Early Settlement and Errors in Merger Control

Luke Garrod

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Bruce Lyons

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Contact Details:

Luke Garrod, L.Garrod@uea.ac.uk

Bruce Lyons, B.Lyons@uea.ac.uk

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Abstract

We develop a model of remedy offers made to an expert agency which has powers to act before any harm is experienced and is required to decide on the basis of tangible evidence. The model provides a relationship between the factors determining the probability of delay and the type of error in early settlements (i.e. insufficient versus excessive remedy). We apply the model using data from European Commission merger settlements. Our econometric analysis confirms the importance of delay costs and the uncertainty associated with the agency's findings. Our results are also consistent with the prediction that delay is not systematically related to the inherent competitive harm of the merger proposal. We use our results to identify specific cases of insufficient remedy in early settlements.

Keywords: Delayed agreement; settlement; Type 1 and Type 2 errors; EC merger control; merger remedies

JEL: K21 - Antitrust Law; L41 - Monopolization; Horizontal Anticompetitive Practices

1   Introduction

There is a substantial theoretical literature on the settlement of private cases before they go to court. The basic framework is an alleged harm caused to B (plaintiff) by the actions or negligence of A (defendent). A and B are private parties with unrestricted freedom to reach agreement out of court. In this literature, the harm cannot be reversed so the settlement is over the size of a transfer payment. However, the nature of a settlement changes if the harm has yet to happen. The settlement

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can then either over-restrict A's activities and behaviour (Type 1 error), or provide B with insufficient protection (Type 2 error). When the potential harm could be experienced by many parties (e.g. B may be A's customers), transaction costs may justify the establishment of an expert agency with legally delegated powers to act on behalf of the wider group. The agency operates in a legal system and must be able to justify its actions in court if settlement is not reached. Depending on the legal system, the role of the court may be to decide whether the agency made its decision following the appropriate process (i.e. judicial review). This is the setting we investigate in this paper. Alternatively, the court may have the power to make its own decision on the merits of the case.

We apply the model in the context of merger regulation. A merger may be welfare-enhancing if it creates efficiencies, but it can reduce welfare if it increases market power and reduces competition. This delicate balance justifies merger control by a competition agency which can prohibit mergers that are expected to lessen competition. In practice, few mergers are entirely prohibited. Instead, the agency accepts a remedy offer that the evidence suggests will eliminate the parts of a merger that are likely to lessen competition while allowing the remainder to merge.[1]

Merger appraisal is usually determined by a two-phase process, the details of which are jursidiction specific.[2] For example, consider merger regulation by the European Commission. In the first phase, the agency conducts a limited investigation of the likely competitive impact of the merger, towards the end of which the merging parties may propose a set of remedies. If they are proposed, the agency has a short period of time to assess the appropriateness of the offer and, based on its evidence, it either clears the merger subject to the proposal or refers the merger to the second phase. If settlement is not reached in the first phase and the merging parties decide to pursue the merger into the second phase, the agency conducts a more detailed investigation and the merging parties can revise their proposal. The agency clears the merger if it deems the final offer appropriate but, if there is still no settlement after the second phase, the merger is prohibited. The merging parties can appeal for 'judicial review' of the decision in court on the grounds that the agency did not follow due process or made a manifest error. If the court finds against the agency in its judicial review, it cannot substitute its own decision but it requires the agency to take into account all its evidence and to interpret it more

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[1] Remedies are usually 'structural' where the merging parties divest some assets, such as certain products or product rights in particular geographic markets. Alternatively, they can be 'behavioural' where the merged entity's behaviour in certain markets is restricted post-merger for a given period.

[2] In the EU, there are explicit Phases I and II. In the USA, the Second Request is the equivalent of Phase II. In the UK, the two phases are undertaken by independent institutions (the OFT and Competition Commission).

carefully.[3] An adverse finding by the court therefore finds against the agency's professional competence in handling the case. In the US, the role of the court is different as it re-evaluates the evidence and makes its own decision. Different jurisdictions may also differ in who has the effective right to make the last offer of remedies.[4]

In this paper, we make use of three institutional features of European Commission merger regulation in order to structure and test a model of the probability of delay in settlement (i.e. referral to the second phase investigation). The first two features guide our modelling of remedy offers and the third facilitates econometric application.

First, in each phase there are statutory time limits on investigations and there is a precise timetable for the merging parties' final offer. This means that the agency's precision in identifying harmful activities is constrained, especially in the shorter first phase. The agency can only accept or decline what the firms have offered. It cannot make a counter-proposal. Although there is communication between the merging parties and the agency before the final offer is proposed, such communication is cheap talk as the Commission makes its decision only after the final offer deadline.[5]

Second, the Commission must base its decisions on the evidence it collects or it would be exposed to a court judgement impugning its professional competence.[6] It is highly unlikely that a European judge would accept a subtle argument on the basis of the screening or signalling value of an offer by the merging parties, even when it would be rational for a private plaintiff to use such information. In this context, the agency cannot act strategically in the sense of setting case-specific acceptance rules conditioned on the size of offer. The agency must accept, refer or prohibit on the basis of its available evidence, which is not updated in the light of the offer. Consequently, offers by the merging parties are strategic only in the sense that the firms have two opportunities to make final offers, one in each phase, and the first phase offer may be used to attempt an advantageous settlement or to reveal information about the agency's initial evidence.

Third, every merger decision is published in the form of a standardised report.

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[3] As Whish (2003) puts it: "Of particular significance will be a failure by the Commission to give a fair hearing; a failure to articulate properly the reasoning behind the decision; and a failure to base a decision on adequate evidence." [p.278] It is because of the nature of judicial review as a professional discipline that we do not model it explicitly as a further element of the uncertainty in determining offers. The time scale of a judicial review is also such that a prohibited merger has never been resurrected after a successful appeal.

[4] For example, this is the agency in the UK with the firms only able to either accept the offer or withdraw from the merger or appeal for judicial review.

[5] A recent judgment by the European General Court confirms the importance of the final offer deadline for the merging parties (Ryainair's appeal against its prohibited merger with Aer Lingus; case T-342/07, 6 July 2010).

[6] See Vesterdorf (2005) for evidentiary requirements as set out by a leading judge, and Scott (2007) and Zhu (2006) for summary comparisons of the US and EU systems of merger control.

This includes settlements and means that a consistent database can be created for a large number of mergers. In particular, we are able to construct measures of the merger-specific parameters which our theory suggests should influence remedy offers, including proxies for the cost of referral and the accuracy of the agency's evidence.

Our model aims to capture the essential features of the EC merger remedy procedure. The agency's delegated task is to allow any merger unless it finds evidence of likely competitive harm beyond offered remedies. The merging firms calculate an optimal Phase I remedy offer which we show to depend on the cost of delay (i.e. referral to Phase II) and the uncertainty associated with the agency's expected findings, but not systematically on the potential harm of the merger. This offer provides a link between the type of error (over- or under-enforcement) and observable characteristics of the merger. While offers and errors themselves are not observable, we do know if the merger was settled in Phase I or Phase II. This allows us to test the model empirically. We then use estimated probabilities of referral to identify specific mergers that are likely to have been settled with each type of error.

Our empirical results confirm the model's positive predictions that referral to Phase II is more likely if the opportunity cost of delay is relatively small and the agency's decision is more uncertain. The uncertainty effect on settlements has received only limited previous support from the empirical tort literature. As also predicted by our model, referral does not appear sensitive to the potential harm of the merger.

The rest of the paper is organised as follows. Section 2 presents our theory of remedy agreement and discusses alternative assumptions.[7] Section 3 develops the empirical implementation and introduces the data. Section 4 presents our econometric results and discusses them in relation to the wider empirical literatures on tort and merger regulation. Section 5 concludes.

2 Offer, Delay and Error in Settlement

2.1 The model

A proposed acquisition is represented as a set of business assets, some of which may currently compete to a greater or lesser extent with the acquiring firm's businesses. Some combinations of these assets are efficiency enhancing while other combinations have anti-competitive effects. For example, the assets may comprise capacity to produce a homogeneous product. Acquisition of all of this capacity

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[7]There have been few other attempts to model bargaining over remedies in merger regulation. Farrell (2003) applies Nash bargaining to determine the appropriate welfare standard of a competition agency.

would facilitate previously unsustainable tacit collusion, whereas acquisition of only a proportion would have no substantial anticompetitive effect. Alternatively, the proposed acquisition may take the form of a portfolio of differentiated products which each have different cross-elasticities of demand with the aquirer's existing product range. Some product combinations would create unilateral market power while others would have no substantial effect.[8]

Define α as a ranked division of the acquired assets: $\alpha \in [0, 1]$. Assets are ranked such that those with higher rank are no less harmful to competition than those ranked lower. Define $\widehat{\alpha} \in (0, 1)$ as the proportion of assets such that those ranked $\alpha \leq \widehat{\alpha}$ have no substantial adverse effect on competition, while assets ranked $\alpha > \widehat{\alpha}$ substantially lessen competition if retained. This ensures that a settlement which allows the merged entity to keep exactly $\widehat{\alpha}$ of the assets is both desirable and feasible. Write $\alpha = \widehat{\alpha} + z$, then any remedy that is approved with $z < 0$ is a Type 1 error, whereas $z > 0$ is a Type 2 error.[9] A settlement that allows the merged entity to retain α generates profit $\pi(\widehat{\alpha}, z) > 0$ where $\pi_{\widehat{\alpha}}(.) > 0$ and $\pi_z(.) > 0$. We assume that $\pi(.)$ is log-concave in z. This limits the extent to which marginal profits can increase with z and is one of two sufficient conditions for a concave profit function.

There is an agency whose delegated task is to allow any merger unless it finds evidence of likely competitive harm having taken account of offered remedies. The agency understands the principles of competition but initially lacks detailed knowledge of the market. It can therefore rank the assets by likely anticompetitive effect but is uncertain of $\widehat{\alpha}$. The merging parties have detailed knowledge of the market and are fully informed. The timing of the settlement process is as follows. In Phase I, the merging parties make a remedy offer, $\widehat{\alpha} + z_1^O$. The agency investigates the appropriateness of the offer and gathers evidence that the required remedy is $\widehat{\alpha} + z_1$. If $z_1 \geq z_1^O$, the agency approves the merger subject to the proposed remedy and the firms receive $\pi(\widehat{\alpha}, z_1^O)$. If $z_1 < z_1^O$, settlement is not reached and the merging parties can choose to withdraw the merger application (and receive $\pi(0, 0) = 0$) or proceed to Phase II which involves a cost of delay, $K > 0$. If the merging parties proceed to Phase II, they make a revised remedy offer, $\widehat{\alpha} + z_2^O$, which can be higher, lower or the same as they made in Phase I. The agency again investigates the appropriateness of the offer and this provides a second estimate of the required remedy, $\widehat{\alpha} + z_2$. We initally assume that the agency learns the truth in Phase II (i.e. $z_2 = 0$) and discuss relaxation of this assumption in section 2.4. For convenience, we refer to $z_1^O < 0$ as a "cautious" offer and $z_1^O > 0$ as an "aggressive" offer.

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[8] In the case of an airline merger, the assets may be city-pair routes or time slots at a congested airport.

[9] The cost of error depends on the social loss associated with these assets being held in socially inefficient ownership.

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The agency draws its first phase evidence from a distribution $F(z_1, s)$ with positive density $f(z_1, s)$ on its support. s is a mean-preserving index of the distribution's spread. $z_1 \in [\underline{z}_1(s), \overline{z}_1(s)]$ is a random variable, $\underline{z}_1(s) \in [-\widehat{\alpha}, 0]$, $\overline{z}_1(s) \in [0, 1 - \widehat{\alpha}]$, $\underline{z}_1(0) = \overline{z}_1(0) = 0$, $\frac{d\underline{z}_1(s)}{ds} < 0$ and $\frac{d\overline{z}_1(s)}{ds} > 0$. We make two economically-motivated assumptions about the shape of the distribution. First, the agency is no less likely to find evidence nearer the truth than it is to find evidence further from it, so it is unimodal with the mode at $z_1 = 0$. Second, the evidence distribution is unbiased, so the mean is also zero for all s. These assumptions imply $F_s(.) \gtreqqless 0$ as $z_1 \lesseqqgtr 0$. We also make two technical assumptions: the density at the lower bound does not increase in the spread (i.e. $\frac{df(\underline{z}_1(s), s)}{ds} \leq 0$); and log concavity of $1 - F(.)$. The former is a natural part of our definition of increasing spread. The latter is a standard restriction in the literature and together with log-concavity of $\pi(.)$ is sufficient to ensure a locally concave profit function.[10]

2.2 Early settlement and type of error

We begin by providing results and intuition from the model with a general distribution as set out above. We then illustrate this with the example of a uniform distribution before discussing generalisations including when the second phase does not reveal the truth. All proofs are provided in Appendix A.

With a fully accurate second phase investigation, the optimal remedy offer in Phase II is $z_2^* = 0$ and expected profit conditional on having reached Phase II is $\pi_2^*(\widehat{\alpha}, K) = \max\{0, \pi(\widehat{\alpha}, 0) - K\}$. The non-negativity constraint derives from the firms' ability to withdraw from the merger if $\pi(\widehat{\alpha}, 0) - K \leq 0$ and receive zero. The withdrawal case is considered in Appendix A. For clarity in the text, we focus on mergers for which it would be worthwhile for the firms to incur the costs of a Phase II investigation if there is no agreement in Phase I; i.e. $\pi(\widehat{\alpha}, 0) - K > 0$. The probability of the Phase I offer being rejected is $F(z_1^O, s)$; i.e. the probability that $z_1 < z_1^O$. $F(.)$ is the probability of referral and its complement, $1 - F(.)$, is the probability of settlement. Expected profit is:

$$\pi_1 = \pi\left(\widehat{\alpha}, z_1^O\right)[1 - F(z_1^O, s)] + F(z_1^O, s)[\pi(\widehat{\alpha}, 0) - K].$$

If there is an internal optimal offer in Phase I, z_1^*, it satisfies:

$$\pi_z\left(\widehat{\alpha}, z_1^*\right)[1 - F(z_1^*, s)] - [\pi(\widehat{\alpha}, z_1^*) - \pi(\widehat{\alpha}, 0) + K]f(z_1^*, s) = 0. \qquad (1)$$

z_1^* thus balances the marginal profit of a more aggressive offer weighted by the probability of acceptance, against the cost of delayed agreement weighted by the

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[10] See Laffont and Tirole (1993) and Bagnoli and Bergstrom (2005) for log-concavity of $1 - F(.)$ and its relation to other economic assumptions. Bebchuk (1984), Nalebuff (1987) and Spier (1992) make the same assumption.

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marginal risk of rejection. However, there need not always be an internal optimum. For some parameter constellations combining high costs of delay and a low spread of evidence, it is optimal for the merging firms to eliminate all risk of their proposal being rejected by offering $z_1^* = \underline{z}_1$ and getting approval for sure. These internal and corner optimality conditions imply a direct relationship (summarised in appendix Lemma 4) between the key parameters characterising the merger proposal ($\widehat{\alpha}$, s and K) and the remedy offer made by the firms (z_1^*).

If the agency's draw from the evidence distribution happens to be $z_1 > z_1^*$, the offer will be accepted but if $z_1 < z_1^*$, the merger will be referred. Proposition 1 focuses on accepted offers. Defining Type 1 error as an accepted offer of $z_1^* < 0$ (i.e. over-enforcement), and Type 2 error as an accepted offer of $z_1^* > 0$ (i.e. under-enforcement), the proposition describes the relationship between the type of error and the parameters characterising the merger ($\widehat{\alpha}$, s and K). The meaning of 'sufficiently' high or low is made precise in Appendix A.

Proposition 1 *A merger settled in Phase I results in a Type 1 (Type 2) error if K is sufficiently high (low) and s is sufficiently low (high). The type of error has no monotonic relationship with $\widehat{\alpha}$.*

Proof. See Appendix A. ■

The intuition behind Proposition 1 is as follows. A higher cost of delay to the firms induces them to be more cautious in their Phase I offers. At one extreme, if there is no cost of delay ($K = 0$), firms lose nothing by making an aggressive Phase I offer. If the agency agrees to settle, this implies a Type 2 error. On the other hand, if the costs of delay are large, firms make a cautious offer and settlement implies a Type 1 error. The potential harm of a merger does not have a first order effect in determining how much to push or concede in Phase I because the marginal benefits and costs are anchored around the truth, $\widehat{\alpha}$. In relation to s, there is little room for bluffing the agency if it is expected to be able to form a very accurate opinion about the merger in Phase I. The cost of a cautious offer is small in relation to the gain in probability of settlement. Only when there is a reasonable chance of the agency not finding evidence against an aggressive offer will the firms find it profitable to risk one. The deeper intuition in relation to s is explored below in the example of the uniform distribution.

Proposition 1 cannot be tested empirically because remedy offers relative to the social optimum are not observable. However, acceptance or rejection of the offer by the agency *is* observed and can be tied to the probability of referral, $F(z_1^*(\widehat{\alpha}, s, K), s)$. The effects of $\widehat{\alpha}$ and K on this probability are straightforward; for example, $\frac{dF(z_1^*, s)}{dK} = f(z_1^*, s)\frac{dz_1^*}{dK} < 0$ (by Proposition 1). Given our relatively general evidence distribution, it is not possible to derive a continuous relationship

with s. However, we can show that there is a critical $\widehat{s}$ at which the optimal offer involves no error, $z_1^* = 0$, and given an unbiased evidence distribution, $F(0, \widehat{s}) = \frac{1}{2}$. For all $s > \widehat{s}$, $z_1^* > 0$ and the probability of referral is greater than a half, and for all $s < \widehat{s}$, $z_1^* < 0$ and the probability of referral is less than a half.

Corollary 1 *The probability of a merger being referred to Phase II is decreasing in K and positively associated with s, but has no systematic relationship with $\widehat{\alpha}$.*

After noting that cautious offers are more likely to be accepted than aggressive ones, the intuition is exactly the same as for Proposition 1. A second corollary links the empirically observable probability of settlement to the normative type of error. It follows directly from Proposition 1, Corollary 1 and the assumption of an unbiased evidence distribution.

Corollary 2 *If the ex ante probability of referral is greater (less) than $\frac{1}{2}$ and the merger is settled in Phase I , there will be a Type 2 (Type 1) error in the settlement.*

Corollary 2 is a distinctive feature of this paper because it links unobservable welfare errors to the quasi-observable probability of referral.[11]   The following empirical work provides econometric support for Corollary 1 and so lends empirical support to Proposition 1 and Corollary 2. It allows us to argue, for example, that if remedies are agreed in Phase I despite a low K and high s, which predict a high probability of referral, the firms will have been risking an aggressive offer and got away with an anticompetitive merger (Type 2 error).

2.3   An example

To understand the intuition of Proposition 1 further, consider the example of: (a) constant marginal profitability of assets ($\pi(\widehat{\alpha}, z) = [\widehat{\alpha} + z]\,\pi$); and (b) uniform evidence distribution ($z_1 \sim U[-s, s]$ with $\widehat{\alpha} \in [s, 1-s]$).[12]   The general probability of referral is $F(z_1^O, s) = \frac{s+z_1^o}{2s}$. It is straightforward to show that $z_1^* = \max(-s, \frac{1}{2}[s - \frac{K}{\pi}])$ so the corresponding probability of referral is $F(z_1^*, s) = \max(0, \frac{1}{4}[3 - \frac{K}{s\pi}])$. K/π can be interpreted as the firms' cost of referral relative to the marginal value of retained assets. The top panel of Figure 1 maps the optimal offer and the lower panel maps the consequent probability of referral.

Start from $s = 0$. It is optimal to offer the socially optimal remedy because the agency already knows the truth. As the distribution spreads, at first there is little to be lost from playing safe and eliminating the risk that an unlucky draw of

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[11] We use "quasi-observable" in the sense that observed frequencies can be used to estimate probabilities.

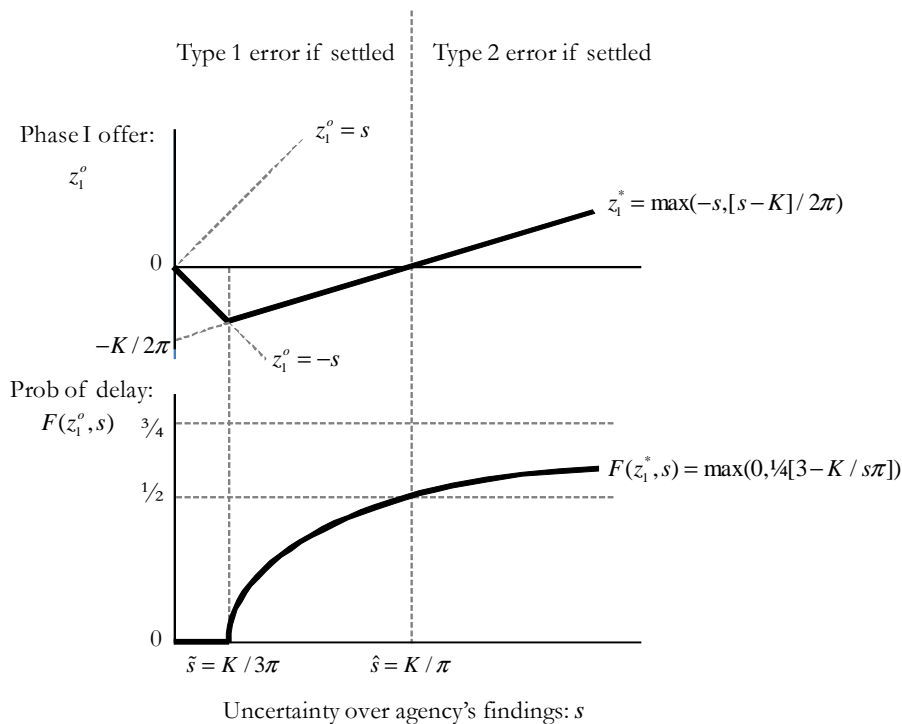[12] See Lyons and Medvedev (2007) for an early version of this example.

Figure 1: Settlement error, delay and uncertainty: example of uniform distribution and linear profit

evidence by the agency might result in a referral. However, for $s > \tilde{s} = K/3\pi$, it is worth trading off a small risk of referral against retaining more assets from the merger. For $s > \hat{s} = K/\pi$, the trade-off becomes such that it is optimal to 'bluff' the agency by offering an insufficient remedy. Put another way, the firms are more likely to bluff the agency when they have a low relative cost of delayed agreement.

For $s < \hat{s}$, an accepted offer is a Type 1 error and the probability of referral $< \frac{1}{2}$, and for $s > \hat{s}$, an accepted offer is a Type 2 error and the probability of referral $> \frac{1}{2}$. The scale of Type 1 error peaks at $\tilde{s}$, but the scale of Type 2 error increases monotonically in s. Each of $\tilde{s}$, $\hat{s}$ and the scale of maximum Type 1 error are increasing in the cost of referral relative to the value of the merger. Finally and consistent with Proposition 1, the optimal offer and probability of delay are independent of the potential harm of the merger, $\hat{\alpha}$.

2.4   Discussion

Our theoretical model is in the tradition of the literature on tort settlements (i.e. damages) in which delay in reaching agreement is due to asymmetric information.[13]

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[13] An earlier literature models delay due to intransigence or mistakes; e.g. Landes (1971), Gould (1973), Posner (1973), Shavell (1982). See Cooter and Rubinfeld (1989) for a detailed review.

The essential idea behind these models can be illustrated by a first stage of ultimatum bargaining followed, if there is no early settlement, by a costly second stage where a court finds the truth. Only one party is fully informed. The uninformed side knows the distribution of 'types' which is common knowledge, as are the costs of delay. If the uninformed party makes the last offer, he can use this to screen for the other's true type.[14] If the informed party makes the last offer, this may be taken by the uninformed party as a signal of her type.[15] Both types of model result in qualitatively similar predictions. Cases with low levels of damage settle early and those with high true damages are more likely to proceed to court. Early agreement is also less likely the greater the uncertainty as to the true type and the lower the costs of going to court. Our model has many similarities to Bebchuk (1984).[16] However, the damage has already been done in a tort so there are no Type 1 or 2 errors with respect to the agreement, only costs of delay.[17] In *ex ante* merger control there is no prior damage but the agency's decision may permit future harm or prevent future benefit. Merger control is thus not completely adversarial. Its aim is to allow the efficient parts of the merger while preventing anti-competitive elements.

Three assumptions in our model merit further attention: certainty in the second phase; the agency's acceptance rule; and continuous divisibility of assets.

So far we have considered the case where the Phase II investigation discovers the truth. Suppose the agency draws its evidence for the second phase from a distribution that has less spread than the first ($s_2 < s$). If evidence is not carried forward between phases and the two evidence distributions are independent, our results are essentially unchanged as there is no strategic link between phases. Phase II is the same as the 'withdrawal if no agreement' Phase I case already developed and, if there is an interior optimum, $s_2 > 0$ may lead to occasional prohibitions. Proposition 1 and the corollaries are unchanged.

If s_2 is related to s, or if evidence from the first phase is carried forward, there is no longer strategic independence between phases. For example, suppose evidence from the first phase is known to be used in the second, then even though the second phase draw may be unbiased, the carried forward evidence is likely to be biased because referral is more likely when the agency has a negative draw. Even though the firms do not know z_1, they can infer it from the fact that their offer

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[14] See Bebchuk (1984), Nalebuff (1987), Spier (1992).

[15] See Reinganum and Wilde (1986). See Schweizer (1989) and Daughety and Reinganum (1994) for models of two-sided uncertainty.

[16] Like Reinganum and Wilde (1986) our model has the informed party making the offer while Bebchuk (1984) has the uninformed party doing so (screening). However, we depart from the former in not allowing the agency to infer evidence from proposals. We discuss this below. Papers applying tort models empirically are discussed in Section 4.4.

[17] Tort claims do have distributional effects and these alter the long-term incentives to avoid accidents or negligence. Inappropriate incentives can thus induce Type 1 or 2 errors in the system as a whole, but not in the specific case in dispute.

was rejected and this will affect their expected profit if they enter Phase II. More precisely, $Ez_1 = \frac{1}{F(z_1^O,s)} \int_{z_1}^{z_1^O} zf(z,s)dz < z_1^O$ and the more cautious is their first phase offer, the worse the firms will expect the agency's finding on expected harm. This may induce a more aggressive Phase I offer as a commitment to less caution in Phase II.[18] The effect of K is unchanged, but carried-forward evidence considerably complicates the analysis of s. Nevertheless, we have no reason to expect the spirit of our results from the basic model to be substantially undermined.

In practice, while the second phase is unlikely to be completely accurate, the nature of the analysis carried out by the agency typically changes and this may limit the extent to which first phase findings bias Phase II. For example, the first phase focus on structural measures based on market shares shifts to a more subtle analysis of competitive effects. This qualitative change in the type of analysis weakens any link between s and s_2.[19]

Next, consider the agency's acceptance rule. In the introduction, we argue from the legal context that all decisions must be backed by evidence that would be acceptable to a court. In Europe, the merging firms are also legally required to make the final offer to the agency. This is the context that motivates our model specification. The agency accepts the firms' offer if it is no more aggressive than is consistent with the agency's draw from the evidence distribution; i.e. accept if and only if $z_1 \geq z_1^O$. This simple acceptance rule is optimal in certain specific circumstances. For example, in the capacity interpretation of assets efficiencies may increase welfare as long as the merging parties acquire no more than $\widehat{\alpha}$ of the acquired firm's capacity, but any larger acquisition relaxes the incentive compatibility constraints sufficiently to facilitate collusion, which results in reduced welfare (even compared with prohibition).

However, this is not generally an optimal acceptance rule for two reasons. First, it takes no account of: the welfare loss of a settlement that deviates slightly from $\widehat{\alpha}$; or the costs of a second phase investigation to either the agency or the firms. Second, our rule results in predictable biases that depend on the characteristics of the merger. Suppose the agency were to develop a more complex acceptance rule of the form: accept if and only if $\rho(z_1, s, K) \geq z_1^O$. If this was public knowledge, the merging firms would try to adapt their offer to signal a high $\widehat{\alpha}$. This is a complex problem and would introduce considerable legal uncertainty. This paper aims to model *actual* behaviour of an agency subject to legal rules. It reflects the practice of the European General Court which will support a prohibition even

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[18]A similar effect is identified in Nalebuff's (1987) signaling argument linking first phase offers to credible second phase actions.

[19]Only 12.3% of Phase II decisions 1990-2010 were prohibitions (10.8% in our 1999-2006 sample). This is consistent with reasonable accuracy in Phase II, though it is possible that it also reflects cautious offers.

if the competitive harm affects only a very small part of the transaction.[20] This paper is not about the optimality of those rules, but even if it were, the simple rule has advantages. For example, it provides clear guidance to business executives and their legal advisers, agencies find complex rules difficult to implement internally, and a judge is unlikely to be convinced by subtle signaling arguments. A sharp rule for the agency also has the strategic advantage of discouraging firms from making making a somewhat anticompetitive offer in the expectation that the agency will accept it as being within the margin of error.

Finally, we have assumed that α is continuously divisible. In practice, merger case assets are usually lumpy and in each case there will be a finite set of potential divisions of those assets. Continuity is assumed as a useful simplification for modelling purposes. We have no reason to expect it to affect our general results.

3 Data and Measurement

3.1 Sample selection and data availability

Explicit merger regulation was first introduced at the EU level with the ECMR (1989). Initially, there was significant uncertainty as to the legality of remedy settlements in Phase I and this was not clarified until 1997.[21] The dataset is constructed from mergers notified and completed under the jurisdiction of the Commission between 1999 and 2006 inclusive. This period encompasses another major revision to the ECMR, which came into effect in May 2004.[22] Amongst other reforms, this modestly increased the time available for investigation and modified the substantive test for a merger.[23] Simultaneous reforms included issuance of the first indicative merger guidelines, appointment of a chief competition economist with supporting team, and a major internal reorganisation of DG Competition.[24] We return to this in section 3.2.3.

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[20] For example, in the Ryanair appeal judgment (case T-342/07, #326), the Court writes: "The creation of a dominant position which would have the effect of significantly distorting genuine competition on one of those routes is itself sufficient to make the transaction incompatible with the common market".

[21] See revision to Art.6(1) in Council Regulation (EC) No 1310/97 of 30 June 1997 amending Regulation (EEC) No 4064/89 on the control of concentrations between undertakings (OJ L 180, 9.7.1997, p.1-6).

[22] See Council Regulation (EC) No 139/2004 of 20 January 2004 on the control of concentrations between undertakings (the EC Merger Regulation) (OJ L 24, 29.01.2004, p1-22).

[23] The Phase I limit rose from one month or six weeks if remedies are proposed, to 25 working days or 35 working days with remedies. The Phase II limit rose from four months to 90 working days or 105 working days if remedies are proposed. The change from the 'dominance test' to a 'substantial impediment to effective competition' test was not proposed to be a major change in practice and it has not turned out to be so. Its main substantive purpose was to allow challenges to a very small number of mergers between firms not ranked #1 in the market but where tacit collusion may become possible (see Lyons, 2009). Its wider purpose was to approve what had become the practice of appraising economic effects rather than applying structural rules.

[24] See Lyons (2009) for a summary of these changes.

Merger decisions in our sampling frame of interventions fall into four catagories: (i) remedy settlements in Phase I (109 mergers); (ii) remedy settlements in Phase II (52 mergers); (iii) unconditional clearances in Phase II (18 mergers); and (iv) outright prohibitions (9 mergers).[25] Of these, 38 could not be included in our sample for three reasons. First, while mergers with both horizontal and vertical issues are included, we removed nine mergers with exclusively vertical issues because we were unable to construct comparable measures for a number of our variables. Second, we excluded five cases in which the Commission referred aspects of the merger to a national competition authority for further investigation, so the merger was only partially covered by the Commission's report.[26] Third, market share data was not reported in 24 of the merger decisions.[27]

Our sampling frame excludes two categories of merger that fall within EU jurisdiction: (a) unconditional clearances in Phase I (2062 mergers); and (b) withdrawals (42 in Phase I and 22 in Phase II). Most mergers are unconditionally cleared in Phase I. The vast majority are uncontroversial as they have a very low risk of anti-competitive effects and are not relevant for investigating delay in settlement. Phase II unconditional clearances are excluded on the grounds that they are not anticompetitive mergers appropriate for remedy settlement. Nevertheless, we investigate the consequences of their inclusion in Section 4.2.

No reports are published on merger proposals that are withdrawn by the merging parties, so we have no data on them. The exclusion of Phase I withdrawals is unlikely to create substantial bias because they are usually for reasons outside the antitrust process (e.g. change in market conditions). However, the exclusion of Phase II withdrawals is potentially more problematic because a significant number may have been in anticipation of a prohibition decision. We investigate this in Section 4.2.

3.2 Measurement of variables

Proposition 1 predicts that the probability of referral to Phase II depends on the degree of uncertainty in relation to the agency's findings (s) and the cost of delay to the merging parties (K) but not systematically on the potential harm of the unremedied merger (inverse of $\widehat{\alpha}$). We also control for unmodelled influences such as broad industry and temporal effects. Our proxy measures are outlined below

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[25] More formally, the decisions were made under (i) Articles 6.1(b) or 6.2 (post- and pre-2004 revisions to numbering, respectively); (ii) Article 8.2; (iii) Article 8.1 or 8.2 (i.e. post- and pre-2004 revisions to numbering, respectively); or (iv) Article 8.3.

[26] These mergers fall under Article 9.3 of the ECMR.

[27] This can occur if the published decision has been heavily censored to prevent sensitive information from being in the public domain or when the merger has been analysed by the Commission in a manner that differs from the norm. For example, in *M.3796 – OMYA / J.M. Huber* the Commission argued that market shares were not a good approximation of market power and consequently these were not reported.

and summarised in Table 1. Technical details are in Appendix B.

3.2.1 Merging parties' cost of referral (i.e. K)

We focus on the opportunity cost of delay in reaching agreement.[28] Most mergers involve multiple product and geographic markets. Given the merger cannot be implemented until all markets are cleared, the merging parties lose out on achieving potential efficiencies for the duration of the Phase II investigation even if only one market is not settled in Phase I. If only a small number out of many markets is subject to dispute, then this opportunity cost of delay is high relative to an otherwise similar merger where most of the markets involve potentially anticompetitive overlaps. We measure this opportunity cost of delay by the percentage of markets with combined market share that is unlikely to be found anti-competitive: *%no-harmmkts*. Anti-competitive effects of horizontal overlaps can arise due to either unilateral or coordinated effects. The former are unlikely if the merging parties' combined market share is sufficiently low.[29] We adopt a 35% unilateral effects threshold for two reasons. First, practitioners often consider 40% as a critical rule-of-thumb for 'dominance', while market shares below 30% are unlikely to be challenged for unilateral effects.[30] Second, commercial confidentiality restricts the reporting of market shares to a five or ten point range (e.g. a true share of 32% might be reported as [30-40]%). In such circumstances we take the midpoint of the reported range, so a strict inequality < 35% excludes most markets in the [30-40]% range. The criteria for coordinated effects are more complex and we identify such markets by using the Commission's own reporting of where it had investigated this as a serious issue.[31] Finally, when counting the total number of markets, we exclude any markets where the merged entity's combined market share is below 15%. This is to avoid a potential reporting bias across cases (see Appendix B for details).

3.2.2 Potential harm (i.e. inverse $\widehat{\alpha}$)

To measure potential harm, we restrict ourselves to objective measurements and avoid use of self-justifying subjective judgments by the agency which might have

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[28]There are no case-specific data on managment and advice costs.

[29]See Davies *et al* (2011) for discussion of the factors that must be satisified for an EC finding of coordinated effects.

[30]EC horizontal merger guidelines (EC, 2002) state market shares in excess of 50% are likely to be evidence of a dominant position and those below 25% are unlikely to be so. However, these percentages incorporate a certain amount of legal caution, especially for havens. This lower threshold is repeated in the introduction to the revised merger regulation (EC, 2004), although no market share guidance was provided in the original 1989 EC merger regulation. See Davies and Lyons (2007) for evidence relating to the "40% rule".

[31]We later check the robustness of our results by removing the few markets below the 35% threshold that the decision identifies as possibly causing concern. Our results do not change.

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been written to support its decision.[32] Instead, we count the number of markets where there is a strong presumption for unilateral or coordinated effects: *#harmmkts*. The more such markets there are in a merger, the greater the potential harm.[33] We draw on the results of Davies *et al* (2011) to identfy an emprically based presumption of market-specific harm as revealed by EC case practice. We count a strong presumption for unilateral effects if the merged entity's market share is $\geq 50\%$ and the incremental market share (i.e. the share of the smaller merging party in that market) is $\geq 20\%$, or combined share $\geq 70\%$ even with negligible increment, or a linear sliding scale inbetween (e.g. combined shares of 60% of which the increment is $\geq 10\%$).[34] Our definition of a strong presumption for coordinated effects is if: they are discussed as a serious issue by the Commission; our unilateral effects threshold is not met; and both the merged entity's combined market share and the share of its largest independent rival are $\geq 35\%$. We also constructed a range of alternative measures, based on either patterns of individual market shares aggregated to the level of the merger, or the Commission's own opinion that the market raises a concern. None of the alternatives affected the significance of our other variables and none was more significant than the one we report.[35] More detail on these sensitivity tests is included in Appendix B.

3.2.3 Uncertainty of the agency's findings (i.e. s)

The merging parties must expect greater randomness in the agency's findings if the merger is complex and the agency is not well prepared to cope with the analysis. More specifically, merging firms will be more uncertain of the agency's findings if: the agency's resources are stretched by a high case load; the agency's objectives and procedures are opaque; the agency lacks experience in the relevant markets; there is a large number of affected markets that require investigation; or the relevant

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[32]It might appear tempting to use the Commission's decision to identify competitively relevant variables such as product substitutability or barriers to entry. However, these are only patchily mentioned in reports and it would be unwise to impute either 'low' or 'high' measures when no such judgment is explicitly reported. More deeply, reporting of substituability and barriers can be highly subjective and might be reported only when needed to bolster a decision.

[33]We could not weight markets by their value because this information is suppressed as being commercially sensitive. Data of the merging parties' annual worldwide turnover is available for 90 mergers. Using this restricted sample, we found no evidence that sales were related to referral to Phase II, even when controlling for selection bias using a bivariate probit with sample selection.

[34]See also the Ryanair appeal (case T-342/07 at #10) for a standard rehearsal of the presumption for shares greater than 50%.

[35]We prefer our share-based measure because it captures the *ex ante* information available to the merging parties and their advisers. It does not depend on the Commission's *ex post* opinion. Only 15% of the markets captured by these share thresholds did not require a remedy. Our emphasis on market share should not be taken as a belief that this is all that matters for merger appraisal. It is not. Our claim is simply that share is an unbiased measure that is of substantial relevance to the agency. *#harmmkts* seems to capture some degree of the potential harm of the merger because the average number of such markets is 4.76 per merger in our full sample, but it is only 0.36 per merger for Phase II unconditional clearances.

economic theory of harm is new or difficult to appraise.

We measure case load by the number of mergers under investigation per 100 case officers employed by the Commission at the time: *caseload*. Case officers include economists, lawyers and senior support staff available for case work. It is possible that a very high case load may bring about a political economy response of administrative 'desk clearing' agreements in order to limit the Phase II burden. We include a squared term to test for this: *caseloadsq*.

The 2004 reforms may have affected the margin of error in the agency's findings, though it is not obvious *a priori* in which direction. On the one hand, any change may raise uncertainty regarding procedures and protocol. On the other hand, uncertainty will be reduced if most of the changes were designed to clarify the agency's approach (e.g. guidelines), streamline its processes and improve its accuracy (e.g. extended time limits). We include a dummy variable for mergers post-reform to pick up the net effect: *2004reform*.

Given that merger control was not introduced until 1990, it may be expected that the margin of error in the Commission's decisions would be reduced over our period as it gained experience. We measure general learning effects with a time trend determined by the day on which the merger was notified: *day*. An industry-specific learning effect is measured by the number of mergers investigated under the ECMR in the same industry (3-digit NACE): *indexp*.[36]

A measurable dimension of the complexity of a merger itself is the number of markets that require nontrivial analysis. The analysis is likely to be hardest for markets that are 'intermediate' in the sense that they are neither obviously competitive nor obviously problematic. The competitive assessment is trivial if very low market shares are combined, as it is obvious that a remedy is not required. Markets with a very strong presumption of harm may also be easy to analyse, but they may still add complexity if the parties claim market shares are misleading indicators or if remedy design is difficult. If so, *#harmmkts* may also measure a dimension of *s*. However, inasmuch as the most difficult analysis will be in intermediate share markets, we count the total number of markets then subtract both the number with a no-harm presumption (as defined in Section 3.2.2) and *#harmmkts* to get a count of the number of markets on the margin of competitive harm: *#intermediatemkts*.

Unilateral effects is the most common, least controversial and simplest theory of harm investigated by the Commission. The analysis of other theories is comparatively less established and we expect firms to be more uncertain about the Commission's findings when these are investigated. We construct four dummy variables for mergers where the Commission undertook serious analysis of: coordi-

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[36] We also considered the Commission's experience of the four theories of harm discussed below, but found no robust results.

nated effects (i.e. does the merger increase the likelihood or sustainability of tacit collusion?): *coordeffects*;[37] vertical effects (e.g. does the merger raise the incentive and ability to foreclose rivals?): *verteffects*;[38] conglomerate effects (e.g. might bundling be used to foreclose rivals?): *conglomeffects*; and elimination of a potential competitor (i.e. might one of the merging parties become a future competitor in a market in which they do not currently compete?): *potcomp*.

The competition analysis is also more complex if the parties argue that benefits outweigh apparently anticompetitive effects. This may be the case if the acquired firm would exit the market in the absence of the merger: *failingfirm*. A similar difficulty can arise with an efficiency defence, especially as this has a history of controversy in European merger control: *efficiencydef*.

3.2.4 Other factors

Moving beyond the factors identified in our model, we take account of possible industry and nationality effects. To capture broad industry effects we identify the one-digit industry (NACE) in which most of the merging firms' activities take place. Two-thirds of our sample was in *manufacturing*, which we use as our base. Energy and telecommunications mergers were the next largest groups, so dummy variables were created for: *energy*; *telecom*; and *otherind* (i.e. non-manufacturing and non-utility). These are intended to pick up unobserved determinants of referral that are correlated with broad technological or demand factors.

It is possible that foreign firms find it harder to predict what the European Commission may require. Alternatively, it is sometimes claimed that merger control is subject to political pressures and bias. We tested for domicile effects relative to the base of mergers between European (EEA) firms: *eeaonly*. Dummy variables were created for mergers between: US firms (*usonly*); European and US firms (*eeaus*); and all other nationality combinations (*otherhome*).

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[37] Coordinated effects were known as 'collective dominance' prior to the revised merger regulation in 2004. The Commission has commonly found analysis of coordinated effects difficult which is evidenced by several appeal court decisions (see Kühn, 2002; and Lyons, 2009).

[38] Kovacic and Shapiro (2000) argue that foreclosure arguments can be used to protect competitors and should be subject to a high standard of proof.

variable	description
phase2	1 if the merger was referred to Phase II; 0 otherwise
eeaonly	1 if the merging parties' domiciles were in the EEA only; 0 otherwise
usonly	1 if the merging parties' domiciles were in the US only; 0 otherwise
eeaus	1 if the merging parties' domiciles were in the EEA and the US; 0 otherwise
otherhome	1 if the merging parties' domiciles are not in the three above categories; 0 otherwise
manufacturing	1 if the merging parties' activities mainly fall under the 1-digit industry (NACE rev 2) C - Manufacturing
energy	1 if the merging parties' activities mainly fall under the 1-digit industry (NACE rev 2) D - Energy
telecoms	1 if the merging parties' activities mainly fall under the 1-digit industry (NACE rev 2) J - Telecommunications
otherind	1 if the merging parties' domiciles are not in the three above categories; 0 otherwise
2004reform	1 if the merger was notified under Council Regulation 139/2004; 0 otherwise
day	number of the day the merger was notified, where 1st Janauary 1999 is given the value 1, 2nd January 1999 is 2, and so on
caseload	mean number of mergers (excluding Phase I unconditional clearances and withdrawals) investigated per 100 case officers per day of the Phase I investigation
caseloadsq	the square of caseload
indexp	number of mergers within a 3-digit industry (NACE rev 2) that the Commission had investigated prior to and inclusive of the relevant merger since merger control was introduced (excluding Phase I unconditional clearances and withdrawals); when a merger falls into two or more 3-digit industries the minimum experience is used

Table 1: description of variables

variable	description
%noharmmkts	percentage of horizontally-affected markets where the merged entity's market share is less than 35% and there is no serious discussion of coordinated effects
#harmmkts	total number of horizontally-affected markets where the merged entity's market share is at least 35% and where there is a presumption of unilateral or coordinated effects
#intermediatemkts	total number of horizontally-affected markets where the merged entity's market share is at least 35% and where there is not a presumption of unilateral or coordinated effects
verteffects	1 if at least one vertical relationship was seriously considered for anti-competitive effects; 0 otherwise
conglomeffects	1 if conglomerate effects were seriously considered; 0 otherwise
potcomp	1 if it was seriously considered whether the merger eliminated a merging party as a potential entrant in at least one market; 0 otherwise
coordeffects	1 if coordinated effects were seriously considered in at least one market; 0 otherwise
efficiencydef	1 if an efficiency defence was seriously considered; 0 otherwise
failingfirm	1 if a failing firm defence was seriously considered; 0 otherwise

Table 1 continued: description of variables

3.3 Descriptive statistics

Table 2 presents some descriptive statistics of the full sample. Just over 60% settled in Phase I. Of the 58 referred to Phase II, there were 37 conditional clearances (i.e. with remedies), 13 unconditional clearances and eight prohibitions. Nearly two-thirds of the mergers were between European firms, but at least one US firm was involved in just over a quarter of merger cases.[39] The Commission's experience of an industry varied from none to 41 previous cases since the introduction of ECMR.[40] Over 70% of the mergers were notified before the 2004 reforms. Our caseload index ranges from a third of the mean in slack times up to twice the mean during busy periods.[41]

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[39] Of the remaining mergers, eight are between a European firm and a non-European/non-US firm, and five are between firms whose domestic markets were outside of Europe and the US.

[40] The Commission had no previous industry experience for 16 mergers in our sample. The industry in which it had most experience as of December 2006 was: C20 - Manufacture of chemicals and chemical products.

[41] The number of case officers at DG Competition increased from 255 in 1999 to 495 in 2006. The data on the number of case analysts were provided by DG Competition. We were provided with annual data measured in October of each year. Since it is unknown when extra case analysts were recruited, we assume that the rate of change between one year and the next is the same for one month and the next. The increase occurs at the beginning of the month and the number of case analysts remains constant for the rest of the month. The following results are robust if we assume that all new analysts are recruited in October of each year.

variable	nobs	mean	std dev	min	max
phase2	150	0.3867	0.4886	0	1
eeaonly	150	0.6467	0.4796	0	1
usonly	150	0.0933	0.2919	0	1
eeaus	150	0.1733	0.3798	0	1
otherhome	150	0.0867	0.2823	0	1
manufacturing	150	0.6667	0.4730	0	1
energy	150	0.0400	0.1966	0	1
telecoms	150	0.0933	0.2919	0	1
otherind	150	0.2000	0.4013	0	1
indexp	150	10.0233	9.4829	1	42
day	150	1296.9870	870.1610	14	2848
2004reform	150	0.2800	0.4505	0	1
caseload	150	2.3440	1.1892	0.74	5.24
%noharmmkts	150	29.2209	25.8004	0	90.91
#intermediatemkts	150	5.4733	8.7873	0	63
#harmmkts	150	4.7600	8.4446	0	66
verteffects	150	0.4000	0.4915	0	1
conglomeffects	150	0.1800	0.3855	0	1
potcomp	150	0.2000	0.4013	0	1
coordeffects	150	0.2467	0.4325	0	1
efficiencydef	150	0.0200	0.1405	0	1
failingfirm	150	0.0200	0.1405	0	1

Table 2: descriptive statistics

An average of 29% of markets had clear presumption of no harm by our structural definition, but this ranged from zero to 91%. Turning to a strong presumption of harm, there was an average of five such markets per merger, ranging between zero and 66. There was a similar average number and range of markets falling between the two presumptions. It is standard practice for the Commission to consider every horizontal market for unilateral effects before considering alternative theories of harm. The most common non-unilateral theory of harm was vertical effects, discussed in 40% of cases. Coordinated effects were seriously considered in about a quarter of mergers, removal of a potential competitor in 20% and conglomerate effects in 18%. There were only three mergers where a failing firm defence was seriously considered, and another three where the merging parties argued an efficiency defence.

4 Estimation Results

4.1 Probability of referral to Phase II

The two-phase process with strict time limits leaves little room for variation in the timing of agreements. Remedies are either agreed in Phase I (after approx 4-5 weeks) or in Phase II (after approx another 4-5 months). Given this binary nature (i.e. remedies agreed in Phase I or not), we adopt a standard probit specification for referral:

$$y^* = x\beta + u, \quad phase2 = 1\left[y^* > 0\right] \quad \text{where } u \sim N(0,1) \tag{2}$$

where y^* is the latent variable for referral to Phase II and its observable counterpart, *phase2*; and $1\left[.\right]$ denotes an indictor function in which the function equals 1 if the term in brackets is true, and 0 otherwise. The specification of vector x follows from section 3. Equation (2) can be estimated by Probit and the results are reported in Table 3.

The maximum number of observations is reduced from the 150 reported in the descriptive statistics due to two perfect correlations. First, all three mergers in which the Commission seriously investigated a failing firm defence were agreed in Phase II, which creates a perfect correlation with referral. Second, three cases claiming an efficiency defence were all referred to Phase II where they were settled with remedies. We return to these defences in our conclusions. This leaves a maximum of 144 observations. Following our discussion in section 3.1, we report results based on three samples. Our baseline Sample 1 is chosen to minimise potential selection bias, a possibility that is investigated through the other two samples. Sample 1 includes all settlements and prohibitions and excludes Phase II unconditional clearances. Sample 2 includes only Phase I and Phase II settlements, and Sample 3 includes all settlements, prohibitions and Phase II unconditional clearances. Samples 2 and 3 are discussed in Section 4.2.

The Sample 1 results are in column (1) alongside the marginal effects (*mfx*). We find support for the role of referral costs in reaching agreement. The coefficient on *%noharmmkts* is negative and significant - a higher proportion of uncontroversial markets significantly decreases the probability of referral to Phase II. We interpret this as a higher opportunity cost of referral, which encourages the merging parties to make an offer that is more likely to be accepted by the agency. The marginal effects suggest that increasing *%noharmmkts* by ten percentage points leads to a 5% point decrease in the probability of referral.

Dependent variable: phase2	proxy	(1)	mfx	(2)	(3)
constant		-2.6644		-2.4255	-3.1780*
		(1.8527)		(2.0024)	(1.6686)
%noharmmkts	K	-0.0194**	-0.0051	-0.0168**	-0.0105*
		(0.0081)		(0.0083)	(0.0061)
#harmmkts	$\widehat{\alpha}$ (or s)	0.0368*	0.0097	0.0292	0.0263
		(0.0224)		(0.0238)	(0.0203)
#intermediatemkts	s	-0.0049		-0.0025	-0.0191
		(0.0211)		(0.0218)	(0.0192)
caseload	s	1.5405**	0.4079	1.2895**	1.0314*
		(0.6150)		(0.6579)	(0.5902)
caseloadsq	s	-0.2253**	-0.0596	-0.1921*	-0.1359
		(0.0952)		(0.1016)	(0.0955)
2004reform	s	-1.5344***	-0.2871	-1.4237***	-0.9604**
		(0.4543)		(0.4643)	(0.3900)
ln(day)	s	0.2058		0.1914	0.3049*
		(0.1982)		(0.2104)	(0.1774)
ln(indexp)	s	-0.5383***	-0.1425	-0.5145***	-0.3919***
		(0.1709)		(0.1710)	(0.1417)
potcomp	s	0.9797**	0.3170	0.9717**	1.1943***
		(0.4276)		(0.4484)	(0.3652)
verteffects	s	0.4533		0.5445*	0.8020***
		(0.3051)		(0.3194)	(0.2816)
conglomeffects	s	0.3712		0.4705	-0.0488
		(0.4036)		(0.4166)	(0.3872)
coordeffects	s	0.6629*	0.2046	0.4432	1.0270***
		(0.3627)		(0.3943)	(0.2916)
energy		1.2411		1.3508*	0.4868
		(0.7888)		(0.7369)	(0.7592)
telecoms		-1.0023*	-0.1729	-1.0757*	-1.1759**
		(0.5410)		(0.5862)	(0.5165)
otherind		-1.3558***	-0.2435	-1.3469***	-1.1268***
		(0.4452)		(0.4600)	(0.3902)
usonly		0.3430		0.2022	0.2424
		(0.4170)		(0.4380)	(0.4255)
eeaus		-1.4467***	-0.2384	-1.1924**	-0.9724***
		(0.5164)		(0.4955)	(0.3769)
otherhome		-0.2170		-0.0030	-0.2738
		(0.5619)		(0.5614)	(0.4956)
no. of observations		133		125	144
log pseudo-likelihood		-47.3798		-43.2285	-63.0622
pseudo r-squared		0.4233		0.4009	0.3304

Note: *** indicates significance on a 2-tailed test at the 1% level; ** at the 5% level; and * at the 10% level. (1) main sample; (2) excl. prohibitions; (3) incl. unconditional clearances

Table 3: Probit analysis of referral to Phase II

It is not so straighforward to disprove the effect of potential harm on referral. All we claim is that our results are consistent with there being no monotonic relationship between the probability of referral and the potential harm of the merger. As discussed in Section 3.2.2, we constructed a range of proxies but the only one that approaches significance is *#harmmkts*.[42] This measure may also be picking up a dimension of complexity in the agency's task if it has to deal with evidence by the parties to counter a structural presumption of harm and evaluate an appropriate remedy.

Our proxies for the uncertainty of the agency's findings can be grouped under agency capacity and economic analysis. Both sets of measures support our expectation that uncertainty increases the probability of referral to Phase II.

First, consider our workload and process measures. The coefficients on *caseload* and *caseloadsq* imply an inverted-U shaped relationship. There is a positive effect on the probability of referral up to around one standard deviation above its mean value as investigation teams are less fully staffed and so less able to make accurate assessments. However, there appears to come a point beyond which there is evidence of a possible desk-clearing effect as concerns about Phase II workload increase.[43] The coefficient on *2004reform* is negative and significant, which suggests that the reforms in 2004 had a net effect of substantially increased clarity and transparency. The insignificance of *day* suggests no generalised learning during the period. However, the coefficient on *indexp* is negative and strongly significant. The first case in a 3-digit industry is 33% points more likely to be referred to Phase II than the tenth case. Finally, the number of markets with market share patterns that lie between presumptions of either harm or no harm, *#intermediatemkts*, is not significant.

The second dimension to uncertainty in relation to the agency's findings is complexity of the economic analysis. Both *coordeffects* and *potcomp* have a significantly positive impact on the probability of referral to Phase II. This is consistent with a greater difficulty in collecting evidence to prove (or disprove) either a coordinated effects theory of harm or especially the absence of incentive or ability to enter. Both *verteffects* and *conglomeffects* have positive signs but neither is statistically significant. Furthermore, although we had to drop all observations of *failingfirm* and *efficiencydef* from the regressions because all such cases were referred to Phase II, this should not detract from the fact that these lines of defence were apparently too complex to agree in Phase I.

Finally, we find quantitatively important political effects. Telecom mergers are

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[42]Note that even the modest level of significance is not robust to a logarithmic transformation (after adding one to each observation because some mergers had no markets in this category).

[43]An alternative explanation relates to the cost of referral for the merging parties during boom periods: inasmuch as merger booms are positively correlated with economic booms, the merging parties may face a larger opportunity cost of delay when the economy is booming.

less likely to be referred to Phase II, which may reflect a willingness to accept network effect or other arguments in a rapidly changing market. There is no evidence of bias against mergers between two US firms or other non-European firms, but mergers between US and European firms are significantly more likely to be settled in Phase I. The latter may be because they tend to have complementary strengths, for example in terms of geographic markets, or it may reflect a political dimension of support for transatlantic cooperation.

4.2 Sample robustness checks

As discussed in Section 3.1, there is a potential selection bias due to the absence of information on withdrawn mergers. Some Phase II withdrawals will have been in anticipation of prohibition so our sample may under-represent cases with features that lead to referral. We investigate this by considering the effect of excluding the eight prohibitions which we expect may have similar characteristics to many of the mergers that were withdrawn in Phase II. This gives Sample 2 which estimates the probability of referral to Phase II conditional on remedies being agreed. There are no substantial changes in either statistical or quantitative significance, but there are some interesting nuances. The coefficient on *#harmmkts* loses its marginal significance, suggesting that if we had data on Phase II withdrawals as well as prohibitions, the significance of this variable may have been enhanced. Other variables that might similarly have an enhanced effect if we had data on withdrawals are *coordeffects* and, to a lesser extent, *%noharmmkts* and *caseload*.

Sample 3 adds unconditional clearances in Phase II to our baseline Sample 1. These are excluded from our baseline sample on the grounds that they are not anti-competitive mergers appropriate for remedy settlement and they are not balanced by marginal unconditional clearances in Phase I. As expected, their inclusion generally reduces the fit of the model, with the exception of three indicators of complex theories of harm: *potcomp*, *verteffects* and *coordeffects*. This can be explained by these theories of harm often being speculative, requiring in-depth analysis, and being less amenable to remedy, leading to a stark choice of unconditional clearance or prohibition.

4.3 Early settlement, probability of referral and type of error

Applying Corollary 1, we can use our estimations to cast light on likely Type 1 or Type 2 errors in Phase I merger remedy settlements. Type 2 errors are expected for mergers settled in Phase I despite a high probability of referral, and Type 1 errors are likely in settlements with a low probability of referral. Based on Sample 1 results, we calculate the predicted probability of referral for each merger. Since the theoretical prediction is that only the variables which increase uncertainty and

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cost of delay determine errors in early settlments, we control for the effects of the other factors discussed in section 3.2.4. To do so, we calculate the predicted probabilities for 144 hypothetical mergers where, others things equal, it is assumed that for all such mergers *eeaonly* $= 1$ and *manufacturing*$=1$. Figure 2 provides the cumulative distribution of the controlled predicted probability of referral to Phase II for Phase I settlements and for mergers that were referred.
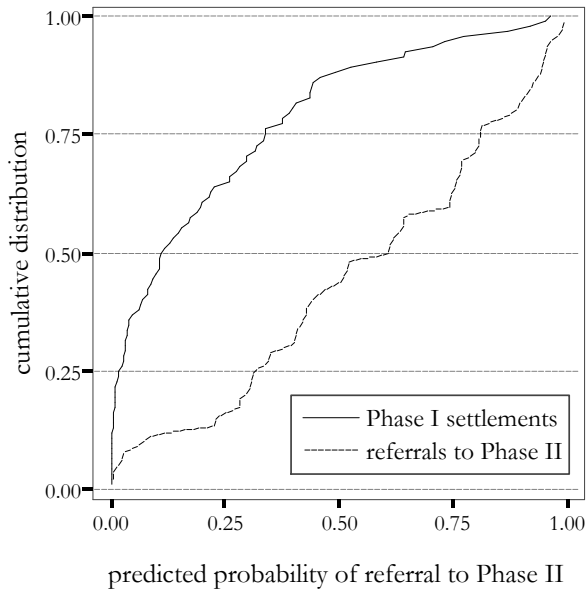

Figure 2: Cumulative distribution of early settlements and referrals

First, consider those mergers settled in Phase I. If the merger is complex, with high s and low K, the merging firms may have achieved a significantly anticompetitive merger by offering too little remedy and getting lucky with the Phase I evidence gathered by the Commission. Just 11 of such mergers were settled despite a controlled predicted probability greater than 0.5. They are listed in Table 4 with their controlled predicted probability and the 'actual' predicted probability based on the full probit regression.[44] Although the uniform distribution special case suggests the scale of error increases monotonically with the predicted probability of referral, this result is not robust to a more general distribution so it is not clear which of these mergers has the largest Type 2 error. We conclude that Type 2 errors are relatively infrequent at only 12% of Phase I settlements.

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[44]Only 6 mergers have an actual predicted probability greater than 0.5.

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merger	notified	controlled pr(phase2)	actual pr(phase2)
YLE/TDF/DIGITA	05/2001	0.964	0.964
AKZO NOBEL/HOECHST ROUSSEL VET	10/1999	0.951	0.583
NEW HOLLAND/CASE	09/1999	0.919	0.480
UNILEVER/BESTFOODS	08/2000	0.872	0.377
TEIJIN/ZEON	06/2003	0.773	0.703
LINDE/BOC	04/2006	0.731	0.731
REXAM (PLM)/AMERICAN NATIONAL CAN	06/2000	0.706	0.182
GLAXO WELLCOME/SMITHKLINE BEECHAM	03/2000	0.647	0.143
SARA LEE/COURTAULDS	03/2000	0.643	0.140
CANDOVER/CINVEN/BERTELSMANN-SPRINGER	06/2003	0.584	0.584
RHODIA/DONAU CHEMIE/ALBRIGHT & WILSON	05/1999	0.527	0.527

Table 4: Mergers settled in Phase I with a predicted Type 2 error

In contrast, there are many more cases where we predict Type 1 error, with 50% of settlements having a referral probability of less than 0.1. While this suggests a larger number of Type 1 errors compared to Type 2, it does not take the relative cost of such errors into account. If a merger is straightforward with low uncertainty, s, and low cost of delay, K, the model predicts only a marginal excess in the optimal remedy offer. In practice, given that assets are not perfectly divisible, such cases may not have resulted in significant inefficiency. As Figure 1 indicates, the greatest Type 1 error could be at intermediate levels of K and s.

It is also possible to cast light on referral errors. All failures to agree in Phase I are costly, but delayed mergers with a high probability of referral are delayed for a reason. In contrast, our model suggests that mergers with a low probability of failure to agree in Phase I are referral errors that are due to either very bad luck in the evidence collected by the Commission, or the Commission's error, or a strategic mistake by the firms. Figure 2 shows that 42% of referrals had a controlled predicted probability of less than 0.5. We also note that six of the eight lowest controlled predicted probabilities (out of those actually referred) went on to be cleared unconditionally in Phase II. These cases appear to go beyond bad luck.

4.4 Related empirical literature

This is the first study to our knowledge that investigates the timing of antitrust remedy settlements. Our results broaden the limited set of empirical applications of tort settlement theory and provide stronger results on the importance of uncertainty

than have typically been found.[45] For example, Fournier and Zuehlke (1996) find that the probability of settlement in US civil lawsuits is increasing in litigation costs and decreasing in the potential value of the court award, but their measure of the expected variability of court outcomes is not statistically significant.[46] Fenn and Rickman (1999, 2001) do not have a measure of uncertainty but find similar results on costs and potential size of damages for UK clinical negligence, health trust empolyment, and personal injury insurance claims. Kessler (1996) does find that complexity delays settlement and there are some subtle effects of institutional delay costs in his study of US automobile bodily injury claims. Because these studies investigate damagess claims, they cannot make inferences about Type 1 and Type 2 errors in specific cases.

Econometric work on merger decisions has focused on the determinants of intervention. For example, Bergman *et al* (2005) aim to explain European Commission intervention decisions.[47] Similar econometric studies have used data from US and other jurisdictions.[48] While Kouliavtsev (2007) is nearer in spirit to the present paper. His empirical model aims to explain the strength of the agreed remedy using US data on DOJ merger settlements. Strength is measured by the ratio of divested assets to total overlap sales, so there is no account taken of competitive impact. His "hostage" measure (similar to our measure of referral cost) significantly increases this measure of the strength of agreed remedy. He has no proxies for complexity or uncertainty.[49]

There has been a small number of *ex post* case study reviews of the success or failure of remedies. Such studies are highly resource intensive, subjective and require the cooperation of firms and rivals for a period of years following the merger. This means that they have been conducted in-house by the agencies on a sample of their own selection. A study by the US Federal Trade Commission (1999)

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[45] Much of the literature investigates medical damage settlements. Cooter and Rubinfeld (1989) review the early empirical literature on legal disputes. There is also a wider literature on bargaining under incomplete information without the shadow of the court. Reviews are provided by Kennan and Wilson (1993) and Ausubel et al (2002). Sieg (2000) provides structural estimation of a bargaining model calibrated on medical malpractice suits in Florida.

[46] In an earlier paper using the same data, Fournier and Zuehlke (1989) do find their measure of variance to be a significant determinant of settlement. The more recent paper is based on Spier's (1992) hazard model.

[47] They include a sample of Phase I unconditional clearances and classify Phase I remedy agreements as non-interventions. Because the dependent variable is intervention, they find market share measures significant and do not include measures of referral costs or complexity/uncertainty. See also Lindsay *et al* (2003) and Martinez Fernández et al (2008) for similar studies using EC data. Ormosi (2009) provides an econometric study of remedies and the efficiency defence.

[48] Most notably, there have been numerous US studies by Malcolm Coate and various co-authors, including Coate *et al* (1995) and Coate and Kleit (2004).

[49] He also has measures of DOJ case load and the hypothetical probability that the merger would be prohibited in court (based on a simple model of concentration, reported entry barriers and likely collusion, each measured in the most concentrated market). The case load measure is insignificant. The prohibition probability, which can be interpreted as a measure of potential harm, is quadratic with weakest remedies at intermediate levels of harm.

found that merging firms could undermine the effectiveness of divestitures, for example, by offering a product range that is too narrow to be viable. The European Commission (2005b) conducted its own *ex post* study of remedies in 40 decisions 1996-2000. They found similar problems to the FTC, especially an inadequate range of assets being offered for sale. Only 57% of remedies were judged to have been clearly effective. Whilst rich in detail, they do not substitute for a more statisical approach.

An alternative statistical methodology to identify agency decision errors is provided by event studies. Eckbo (1983) and Stillman (1983) first proposed the idea that the change in stock market value of rival firms at the time of a horizontal merger announcement could be used to identify expected competitive effect. If rival stock prices rise, this suggests the merger will be anti-competitive, and if rival valuations fall it is consistent with an efficient merger enhancing competition. The approach has much intuitive appeal but has been subject to substantive criticisms.[50] Duso *et al* (2007) appreciate these problems but argue that there is still information in this approach and apply it to a sample of all EC merger decisions in a period overlapping our own sample. Their sample is a roughly equal number of Phase II cases (most of which required remedies or prohibition) and a random sample of Phase I cases (most of which were cleared unconditionally). They assume that the stockmarket capitalises competitive impact but not anticipated remedies or prohibition. Their definition of a Type 2 error is an unconditional clearance in Phase II. This is quite different to our definition so our results are not comparable.[51]

5 Conclusion

Agreement over remedies under the European merger regulation provides an unusual opportunity to model and test a theory of settlement. The institutional setting, including a fixed timetable of offers, gives a common structure to merger settlements. It also facilitates collection of data on agreements that differ by

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[50]Criticisms include that: effects on rivals may not measure competitive impact so much as putting them either "in play" or "out of play" in the market for corporate control; announcements may signal the ability of rivals to achieve efficiencies themselves; affected markets are often only a small part of the activities of conglomerate firms and so may have a negligible effect on share price; difficulty in identifying competitors in narrowly defined antitrust markets; stock market arbitragers may not be able to predict competitive effects (on either the merging parties or their rivals) in a few days around the merger announcement when it takes a competition agency many weeks; it is essentially a judgement call for the econometrician to interpret stock price changes as capitalising or not regulatory intervention by the agency (remedies or prohibition).

[51]On their definition, they find that 56% of all anti-competitive mergers are Type 2 errors (i.e. no remedies required) and 42% of pro-competitive mergers are Type 1 errors (i.e. remedies or prohibition). They go on to conduct a probit analysis of the incidence of error in terms of political economy factors. Aktas et al (2007) also use an event study of EC merger announcements and subsequent interventions to examine political economy issues.

individual merger characteristics such as uncertainty. Merger settlements are particularly interesting because they aim to prevent future anticompetitive behaviour, unlike damages claims which are transfers following some previous harm. Merger control is thus subject to Type 1 or Type 2 error, depending on whether remedies are too restrictive or too lenient. Our model provides a link between the probability of delay in settlement and the expected type of error in early agreement.

We find that parties condition their offers on the degree of uncertainty (measured by the complexity of merger appraisal and the pressure on agency resources) and the cost of referral. Merging firms make more generous offers in Phase I if the the cost of referral would be high. A high case load, up to a point, makes it more difficult for the agency to discover the true competitive effects and so makes it more difficult to reach early agreement. There are also significant learning effects as the agency's findings become more predictable when it has more industry-specific experience. Major administrative reforms in 2004 appear to have improved predictability. The difficulty of appraising coordinated effects, potential entry or the failing firm or efficiency defenses mean these are likely to cause delay in settlement. We cannot prove emprically that the potential anticompetitiveness of the merger has no effect on referral. However, consistent with our theoretical model, we find no evidence to support a superficially plausible claim that more harmful mergers are harder to agree in Phase I.

A wider implication of our findings is that we can associate Type 2 errors (e.g. too little required divestiture of assets) with early agreement of remedies in complex mergers with a low cost of delay. These are the mergers where firms find it worthwhile to bluff (i.e. to offer inadequate remedies) and the agency does not find sufficient evidence of anticompetitive harm in its initial investigations. Although some of these mergers may have caused substantial welfare loss, we also find that they are relatively few in number. More often, early agreement is associated with firms offering excess remedy (Type 1 error).

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A   Appendix: analysis and proofs

A.1   Optimal offers

Given that true $\widehat{\alpha}$ is revealed to the agency in Phase II and $\pi_z(\widehat{\alpha}, z) > 0$, $z_2^* = 0$. Firms can withdraw from Phase II (and the merger) if $\pi(\widehat{\alpha}, 0) - K < 0$, so if there is failure to agree remedies in Phase I, the merging firms receive $\pi_2^*(\widehat{\alpha}, K) = \max\{0, [\pi(\widehat{\alpha}, 0) - K]\}$.

Now consider Phase I. The probability of referral to Phase II (i.e. that $z_1 < z_1^O$) is $F(z_1^O, s)$. Expected profit is

$$\pi_1 = \pi\left(\widehat{\alpha}, z_1^O\right)[1 - F(z_1^O, s)] + F(z_1^O, s)\max\{0, [\pi(\widehat{\alpha}, 0) - K]\}. \qquad (3)$$

Lemma 1 π_1 *is locally concave and decreasing at* $z_1^O = \overline{z}_1$.

Proof. The second derivative of (3) is

$$
\begin{aligned}
A_1 \equiv \quad &-\{2f(z_1^*, s)\left[\pi_z(\widehat{\alpha}, z_1^*)\right] + f_z(z_1^*, s)[\pi(\widehat{\alpha}, z_1^*) - \max\{0, [\pi(\widehat{\alpha}, 0) - K]\}] \\
&-\pi_{zz}(\widehat{\alpha}, z_1^*)[1 - F(z_1^*, s)]\} < 0.
\end{aligned}
\qquad (4)
$$

Log-concavity of $1 - F(.)$ implies: $\left[f(.)^2 + [1 - F(.)]f_z(.)\right] \geq 0$. For local concavity around an interior optimum, substitute the first order condition (5) [from below] and rearrange to give $f(.)\pi_z(.) + f_z(.)[\pi(\widehat{\alpha} + z_1^*) - \pi_2^*(.)] \geq 0$. The term in square brackets must be positive or it would not be profitable to agree in Phase I. From this it is clear that the sum of the first two terms in (4) is positive. If $\pi_{zz}(.) \leq 0$, then (4) is surely satisfied. If $\pi_{zz}(.) > 0$, then log-concavity of $\pi(.)$ after substituting (5) gives $-\pi_{zz}(.)[1 - F(.)] + f(.)\pi_z(.) \geq 0$. Adding this inequality to $f(.)\pi_z(.) + f_z(.)[\pi(\widehat{\alpha}, z_1^*) - \pi_2^*(.)] \geq 0$ proves $A_1 < 0$ as long as at least one of the log-concavity assumptions is strict. Next consider the payoff to a marginally more aggressive offer at $\overline{z}_1$. Noting that $\pi(\widehat{\alpha}, z_1^*) > \pi_2^*(.)$, $\overline{\pi}_z = -[\pi(\widehat{\alpha}, \overline{z}_1) - \max\{0, [\pi(\widehat{\alpha}, 0) - K]\}]f(\overline{z}_1, s) < 0$ for all s and K. ∎

The next lemma prepares the ground for examining corner solutions. Noting that $F(\underline{z}_1, s) = 0$, at the lower bound to the evidence distribution: $\underline{\pi}_z(s, K) =$

$\pi_z\left(\widehat{\alpha}, \underline{z}_1(s)\right) - [\pi\left(\widehat{\alpha}, \underline{z}_1(s)\right) - \max\{0, [\pi\left(\widehat{\alpha}, 0\right) - K]\}] f(\underline{z}_1(s), s)$. $\widehat{\alpha}$ is suppressed as an argument of $\underline{\pi}_z(.)$ to simplify notation. Define $\widetilde{s}(K)$ as s satisfying $\underline{\pi}_z(\widetilde{s}, K) = 0$, if this exists, or zero otherwise.

Lemma 2 *(a) Lower bound expected marginal profit, $\underline{\pi}_z(s, K)$, is increasing in s. (b) $\underline{\pi}_z(0, K) < 0$, $\underline{\pi}_z(s, K) \leq 0$ for all $s \leq \widetilde{s}(K)$, and $\underline{\pi}_z(s, K) > 0$ for all $s > \widetilde{s}(K)$. (c) $\widetilde{s}(0) = 0$. (d) $\frac{d\widetilde{s}(K)}{dK} \geq 0$.*

Proof. (a) $\frac{d\underline{\pi}_z}{ds} = [\pi_{zz}\left(\widehat{\alpha}, \underline{z}_1(s)\right) - f(\underline{z}_1(s), s)\pi_z\left(\widehat{\alpha}, \underline{z}_1(s)\right)] \frac{d\underline{z}_1(s)}{ds} - \left[\pi_z\left(\widehat{\alpha}, \underline{z}_1(s)\right) \frac{df(\underline{z}_1(s),s)}{ds}\right]$. The first term in square brackets is negative by the log-concavity assumptions (see proof of Lemma 1). $\frac{d\underline{z}_1(s)}{ds}$ and the second term in square brackets are negative by our definition of increasing spread. Thus, $\frac{d\underline{\pi}_z}{ds} > 0$. (b) Suppose $s = 0$, then $f(0,0)$ is a spike and $\underline{\pi}_z(0, K) < 0$. $\underline{\pi}_z(s, K) > 0$ for all $s > \widetilde{s}(K)$ follows from $\frac{d\underline{\pi}_z}{ds} > 0$ and the definition of $\widetilde{s}(K)$. (c) If $K = 0$, then $\underline{\pi}_z(s, 0) = \pi_z\left(\widehat{\alpha}, \underline{z}_1(s)\right) - [\pi\left(\widehat{\alpha}, \underline{z}_1(s)\right) - \pi\left(\widehat{\alpha}, 0\right)] f(\underline{z}_1(s), s) > 0$ for all s because $\pi\left(\widehat{\alpha}, \underline{z}_1(s)\right) < \pi\left(\widehat{\alpha}, 0\right)$, so $\widetilde{s}(0) = 0$ by definition of $\widetilde{s}$. (d) If $[\pi\left(\widehat{\alpha}, 0\right) - K] \leq 0$, $\frac{d\widetilde{s}(K)}{dK} = 0$; and if $[\pi\left(\widehat{\alpha}, 0\right) - K] > 0$, $\frac{d\widetilde{s}(K)}{dK} > 0$. This follows from total differentiation of $\underline{\pi}_z(s, K) = 0$ and log-concavity (see Lemma 1). ∎

Lemma 3 *For $s < \widetilde{s}$, there is a corner optimum offer: $z_1^* = \underline{z}_1$. For $s \geq \widetilde{s}$, there is an interior optimum satisfying:*

$$\pi_z\left(\widehat{\alpha}, z_1^*\right)[1 - F(z_1^*, s)] - [\pi\left(\widehat{\alpha}, z_1^*\right) - \max\{0, [\pi\left(\widehat{\alpha}, 0\right) - K]\}] f(z_1^*, s) = 0. \quad (5)$$

Proof. If $s < \widetilde{s}$, it is not profitable to offer more than $\underline{z}_1$ because $\underline{\pi}_z(s, K) \leq 0$ (Lemma 2(b)). If $s \geq \widetilde{s}$, $\underline{\pi}_z(s) > 0$ and the interior optimum is given by the first order condition (5). The upper bound is never a corner optimum because $\overline{\pi}_z < 0$ for all s and K (Lemma 1). ∎

Lemma 4 provides the key results linking merger characteristics to the optimal offer. Define $\widehat{s}(K)$ as the minimum $s > 0$ for which $z_1^* = 0$. From this definition and Lemma 3, $\widetilde{s} < \widehat{s}$.

Lemma 4 *(a) $z_1^*(\widehat{\alpha}, s, K)$ is weakly decreasing in K, with $z_1^*(\widehat{\alpha}, s, 0) > 0$ and $z_1^*(\widehat{\alpha}, s, K) < 0$ for some s and $K > 0$; (b) $z_1^*(\widehat{\alpha}, s, K) < (>) 0$ as $s < (>) \widehat{s}$; and (c) , $z_1^*(\widehat{\alpha}, s, K)$ is non-monotonic in $\widehat{\alpha}$ except in special cases (in which it may be either increasing or decreasing).*

Proof. (a) From Lemma 3, if $s > \widetilde{s}$ and $\pi\left(\widehat{\alpha}, 0\right) - K \leq 0$, total differentiation of (5) gives $\frac{dz_1^*}{dK} = f(z_1^*, s)/A_1 < 0$ (by Lemma 1). Also, the marginal profit of a slightly more aggressive offer at $K = 0$ and $z_1^O = 0$ is $\frac{1}{2}\pi_z\left(\widehat{\alpha}, 0\right) > 0$. This is because the evidence distribution is unbiased so $F(0, s) = \frac{1}{2}$. Thus, $z_1^*(\widehat{\alpha}, s, 0) > 0$. If $s < \widetilde{s}$

or $\pi\left(\widehat{\alpha},0\right)-K\leq 0$, the optimum offer is independent of K. Finally, the proof of part (b) shows that $z_1^*(\widehat{\alpha},s,K) < 0$ for sufficiently small s (including $s\in[\widetilde{s},\widehat{s}]$).

(b) If $s<\widetilde{s}$, $z_1^*=\underline{z}_1(s)<0$ which is decreasing in s by assumption. Next consider $s>\widetilde{s}$. Standard comparative statics cannot sign $\frac{dz_1^*}{ds}$ because all combinations of sign are possible in relation to $F_s(z_1^*,s)$ and $f_s(z_1^*,s)$ (see below on 'increasing spread'). We proceed by considering the cases of $z_1^*<0$, $z_1^*=0$ and $z_1^*>0$ in turn. By the properties of the corner solution for sufficiently low s and the definition of $\widehat{s}$, $z_1^*<0$ for all $s\in(0,\widehat{s}]$. At $z_1^*=0$, our assumption of unbiased evidence distribution implies $F_s(0,s)=0$ and $f_s(0,s)<0$ (see also below on 'increasing spread'), so total differentiation of (5) gives $\frac{dz_1^*}{ds}=\{[\pi\left(\widehat{\alpha},0\right)-\max\{0,[\pi\left(\widehat{\alpha},0\right)-K]\}f_s(0,s)\}/A_1>0$. This implies $z_1^*>0$ for all $s>\widehat{s}$ because the optimum can never 'cross back' to $z_1^*<0$. Note that for sufficiently low K, we show in part (a) that $z_1^*>0$, and for sufficiently low s we have just shown that $z_1^*<0$, so $\widehat{s}>0$.

(c) If $s<\widetilde{s}$, $z_1^*=\underline{z}_1(s)$ is independent of $\widehat{\alpha}$. Next consider $s>\widetilde{s}$. We proceed by counter-examples for a simple special case. Suppose $\pi\left(\widehat{\alpha},z_1^*\right)=\pi\left(\widehat{\alpha}+z_1^*\right)$. If $\pi\left(\widehat{\alpha},0\right)-K>0$, then $\frac{dz_1^*}{d\widehat{\alpha}}=-\{\pi_{zz}\left(\widehat{\alpha}+z_1^*\right)[1-F(z_1^*,s)]-[\pi_z\left(\widehat{\alpha}+z_1^*\right)-\pi_z\left(\widehat{\alpha}\right)]f(z_1^*,s)\}/A_1$, which cannot be signed. For example, if $\pi_{zz}\left(\widehat{\alpha}+z_1^*\right)>0$ and $z_1^*\leq 0$, then $\frac{dz_1^*}{d\widehat{\alpha}}>0$. If profits are linear, $\pi_{zz}\left(\widehat{\alpha}+z_1^*\right)=0$ and $\pi_z\left(\widehat{\alpha}+z_1^*\right)=\pi_z\left(\widehat{\alpha}\right)$ so $\frac{dz_1^*}{d\widehat{\alpha}}=0$. If $\pi\left(\widehat{\alpha}\right)-K\leq 0$, then $\frac{dz_1^*}{d\widehat{\alpha}}=-\{\pi_{zz}\left(\widehat{\alpha}+z_1^*\right)[1-F(z_1^*,s)]-\pi_z\left(\widehat{\alpha},z_1^*\right)f(z_1^*,s)\}/A_1<0$ by log-concavity. No sharper results are possible when $\pi\left(\widehat{\alpha},z_1^*\right)$ cannot be written as $\pi\left(\widehat{\alpha}+z_1^*\right)$. ∎

Proposition 1 follows as a corollary of Lemma 4. If the evidence drawn by the agency in Phase I is such that $z_1>z_1^*$, the merger will be settled subject to the offered remedies. The error associated with settlement is given by Lemma 4.

A.2 Increasing spread

s is a mean-preserving index of the spread of $F(.)$, and Figure A1 illustrates an increase in spread where $s'>s''>0$.
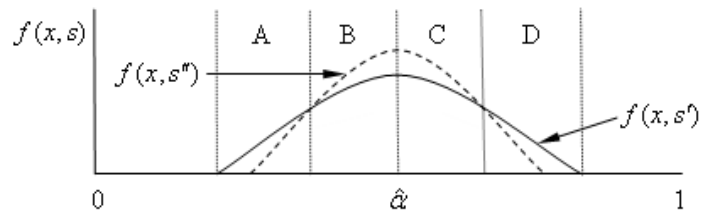

Figure A1: a reduction in the spread of the distribution

There are four ranges, each with a different combination of signs on $F_s(.)$ and $f_s(.)$:

	$F_s(.) > 0$	$F_s(.) < 0$
$f_s(.) > 0$	A	D
$f_s(.) < 0$	B	C

B Appendix: Construction of variables

A partly-censored version of every merger decision by the European Commission is published on its website.[52] The website also provides general information including: (i) the formal decision; (ii) the regulation used; (iii) the date of notification, date of referral to Phase II (if applicable), and the date of decision; and (iv) the statistical classification of the parties' economic activities (NACE). From this we constructed: *phase2*, *2004reform*, *indexp*, *day* and the industry dummies. We constructed *caseload* from start and end dates for each merger investigation and data on the number of relevant staff (provided to us by DG Competition). The domiciles of the parties are usually stated in decisions, and in the few cases where it was not disclosed this was obtained from the firms' websites or annual reports. To identify specific competitive effects analysed in each merger, we word-searched each decision for the relevant terms in Table B1. Where such terms were found, a close read of the text determined whether there was serious discussion or whether it was mentioned in a cursory manner simply to dismiss the possibility. We counted only the former.

variable	words searched
coordeffects	coordinat[ed], collective dominance, collusi[on]
verteffects	vertical, foreclos[ure]
conglomeffects	conglomerate, bundl[ing], portfolio
potcomp	potential comp[etitor], entr[ant]
efficiencydef	efficien[cy], cost saving[s], synerg[y]
failingfirm	failing firm, rescue merger

Note: For words with [.], we only searched for the term before the square brackets so the word search also identified plurals and similar words (e.g. coordinat[ed] and coordinat[ion]).

Table B1: terms searched

The remaining variables are based on market shares in those markets where the merger joins a horizontal overlap of activities. This does not mean that market share is all that matters or that the Commission ignores competitively relevant factors such as product substitutability, nature of competition, buyer power or entry barriers. Our concern is to avoid distortions that might arise from collecting

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[52]See: http://ec.europa.eu/competition/mergers/cases/

subjective data from merger reports. As explained in the text, we do not use qualitative variables in our econometrics because there is a strong suspicion of a reporting bias. For example, entry barriers are much more likely to be mentioned explicitly to justify decisions when there is failure to agree, even though they should also be relevant for markets where harm is expected by the agency absent agreed remedies: 'high' entry barriers are explicitly mentioned in 35.8% of Phase I settlements compared to 55.3% in Phase II and 100% of prohibitions.[53] Neverteless, we return to a sensitivity test of subjective measures at the end of this Appendix.

Our first aim was to identify the number of relevant markets in a merger that might require competition analysis. Data are not generally available on the size or value of each market. For the vast majority of markets with horizontal overlap, especially those with a large combined market share, an estimate of the merging parties' combined market share, s_M, is either reported directly in the documents or can be calculated by adding the merging parties' individual market shares (which is the method that the Commission usually uses to estimate the merging parties' combined market share). However, markets are often not reported in detail when the merging parties' combined market share is sufficiently small such that competition concerns are highly unlikely to arise from the merger. Close reading of numerous decisions suggest a reporting threshold between 15% and 25%.[54] To minimise any noise or bias due to inconsistent reporting of markets with low combined market shares, we did not count markets with a combined market share $< 15\%$ to arrive at the number of relevant markets ($\#mkts$). We tested the sensititvity of our results by varying this cut-off threshold between 0% and 25% market shares. We found no significant difference to our econometric results presented in section 4.

On a market by market basis, we index the merging party with the larger pre-merger market share as 1 and the partner as 2, with market shares S_1 and S_2 respectively and $s_M = S_1 + S_2$. As explained in the text, market shares are typically reported as being within a five or ten percentage point range in which case we assumed the midpoint; for example, $[30\% - 40\%]$ is taken as 35%. One implication is that the last digit of most of our shares is either a five or a zero (or less frequently 2.5 or 7.5). The incremental market share is not reported for 18.2% of the 2,270 markets in our sample, including 113 markets with $s_M \geq 50\%$ (12.2% of such markets). When not reported, we set s_2 at the midpoint between a notional minimum overlap of 5% and $s_M/2$. A sensitivity test assuming unreported $S_2 = s_M/2$ leaves the results in Table 3 virtually unchanged, except that $\#harmmkts$ is

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[53] Unsurprisingly, reported high entry barriers are usually significant in the empirical studies of merger interventions reviewed in section 4.4.

[54] For example, it was stated in *M.1378 – Hoechst/Rhône-Poulenc* that "there is only one affected market, where the share of the parties exceeds 15%" (p21) and in *M.1878 – Pfizer/Warner Lambert* that "In 11 national markets, the operation does not give rise to competition concerns because the aggregated market share of the parties remains below 25%" (p10).

insignificant at the 10% level.

Markets where there is unlikely to be a finding of lessening competition are those with both $s_M < 35\%$ and no serious discussion of coordinated effects as the main theory of harm. Dividing the number of such markets ($\#noharmmkts$) by $\#mkts$, we constructed: $\%noharmmkts$.

We draw on Davies *et al* (2011) to identify market share combinations for which the European Commission is likely to have a strong presumption of competitive harm.[55] By examining a large number of decisions, they show that the combined market share, the incremental market share and the leading rival's market share (s_R) are strongly related to findings of unilateral and coordinated effects. For unilateral effects, a higher s_M may be allowed if S_2 is relatively small. The role of s_R in unilateral effects is that of a 'strong rival', typically one larger than the merged entity. Our definition of a strong presumption of unilateral effects excludes cases of $s_R > s_M$. We define a strong presumption as when:

$$s_M \geq 50\% + X\% \text{ and } s_2 \geq 20\% - X\% \text{ where } X = \{0, 5, 10, 15, 20\}.$$

Similarly, we define a strong presumption of coordinated effects as when:

$$s_M \geq 35\% \text{ and } s_R \geq 35\%,$$

and the market does not qualify for a strong presumption of unilateral effects. Adding the number of markets with strong presumptions of unilateral and coordinated effects, we get: $\#harmmkts$.

The number of intermediate markets lying between strong presumptions of harm and no harm is: $\#intermediatemkts = \#mkts - \#noharmmkts - \#harmmkts$.

We constructed a range of alternative variables in an attempt to design better proxies for potential harm. These included market share based variants of $\#harmmkts$ that only count the number of markets greater or equal to a certain threshold, measures of mean combined market share for markets greater than a certain threshold, and the product of market shares (which captures the incremental HHI). All tell a similar story: the variable attempting to capture potential harm is insignificant and the other results are robust. We also constructed non-market-share based measures. In particular, we used the Commission's own opinion of which markets 'raise a concern'. Although, as discussed in the text, we prefer objective measures, the Commission's opinion takes into account wider issues such as barriers to entry, product substitutability and mitigating factors. When Commission opinion-based variables replace those based on market share, the only change to the section 4 results is that $\#harmmkts$ is insignificant at the 10% level.

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[55] See especially their Fig. 4.