



Tacit Collusion, Firm Asymmetries and Numbers: Evidence from EC Merger Cases

by

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Abstract: The purpose of this paper is to identify empirically the implicit structural model, especially the roles of size asymmetries and concentration, used by the European Commission to identify mergers with coordinated effects (i.e. collective dominance.) Apart from its obvious policy-relevance, the paper is designed to shed empirical light on the conditions under which tacit collusion is most likely. We construct a database relating to 62 candidate mergers and find that, in the eyes of the Commission, tacit collusion in this context virtually never involves more than two firms and requires close symmetry in the market shares of the two firms.

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1 Motivation & Objectives

The received wisdom about tacit collusion is that it is more likely the fewer leading players there are in a market, and the more symmetric they are. This was recognised long ago in the Structure-Conduct-Performance paradigm, and subsequently formalised by the theory of repeated games.¹ However, in spite of the theoretical consensus, the empirical literature offers few stylised facts on the most simple of questions – how few is few, and how symmetric is symmetric? Given that the concept is somewhat elusive and the practice not illegal, this is probably unsurprising, but it certainly contrasts with the burgeoning empirical literature on hard-core collusion (for example, Harrington (2005) and Bolotova et al (2006)).

The purpose of this paper is to attempt to fill this gap in knowledge, albeit in an indirect way. While there may be no existing large database of cases involving policy intervention to combat tacit collusion – unlike hard-core cartels – there is one area of policy where Competition Authorities (CA) do assess the *prospects* of tacit collusion and intervene accordingly. This is in the area of merger control for the subset of cases which may have coordinated effects/collective dominance.² In most major jurisdictions, one might expect to observe a reasonably large number of such cases, potentially providing the scope for constructing a database sufficiently large to support econometric analysis designed to uncover stylised facts about the sorts of markets and market structures that are associated with tacit collusion – at least as seen through the eyes of the CA.

This is the objective of the current paper, using the European Commission as an example of a CA. More specifically, the purpose is to identify the implicit structural model, especially the roles of concentration and size asymmetries, that the Commission has used to identify (and therefore prohibit or remedy) those mergers which it believes will lead to collective dominance. Of course, it can be argued that, even if we are successful in this venture, our results might reveal very little about tacit collusion *per se*, as opposed to merely the Commission's own conjectures and understanding of it. We accept that it must be an open question as to whether the Commission has the 'right' model. But, even if not, our analysis is still of interest within the policy literature, given the controversies of recent years, for example, concerning the Commission's decisions in celebrated cases such as Airtours (1999), the academic critique of the Nestle-Perrier case (Compte et al, 2002), and the 2004 revision to the European Merger Regulation.³

We proceed by first isolating from the population of about 3,000 mergers considered by the Commission over the years 1991-2004 those in which it appears to have seriously considered collective dominance as a potential outcome. This identifies just 62 mergers which, between them, impacted on (i.e. had overlaps between the merging parties in) 367 different markets. This

¹ For examples, see Scherer and Ross (1970) and Ivaldi et al, (2003) respectively.

² Hereafter, we employ the European terminology, Collective Dominance. In the next section, we explore terminology a little further.

³ See also Kuhn (2001) for a discussion of some of the policy issues raised here.

forms our core database. Preliminary descriptive statistics establish a number of facts – the two most striking are that: (i) most of the markets concerned have no more than two or (much less frequently) three major players, and (ii) with just a single exception, the Commission only ever identifies collective dominance with a market of two major firms. Building on these facts, we construct and then test a simple structural model, designed to predict under what circumstances the Commission will judge a market to be collectively dominant, as opposed to singly dominant, or neither. To our knowledge, there have been no previous studies devoted exclusively to the decisions of a CA on collective dominance (coordinated effects). While there has been a fairly large literature attempting to econometrically explain the decisions of CAs in merger analysis (and other areas of competition policy), rather strangely, previous studies have typically not differentiated between unilateral and coordinated effects, implicitly assuming that the same model applies to both. Below, we briefly survey this previous literature and argue that it is deficient in two other respects. First, it tends to be over-reliant on explanatory variables which are based on subjective qualitative assessments of key variables such as barriers to entry and buyer power. We argue that the use of such variables runs the risk of circularity (information is usually taken directly from CA reports justifying their own decisions) and also fails to acknowledge that such ‘variables’ should be often treated as necessary conditions. Second, invariably, studies characterise a CA’s decision in a particular merger as simply intervene/not intervene. In fact, most mergers involve a number of different markets, and it is common for the CA to intervene in some of those markets but not others – ignoring this within-merger dimension, the analysis discards a potentially rich source of extra information.

In contrast, our approach avoids the need to measure the unmeasurable (such as barriers to entry). We do this with careful sample selection designed to control for such factors. We also exploit within-merger heterogeneity by making the individual market, rather than the aggregate merger, the unit of observation. This means we attempt to predict not just whether the CA intervenes in a merger but also whether it intervenes in some but not other markets covered by that merger. Since it is quite common for the European Commission to judge that a given merger is singly dominant in one market but collectively dominant in another, our model must also be able to discriminate by type of competitive harm.

Using a multinomial logit estimator, we find that a simple structural model, based only on information on the market shares of the two largest firms, is able to correctly predict 80% of the Commission’s decisions, including those on collective dominance. As already mentioned, with a singular exception, the Commission only ever equates collective dominance with two major firms in a market, and, even then, requires a relatively high degree of symmetry between the market shares of those firms.

In the concluding section we return to our initial theme, and ask what do these results tell us about tacit collusion? Perhaps very little – if one is not prepared to credit the European Commission with the ability or skill to predict the structural circumstances under which it is likely to occur. However, less

sceptically, we suggest that, superficially at least, these results are in stark contrast with what we know about cartels. It is evident from the literature that cartels typically involve more than just two firms, and size asymmetries within the cartel can be far more pronounced than those identified in our results. We end by speculating on a future research programme which might explore the interface between hard- and soft-core collusion.

The paper has eight more sections. Section 2 briefly surveys relevant previous literatures. Section 3 describes the construction and main characteristics of the database; all EU mergers with the potential for collective dominance. Section 4 introduces a new geometric construction – the oligopoly triangle - which proves to be a useful device for clarifying how best to measure the key elements of market structure – concentration and asymmetry. Section 5 presents a model of the CA's decision-making, which allows the CA to decide between intervening and not-intervening in a multimarket merger on a market-by-market basis. Section 6 describes our empirical methodology, and section 7 reports the results of estimation. Section 8 explores some of the direct and indirect implications of our results.

2 Previous relevant literatures

Terminology

Throughout this paper, we take the term 'collective dominance' (European parlance) to be synonymous with 'coordinated effects' (US). Both terms refer to mergers where it is anticipated that the firms remaining in the market post-merger (including the merged firm) would be likely to coordinate their actions. Clearly, no CA could allege that such coordination would amount to formal collusion – to block a merger on such an interpretation would be tantamount to asserting that post-merger, firms would act illegally. Rather, coordination must refer in effect to 'tacit collusion', the spirit of which is still captured perfectly by Chamberlin's oft-quoted words of nearly 80 years ago:

"If each (firm) seeks his maximum profit rationally and intelligently, he will realise that when there are only 2 sellers, his own move has a considerable effect upon his competitors, and that it makes it idle to suppose that they will accept without retaliation the losses he forces upon them. Since the result of a cut by any one is inevitably to decrease his own profit, no one will cut, and although the sellers are entirely independent, the equilibrium result is the same as though there were a monopolistic agreement between them" (Chamberlin, Monopolistic Competition, 1929).

Thus, we take collective dominance,⁴ coordinated effects and tacit collusion to be synonyms.

Theoretical literature on tacit collusion and asymmetries

The conventional interpretation of tacit collusion as a potential equilibrium outcome of a dynamic non-cooperative game is well summarised, for example, by Ivaldi et al (2003) writing for the European Commission. They derive the standard results on the market conditions under which tacit collusion is likely: (i) fewness of competitors, (ii) symmetry of market shares, (iii) entry barriers, (iv) frequent interaction, (iv) price transparency, and a number of other factors. Table 6 below confirms that the European Commission often takes account of such factors when coming to decisions on collective dominance. But it is the first two – we shall call them the ‘structural model’ – that are our main interest here.

As Ivaldi et al note, market share asymmetry is important, not only in its own right, but also because of the underlying asymmetries it may reflect. In recent years, the theoretical literature has explored various possibilities: Rothschild (1999) on costs, Compte et al (2002) on capacity, Kuhn (2004) on the number of products, Vasconcelos (2004) on capacity/costs. Although the details of these models vary, the underlying mechanism always works through the asymmetry this causes between firms in the profitability of/ability to punish and/or deviate.

Turning to the empirical literature, very little is known about asymmetries and tacit collusion; indeed, there does not even appear to be much evidence on firm numbers. There are of course many industry case studies which attempt to deduce from observed conduct whether firms are behaving in a tacitly collusive, as opposed to competitive, manner,⁵ but, as far as we know, there is no body of studies on which we can draw to answer questions such as: what sorts of firm numbers and what sorts of asymmetries are consistent with tacit collusion?

Empirical modelling of CA merger decisions

Faced with this paucity of empirical knowledge, we approach the subject indirectly, using data from the one area of competition policy where it is possible to assemble a relatively large body of cases where tacit collusion is at least a possibility, i.e. mergers with potential for creating collective dominance.

There is already a sizeable and growing empirical literature which attempts to explain CA decisions on mergers (and other areas of anti-trust policy), in

⁴ In the current paper, we side-step the policy debate concerning the so-called ‘gap industries’ (see, for example, Baxter and Dethmers (2005)). These are markets (prior to the introduction of a substantive test in the ECMR in 2004) where unilateral effects might have occurred but could not be pursued by the Commission because ‘single dominance’ was not satisfied. It might be argued that some cases prior to 2004 were pursued under collective dominance because the option of unilateral effects was not open to the Commission. In that sense, there may be a doubt as to whether all cases of collective dominance really can be identified with tacit collusion. In future work, we intend to compare EC practice before and after 2004, and with UK practice.

⁵ Early examples are Bresnahan (1989) and Slade (1987), and more recently Slade (2004).

terms of the structural and other characteristics of the firms and markets concerned, but rather strangely most of it ignores the distinction between coordinated and unilateral effects.

Early work by Coate and McChesney (1992), Khemani and Shapiro (1993), and Weir (1992, 1993) focussed on the US, Canada and the UK, but increasingly in recent years, the decisions of the European Commission have attracted more attention, exploiting the large database of reports on the Commission's website. Table 1 provides a non-exhaustive listing of the main and/or most recent contributions.

Table 1 Previous econometric studies of CA merger decisions

	Data	Period	Sample size	Dependent variable(s)
Coate & McChesney (1992)	US Mergers (FTC)	1982-86	70	Decision to challenge merger
Khemani & Shapiro (1993)	Canadian Mergers (Director of Investigation & Research)	1986-89	75	Merger decision: - no issue - monitor - restructure - challenge
Weir (1992), (1993),	UK Mergers (MMC)	1974-90	70 & 73	Merger decision: - allow - disallow
Davies et al (1999)	UK monopoly abuse (MMC)	1973-95	73	Adverse finding
Duso et al (2003)	EC Mergers	1990-2002	167	Probability of type I errors in sample of pro competitive mergers & type II errors in anti-competitive mergers (event study)
Lauk (2003)	German Abusive practices & cartels Federal Cartel Office	1985-2000	196	Adverse finding
Lindsay et al. (2003)	EC Mergers	2000 - 2002	245	Clear merger and - divestiture remedy - alternative remedy or prohibition
Schinkel et al (2004)	European Antitrust Cases	1964-2002	All	1) Infringement decision 2) Decision to appeal
Bergman et al (2005)	EC Mergers	1990-2002	96	1) Initiate a Phase 2 investigation 2) - Allow (incl remedy) - Prohibit merger
Coate and Ulrich (2005)	US Mergers	1996-2003	151	Clear merger
Grout and Sonderegger (2005)	EU & US Cartels	1990-to date	70+68	Inter-industry difference in incidence of cartels
Bougette and Turolla (2006)	EC Mergers	1990-2005	229	1) - phase 1 no remedies - phase 1 remedies

				- phase 2 no remedies - phase 2 remedies 2) As above but distinguish between type of remedy
Brown and Hesse (2006)	UK Mergers (OFT & CC)	1998-2004	177	Clearance decision

Although these studies differ in their objectives and detail, it is possible to stylise most as follows. The typical database is cross-section, covering a large number of different merger decisions over a given time period. The unit of observation is the individual merger, and the dependent variable is the CA's 'decision' on the merger – this might refer to outright prohibition, but is more generally whether the CA requires remedies before the merger is allowed. Typically, the probability of intervention (P) is posited to depend on three vectors of explanatory variables:

$$P = P(\mathbf{S}, \mathbf{X}, \mathbf{Z})$$

S are market share and concentration type variables (e.g. HHI, the Hirschman-Herfindahl index) measured as both the levels and changes resulting from the merger; **X** are other market characteristics, such as entry barriers and buyer power, and **Z** is a vector of sundry, mainly institutional/political variables, such as the identity of the EC Competition Commissioner in EU cases, the nationality of firms etc. Typically, econometric estimators are logit, probit, ordered probit or multinomial logit. The strongest results are usually obtained for the market structure variables – invariably, the probability of intervention increases with the level and increase in the HHI index and with the level and increase in the market share of the merged firm. Barriers to entry are also usually strongly significant, especially where interacted with concentration.

Although none of these studies specifically focusses on collective dominance, they do raise some issues which are of direct relevance to our own work. First, although collective dominance may not have been the primary concern, most merger samples will include at least some mergers of this type. Rather strangely, with only one real exception, these studies fail to distinguish unilateral and coordinated effects. Implicitly, this means that the same structural model has been assumed for both types of merger. This is a serious limitation. For example, as shown below, an increase in the HHI index will typically increase the chances of unilateral effects, but not, typically, of coordinated effects. Similarly, while an increase in the size of a number two ranked firm may sometimes increase the chance of coordinated effects, it is less likely to be identified with a strong unilateral effect – indeed, it may sometimes be viewed as an important constraining influence on the dominance of the first-ranked firm.

Coate and Ulrich's study (2005) of US mergers is the one serious exception,⁶ in that their structural model differs between unilateral and coordinated effects.⁷ However, their criterion for distinguishing the types of market prone to the two different effects is somewhat arbitrary, not to say puzzling. They assume that the theory of concern will be coordinated effects if either: (i) the product is homogenous and there are more than two pre-merger rivals to the merging firms, or (ii) the product is heterogeneous but the merging parties have a market share of less than 35%. Otherwise the theory of concern will be unilateral effects. Testing this model, they find that, in potential unilateral effects (as just defined) cases, it is the number of rivals which seems to drive the CA's decisions, while it is the level and change in the HHI index which matter in potential coordinated effects markets. It is not obvious to us how either the distinguishing criterion or these results relate to any known theory. For example, we show below that the HHI index should not be a good predictor of the likelihood of coordinated effects. Moreover, prevailing theory suggests that collusion is more likely in homogeneous product markets with fewer firms – Coate and Ulrich seem to discount the possibility that tacit collusion can occur in homogenous product markets with fewer than three firms.

Second, the typical data sources for these studies are the merger decision reports of the CAs, and this necessarily constrains the analysis. Of particular concern are variables such as entry barriers, buyer power, price transparency etc, for which most studies construct simple binary high/low proxy variables, where 'high' is based on a necessarily subjective reading of the case details. For example, with barriers to entry, invariably, 'high' is recorded if the CA itself identifies high barriers. This raises the obvious doubt that the CA will be self-justifying in its written description of cases; thus, a CA is unlikely to pass a merger without intervention if it has noted that entry barriers are high, or to block a merger in spite of admitting that barriers are low. It is difficult to see how artificial measures such as this would ever prove to be insignificant in explaining decisions.

Third, and focusing now on European Commission cases, most mergers impact on a number of different product and geographical markets. It is not uncommon for the Commission to intervene, for a given merger, in some but not all of the markets covered. However, most empirical studies characterise the Commission's decisions only at the overall merger level. Where the intervention is prohibition of the merger as a whole, this is natural, but when targeted at just some of the markets covered by the merger, there is an obvious aggregation problem. Consider two different mergers: A, a single market merger in which the Commission requires a remedy, and B, covering 20 markets in only one of which a remedy is required. A simple dichotomous intervention/non-intervention distinction would record A and B as

⁶ Bergmann et al (2005) also make a token allowance for the difference between unilateral and coordinated effects, by including an additional explanatory dummy variable, which takes the value of unity 'if the Commission finds that the firms will be collectively dominant after the merger'. Not only is this tautological in that such a variable would seem to be certain to predict the Commission's decision to intervene, but also the inclusion of such a dummy variable implies a simple shift effect, rather than the possibility that a quite different structural model is required to explain coordinated effects.

⁷ Even in this case, however, the discussion is relegated to an under-emphasised Appendix of the paper.

equivalent. Moreover, in B, how should market shares, market structure and the other explanatory variables be measured? Some studies, e.g. Bergman et al. (2005) choose to represent the merger by the market in which the competition problems were most severe; alternatively, one might measure variables at their mean or representative values across markets. However, any such solutions are not only imprecise, but also discard valuable intra-merger variance: between-market within-merger differences in both the decisions and market characteristics offer the potential for a much deeper analysis of the CA's model.

Our research methodology will aim to exploit this intra-merger dimension. Our main focus is on structural variables, but we will not assume that the CA employs the same model when deciding collective and single dominance, and, given our primary interest in asymmetries and tacit collusion, we will not rely on concentration measures, which do not take account of asymmetries. The methodology we use also side-steps the need to employ judgemental dummy variables reflecting factors such as barriers to entry.

3 The database of EU mergers involving potential collective dominance

Our first task is to identify from the population of all mergers on which the European Commission published a judgement, 1990-2004, the subset in which it appears to have contemplated collective dominance as a *potential* consequence. Having identified this subset, we present some key characteristics of the markets concerned and the Commission's decisions.

Merger control in the EU

Since the European Merger Regulation (ECMR) came into effect in 1990, the European Commission has published decisions on approximately 3000 mergers.⁸ The Regulation was revised in 2004 and to avoid any possibility of structural breaks since 2004, we confine analysis to the years 1990-2004. Appraisal of any merger may involve one or two phases. In Phase 1, the Commission undertakes an initial investigation: in about 90% of all mergers, no competition concerns were raised in this Phase, and the mergers were allowed to proceed without modification. Of the remaining 10%, in about half, commitments (remedies) were agreed in Phase 1, and on that basis, the merger was allowed to proceed. However, in 127 other cases, the appraisal went to a Phase 2, more extensive, investigation. Here, remedies were much more likely (77), and, in the extreme, the merger was blocked entirely (in 19 cases).

Thus, outright prohibition is relatively uncommon, but in about 200 other cases, the Commission required commitments from the merging parties to

⁸ These are all mergers with a European, as opposed to purely national, dimension, and which exceed specified turnover thresholds.

remove specific competition concerns. Throughout this paper, the term ‘intervention’ will be used to encompass not only outright prohibitions but all cases of commitments/undertakings/remedies agreed or imposed in either Phase. It is important to remember that, where an intervention takes place, very often this will relate to only some of the markets involved in a given merger.

Identifying mergers potentially involving collective dominance: the CD sample

Within this population, we word-searched all merger reports for the use of one or more of the following phrases: *collective dominance*, *(tacit) collusion*, *joint dominance*, *oligopolistic dominance* or *coordinated effects*. This isolated 94 candidate mergers, but closer textual examination revealed that in 32, the above phrases were only used in a cursory manner – typically in a throwaway single sentence or short paragraph, revealing that the Commission had easily dismissed the possibility. In each of the remaining 62 mergers, the text of the Commission’s report includes a non-trivial discussion of the possibility that the merger might lead to collective dominance in at least one of the markets potentially impacted upon by the merger. It is this subset of cases which forms the database for the current paper. Hereafter, it is referred to as the CD sample.

Some key characteristics of the CD sample mergers

A Collective dominance is an issue in a only a small proportion of all mergers

In no year of this period did the mergers in this sample account for more than 4% of the total. This suggests that it would be futile to use this database to test any time series based hypotheses (for example, that the Commission was increasingly more inclined or disinclined over time to intervene on the grounds of collective dominance).

B All mergers are horizontal

A reading of the merger reports confirms that there are no instances which entail significant vertical or portfolio dimensions.

C Most mergers are multimarket, but typically involve similar product markets

In any jurisdiction, most big mergers will involve more than just one product market, and in the European context this is likely to be even more pronounced due to the important geographical dimension - most mergers impact on more than just one Member State, and, more often than not, the European Commission judges markets to be national rather than europe-wide or world-wide. (For this sample, over 60% of markets were judged to be national.)

In this set of 62 mergers, we have identified 367 different markets in which the Commission reported overlaps between the merging parties, and for which there are useable data. Thus, the average merger covered six different markets, but the distribution is heavily skewed around this average (Table 2).

Table 2 Number of product markets by merger

Markets	Mergers	Number of mergers involving:		
		Only one 4-digit industry	Two 4-digit industries	Three 4-digit industries
1	18	18		
2-4	27	26	1	
5-9	6	4	2	
>10	11	7	3	1
Total	62	55	6	1

However, for nearly all 62 mergers, the different markets covered are very closely related in product space. This is either because the merger impacts on exactly the same product market in more than one country, and/or because, even where more than one product market is involved, they are closely related. For example, in terms of the NACE industry classification, used by the Commission, for 55 of the mergers, all markets covered by each merger belonged to the same 4-digit industry⁹ and six involved only two 4-digit industries.¹⁰ As will be seen this is an important feature of the data.

D Markets typically involve only one, two or sometimes three major players

Most EC merger decision reports provide sufficient information to estimate the market shares of the leading players in each market, both before and after the proposed merger.¹¹ However the Commission very often only reports shares within size bands, e.g. 30-40%. In those cases, our standard procedure is to take the midpoint of the range. This is unavoidable, but it is acknowledged that this adds a degree of imprecision to all results reported in this paper. But with this caveat, these market share data provide a rare insight into the types of market structures which may be considered to be conducive to tacit collusion, at least, as seen through the eyes of one major CA.

⁹ The market definitions used in CA investigations, including mergers, are typically less aggregate than the 4-digit level. Nevertheless, the 4-digit definition is still fairly disaggregated and typically groups together markets which are closely related on both the demand side and in terms of technology. There are over 700 4-digit industries

(http://ec.europa.eu/comm/competition/mergers/cases/#by_nace).

¹⁰ Even the one exception (Alcan-Pechiney) involving three 4-digit industries was confined to a small cluster within the Aluminium sector: Licensing of technology (CB.13.20), Standard flat roll products (DJ.27.32) and Cans, foil, packaging, aerosols etc (DJ.28.72).

¹¹ It is the convention for most CAs to 'estimate' the post-merger market share of the merging firms by simply adding their pre-merger shares. We also adopt this convention here. However, it should be emphasised that this is not the same as the actual market share of the merged firm post-merger. Not only is the report produced at the time of the proposed merger, and is ex-ante, but it also fails to acknowledge a general result from the theoretical equilibrium literature – typically, a merging firm will choose to produce less after the merger than did the sum of the constituent firms pre-merger (see, inter alia, Farrell and Shapiro (1990), Salant et al (1983)).

Table 3 Post-merger market shares* in the CD sample

Number of markets with:

Range (%)	S1	S2	S3	S4	S5
$S_i > 10$	366	340	186	53	8
$S_i > 15$	361	286	75	9	
$S_i > 20$	353	240	33		
$S_i > 25$	328	163	3		
$S_i > 33$	267	87			
$S_i > 40$	157	11			
$S_i > 50$	78				
$S_i > 60$	36				
Mean	42.4	25.3	11.8	6.4	3.5
Max	95	47.6	33.3	20	15.8
Min	5	3.7	0	0	0

* See note 14 for definition of post-merger shares.

Table 3 reports the distribution of market shares across markets for each of the top 5 largest firms. As an illustration of how to read the table, suppose a 'significant' market share is defined to be 15% or more. In that case, reading backwards across the second row, the sample includes 9 markets in which there are four significant players - call them quadropolies; 66 (=75-9) triopolies; 211 (=286-75) duopolies; and 75 (=361-286) monopolies.

Of course, 15% is an arbitrary yardstick, but any plausible alternative would yield a qualitatively similar conclusion: broadly speaking, markets in this sample are typically very small-number oligopolies. The large majority (about 75% on our criterion) are either monopoly or duopoly, with the other 25% being triopolies or, in a very few cases, quadropolies. This is confirmed by the modal size classes (not visually obvious from this form of the table): 40-50% for the #1, 20-40% for the #2; and 0-10% for 3rd, 4th and 5th firms. A similar pattern is true for the means.

The Commission's decisions

Although the defining feature of mergers in this sample is that the Commission obviously considered the possibility of collective dominance, in the event, it actually intervened in only 25 (Table 4). Hereafter, we refer to the two sub-samples of mergers as:

INTMERGERS: the 25 mergers in which the Commission intervened in one or more of the markets covered by the merger

NONINTMERGERS: the 37 mergers in which there was no intervention in any market - the merger was cleared without any remedy

The Commission's report on any merger discusses each market in which there are overlaps between the merging parties. In each case, it judges whether intervention is required in the market concerned. A key feature of the 25 INTMERGERS is that intervention at the merger level does **not** mean that intervention was required in all markets covered by the merger (Table 4). Indeed, in aggregate, these mergers involved 222 different markets, but the Commission chose to intervene in only just over half (118).

Table 4 Types of decisions at the market level

	Total	INTMERGERS	NONINTMERGERS
Mergers	62	25	37
Markets	367	222	145
Non-interventions	249	104	145
Interventions	118	118	0
<i>of which:</i>			
SD	73	73	0
CD total	45	45	0
<i>of which:</i>			
CD-DUO	29	29	0
CD-TRI	1	1	0
CD-LINKS	15	15	0

Moreover, by no means all market interventions were to avoid collective dominance. Usefully, the Commission reports spell out, for each market, the theory of harm which the intervention is designed to rectify – either single or collective dominance (hereafter SD and CD). In fact, SD interventions outnumber CD decisions – 73 as opposed to 45.

In summary then, there are two sub-samples in the CD sample, distinguishing whether or not the merger was challenged. Even within the sub-sample where intervention did occur, there are differences between markets: single dominance, collective dominance and non-intervention are all possible. These turn out to be crucial features of the database.

Markets with collective dominance

Most commonly, the Commission identifies collective dominance as the theory of harm when the post-merger market would include just two remaining 'large' firms, who it believes would tacitly collude post-merger. We refer to these 29 markets as **CD-DUO**. There is only one case in which collective dominance would involve 3 firms post-merger (**CD-TRI**) – the infamous Airtours merger. This is a striking finding: it appears that, in the eyes of the European Commission, collective dominance (tacit collusion) is effectively a problem associated with duopoly.

There is however another class of cases which the commission identifies with collective dominance. This is where the merger would lead to a market structure in which only a few significant players remain, and where one or more of them are 'structurally linked' in some way. Most commonly, the links refer to common shareholders/shareholdings amongst a pair of firms, but

occasionally, they do not relate to common ownership, e.g. petrol swaps amongst the majors in retail petrol. But in all such cases, the Commission treatment appears to be the same, namely linked firms are effectively viewed as a single entity.¹² We refer to these cases as **CD-LINKS**.

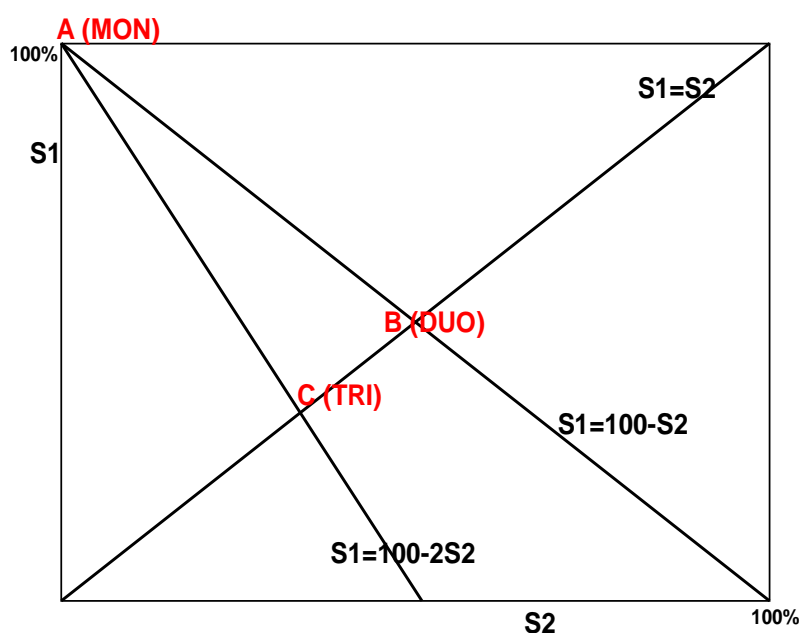
4 The oligopoly triangle

This section presents a simple graphical device which helps specify the key dimensions of structure in this context. It builds on two of the above features of the database: (i) the vast majority of markets in this sample are either monopolistic or duopolistic, and (ii) the Commission never associates collective dominance with markets of more than two significantly sized firms - with only one exception. In these circumstances, a remarkably concise way of displaying the key structural features of the markets in this sample is to plot the market shares of the #1 and #2 ranked firms, post-merger.

Literal triopoly

In a market with just a literal triopoly of firms, plotting the market share of the largest firm (S1) against that of the second (S2) provide a complete characterisation of market structure.

Figure 1 The Oligopoly Triangle



¹² As an illustration, in M.1517 Rhodia/Donau Chemie/Albright & Wilson (1999), 'Rhodia has structural links with Prayon...(and it) has been suggested that Rhodia and Prayon are commercially regarded as one block in the market. If this is true one might add Prayon's...market share to the parties'.

First, note that the (S2, S1) point must lie in the small triangle ABC, bounded by the three lines shown in figure 1:

$$\begin{aligned} S1 &= S2, && \text{since } S2 \leq S1 \\ S1 &= 100 - S2, && \text{since } S1 + S2 \leq 100 \\ S1 &= 100 - 2S2, && \text{since } S3 \leq S2 \text{ and therefore } 100 - S1 - S2 \leq S2, \text{ i.e. } 100 - 2S2 \leq S1. \end{aligned}$$

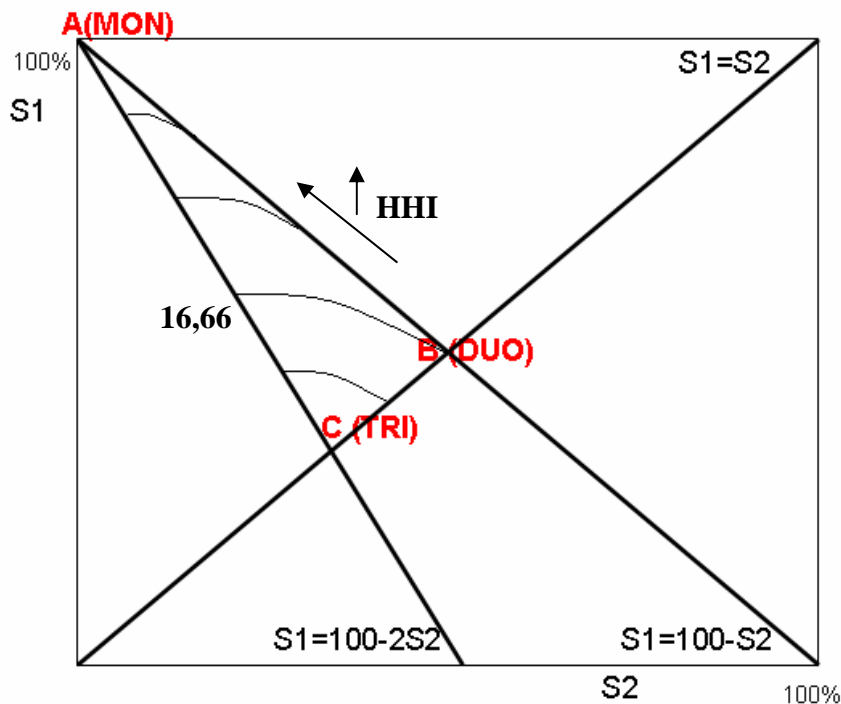
Second, note that the three corners of ABC portray the three limiting market structures: monopoly (MON), symmetric duopoly (DUO) and symmetric triopoly (TRI). Third, and more generally, representing concentration by the combined share of the two largest firms, this increases with moves in a northeasterly direction, being highest (100%) along AB, and lowest at C (67%). Increasing size asymmetries between S1 and S2 moves the point in the direction from B to A, and increasing asymmetries between S1 and S3 move it from C to A. In such a literal triopoly, one might perhaps expect a CA to find dominance wherever the point was in this triangle – more likely, single dominance in the area towards A and collective dominance in the area towards B (duopoly) or C (triopoly).

Interpretation of the triangle becomes less clear-cut once other smaller firms appear in the market (with aggregate share F). Although it remains true that the location of any point reveals both the level of concentration (S1+S2) and the degree of asymmetry between S1 and S2, there is now an indeterminacy on the relative sizes of S3 and F. So long as $F + S3 \leq S2$, then the point will remain within ABC triangle, but now location at point C, for example, can not discriminate between literal triopoly and symmetric duopoly coupled with a large fringe. More generally, with a more sizeable fringe, markets may be located below AC, and the diagram alone is insufficient to tell us anything other than the combined share and ratio of S1 and S2. Having said this, as just noted, most markets in this sample have only one or two significant players, and the Commission has only in one instance judged a market to be collectively dominant by virtue of three large players.

Relationship to HHI index

The triangle also illustrates an important deficiency in the familiar Hirschman-Herfindahl index (HHI) in this context. Although this is widely used in competition economics and usually plays a prominent role in merger guidelines, it is a particularly blunt tool for identifying size asymmetries amongst the leading firms, and is misleading when attempting to identify the likelihood of collective dominance.

Figure 2 Iso-HHI curves in the Oligopoly Triangle



To illustrate why, figure 3 depicts a family of “iso-HHI curves”. Each curve describes the locus of S_1 , S_2 pairs consistent with a given HHI value (assuming $N=3$ ¹³), and is quadratic in S_1 and S_2 ¹⁴. With increasing values of HHI, the curves move in a northerly direction, each having a maximum along AC and declining monotonically until its intersection with AB. Thus, movements towards A are associated with higher concentration and high and increasing values of HHI should be useful indicators of the likelihood of single dominance. But the same is not true for collective dominance. As market structures become more symmetric, such as depicted by points B or C, the HHI index actually falls. Moreover, HHI does not discriminate between structures which one might expect to be conducive to either single or collective dominance. For example, the curve for $HHI = 2500$, shown in the figure, is consistent with both asymmetric triopoly (66.7, 16.3, 16.3) and perfectly symmetric duopoly (50, 50), structures likely to be indicative of single and collective dominance respectively.¹⁵

Fitting the Commission’s decisions to the triangle

As a descriptive preliminary to the econometrics below, Figure 3 uses the triangle construction to depict structures and decisions for the present database. Thus, figure 3(a) shows all 367 markets, distinguishing the markets

¹³ Or, equivalently, assuming that no firm outside the top 3 has a significant market share. The HHI index is relatively insensitive to the addition of small firms because it is the sum of squared market shares.

¹⁴ Since $HHI_0 = S_1^2 + S_2^2 + S_3^2 = 2S_1^2 + 2S_2^2 - 2S_1 - 2S_2 + 2S_1.S_2 + 1$, then $S_1^2 + S_2^2 - S_1 - S_2 + S_1.S_2 + (1 - HHI_0)/2 = 0$

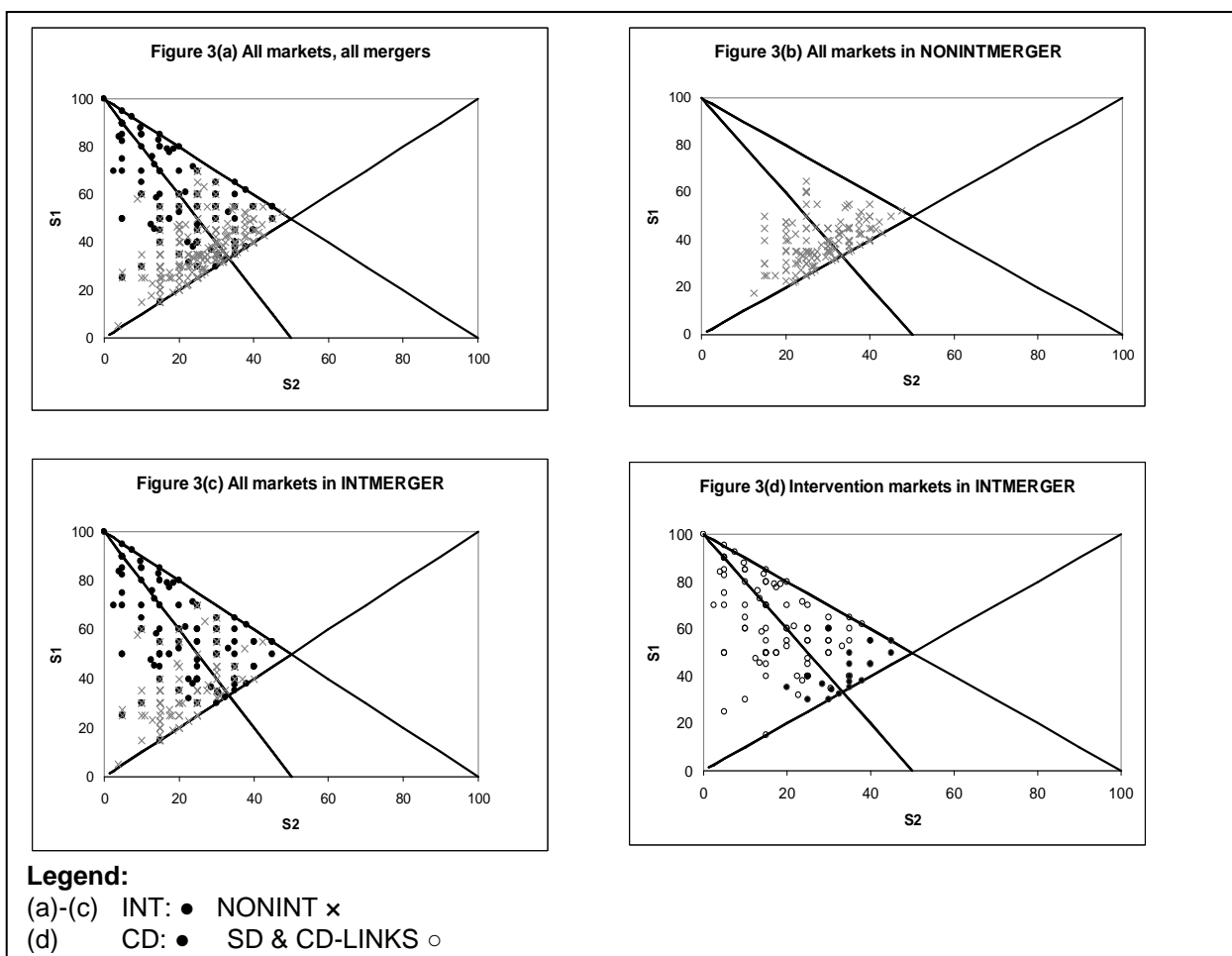
¹⁵ Algebraically, this is because HHI is positively related to the magnitude of size asymmetries for given numbers. It can easily be shown that $HHI = (C^2 + 1)/N$, where C is the coefficient of variation of market share – an obvious measure of size inequalities.

with and without interventions. Unsurprisingly, interventions are most common towards the top left corner, extending even below the literal triopoly segment of the diagram. This indicates that in a market where a merger creates a singly dominant firm, intervention is likely, even where there is a sizeable fringe, so long as there is no other major player in the market. On the other hand, non-intervention becomes much less likely in markets which lower concentration and with more symmetry between S1 and S2.

Figure 3(b) is confined to the markets in the NONINTMERGERS sub-sample. By definition, none of the markets involved in these mergers was intervened. While the scatter is clearly less dispersed, clustering closer to the line of symmetry between S1 and S2, a number of these markets are highly concentrated – clearly, high concentration is insufficient for the Commission to intervene in a market.

Figures 3(c) and 3(d) refer to the INTMERGERS sample of mergers. As explained earlier, although all mergers in this sub-sample have some markets which were challenged, there are also a large number of markets in which no intervention was required. It is this set of markets which forms the basis of the econometric modelling below. As can be seen (figure 3(c)), the scatter is dispersed widely within and below the triangle, indicating a full range of differing market structures, both in terms of concentration and inequality between S1 and S2. Finally, focussing only on those markets in INTMERGERS in which intervention occurred (figure 3(d)), and distinguishing single from collective dominance, there is clear evidence that, with some exceptions, the Commission typically employs a ‘symmetry screen’ to the sizes of S1 and S2 – very few interventions against collective dominance occur very far from the main diagonal. Having said this, single dominance has sometimes been found for markets with fairly symmetric firm sizes.

Figure 3 Fitting the Sample Mergers and Markets to the Oligopoly Triangle



It is clear from these simple diagrams that any explanation of the Commission's decision-making should acknowledge two features of the size distribution – the level of concentration – which can be adequately captured here by the sum of S_1 and S_2 , and some indicator of the inequality in size between the top two firms, S_1/S_2 or vice versa.

5 A Model of the CA's decision-making

In its assessment of any horizontal merger,¹⁶ we assume the European Commission makes a **simultaneous**¹⁷ choice between three alternative options, for each market covered by the merger in which the parties have overlapping market shares:

- NI: Non intervention
- SD: Intervention by requiring remedies¹⁸ to avoid Single Dominance

¹⁶ For simplicity, we do not discriminate between whether the decision requires relatively brief or more extensive analysis (phases 1 and 2 respectively in the European context).

¹⁷ Below, we also test an alternative, two stage, sequence in which the CA first decides whether or not to intervene, and then, if intervening, whether on the grounds of single or collective dominance.

¹⁸ As throughout, 'remedies' includes, as a rare occurrence, outright prohibition, in which case the decision applies to all mergers covered by the merger.

- CD: Intervention by requiring remedies to avoid Collective Dominance

The choice is based on an assessment of the likelihood of competitive harm, employing the published guidelines.¹⁹ These typically enumerate a list of relevant merger and market characteristics. For convenience, these are referred to as:

- **S, a vector of structural indicators S:** market shares, concentration and changes therein,
- **X, a checklist vector of market characteristics X:** the existence of entry barriers, price transparency (in the case of collective dominance), absence of buyer power amongst customers, excess capacity etc.,
- Sometimes, the CA also refers to subsidiary evidence of competition and potential competition, beyond these merely static measures. This might include the scope for future supply side substitution from outside the narrowly defined industry, competition for the market (innovation), fluctuating market shares, etc.. We refer to these in shorthand as **dynamic measures of competition**.

It is assumed that the X variables have the status of a necessary, but not sufficient, condition for finding dominance (competitive harm). For example, given free entry or strong buyer power, the Commission will not judge the merger to have any competitive harm – regardless of the level of concentration or market shares of the leading players. But where the conditions are satisfied, the merger is deemed to have the *potential* for dominance, and we refer to the merger as satisfying the **necessary X conditions** in the market concerned. Crucially, although these X characteristics are observable by the CA, they are inherently unmeasurable in any objective way by the econometrician.

The **dynamic measures** play a less pervasive conclusive role – they are not always explicitly referred to in reports and do not appear to be routinely factored into the decision process. Therefore, we do not attribute them with the status of necessary conditions, nor do we attempt to include them in the estimation below.

Specification of the structural model

On the other hand, the structural indicators are observed, measured and reported in decisions by the Commission. We assume that the Commission employs a consistent structural model, based on these indicators, in evaluating whether the merger would result in a market structure leading to potential competitive harm, and, if so, whether from single or collective dominance. The purpose of the econometric analysis below is to identify the form of this structural model.

¹⁹ See the guidelines for the US: <http://www.usdoj.gov/atr/public/guidelines/hmg.htm>, and the EU: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2004/c_031/c_03120040205en00050018.pdf

It is hypothesised that the Commission's structural model has two dimensions:

- the level of concentration and
- size symmetries amongst the leading players

In general, there is a wide variety of candidate measures for both, but we can readily narrow down the choice here by appealing to the above descriptive analysis. We know that it is rare for the European Commission to intervene in markets where the share of the largest two firms is not large, and with only one exception, collective dominance is never confirmed with more than two players involved. Therefore, we opt for the simplest specifications, requiring information on only the market shares of the largest two firms:²⁰

- concentration is measured by the sum of the market shares of the two largest players, post-merger: $SUM = S1+S2$
- size symmetry is measured by the ratio of the market shares of the two largest players, post-merger: $RATIO = S2/S1$

Since CA guidelines typically refer to both the potential **levels** and **changes** of market shares and concentration post-merger, we also include:

- Change in concentration: CHASUM
- Change in asymmetry: CHARATIO

From the descriptive triangles above, expectations are straightforward: higher values of SUM and CHASUM should make both collective and single dominance more likely, and higher values of RATIO and CHARATIO should make collective dominance more likely than single dominance.

Given these assumptions, the CA's decision can be specified as in two parts:
I Are the necessary X conditions for potential dominance satisfied?
II If yes, does the structural model point to SD, CD or neither?

Although it might be natural to think of this as a *sequential* two-part decision, in practice we suspect that CAs typically collect the required data, and answer the two questions, simultaneously. In any event, the sequence is irrelevant for our purposes - all that matters is that the structural model only effectively comes into play when the necessary X conditions are satisfied.

We assume that the choice between the three alternatives can be modelled using a multinomial logit estimator (MNL). Thus, using the conventional

²⁰ In general, one might expect that the shares of the 3rd largest and other smaller firms might also play a role, but, to anticipate, experiments distinguishing S3 from the fringe of smaller firms add no explanatory power to the estimated model. Also, note that, in this formulation of the model, firms 1 and 2 are 'anonymous' in the sense that the merged firm might be ranked either number 1 or 2, or neither. In fact, in 71% of all markets in this sample, the merged firm would become: #1 post-merger, and #2 or #3 in 23% and 5% respectively.

terminology,²¹ for market j in merger i , the ‘utility’ the Commission derives from choosing action k ($k= NI, CD$ or SD) is:

$$U_{ijk} = a_{ijk} + b_{ijk} \text{SUM}_{ij} + c_{ijk} \text{CHASUM} + d_{ijk} \text{RATIO}_{ij} + e_{ijk} \text{CHARATIO}_{ij} + \varepsilon_{ijk} \quad (1)$$

where ε is an unobservable error term, assumed to be mutually independent distributed according to a Type I extreme value distribution.

The probability that the Commission chooses action k is as follows:

if the necessary X conditions are satisfied:

$$\Pr\{y_{ij} = k\} = \Pr\{U_{ijk} = \max (U_{ijNI}, U_{ijSD}, U_{ijCD})\} \quad (2a)$$

if the necessary X conditions are not satisfied,

$$\Pr\{y_{ij} = NI\} = 1, \Pr\{y_{ij} = SD\} = \Pr\{y_{ij} = CD\} = 0 \quad (2b)$$

Note that, in employing this model of decision-making, we make the assumption that the choice between the alternatives is simultaneous, and of the independence of irrelevant alternatives (IIA). Below, we test for IIA and also experiment with an alternative two-stage decision process.

6 Empirical Methodology

Our purpose here is to isolate the form and parameters of the structural model, as in equation (1), having ‘controlled’ for the other X market characteristics. However, this presents a major methodological problem. We have argued that these other characteristics, while observable by the Commission, are inherently unmeasurable in any ‘objective’ manner by outside researchers: concepts such as barriers to entry, buyer power and price transparency defy direct measurement. Moreover, we prefer not to follow the traditional route of ‘measuring’ the X variables by constructing proxies and/or categorical dummy variables, based on available qualitative information. Although this has been the norm in the previous literature in this area, (see section 2), we find this unattractive for the following reason. The only practicable source of evidence on these characteristics is the information provided by the CA itself in its merger reports, and this poses two problems. First, many reports are short and do not include sufficient information. Second, even if one were able to form an accurate reading of the Commission’s assessment for every relevant market characteristic in every case, by its nature, such an exercise would be intrinsically logically circular. Ultimately, a merger report is a subjective justification by the decision-maker of its decision. Since the decision-makers are publicly accountable, ultimately

²¹ See, for example, Greene (2003, section 21.7)

to the courts, it is highly improbable that they will cite 'evidence' which is contrary to their own published guidelines. For instance, it is unlikely that any CA would intervene in a market unless it believed that entry barriers were significant. As such, to construct an explanatory variable recording entry barriers as 'high', based on statements to that effect in the report, would be to construct a variable which would be a more or less perfect predictor.

Identifying an appropriate sub-sample: INTMERGERS

Our solution to this problem is to employ a methodology which avoids the need to 'measure' these X variables. Instead, we proceed by carefully selecting a sample of markets for which there is reason to believe that all the necessary X conditions are satisfied, and then, only within that sample, to attempt to discriminate between the Commission's decisions (CD, SD or NI) in terms of the structural model.

To identify such a sample, we recall an important feature of the sample mergers and then introduce an additional assumption. First, recall from section 3.3 (fact D) that virtually every merger in the CD sample, although usually multimarket, impacts on a set of very closely related markets. Thus, in 55 of the 62, all markets covered by each merger are located within the same 4-digit NACE industry. We now introduce an additional assumption:

Mergers are X-homogeneous: all markets covered by a given merger share the same X market characteristics.

In other words, we assume that all X market characteristics are substantively similar merger-wide, rather than being market-specific within the merger. This is clearly an approximation, but not unreasonable if the product characteristics and supply conditions are broadly similar for a given product market in different countries, or to very closely related narrow markets within the same 4-digit industry. So, for example, if there is insufficient buyer power, potential for entry etc to constrain dominance in the Belgian widget market, the same is likely to also be true for the widget market in all other member states.

If so, it follows that, if the Commission is observed to have intervened in the market for blue widgets in Belgium, the necessary X conditions for dominance will have been satisfied not only for Belgian blue widgets, but also, by implication, for all other markets covered by the same merger (e.g. blue widgets in France, red widgets in Belgium etc).

This line of reasoning suggests that we can assume that the necessary X conditions for dominance will have been satisfied for *all* markets covered by any merger in which the Commission has intervened in one or more markets. The set of mergers satisfying this criterion is the INTMERGERS sub-sample as described earlier. As such, this sub-sample provides scope for a controlled experiment, in which the necessary X conditions have been controlled for (satisfied), leaving the opportunity to apply the structural model to discriminate between the Commission's decisions for all markets within those mergers. It should be stressed that this is not a circular exercise. Although, for each of these mergers, the Commission intervened in at least one market, it did not

intervene in all markets. As shown in Table 4, the 25 mergers in INTMergers account for 222 different markets, in which there are differences not only in the nature of intervention (45 for CD and 73 for SD), but also a sizeable number of markets (104) in which there was no intervention.

An indirect test of X-homogeneity

Given the central role of the X-homogeneity assumption in this research design, a test of its validity is clearly desirable. Direct tests are impossible, given the inherent unmeasurability of many of the X-characteristics, but an indirect test is feasible. This uses one other convenient feature of the database.

Whenever the Commission decides not to intervene in a market, it typically explains its reasons – usually in terms of market structure variables, the X market characteristics and sometimes also the dynamic measures of competition. This provides the opportunity to assess the model in terms of its predictive power for individual observations (markets). We use this information in three ways to test the X-homogeneity assumption.

First, when fitting the model only to the (appropriate) INTMergers, assuming that we have correctly specified the structural model and that X-homogeneity is valid, we should expect not only a close fit, (i.e. few incorrect predictions) but also, where the equation does incorrectly predict intervention in a market, the Commission's stated reasons for non-intervention should include neither market structure reasons nor the absence of necessary X conditions.

Second, when the model is fitted (inappropriately) to the full sample, including mergers in NONINTMergers, incorrect predictions of intervention are to be expected for both sets of reasons. A number of NONINTMergers mergers will presumably *not* have satisfied the necessary X conditions. Moreover, since the X variables are necessarily excluded from the model, not only is a poorer predictive power probable, but also the estimated parameters of the structural variables are likely to be biased. Biased estimates of the structural model may therefore incorrectly predict interventions – even in those cases where the necessary X conditions are satisfied.

Third, returning to the estimated parameters from the INTMergers equation, these can be used to predict (out of sample) decisions for NONINTMergers. In this case, because estimates should not be biased, the proportion of incorrect predictions should decline and crucially, all should correspond to cases where the Commission cites the absence of necessary X conditions.

7 Results

The results of fitting the multinomial logit are reported in Table 5. Initially (Table 5(i)), the model is estimated excluding CHASUM and CHARATIO

because, for about a quarter of all markets, the Commission's reports provide insufficient information on the pre-merger market shares.²² Table 5(ii) reports the results for the smaller sample for which we are able to compute pre- and post-merger shares, and thus the changes.

Table 5(i) Multinomial logit results, levels

	(i)	(ii)	(iii)	(iv)
Sample	INTMERGER	Total	Total	INTMERGER
N	222	367	367	222
SD				
HHI			0.00104** (0.000104)	0.00114** (0.000187)
SUM	0.0608** (0.0101)	0.0494** (0.0114)		
RATIO	-5.650** (1.175)	-7.554** (1.096)		
Constant	-1.521** (0.540)	-0.551 (0.711)	-4.540** (0.490)	-3.718** (0.451)
CD				
HHI			0.000489** (0.000134)	0.000663** (0.00025)
SUM	0.0985** (0.0191)	0.0602** (0.0158)		
RATIO	8.508** (2.171)	4.437** (1.413)		
Constant	-14.524** (2.162)	-9.907** (1.644)	-3.525** (0.644)	-2.987** (0.727)
Pseudo R2	0.445	0.385	0.212	0.244
LL	-121.8	-182.2	-233.4	-165.9
Correct predictions (%)	79	80	77	66
SD (%)	77	66	43	66
CD All (%)	80	32	27	32
CD-DUO & TRI	69	0	0	0
CD-LINKS	100	93	80	93
NI (%)	80	93	95	81

Estimated standard errors in parentheses, ** indicates significance at 99% level, * at the 95% level. Equations are estimated with observations clustered by merger, and are corrected for any heteroscedasticity.

²² In other words, the Commission only reports the post-merger share of the merged firm (i.e. the sum of the merged parties' pre-merger shares), and not their individual pre-merger shares.

Table 5(ii) Multinomial logit results, including changes

	(v)	(vi)
Sample	INTMERGER	INTMERGER
N	174	174
SD		
HHI		0.000795** (0.0000694)
CHAAHI		0.00352** (0.00103)
SUM	0.0881** (0.0143)	
RATIO	-4.363** (1.691)	
CHASUM	0.0608 (0.0510)	
CHARATIO	-5.831** (2.129)	
Constant	-5.472** (1.098)	-5.190** (0.580)
CD		
HHI		0.000665* (0.000288)
CHAAHI		0.00150 (0.000957)
SUM	0.104** (0.018)	
RATIO	8.707** (2.535)	
CHASUM	0.0800* (0.0397)	
CHARATIO	-2.442 (1.534)	
Constant	-15.69***	-3.833** (0.912)
Pseudo R2	0.495	0.349
LL	-87.5	-112.7
Correct predictions (%)	78	74
SD (%)	75	74
CD All (%)	77	23
CD-DUO & TRI	71	0
CD-LINKS	100	100
NI (%)	80	93

Equation (i) shows our preferred version: the structural model fitted only to the markets in INTMergers.²³ As can be seen, CD and SD are both significantly more likely the higher is concentration (SUM); and single (collective) dominance is less (more) likely the larger (smaller) is RATIO: thus, we can confirm the expectation that collective dominance becomes more likely the more equally sized are the top two firms. The model successfully predicts the Commission's decisions (including CD) in roughly 80% of all markets. A standard χ^2 test confirms that we can accept the Independence of Irrelevant Alternatives.

Figure 4 Predicted decisions within the triangle (from eqn. (i), Table 5)

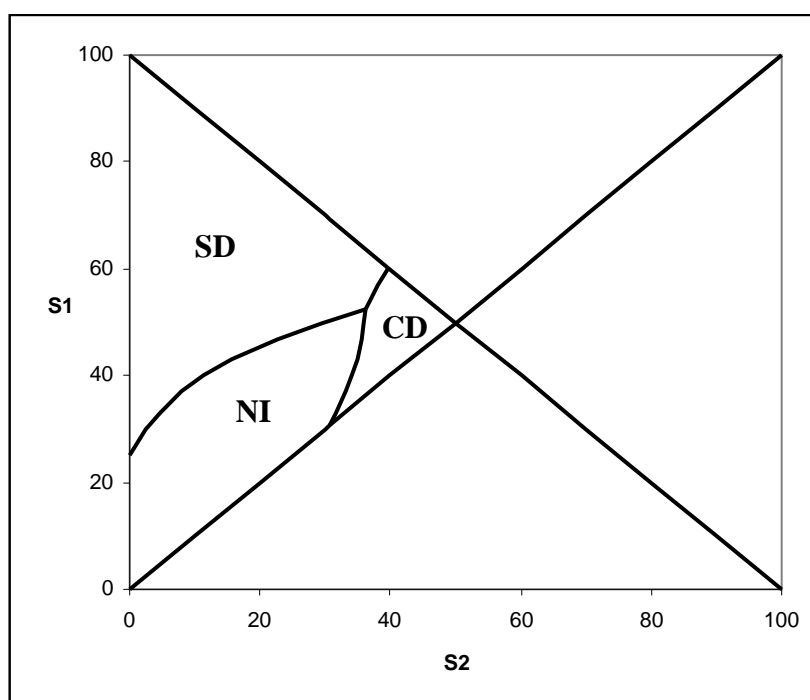


Figure 4 illustrates the results graphically in terms of the oligopoly triangle. The three regions are computed using the estimated parameters from (i) and depict for the {S1,S2} pairs the decision which the equation predicts as most probable. We return to a numerical translation in the next section, but, for the moment, note that collective dominance is the most likely outcome for only a relatively small area located near to the point of symmetric duopoly.

Equation (ii) fits the same equation, but now (inappropriately) to the full sample including mergers in NONINTMergers. The signs and significance of coefficients are unaffected but now the model fails completely to correctly

²³ In all results shown, the CD-LINKS cases are treated as single dominance decisions, recording the market shares of structurally linked firms as single entities. This is in accordance with the Commission's own reports, although they do not refer to CD-LINKS as equivalent to single dominance. In preliminary experiments, not shown here, equation (i) was first estimated excluding and then including the 15 cases concerned in INTMergers – all coefficients estimates and significance were virtually identical across the two equations.

predict cases of collective dominance.²⁴ This confirms our expectation that failing to control for the excluded X variables (as in NONINTMERGERS) seriously impairs the predictive power of the model. As can also be seen, the point estimates of the coefficients in (ii) are noticeably different from those in (i). Again, this is to be expected: estimating the model on a sample which includes an omitted variable which might be expected to differ significantly between INMERGERS and NONINTMERGERS may well lead to biased estimates.

Equations (iii) and (iv) provide a yardstick against which to assess our model. In this case, the HHI index is used as the structural measure, first for INTMERGERS, then for the full sample. While the estimated coefficients in both equations show that both types of intervention are significantly more likely the higher is the HHI index, the fit is quite low and the equation fails to correctly predict²⁵ any CD decisions and less than half of the Commission's SD interventions. This confirms the earlier expectation from figure 2 that the HHI index is a very blunt tool for identifying likely cases of collective dominance.

We now turn to the second step in our tests of the model: close examination of the model's *incorrect* predictions of CD. When estimated on the (appropriate) INTMERGERS, the model predicts collective dominance in 42 markets (column 1 of Table 5). Only seven of these predictions are incorrect, in that the Commission decided against intervention. Moreover, in none of the seven does the Commission cite as its reason for non-intervention the absence of the necessary X conditions. This offers very strong support for our key assumption of Merger X-homogeneity – there is no evidence for this sub-sample that exclusion of X variables has compromised the estimates. On the other hand, when estimated on the full sample, as explained already, the model does not successfully predict any of the cases of collective dominance, except for those involving structural links.

However, when applying the estimated coefficients from equation (i) to predict outcomes (out of sample) for NONINTMERGERS, collective dominance is predicted for 43 of the 145 markets concerned. Of course, these predictions are all incorrect – by construction, INTMERGERS sample includes all mergers in which the Commission decided not to intervene in any of the markets. What is relevant here are the reasons given by the Commission for non-intervention in these 43 markets. As can be seen, (column 2 of Table 6), for 33 of the markets, the Commission's cited reasons were that one or more of the necessary X conditions was not satisfied – most frequently, that price was not transparent. Again, this is strong support for our strategy of focussing on the INTMERGER sub-sample. It is clear that, outside of these mergers, the necessary X conditions are frequently not satisfied, making it impossible to isolate structural factors.

²⁴ Except CD-LINKS which, as explained in the previous note, are treated here as single dominance, having added together the post-merger shares of the linked firms.

²⁵ Throughout, conventionally, we take the model's predicted outcome as the one with the highest probability of SD, CD and NI.

Turning more briefly to the other reasons for non-intervention, structural reasons were given in two cases within INTMergers and four within NONINTMergers. Arguably, these are the markets for which the structural model ‘fails’. However, these may equally be interpreted as evidence of inconsistent decision-making by the Commission – the proportions are not large (5% and 10% respectively) and such a relatively low incidence of inconsistency would not be surprising over a 15 year period covering hundreds of different markets. Finally, in about 10% of the markets in which the Commission chose not to intervene, the reason given was supplementary evidence that competition was still likely to be effective, in spite of high static concentration, because of dynamic factors. Since our structural model is static and has not attempted to capture such factors, such explanations are relegated in effect to the disturbance term.

Table 6 Incorrect predictions of Collective Dominance: reasons cited by Commission for non-intervention

	INTMERGER	NONINTMERGER
Markets for which CD predicted	42	43
of which CA did not intervene	7 (16%)	43 (100%)
Explanations for non-intervention		
Necessary X factors not satisfied	0	33 (78%)
Of which:		
Price not transparent	0	26
Buyer Power	0	5
Easy Entry	0	5
Excess Capacity	0	5
Differentiated products	0	8
Structural reasons	2 (5%)	4 (10%)
Asymmetric/fluctuating market shares	1	2
Strong 3 rd player etc.	1	2
Evidence of dynamic competition	4 (9%)	5 (12%)
Innovation etc.	1	4
Fluctuating market shares	3	1
Only small increment in market share	1 (2%)	

Part (ii) of Table 5 re-estimates the model for INTMergers, but now including the change variables CHARATIO and CHASUM, albeit for a smaller sample size (N = 174). Results are fairly robust to the reduction in sample size, the overall fit is substantively unchanged, as are the signs, magnitudes and significance of coefficient estimates on SUM and RATIO. The estimated

coefficients on the new variable, CHASUM, are consistent with the expectation that mergers which increase concentration by more are more likely to attract intervention, but not significantly so for SD. The estimated coefficient on CHARATIO suggests that the more the merger increases size equality, the less likely the Commission is to find SD, but this variable is insignificant (with the 'wrong' sign) for CD. Overall, this is not conclusive evidence that the structural model includes an important recognition of the magnitudes of the changes, as well as of the levels. Again, merely for comparative purposes, equation (vi) returns to the HHI index, as an alternative to our structural model, now including both the level and change in HHI. As before, the equation completely fails to correctly predict any CD cases (except CD-LINKS).

In a variety of other unreported results, we have experimented with alternative functional forms for the structural model, but they add nothing to predictive power. We have also included other explanatory variables – for consistency with practice in the previous literature. However, distinguishing between the phases of the decisions, the identities of the Competition Commissioners, and whether the geographical market definition relates to individual member states, as opposed to the World or the EEA, again fails to identify any additional significant effects.

Finally, we have also experimented with a two stage probit model, with the first stage explaining whether or not the Commission intervenes, and the second stage explaining the type of prediction (whether SD or CD) in those markets where intervention occurs. When judged by predictive power – measured as above by proportion of correct predictions – this model performs noticeably worse than the Multinomial Logit.

8 Implications and conclusions

As explained in the introduction, the immediate purpose of this paper was to identify the European Commission's (implicit) model of collective dominance in the context of mergers. Beyond this, we argued that this might provide some indirect empirical evidence on the structural conditions under which tacit collusion might arise in real world markets. Here, we review both objectives in the light of results.

The Commission's model of collective dominance

It is clear that the Commission views collective dominance as a rare occurrence. Over a 15 year period, covering about 3,000 mergers, we have only identified 62 (about 2%) in which the merger report includes a non-trivial discussion of the possibility that the merger might involve collective dominance in at least one of the markets covered by the merger. Even amongst these cases, the Commission only actually intervened by requiring remedies (or very rarely outright prohibition) to avoid collective dominance in 44 of the 367 markets (11%) covered by those mergers. Thus, the aggregate probability that a merger might lead to collective dominance in a particular market is only 0.2%

In assessing the likelihood of collective dominance in a given market, the Commission is guided by both market structural variables and a set of other market characteristics, such as price transparency and entry barriers. It appears that both sets of variables have the status of necessary conditions – the Commission requires not only that the structural indicators are consistent with tacit collusion, but also that the price is transparent, entry is difficult, etc.

On the structural side, both high concentration and reasonably symmetric market shares of the leading players are required. Strikingly, with only one exception, collective dominance has never been associated with more than just two firms. Our results have helped quantify what is meant in practice by symmetry. As shown earlier in Figure 4, there is only a very restricted range of values for the market shares of the two firms in which collective dominance can arise. As can be seen from the figure, if the larger firm has no more than a quarter of the market ($S1 < 25\%$) the Commission will not intervene, while if it has more than 60%, the decision will be single dominance. It is only in the intermediate range that the share of the second firm becomes important. So long as $S1 < 52\%$, anything is possible: single dominance if $S2$ is very small, no intervention if $S2$ is sufficiently large to counteract the potential dominance of the larger firm, or collective dominance as the two firms become more equally sized. For example, at $S1 = 40$, the decision will be single dominance for $S2 < 12$, non-intervention for $12 < S2 < 33$, and collective dominance for $S2 > 33$. Once $S1 > 52\%$, non-intervention is no longer a possibility, and the choice is simply between single and collective dominance. For example, if $S1 = 50\%$, single dominance is found unless $S2 > 35\%$.

Table 7 Possible outcomes at different sizes for #1 ranked firm

S1 (%)	NI	CD	SD
'Low, <25	√		
'Intermediate', 25-52	√	√	√
'Intermediate-high', 53-60		√	√
'High', >60			√

However, as explained, these estimates refer only to the *structural potential* for collective dominance. It is also necessary that a series of other key market characteristics (the necessary X conditions) are conducive to dominance. An important thesis of this paper is that because many of these market characteristics are not only necessary conditions, but also inherently unmeasurable it is difficult both to quantify their significance, and to isolate the underlying structural model. Our solution to this problem has been to attempt to isolate their impact by careful sample selection. We now return to the earlier results in Table 6 to tease out an assessment of just how important these other characteristics are.

Recall first that Table 6 records the frequencies with which each of these variables were cited by the Commission as a reason for non-intervention in those cases where our model predicted that the structural indicators were consistent with collective dominance. Now combining the INTMERGERS and

NONINTMERGERS sub-samples, there are 85 markets for which the structural model predicts collective dominance²⁶ – conditional on the X conditions being satisfied. Of these, the Commission did not, in fact, intervene in 50, in 33 of which it reports that the X conditions were not satisfied. In that sense, we estimate that the probability that the Commission will not intervene, in spite of market shares which would otherwise suggest collective dominance, because the X conditions are not satisfied is 0.41 (=33/85).

The wider significance of our results for tacit collusion

Turning to the implications of these results for advancing our wider understanding of tacit collusion, what have we learned? One perfectly tenable response, is “nothing, unless one can really trust in the ability of a CA to correctly identify such markets.” But putting aside disbelief, at least for the sake of the argument, some of the above results provide fascinating contrasts with findings from adjacent literatures.

Consider first firm numbers. Here, tacit collusion is virtually never identified with more than two firms. Intriguingly, this resonates with the message which is emerging from the experimental literature on tacit collusion. For example, Huck et al (2004), surveying the literature, suggest that there is some evidence of collusion occurring in duopoly settings, but, in contrast, collusion is rarely found when there are more than two firms. In their own Cournot experiment, varying the number of firms supports this finding: collusion is sometimes found with only two firms, but with three firms Cournot Nash equilibrium behaviour is usual, and with four or more firms even more competitive behaviour is sometimes found. This is in marked contrast with what we know from the empirical literature on cartels, where very often far more than just two firms are involved. On asymmetries, there appears to be little or no systematic evidence from either the empirical cartel literature or from experimental work. However, a casual reading of the official reports on real world cartels suggests that they often involve sets of firms with far greater market share asymmetries than those we have found in the current sample of collective dominance mergers. This is a topic on which further research is merited.

More generally, contrasting the literatures on hard-core and soft (tacit) collusion turns out to be thought-provoking in a number of respects. It raises the obvious question: “are tacit collusion and cartels substitutes?”;²⁷ for example, do firms only look to form cartels when the legally safer option of tacit collusion is unattainable? A further speculative thought is provoked by the Commission’s readiness to intervene against a given merger in some markets on the grounds that it will create single dominance, but in others to avoid collective dominance. Are single and collective dominance seen as alternatives, not only by CAs but also by the firms themselves? After all, if

²⁶ Recall that the 42 within INTMERGERS are within-sample and the 43 in NONINTMERGER are outside-of-sample predictions (generated by applying the model estimated on INTMERGERS to the values of the structural variables observed in the NONINTMERGERS sample).

²⁷ This was the subject of an exploratory presentation made by one of the authors with Hviid (2006). http://www.ccp.uea.ac.uk/publicfiles/Events/collusion_slides.pdf

tacit collusion is unsustainable because of large asymmetries within the group, the implication is that one (or more) firms must enjoy some significant advantage over the others. If so, the choice for the larger firms may well be between pursuing unilateral behaviour designed to exploit that advantage and tacit collusion. Questions such as these raise doubts that the same theoretical model may not be appropriate for all forms of collusion, as well as questioning whether the alternative to either cartels or tacit collusion is necessarily the competitive outcome. Empirically, it suggests a wider research agenda directed by the question: "are there well-defined (i.e. observable and predictable) differences between the conditions which give rise to tacit collusion, hard core collusion (cartels), and single dominance?"

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Annex 1 The CD Sample

Year	Merger	Phase	Decision
1992	M.190 Nestle/Perrier	2	CD
1993	M. 308 Kali+Salz/MDK/Treuhand	2	CD
1993	M.337 Allied Signal/Knorr Bremse	1	NI
1993	M.358 Pilkington/SIV	2	NI
1994	M.390 Akzo/Nobel Industries	1	NI
1994	M.315 Mannesmann/Vallourec/Ilva	2	NI
1994	M.484 Krupp/Thyssen/Riva/Faleck/Tadfin/ASD	2	NI
1996	M.619 Gencor/Lonhro	Prob	CD
1996	M.3314 Air Liquide/Messer Targets	1	CD&SD
1996	M.821 Baxter/Immuno	1	NI
1996	M.818 Cardo/Thyssen	1	NI
1998	M.1082 Allianz/AGF	1	CD
1998	M.1229 American Home Products/Monsanto	1	SD
1998	M. 1225 Enso/Stora	2	NI
1998	M. 1164 GEC/Alsthom/Gegelec	1	NI
1998	M. 1230 Glaverbel/PPG	1	NI
1998	M.1016 PriceWaterhouse/Coopers & Lybrand	2	NI
1998	M. 1223 Tyco International/US Surgical Corp	1	NI
1998	M. 1245 Valeo/ITT Industries	1	NI
1999	M.1467 Rohm and Haas/ Morton	1	CD
1999	M.1524 Airtours/First Choice	Prob	CD
1999	M.1378 Hoechst/ Rhône – Poulenc	1	SD
1999	M.1517 Rhodia/Donau Chemie/Albright & Wilson	1	CD&SD
1999	M.1313 Danish Crown/Vestjyske Slagterier	2	CD&SD
1999	M.1571 New Holland/Case	1	CD&SD
1999	M.1681 Akzo Nobel/Hoechst Roussel Vet	1	CD&SD
1999	M. 1383 Exxon/Mobil	2	CD&SD
1999	M.1551 AT&T/Mediaone	1	NI
1999	M. 1432 Agfa-Gevaert/Stirling	1	NI
1999	M.1539 CVC/Danone/Gerresheimer	1	NI
1999	M.1363 Dupont/Hoechst/Herberts	1	NI
1999	M. 1440 Lucent Technologies/Ascend Communications	1	NI
1999	M. 1491 Robert Bosch/Magneti Marelli	1	NI
1999	M. 1494 SAIR Group/AOM	1	NI
2000	M.2016 France Telecom/Orange	1	CD
2000	M.1741 MCI Worldcom/Sprint	Prob	SD
2000	M.1663 Alcan/Alusuisse	2	CD&SD
2000	M.1630 Air Liquide/BOC	2	CD&SD
2000	M.1882 Pirelli/BICC	2	NI
2001	M.2389 Shell/DEA and M. 2533 BP/E.ON*	2	CD
2001	M.2420 Mitsui/CVRD/CAEMI	2	SD
2001	M.2097 SCA/Metsä Tissue	Prob	CD&SD
2001	M.2314 BASF/Eurodiol/Pantochim	2	NI
2001	M. 2348 Outokumpu/Norzink	1	NI

2001	M.2537 Philips/Marconi Medical Systems	1	NI
2001	M.2498 UPM-Kymmene/Haindl	2	NI
2002	M.2690 Solvay/Montedison-Ausimont	1	CD&SD
2002	M.2886 Bunge/Cereol	1	NI
2002	M. 2810 Deloitte & Touche/Anderson UK	1	NI
2002	M. 2816 Ernst & Young France/Anderson France	1	NI
2002	M. 2824 Ernst & Young/Anderson Germany	1	NI
2002	M.2702 Norsk Hydro/Vaw	1	NI
2002	M.2838 P&O Stena Line (Holding) Limited	1	NI
2002	M. 2965 Staples/Guilbert	1	NI
2003	M.2972 DSM/Roche Vitamins	2	SD
2003	M.3197 Candover/Cinven/Bertelsmann-Springer	1	SD
2003	M.3225 Alcan/Pechiney (II)	1	SD
2003	M.3287 Agco/Valtra	1	NI
2003	M.3276 Anglo American/Kumba Resources	1	NI
2003	M.3268 Sydkraft/Graninge	1	NI
2003	M.3060 UCB/Solutia	1	NI
2004	M.3333 Sony/BMG	2	NI

Prob indicates outright prohibition.

* These two mergers were treated simultaneously in a single judgement by the Commission.