by adjusting its output level. Overall, since deviation is less tempting but the fear of retaliation less strong, it is not easy to compare the scope for collusion under the two forms of competition.

The mechanisms bear strong similarities, however, so that the factors discussed above affect the scope for collusion in the same manner.

Capacity, investment and prices

In some industries such as the chemical industry or in the paper industry,³⁷ capacity choices are key determinants of the outcome of competition. In such industries, one may be concerned about the potential coordination of firms on

such as short-term financial or liquidity constraints, the number of customers interested in the various offerings and the frequency of their purchases, and so forth. A complete analysis should however also consider the various issues (e.g., predation) and solutions raised by these deeper sources of asymmetry.

³⁷ The chemical industry is investigated by Gilbert and Lieberman (1987) and the newsprint industry is studied by Booth et al. (1991), whereas Christensen and Caves (1997) investigate the pulp and paper industry.

collusive capacity choices. The role of excess capacities in supporting price collusion has been discussed above. Here, we focus instead on situations where firms produce close or up to full capacity utilisation. In this case, a reduction in capacity reduces supply and therefore implies higher prices.³⁸ Collusion then consists in building less capacity, in order to constrain the subsequent prices. There is a close connection between this type of rivalry in capacity choices and competition in quantity. Thus, to a large extent the analysis of collusion under quantity competition applies to the analysis of collusion in capacities.

In particular, if capacities are short-lived, as for example in the Air-tour/FirstChoice case, and if market conditions are indeed such that firms adjust their prices so as to sell up to capacity, a collusion in capacity is formally identical to a collusion on output levels, and thus to collusion with quantity competition. In other cases, though, the nature of capacities and their interplay with price competition introduce some differences.

First, capacity choices are not final production decisions. Once capacities are in place, firms still interact through their pricing decisions. And they need not always reach a full capacity utilisation rate, in particular when demand is uncertain at the time capacity is built. This means that collusion on capacities will usually involve some form of collusion on prices as well.³⁹ A second aspect is that often capacity choices come in infrequent bursts, at points in time that may differ from one firm to another. The "lumpiness" aspect of capacity building leads to pre-emption phenomena. Last but not least, capacity choices often involve some irreversibility, in contrast with product decisions. Clearly, irreversibility may impede collusion. However irreversibility matters mostly when it is strong and when demand is constant or declining; in this context there is little or no prospect of building new capacities in the future, and thus little scope for repeated interaction. If instead demand is growing fast enough, or if capacities depreciate fast enough, irreversibility matters less because there will be frequent additions of capacities, even on a collusive capacity expansion path, which opens the scope for retaliation. The reader can refer to UPM-Kymmene/Haindl (M. 2498) for a discussion of these issues in the context of the paper industry.

Bidding markets

The principles reviewed above apply to bidding markets as well. For example, collusion is easier when few bidders repeatedly participate in the same bidding markets, when the frequency of these markets is high (e.g., daily markets), and so forth. In addition, bidding markets can be designed in ways that either hinder

³⁸ See Kreps and Scheinkman (1983).

³⁹ Staiger and Wolak (1992) characterise collusive conducts in the case where capacities are short lived and demand fluctuates in an unpredictable manner. Collusion may emerge, based on coordination on low capacity levels and depending on the realised levels of demand, and so prices may or may not be collusive.

or facilitate collusion. For example, sealed bid auctions generate less information (that is, except if the auctioneer reveals the details of all the bids afterwards) than public descending procurement auctions, where sellers observe at each moment who is still bidding at the current price. Therefore, a close look at the organisation of the bidding markets may be necessary to assess the likelihood of collusion.⁴⁰

Research and Development

Collusion on innovation strategies is subject to the observations already made when discussing the impact of innovation on collusion on prices, and particularly complex to implement. It suffers from substantial transparency problems, making it hard to monitor. The inherent uncertainty attached to R&D projects and the time lags usually involved further contribute to make such collusion difficult. Collusion on R&D is thus unlikely.

8.6. Implications for merger control

The previous section has shown that many factors affect the sustainability of collusion. Most often, a given market will have some characteristics that facilitate collusion, and some that tend to hinder collusion. Predicting on this basis alone the likelihood of collusion can thus be complex.

In addition, the same market situation can give rise to different equilibria. That is, the fact that firms *can* sustain collusion does not mean that they actually succeed in doing so. In particular, the firms may well compete in each period as if it were the last one, even if there exists another equilibrium in which they maintain monopoly pricing in each and every period. It is thus impossible to rely on a theoretical analysis alone to determine whether collusion is *actually* taking place. In an antitrust *ex post* context,⁴¹ the analysis of past history of the industry can help answer that question. In a merger control context, the situation is different. The merger control office must evaluate *ex ante* the future evolution of the industry; the past history may then only provide limited information to that effect.⁴²

⁴⁰ See, e.g., Klemperer (2002).

⁴¹ For a discussion of collective dominance in the context of Article 82 of the European Treaty, see the DG Competition discussion paper on the application of Article 82 of the Treaty to exclusionary abuses.

⁴² Past behaviour can however provide some information about specific characteristics of the market participants, which can for example be useful to identify whether firms are prone to collusion or of a “maverick” type (see the new Guidelines on the assessment of horizontal mergers, European Commission, 2004). This was the case for instance in Nestlé/Perrier (case M. 190). Lack of evidence of past collusive conduct can be also used by courts. For instance in *FTC v. Arch Coal* (District of Columbia, Aug. 16, 2004), the court relied both on lack of evidence of past collusive conduct and on structural factors such as lack of transparency and demand uncertainty to rule that tacit collusion was not likely.

Short of determining whether collusion will indeed occur, a highly difficult if not impossible task, the merger control office can however address a different but still relevant question: will the merger create a situation where collusion becomes more likely, that is, will collusion be significantly easier to sustain in the post-merger situation? This is the basis for a structural approach that assesses the impact of the merger on various factors affecting collusion and uses this to assess whether the change is conducive to collusion. Notice that such an approach is not conflicting with a behavioural approach. Any evidence on conduct can be used in assessing the importance of the structural changes.⁴³

A merger often affects many of the factors that are relevant for the sustainability of collusion and it can affect them in ways that tend to off-set each other. For example, a merger reduces the number of competitors, which tends to facilitate collusion, but it can make the remaining competitors more asymmetric, which tends to hinder collusion. The impact of the merger on collusion can thus involve a difficult assessment of possibly conflicting effects. Ideally, this could be done by building a “meta-model” encompassing all the relevant characteristics. However, the previous section makes clear that such a “global model” would probably not be tractable, and thus quite useless. It is therefore necessary to identify the characteristics that are most relevant in each particular industry, and also to prioritise these factors.

While many factors appear relevant when evaluating the impact of a merger on collusion, the above overview highlights natural dividing lines among these factors.

First, some factors that may or may not be affected by the merger have a decisive impact on the firms’ ability to sustain tacit collusion. These factors include *entry barriers*, the *frequency of interaction* and the role of *innovation*. Clearly, there is little scope for collusion in the absence of entry barriers, or if firms interact very infrequently, or else in innovation-driven markets. Therefore, whenever an industry presents one of these features, collusion is unlikely to constitute a significant concern.

Second, some factors are both relevant and likely to be directly affected by mergers. These factors include the number of market participants, of course, but also the degree of symmetry among those participants. Other factors in this second group would be the removal of a maverick firm, as well as the existence of structural links or of cooperative agreements.

Third, a series of factors can have an influence on the sustainability of collusion, possibly to a lesser extent, and may or may not be directly affected by mergers. Among these, the degree of market transparency appears to be a key factor. Other factors include product differentiation, the characteristics of demand (demand trend and fluctuations, as well as demand elasticity and buying

⁴³ A difference between US and EU may come from different weights put on conduct and structure. Casual observation suggests that US courts put more emphasis on conduct in assessing coordinated effects than European courts, but due to the fact that courts acted in a different legal environment (as mentioned in the introduction), this may be misleading.

power), multi-market contact, or the organisation of particular markets such as bidding markets. These dimensions are relevant to assess the plausibility of collusion, particularly when the factors of the first two groups do not suffice to send a clear signal.

The above discussion thus provides some basis for prioritising the relevant factors. But this discussion also calls for a structural analysis. Rather than a pure “check-list” of relevant factors, it seems indeed more appropriate to develop a clear understanding of which dimensions are most relevant, as well as of how they affect collusion—and are affected by a merger. This not only helps prioritise these factors, but also facilitates an overall assessment when several factors are relevant and push in different directions. For example, the above discussion provides an analytical framework for assessing how these conflicting factors affect the effectiveness of retaliation, and thus how these retaliation possibilities are modified by a merger.

Moreover the interplay of the factors may be important. We have for instance pointed out that the effect of demand growth depends on entry barriers. If entry barriers are so large that entry is highly unlikely to occur, demand growth fosters collusion. If instead entry barriers are moderate, demand growth may be sufficient to outweigh them and stimulate entry, which would in turn impede collusion. Similarly, product differentiation may affect market transparency, by affecting what firms can infer from available data. In both instances, it becomes important to undertake a joint assessment of the factors.

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