



Ringleaders in larger numbers, asymmetric cartels

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1 Introduction

The concept of a cartel ringleader has a very specific legal relevance for the fining policies of Competition Authorities (CA), but surprisingly it is rarely modelled in the economic theory of cartels, and empirically there appears to be only a few case-specific discussions. The purpose of this paper is to explore empirically what are the specific roles and responsibilities of ringleaders as revealed in close readings of the European Commission's decision documents for a sample of those cartels detected over the years 1990-2008. It identifies how frequently they exist and who they are and what they do. In particular, it investigates how far the ringleader helps explain one of the main empirical puzzles concerning cartels. The conventional theoretical wisdom is that collusion is more likely in markets in which firms are few and symmetric, because asymmetry and greater numbers create incentives to deviate in the collusive and punishment phases. However, many real world cartels involve relatively large numbers of firms, who often exhibit considerable asymmetries in size. Thus it explores how far the ringleader can be interpreted as an organisational 'solution' to the classic cartel problems which are likely to be most pronounced when cartels comprise relatively large numbers of asymmetric firms.

That collusion is most likely with fewness and symmetry of firms is a conventional wisdom. In policy terms it forms part of standard structural screening methods for the potential presence of cartels and the checklist of necessary conditions for mergers to have coordinated effects. It is also firmly embedded in the academic Industrial Organisation literature. This dates from at least the early Structure-Conduct-Performance paradigm which often merely *asserted* that collusion is more likely in more concentrated markets with a small number of symmetric firms. This was subsequently formalised, if qualified, by game theoretic understandings (see, for example, Ivaldi et al's overview (2003)³: coordination amongst potential cartel members is easier, in terms of a shared common focal point with only a small number of similar firms; and incentive compatibility constraints are less likely to be satisfied as firm numbers and asymmetries increase.

However, evidence from the empirical literature on cartels offers only limited support for these propositions. For instance, Levenstein and Suslow (2004) suggest that "The empirical evidence on the relationship between industry concentration and cartel stability is mixed. All else equal, concentration undoubtedly aids cartel stability,..... But organizational responses, such as industry associations, can overcome the challenges posed in forming a cartel in an un-concentrated industry,

³ For other literature surveys on the market characteristics that should facilitate collusion, see: Posner (1976, 2001), Scherer and Ross (1990), Motta (2004), Grout and Sonderegger (2005), Feuerstein (2005), and Cabral (2005).

and cartels can, by increasing profitability, allow marginal firms to survive and so decrease concentration.” In a number of different cross-section studies⁴ the sample mean number of cartel members varies between 7 and 29, and concentration is only moderately high in many cases (the average 4-firm concentration ratio ranges from 43% to 75%). As far as we know, there exists no previous quantitative cross section study of size asymmetries within cartels, but Grout and Sonderegger (2005) report considerable heterogeneity in market shares of members in their case studies of selected EC cartels. De (2010), in a study which covers roughly the same sample as the current paper, also reports a relatively large number of members in many cartels (on average, 6.85 for 98 cartels) and often significant levels of asymmetry among firms.

Part of the explanation for this apparent disconnect between theory and empirics for cartels might lie in a sample selection problem: all of the evidence necessarily relates to *detected* cartels, and this leaves open the possibility that it is the more stable undetected cartels which may typically be the smaller number symmetric cases. Equally however, it is often overlooked that most repeated game theory is better suited as a depiction of tacit, rather than explicit, collusion. Once one allows for the explicit communication and formal agreements that characterise real world cartels, it may be that constraints on their formation and stability are less binding, even with larger numbers and asymmetric firms. Indeed, the recent empirical case study literature on prosecuted cartels often emphasises that it is the organizational characteristics of cartels which impact most on the success of their agreements.⁵ This literature reveals that cartels often use sophisticated mechanisms to coordinate, monitor and enforce their agreements. However it rarely discusses the potential role of the ringleader as one of these organisational characteristics.

In fact, the term ‘ringleader’ rarely, if ever, appears in any of the seminal theoretical and empirical surveys of the cartel literature. Historically, perhaps the most relevant literature is that on price leadership in oligopoly. Stigler (1947) and Markham (1951) identified three categories of leadership: dominant firm, barometric and collusive, lying on a spectrum ranging from the dominant Stackleberg leader with a competitive fringe, to more ‘democratic’ cooperative arrangements, with the role of leader delegated almost arbitrarily as a matter of convenience, or shared around with the identity of

⁴ These are surveyed by De (2010), and include Posner (1970), Hay and Kelly (1974), Frass and Greer (1977), Jacquemin et al (1981), Marquez (1994), Dick (1996), Alexander (1997), Symeonidis (2003), Grout and Sonderegger (2005), Suslow (2005), Zimmerman and Connor (2005), Combe and Monnier (2010), Levenstein and Suslow (2010).

⁵ See, for example, Harrington (2006), De (2010), Levenstein and Suslow (2010) for detailed analysis of the organizational characteristics and their impact on the cartel success.

the leader changing from time to time. Of these three types, collusive leadership is most relevant here but it has since attracted little attention in the theoretical literature.⁶

The concept of a 'leader' features slightly more prominently in the general economics literature on organized crime, where it is often argued that leaders should be punished more harshly than other members of a conspiracy (Silving, 1967; Robinson, 1987 etc.) – not because of the gravity of their offence, but because they have committed multiple offences, by also organising and/or instigating the offence as well as being part of it (Elder (2010)).

More specifically in the context of cartel law, the ringleader has begun to attract increasing attention, especially the possibility that ringleaders be treated asymmetrically in leniency programmes. In part, this has been fuelled by a transatlantic policy difference - ringleaders are eligible for fine reduction and even immunity under the EC's leniency programme, but not in the US⁷. Leslie (2006) argues that the deterrence effects of ringleader exclusion from leniency are straight forward. On the one hand, excluding ringleaders from the programme will reduce the distrust between the leader and other members since the leader has no incentive to break the agreement; on the other hand, increasing the penalty for ringleaders should increase deterrence. In a more formal model of ringleader exclusion and deterrence, Herre and Rasch (2009) find that if the probability of detection is low, then a non-discriminatory leniency policy should be preferred since additional information provided by the ringleader will facilitate prosecution. On the other hand, if the probability is high, then ringleader exclusion creates an asymmetry among firms, which makes collusion difficult to sustain. However, Bos and Wandschneider (2011) show how ringleader exclusion can create a perverse effect, leading to higher collusive prices in the presence of heterogeneous firms.

There are few empirical studies of cartel ringleaders. However, Ganslandt, Persson and Vasconcelos (2012) present two suggestive observations based on their reading of a sample of 43 EC cartel cases, 2002-2007. First, in 10 (23%), the EC found evidence of ringleaders; second, in 16 (38%), the size of

⁶ A recent exception is Mouraviev and Rey (2011) who provide results on the circumstances under which collusive price leadership will be adopted, and which firm should be delegated the leader. However, their model is still best interpreted as one of tacit collusion.

⁷ The EC moved from a 'discriminatory approach' towards ringleaders to a 'non-discriminatory approach' with the 2002 and 2006 leniency notices. Ringleaders can apply for fine reduction and even for immunity from fines provided 'the undertaking did not take steps to coerce other undertakings to participate in the infringement' [European Commission (2002) 'Notice on immunity from fines and reduction of fines in cartel cases', Para A11 (c)]. In the US, amnesty can be granted under the corporate leniency programme if there are multiple ringleaders or instigators of the cartel and the first reporting firm is one of them, whereas in the EU, a single ringleader (or instigator) and multiple ringleaders (or instigators) are treated identically.

the largest firm exceeded that of the second largest by at least 50%. On this basis they conclude “These observations raise the question of why so many cartels are asymmetric and have ring leaders.” Putting aside our doubts about the casual nature of this empiricism – the statistical association is not established because they do not report how many of the ringleaders occurred in the asymmetric cartels - they construct a theoretical model which is clearly relevant for our purposes. It predicts that a certain amount of asymmetry within cartels may actually *facilitate* collusion. Having said this, it is very restrictive in two key assumptions: (i) cartels can only be formed if there is a ringleader; (ii) there are indivisible fixed costs of collusion which are not easily shared, and therefore must be borne by the leader. In these circumstances they show that cartels will only exist where there are moderate asymmetries within the cartel: on the one hand, symmetry means that there will be no one firm with the incentive to cover the indivisible cost, on the other hand, too much asymmetry will give the smallest firm a strong incentive to deviate (the smallest firm has the highest incentive to cheat and business steal.) Although they do not elaborate at length on what these fixed costs might be, they point to the potential cost of buying out potential entrants and incurred higher penalties under a leniency regime.

The objectives of the current paper are different. Rather than merely assume the existence of a ringleader, it investigates how often ringleaders are observed, who they are, what they do, and how far their activities be interpreted as organisational solutions to the classic cartel problems especially in cartels with many, and asymmetric, firms.

The structure of the paper is as follows. The next section draws on the previous literature to derive four propositions about the existence and nature of ringleaders. Section 3 describes the sample of EU cartels and derives some relevant stylised facts. Building on these, section 4 conducts logit and multinomial logit analysis of the probability that a cartel will have a ringleader of different types - in terms of the number of members and their asymmetries. Section 5 summarises and concludes.

2. The ringleader’s role in solving the cartel problems

This section recalls from the literature what are known as the ‘cartel problems’, and why they are most likely to be acute in cases with a large number of potentially asymmetric cartel members. It asks how far these problems can be alleviated by a ringleader and suggests four empirically verifiable propositions.

The difficulties inherent in forming and maintaining a cartel, referred to seminally by Osborne (1976) as the 'cartel problems', are to: locate the contract surface; choose a point on that surface; and to detect; and to deter potential cheating. Stigler (1964) also highlighted the problem of sustaining an agreement amidst cheating and new entry into the market.

It is usually argued that these problems are likely to be more pronounced with a large number of members. With many firms in the cartel, a price cut will yield a large increase in market share for the deviator which is likely to outweigh the losses in subsequent punishment periods. Equally, the larger the number of firms, the smaller is each firm's share of collusive profit and this reduces the incentive to collude. Moreover, for a cartel using output quotas, a large number of firms can be problematic if the cartel is not all-inclusive (Selten, 1973, suggests that the maximum number is 6). Since it may be more attractive not to join the cartel but to free ride on the cartel price, the cartel will be stable if and only if its members do not find it profitable to exit (internal stability) and the players outside cartel do not find it profitable to join the cartel (external stability)⁸.

It is also usually recognized in the theoretical literature that asymmetry among firms will generally hinder collusion. The coordination problem becomes harder when firms have divergent preferences and a natural focal point is hard to find. A more equal distribution of assets relaxes the incentive constraints for both large (more efficient) and small (less efficient) firms, and thereby facilitates collusion (Motta, 2004). The majority of papers on asymmetry focus on cost asymmetry⁹, but with some exceptions which consider asymmetry in capacity, or the discount factor, or product differentiation.¹⁰ Unless the least cost firm produces all the output (which implies illegal side payments), Pareto efficient allocation requires that the cartel price will be even higher than the monopoly price of the most-efficient firm, and the incentive for it to deviate is high. Similarly, asymmetric capacity also reduces the sustainability of collusion. However, here, the literature differs on which firms have the highest incentive to deviate. Compte et al (2002) show that with market shares proportional to capacity, if the largest firm is too large, it is the capacity of this firm which plays an important role since it has the highest incentive to cheat. On the other hand, Vasconcelos, (2005) finds that with an unequal distribution of capacity, the small firms gain more from deviation from the collusive equilibrium whereas the large firms gain more from deviating from the

⁸ However, Brock and Scheinkman (1985) show that if the number of firms increases, holding capacity constant, with a small number of firms, the ability to collude increases with an additional firm but eventually falls. This result is strikingly different from the theoretical prediction without capacity constraints.

⁹ Patinkin (1947), Bain (1948), Bae (1987), Harrington (1991), Verboven (1997) and Rothschild (1999), Miklós-Thal (2009)

¹⁰ See Lambson (1994) Compte et al (2002) and Bos and Harrington (2011) for capacity asymmetry; Harrington 1989 for discount factor and Kühn and Rimler (2007) for product differentiation.

punishment phase. However, Bos and Harrington (2011) show that, where cartels are not all inclusive, the capacity of the medium sized firms will play the most important role. Similarly, Kühn and Rimler (2007) show that although a decrease in product varieties facilitates collusion, consolidation of varieties (the same number of varieties in the hand of smaller number of firms) also facilitates collusion. For firms with different discount factors, the same collusive price is sustainable as long as the average discount factor is sufficiently high (Harrington 1989). But output quotas need to be distributed in accordance with firms' discount factors. There is also a theoretical literature on how cartels might attempt to handle enforcement of asymmetric arrangements - mostly in the presence of private information about costs (Athey and Bagwell, 2001 and 2008) or price (Harrington and Skrzypacz, 2007): market share favours to the high cost firm to truthfully report costs or a compensation mechanism on the basis of reported sales respectively.

Empirical studies also tend to focus on the organisational mechanisms which cartels use to cope with these problems. However, none of these studies explicitly identifies ringleaders as one of them. Therefore, we next explore the potential role of ringleaders by applying a fairly common typology of various cartel organisational activities: (i) formation, instigation and approaching potential members, (ii) organisation and monitoring, (iii) the nature of the agreement, and (iv) coercion and enforcement. Although the CAs do not always tightly or formally define the term cartel 'ringleader', the EC (2006a¹¹) now distinguishes two broad types of activity in its decisions - 'instigation' and 'leadership'. An instigator is involved in the initial birth and/or subsequent enlargement of the cartel (which coincides with (i) above), and 'leadership' which implies a proactive and leading role, which might entail coercion and leadership in internal punishment mechanisms (which coincides with (ii) and (iv))

2.1 Formation, organising and monitoring

Presumably any conspiracy, whatever the context, is born from an individual/group's realisation that it may be practicable and profitable, and thus any cartel requires somebody to take the initial initiative – to at least instigate discussions. In that sense, probably every cartel requires one or more ringleaders. On the other hand, where there are only a few conspirators, all members of the group may be in on the conspiracy almost from the start and there is no need for any single instigating leader. This suggests that a fruitful way of expressing the question is to ask 'under what circumstances, will a conspiratorial group choose to delegate or recognise (sometimes reluctantly perhaps) that one of its members should take on this role? This can then be viewed as an alternative

¹¹ European Commission (2006a), Case T-15/02 BASF v Commission Summary of Judgement, March 15th 2006

to a default which is that *all* members share the responsibility, in which case there is no ringleader. This framing of the question has the policy corollary that all firms should be fined equally, unless one or more of them can be singled out for disproportionately larger penalties.

Clearly, the advantages of delegation should increase rapidly with N , the number of members. With multilateral agreements, exchanges of information etc. (i.e. bilateral contacts) between all members of the network, the number of links increases quadratically with N , but only linearly if all members need deal only with a single leader.

Similarly, organising meetings and monitoring are largely administrative functions which might also be delegated to any member of the group or shared around. Again the logic of delegating to a ringleader is obvious as the size of the group increases. On the other hand, there is evidence that activities like convening and conducting meetings, exchanging information on prices or sales for monitoring purposes are sometimes conducted through the offices of an appropriate trade association, either alongside or instead of a ringleader. For example, in the lysine case:

“On 14 May 1993 ADM and Ajinomoto/Eurolysine met in Tokyo in order to continue the discussion commenced in Decatur..... ADM stated that the way for them to communicate is through a trade association.”¹²

But equally there are many examples where a cartel’s designated ringleaders played the same role. In the carbonless paper cartel, the Commission reports that:

“There is no doubt that AWA, which is the leading producer of carbonless paper in Europe, was the principal leader of the cartel throughout the EEA. The factual evidence on meetings presented in Part I show that several cartel meetings were convened and conducted by representatives of AWA.”[Para 418: Carbonless paper cartel, 2001]¹³

2.2 Nature of the agreement

It is also clear from case study evidence¹⁴ that there is heterogeneity between cartels concerning the focus of their conspiracy, i.e. the nature of the agreement, and what they coordinate on, and it is likely that the need for a ringleader will vary depending on the nature of the agreement.

¹² Para 100, Official Journal, L series 152/24, 7/06/2001, Case COMP/36.545/F3-Amino Acids, Decision of 7 June 2000.

¹³ Para 148, Official Journal, L series 115/1, 21/04/2004, Case COMP/E-1/36.212 – Carbonless paper, Decision of 20 December, 2001

¹⁴ Posner (1970), Hay and Kelly (1974), Frass and Greer (1977), Suslow (2005), Zimmerman and Connor (2005), Bolotova et al (2006), Harrington (2006), Combe and Monnier (2010), Levenstein and Suslow (2010)

In broad terms, agreements relates to one or more of price fixing, bid rigging or market sharing, where market sharing can entail one or more of territorial allocation, customer allocation and/or setting market share quotas. The vast majority of cartels include an element of price fixing (indeed, in Harrington's sample (2006, p.6), all cartels did), but market share agreements also occur in many. As such, coordination on price is a very common task for cartels, with the implication that a price leader will often be required. In fact, price coordination may require sophisticated mechanisms on the part of cartel members where the product is complex and differentiated. As discussed earlier, the traditional Industrial Organisation literature identified three types of price leadership: dominant firm (*a la* Stackelberg), barometric and collusive. Insofar as these also occur within cartels, with Stackelberg, the term ringleader has an obvious meaning, and the leader would typically have a much larger market share, perhaps deriving from a significant cost or capacity advantage. In the case of collusive or barometric leadership, on the other hand, there may be a number of ringleaders, where at the limit all firms may engage at some point in the activity, in which case there may be no unique ringleader who can be singled out by the CA for a heavier penalty.

However, other types of agreement, once in place, should require relatively trivial monitoring with little likelihood of punishment necessary. This is likely particularly for market sharing of the territorial or customer allocation forms which will be more or less self-enforcing.

2.3 Aggressive leadership, coercion and enforcement

With price agreements and market share quotas which are intrinsically more prone to cheating and therefore monitoring and punishment – credibly threatened and/or enacted - and where reconciling differential incentives requires that one firm cedes more than others, it makes sense for there to be a firm that is capable/ willing to make concessions, and to have capability and credibility to threaten punishment on the one hand, or to compensate and even make side payments on the other hand. Depending on the structure of the cartel (in terms of market shares, capacity, differential costs), this might point directly to the leading firm(s). Coercion and enforcement activities entail a much more aggressive role for the ringleader – it is much more than just a facilitator.

In summary, the precise roles of the ringleader will vary from case to case. Sometimes these may be largely ***facilitating***, i.e. approaching new members, monitoring, and convening and conducting meetings, but sometimes they may be more ***aggressive*** – dictating price, coercing, and, where necessary, leading in the compensation schemes and punishment activities of the cartel. From the above discussion, we propose four testable propositions.

P1: Cartels may have no ringleader, or no unique ringleader

The default is that all firms take the responsibility of leadership collectively, in which case all are equally culpable. Alternatively, leadership may be shared by a sub-set. A ringleader may be less necessary where activities can be conducted through a trade association

P2: The likelihood of a ringleader will vary with the nature of the agreement

A ringleader may be required where the agreement involves coordinated pricing, but unnecessary where there is only market sharing which is confined to allocation of territories/customers, both of which require less monitoring and enforcement.

P3: Ringleaders are more likely in cartels with more members who are more asymmetric

With larger numbers and asymmetries, the traditional cartel problems are likely to be most acute, and a leader may be a necessary organisational response.

P4: 'Aggressive' ringleaders are likely to enjoy some size-related advantage over other members

Following the above, but also Ganslandt et al (2012), to the extent that some ringleader activities involve an indivisible fixed cost and are not merely organisational (e.g. buyouts, coercion and aggressive punishment strategies) these may require a 'deep pocket' and or size related (e.g. cost or capacity) advantage, and the largest member is most likely to be able to cover this cost whilst retaining the incentive to collude.

3. The sample and descriptive findings

These propositions are tested for a sample of 89 prosecuted EU cartels¹⁵ - horizontal agreements infringing Article 101(1) or Article 65(1) of the ECSC treaty - over the period 1990-2008. The primary source of information is the European Commission's (EC) final prohibition decisions published in the

¹⁵ This sample is larger than those used in the two above cited empirical studies: Ganslandt et al (2012) have 43 and Bos and Wandschneider (2011) who have 75. Detailed data on these cartels and some preliminary analysis on ringleaders are included in De (2010).

Official Journal (L series), Summary decisions (C series) and press releases published on the DG Competition website¹⁶.

This time period includes years both before and after the EC introduced its leniency notice in 1996 (subsequently revised in 2002 and 2006). Transparent rules specifying increased fines for ringleaders also came into force with the introduction of leniency notice. Initially, ringleaders were excluded from applying for leniency, but in 2002, this was changed so that they were also allowed to apply for reduced fines, but not complete immunity. Thus, our chosen start year pre-dates the formal recognition of ringleaders because it is clear from the EC's decision documents that it was alert to the possibility of ringleaders even in the early 1990s (the first identified ringleader was in 1994)¹⁷. The end year was the most recent available at the time of the research, bearing in mind the time lag between the investigation and availability of the report in the public domain.

3.1 Frequency of Ringleaders

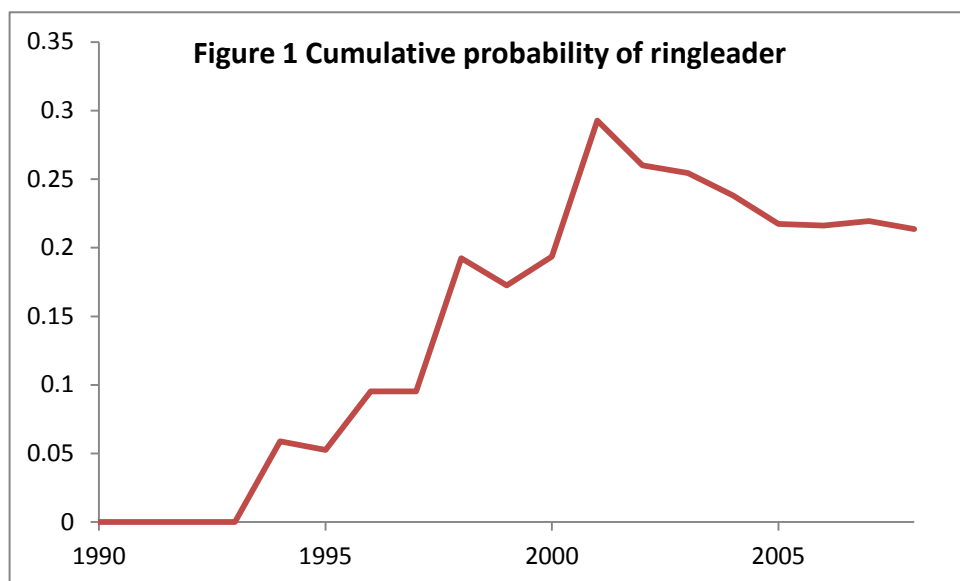
In approximately one fifth (19) of these 89 cartels, the EC identified a ringleader or ringleaders (Table 1). Over the period, the proportion having ringleaders increased up to 2001 and then fell back. This is seen more easily in Figure 1, which depicts the cumulative probability that ringleaders were identified.

Table 1 Incidence of cases and ringleaders over time

	1990-3	1994-6	1997-9	2000-2	2003-5	2006-8	Total 1990-2008
All cartels	11	10	8	21	19	20	89
RL cases	0	2	3	8	2	4	19

¹⁶ <http://ec.europa.eu/competition/cartels/cases/cases.html>. This has been supplemented, where necessary, by the opinion and judgements of the Court of First Instance and European Court of Justice. The judgements 1997 onwards can be found on the CURIA website (http://curia.europa.eu/jcms/jcms/j_6/), and before 1997 from the DG Competition website (<http://ec.europa.eu/competition/court/index.html>). Some additional information was also collected from various relevant merger cases reported on the DG Competition website, <http://ec.europa.eu/competition/mergers/cases/>

¹⁷ In its Carton board judgement, the European Court of Justice clearly states that a higher percentage (9%) of turnover is used in calculating the ringleaders' fines compared to the other members (7.5%). [para 71 of the Judgment of the Court C-248/98 P, 16th November 2000]



It should be underlined that these 19 cases are those in which the EC feels sufficiently confident to explicitly identify a ringleader or ringleaders. In a further 8 cases, it reports allegations of ring-leadership from other cartel members, but was not satisfied that it could establish sufficiently hard corroborating evidence. For example, in the industrial thread cartel, it reports:

“.. some parties state that Coats was the driving force of the cartel. However, they did not produce any evidence to the effect that Coats has compelled any other undertaking to take part in the cartel or that it acted as an instigator.” [Para 366: Industrial thread Benelux and Nordic countries, 2005]¹⁸

Arguably then, the incidence of ringleaders may be higher than recorded here. Issues of sample selection are discussed in section 4.

3.2 What ringleaders do

Table 2 summarises the ringleaders’ activities that the Commission observed and used to justify its decisions. In most cases the ringleader is associated with more than one of these activities – on average more than three.

Table 2 Ringleader activities

Types of activity	Frequencies*	
Organisational		
Instigation/approaching new members		14

¹⁸ European Commission (2005) Case COMP /38.337- PO/Thread, Decision of 14 September 2005.

Administrative		17
of which:		
<i>Convening/conducting meetings</i>	16	
<i>Monitoring/secretariat</i>	12	
<i>Acting as intermediary</i>	7	
Aggressive		
Dominant price leadership		9
Coercion/threatening/enforcing		5
Classification of Cartels**		
Organisational ringleader(s) only		8
Aggressive ringleader(s)		11
No ringleader		70
<i>Notes: * most ringleaders engage in more than one activity; **a cartel is classified as organisational only, if its ringleaders engage only in organisational activities; most aggressive ringleaders are also organisational</i>		

Using the distinction drawn in the previous section, these are classified as organisational or aggressive. In the large majority (14 out of 19), the ringleader(s) is found to have instigated the agreement¹⁹, although in no case is instigation the sole activity of the leader, and in 17, the ringleaders are involved in some form of administrative functions. Thus, in nearly all cases, ringleader(s) are found to have instigated and been responsible for the administrative functions of convening and conducting meetings, and of monitoring. The more aggressive functions, such as dominant price leadership, and coercion/threats/enforcement are less frequent (9 and 5 respectively), but as implied by the above, are usually conducted alongside the above organisational activities. It follows then that most aggressive ringleaders also engage in organisational activities, but the reverse is not so. Examples of aggressive cartels include lysine (in which Ajinomoto and ADM together engaged in all six activities); and carbonless paper and sorbates, in which ringleaders were actively aggressive in both in price leadership and coercion/enforcement. On the other hand, in paraffin wax, sodium gluconate and gas insulated switchgear, the ringleaders were completely administrative in nature, concentrating only on convening/conducting meetings, playing the role of intermediary and monitoring the agreements.

¹⁹ The exceptions are sorbates, Spanish bitumen, gas insulated switchgear, paraffin wax and sodium gluconate cartels; in these case presumably, all members instigated jointly.

The EC decision documents also provide some indirect evidence of what ringleaders do to enforce agreement, by using, *inter alia*, compensation schemes and price wars (Table 3).

Table 3 Types of enforcement: ringleader versus non-ringleader cartels

	All cartels	Ringleader cartels	Non- ringleader cartels
Compensation schemes	32(36)	13(68)	19(27)
Price Wars	18(20)	7(37)	11(16)
Total	89	19	70

Note: percentages of column totals shown in parentheses

Compensation can take various forms, but broadly speaking refers to schemes whereby firms that sell more than their allocated quota compensate the other parties ex-post. Price wars can sometimes be the result of concerted behaviour by a set of punishing firms or sometimes more of individual retaliation to a specific violation of the agreement. Both are significantly more likely to occur where a ringleader exists – more than two thirds of ringleaders organise some form of compensation scheme, while only a quarter of non-ringleader cartels have such schemes; and price wars are twice as likely in cartels with a ringleader than in those without.

An example of a price war conducted by the ringleader on a bilateral basis is pre-insulated pipes, for which the Commission states that:

“It is accepted, however, by the Commission that from about March-April 1993 prices for new business in Denmark began to fall...There were mutual recriminations: Løgstør claims that ABB engineered the whole situation in order to discipline the other producers and force them to continue in the cartel. It says it was even told by ABB that the latter had allocated a credit line of DKK 50 million to eliminating Løgstør in a price war (Løgstør Reply to Statement of Objections, pp. 22 to 24, 32, 40 and 42). ABB, however, attributed the blame to Løgstør’s demands for an increase in its quota...”[Para 37: Pre-insulated pipes, 1998]²⁰

An example of a ringleader (Daicel) implementing a compensation scheme is sorbates:

“In 1981, it implemented the cartel penalty system against Chisso, having compelled Chisso to buy 60 to 70 tons from it because Chisso had exceeded its volume quota for 1980. Moreover, it was Daicel which insisted

²⁰ Official Journal, L Series 24, 30/01/1999, Case IV/ 35.691-Pre-insulated pipes, Decision of 21 December 1998.

most vehemently on complying with set market share quotas, because it had the largest share of all the Japanese producers and therefore had the greatest interest in maintaining the *status quo*.”[Para 364: Sorbates, 2003]²¹

3.3 Who Ringleaders are

Table 4 turns to numbers of ringleaders in different cartels and their identities. Perhaps surprisingly, in 11 of the 19 cartels, there was more than one ringleader. In an extreme example, Cartonboard, there were seven - each a market leader in its own national market within the EU. Similarly, in some of the global cartels, different leaders represented different continents. In gas-insulated switchgear, the Japanese members rotated leadership among themselves; amongst the European members, initially Siemens was the leader, but Areva/Alstom took over leadership when Siemens temporarily departed the cartel.

Table 4 Size ranks of ringleader(s), and by type

Rank(s)	Total	Aggressive	Organisational
#1 sole	7	5	2
#1 & #2	6	6	0
#2 sole	1		1
Sole outsider	1		1
Others (multiple RL)	4		4
Total	19	11	8

* two each with 2 ringleaders (#1 and #2), one with 5 (#1, #2, #3,#4&-#5), and one with seven (#1, #2, #3, #4, #5, #6 & #10)

Nevertheless, in most (16 of the 19) of the cartels the largest firm in the industry was either the sole or one of the ringleaders. The three exceptions are: Spanish tobacco processors, in which the ringleader was, strictly speaking, an outsider to the industry, being a distributor, rather than producer, of tobacco; citric acid, in which the two ringleaders, ADM (#2) and Roche (#4), were the market leaders in two other closely adjacent cartels (Lysine and Vitamins respectively); and sodium gluconate in which the identified ringleader, Jungbunzlauer, was the second largest firm in the market.

²¹ Official Journal, L Series 182/20, 13/07/2005, Case No. C.37.370 – Sorbates, Decision of October 1 2003.

Table 4 provides a clearer focus on the significant roles of #1 firms: in all 11 ‘aggressive’ cases, the #1 ranked firm was a ringleader – either alone or together with the #2 firm. This is consistent with the intuitively plausible implication that, if a ringleader is to exert an aggressive role, it must also be able to wield some power within the cartel. In contrast in the 8 organisational only cases, it is much more common to find multiple-leadership and not always involving a dominant leading firm. This apparent broad dichotomy sheds light on Proposition 3 above and has direct implications for the specification of the econometric model below.

3.4 Ringleaders by cartel type (nature of the agreement)

According to Proposition 2, the ‘need’ for a ringleader may differ between different types of cartel agreement, being least pronounced where the collusion ‘merely’ requires forbearance by members, so that each respects its rivals’ initial endowments of home territories and/or captive customers, and cheating is therefore easier to detect and there is no necessity to agree on common prices.

Table 5 reports the incidence of different types of agreements in the present sample. Confirming Harrington’s (2006) earlier finding, nearly all cartels fix price and/or rig bidding, but the various forms of market sharing are also common. In addition, as is clear from comparing the sum of the cells in the first column with the column total, typically agreements cover more than one dimension, usually a combination of price and market sharing.

Table 5 Types of agreement: ringleader versus non-ringleader cartels

Nature of Agreement	All Cartels	Cartels with Ringleaders	Probability of Ringleader
Price agreements			
Price Fixing	70	18	0.26
Bid Rigging	18	7	0.39
Market sharing agreements			
Territorial	16	5	0.38
Customer	29	5	0.17
Quota	26	10	0.38
Without price fixing/bid rigging	13	0	0
TOTAL	89	19	0.21

The second column shows the incidence of ringleaders by type of agreement, and at first sight, this reveals no obvious tendency for ringleaders to be more prevalent for certain types of agreement than others. However, this is misleading precisely because cartels typically employs combinations of agreement types, thus these are estimates of unconditional probabilities. Rather, the key appropriate statistic is reported in the last row of the Table, which isolates those cartels which confine their agreements exclusively to market sharing (usually territorial or customer allocations), without the need to agree on price. As can be seen, there are 13 such cartels, in none of which is there a ringleader. This allows us to draw a very strong conclusion, for this sample at least: *conditional on the cartel having no agreement on price fixing or bid rigging, it will never involve a ringleader.*

In summary, these descriptive statistics have provided strong supporting evidence for our Propositions 1, 2 and 4 for this sample of EC cases: ringleaders only occur in a minority of cartels, and there is often more than ringleader; ringleaders are never found in cartels where the collusion can be effected without involving price (typically, where territorial and/or customer allocation is sufficient; and the ringleader is usually the largest cartel member, especially where its functions are ‘aggressive’.

4 Are Ringleaders more likely in larger number asymmetric cartels?

This section tests Proposition 3, concerning size and asymmetry within the cartel, while allowing for the possibility that it may be sensitive to the type of ringleader and type of cartel agreement.

4.1 Model and specification

(i) Initially, the model is tested using a simple logit form:

$$pr\{RL_i\} = f(N_i, A_i, Z_i) \dots\dots\dots (1)$$

where $pr\{RL_i\}$ is the probability that cartel i has a ringleader or ringleaders, measured using a binary variable with 1 denoting existence of a ringleader.

N is **number of cartel members** over its duration²².

²² This is measured by the average number of members over the cartel’s duration. Typically this is time invariant, although there are some cartels with entry in the early years and exit towards the end of the cartel period.

A is the **asymmetry of market shares** of members. In the results reported here this is measured by the range of market shares, i.e. the difference in market shares between the largest and smallest members²³ (Range). This is our preferred measure as it reflects the sizes of those firms (either the largest or the smallest) which previous theoretical literature most commonly highlights as crucial to the cartel stability in terms of incentive compatibility.

Z_i are other characteristics of the market and cartel. From the above discussion, we identify three such characteristics:

Trade Assoc is a dummy variable indicating the presence of a **trade association** actively involved in the cartel. The expectation is that this reduces the need for a ringleader.

Time is a **time trend**, included in quadratic form, bearing in mind Figure 1. This variable controls for the possibility that firms may be more or less willing to fulfil the role of ringleader over a time period when there were policy changes in the fining policy of the CA. Also, the inclusion of this trend may help to control for certain types of selection bias (see below).

Nature of the cartel agreement is another variable to capture the characteristics of the cartel. The previous section has already confirmed that the nature of the agreement does matter: ringleaders never occur where collusion does not involve price agreements. However, this cannot be included as a regressor because it is, by definition, a perfect (negative) predictor. As an alternative treatment, the equation will be re-estimated, omitting those cartels without price agreements.

(ii) In addition, to test whether the marginal effects of firm numbers and asymmetries differ by ringleader type, the equation is then re-estimated as a multinomial logit, where the cartel chooses between three alternatives, no ringleader, a merely organisational ringleader, or an aggressive ringleader:

$$pr\{k_i\} = pr\{U(k) > U(l)\} \text{ for all other } l \neq k.$$

$$\text{where } U(k) = f(N_i, A_i, Z_i) \quad (2)$$

²³ In fact, the results reported below are robust to alternative measures of size asymmetry; including Gini based measures and the coefficient of variation. For further discussion see De 2010, chapter 6.

4.2 Sample size

In order to measure Range (or any other measure of asymmetry), we require usable information on the market shares of individual members. While the EC does not routinely report this in its decision documents, it is possible to infer individual market shares for most cartels, if sometimes only approximately²⁴.

However, this proved impossible for 25 of the 89 cartels: in 14 cases this was because the cartel comprised an 'association of members', very often these associations include very large, but unreported, numbers; 5 cases involved shipping for which no individual firm data are reported; and in 6 other cartels, no reliably useful data were reported or could be inferred. Below we discuss whether these exclusions are likely to aggravate problems of sample selection.

4.3 Results

Equation I in Table 6 shows the logit results for the full sample, making no distinction between cartel or ringleader types. Both N and Range are positively significant at at least the 5% level (hereafter, 'significance' always refers to the 5% level): ringleaders are more likely, the more members in the cartel and the greater are asymmetries in their sizes. The significant coefficients on the quadratic time trend imply an increasing tendency to ring-leadership up until 1999/2000, but thereafter the probability declines. This is consistent with an increased willingness by the CA through the 1990s to identify and name ringleaders. The tailing off and then reversal of the trend thereafter could be consistent with a decline in this willingness, increased skills of ringleaders in concealing their activities, and/or a deterrent effect on the number of cartels actually requiring a ringleader. Each of these explanations would be consistent with the increased tendency for ringleaders to be penalised more heavily as a consequence of the EC's leniency programme. The negative coefficient on Trade Assoc is consistent with expectations – ringleaders are less necessary given the presence of a trade association - but this is only very weakly significant (at the 15% level). The equation's success in correctly predicting outcomes²⁵ is relatively high (81%) for a study such as this. Nevertheless, there are 7 cartels where the equation fails to identify the presence of a ringleader and 5 where it incorrectly predicts a ringleader (referred to hereafter as Type 1 and Type 2 errors respectively).

Equation II re-estimates the model, but now only for those cartels found to be fixing price or rigging bids. Signs of all coefficients are unchanged, and significance levels are now increased, especially for

²⁴ See De (2010, pp.109-111). Members' shares are often reported as ranges, e.g. 10-20%; in such cases we typically employ the midpoints, subject to moderation where other information is available on an *ad hoc* basis.

²⁵ A prediction is deemed successful if the predicted probability of the actual outcome exceeds 50%.

Range and Trade Assoc is now significant at the 6% level. The time trend continues to predicts a turning point at 2000. The explanatory power of the equation is enhanced: 86% of cases are now correctly predicted, and there are only 4 Type 1 and 4 Type 2 errors. Thus, exclusion of non price fixing/bid rigging cartels provides more precise estimates.

Equation III estimates the second, multinomial, model, distinguishing between organisational only and aggressive ringleaders, as opposed to no ringleaders. All estimated coefficients have the same sign as before, and all coefficients remain significant at the 5% level, except the time trend which slips to 10% significance and 13% for trade association for organisational ringleaders. A Wald test on the difference between the coefficients on Range reveals that this has a significantly greater impact for aggressive ringleaders: greater asymmetries are particularly associated with aggressive ringleaders. None of the other variables has a significantly different impact between the two types of ringleader. The equation generates predictions which are 85% correct²⁶, and there are 5 Type 1 and 2 Type 2 errors (and a further 2 for which the 'wrong' type of ringleader is predicted.) A Hausman test for Independence of Irrelevant Alternatives confirms that the assumption can be accepted.

Table 6 Results

	Equation I (Full sample)		Equation II (Only price fixing &/or bid rigging)		Equation III (Only price fixing &/or bid rigging)			
	logit		logit		Multinomial logit			
					Organisational ringleaders		Aggressive ringleaders	
	Coef.	P>Z	Coef.	P>Z	Coef.	P>Z	Coef.	P>Z
Time	0.885	0.044	1.713	0.044	1.304	0.107	2.908	.008
Time Squared	-0.042	0.025	-0.079	0.024	-0.058	0.081	-0.143	.002
Number	0.448	0.000	0.690	0.001	0.615	0.002	0.804	.002
Range	8.642	0.044	19.398	0.000	14.713	0.005	29.884	.000
Trade Assoc	-1.114	0.152	-2.388	0.054	-1.846	0.132	-3.658	.011
Constant	-9.802	0.007	-18.08	0.008	-15.42	0.017	-27.32	.002
Observations	64		59		59			

²⁶ In this multinomial case a prediction is deemed successful if the predicted probability of the actual outcome exceeds the predicted probabilities of each of the two alternatives.

Wald $\chi^2(5)$	17.11	18.54	36.23
Pseudo R^2	0.349	0.547	0.515
Log pseudo likelihood	-25.33	-16.79	-24.28
Correct predictions	81.2%	86.44%	84.75%

In summary, the three models robustly confirm Proposition 3 for this sample: ringleaders are more likely in asymmetric, large number cartels, and that this is most pronounced for aggressive ringleaders. There is weaker evidence that trade associations may sometimes be a viable alternative to ringleaders. Over time, *ceteris paribus*, the EC was increasingly successful in identifying ringleaders through the 1990s, although this trend was reversed through the 2000s. This time pattern is consistent with an impact for the changed treatment of ringleaders as part of the EC's leniency programme.

4.4 Possible sample selection bias

It is inevitable in any empirical study in which the purpose is to explain the decisions of a CA, that there is a potential selection problem. In this case there are 4 potential sources.

First, there is the generic issue well known in the previous cartel literature that the researcher only observes *detected* cartels, and these may not be a random sample of the population as a whole. This possibility cannot be rejected, and it qualifies all results as conditional on cartel detection.

Second, in this particular context, the 'existence' of a ringleader depends on the inevitably (to some extent) subjective judgements of the CA on what constitutes penalisable ringleader activities. As already noted, this problem is further aggravated by the likelihood that the stiffening of fines on ringleaders may have made the CA itself more cautious in naming a ringleader²⁷, in the fear that more severe punishment would increase the likelihood of appeal. Similarly, ringleaders themselves may be more adept in concealing their leading role in periods of more severe punishment. Ideally, the model should properly be framed as having two stages. Stage 1, as described by Equations (1) or (2), would refer to the probability that a ringleader *actually* exists; while stage 2 would relate to the conditional probability that the CA publicly identifies a ringleader, given that one exists. However, in practice, the researcher only observes the outcomes of the 2 stages conflated, and identification of

²⁷ In section 3, we referred to 8 cases in which there was the suspicion, which could not be definitively substantiated, of the existence of a ringleader.

parameters from each stage separately is effectively impossible. For this reason, results should be further qualified by acknowledging that the purpose here is confined to explaining the stated decisions of the CA in the cases it detects. As argued above, it is possible that the inclusion of the quadratic time trend may have 'corrected' for any such effects. However, a possible identification problem clearly remains because one cannot be sure that these two effects will be independent of the cartel's structure (firm numbers and asymmetries).

Third, and more routinely, there are the usual sample attrition problems, not uncommon in studies such as this. As noted above, 25 observations were lost because of lack of data. However, it is probable that most of these cartels (notably the associations of members and shipping lines) had relatively large numbers of members, and since none had an identified ringleader, their exclusion is likely to have biased downwards the impact of N in the above regressions.

Fourth, our exclusion of the non-price fixing non-bid rigging cartels in equations II and III might have introduced bias if these cartels differ significantly from the remaining sample in their structures.

Given the relatively small size of the sample and sub-samples, the only practicable option for investigating some of these issues is to employ elementary t tests to compare sample mean N and Range between: (i) cases up to and cases after 2000, and (ii) cartels with and without price fixing or bid rigging. The former are completely insignificant, but the latter reveal weakly (at the 10% level) significant tendencies for cartels without price fixing or bid rigging to have fewer members, but greater asymmetries. Since these two effects pull in opposite directions in terms of their predicted impact on the probability of ringleaders, it is unclear whether the exclusion of these cases will have introduced any significant bias to the estimates in equations II and III.

5 Implications & Conclusions

As far as is known, this is the first paper of its kind, empirically identifying the incidence and characteristics of ringleaders for a sample of cartels. Its main analytical purpose is to evaluate how far the ringleader can be interpreted as an organisational mechanism enabling cartelists to overcome the 'cartel problems' in those instances where they are likely to be most pronounced, i.e. larger asymmetric sets of members.

It has generated a series of results, and it is acknowledged that these should be seen in the context of a relatively small sample size, which may be subject to sample selection bias, a simple model, and dependent variables which reflect the subjective decisions of a CA.

Subject to these qualifications, there are six main results. All should be interpreted to refer to the stated decisions of the CA on the set of cartels it actually detects. First, ringleaders are observed in about one in five cartels. Second, especially where the ringleader engages in 'aggressive' activities, it tends to be the largest member or members of the cartel. On the other hand, where the activities of the ringleader are confined to a more facilitating organisational nature, it is not uncommon to observe a number of ringleaders, some or all of whom are not dominant. Third, ringleaders only occur where the conspiracy involves price fixing or bid rigging. Other forms of agreement, notably pure territorial or customer allocation, do not appear to require a ringleader - such agreements are more amenable to self-monitoring and enforcement and secret deviation is difficult. Fourth, ringleaders are less common where an existing Trade Association may be able to fulfil similar roles. Fifth, a significant inverse quadratic time trend suggests that the European Commission had an increasing propensity to name ringleaders in the 1990s, but this has been reversed since 2000. This is consistent with, but certainly does not prove, a deterrent role from the increasingly asymmetric fines imposed on ringleaders. It is unclear whether this is 'cosmetic' – in the sense that ringleaders have become more sophisticated in revealing their leading roles and/or that the CA has become more cautious in naming a ringleader and thereby invoking appeals – or whether policy has had the effect of deterring the subset of cartels in which a ringleader is necessary.

Finally, and most important given the paper's main objective, the evidence strongly confirms that ringleaders are statistically more likely in cartels with a relatively large number of members who are asymmetrically sized. This finding has an important implication for policy makers, since it clearly underlines that collusion may not be confined to small number symmetric size distributions of firms.

Further research on all of these findings is required, including replication, if possible, for other CAs, and also further in-depth case analysis of individual cartels. Moreover, this paper is largely empirical in its intentions. Further theoretical research is required, perhaps employing theories of coalition and network formation. The stylised facts uncovered in this paper should provide a useful input into any such future empirical work.

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