The effect of EU antitrust investigations and fines on a firm’s valuation*

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Abstract

A typical EU antitrust investigation involves a sequence of events (surprise inspection, Commission decision, Court judgment) which affect the investigated firm’s market value. We first model these relationships, and then use event study techniques to estimate the impact of these antitrust events on a firm’s share prices. A surprise inspection reduces on average the firm’s share price by 2.89%, an infringement Decision by the European Commission reduces it by 3.53%. The Court judgments do not have a statistically significant effect on the firm’s valuation. Finally, we find that the fine accounts for only a fraction of the loss in the firm’s value due to the antitrust procedure. We conjecture that most of the loss is due to the cessation of illegal activities.

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1 Introduction

Antitrust laws are fundamental in market economies, as they prevent firms from distorting competition in a way that is detrimental to economic efficiency, and fines are a crucial tool for the enforcement of antitrust laws. Only if the penalties that firms incur when found guilty of antitrust infringement are large enough, will the firms be deterred from engaging in anti-competitive behaviour.

In the US, managers who have been found guilty of a conspiracy can be given prison sentences, and firms are subject to fines and to the payment of treble damages in private actions. In the EU, which is the object of this study, competition law violators are not subject (at EU level) to criminal penalties, and private damages actions are extremely rare, but firms can in principle be given fines up to 10% of their previous year's turnover.

Yet, anecdotal evidence suggests that the impact of antitrust investigations and fines may be weak. Indeed, a large number of firms (and in fact several firms from the sample we analyse in this paper) are repeat offenders. Moreover, infringement Decisions by the European Commission and Community Court judgments do not seem to trigger management changes very often. This raises the question of the extent to which firms are seriously affected by the fines they receive, or expect to receive.\footnote{Connor and Bolotova (2006), building on a large number of studies, estimate the mean cartel overcharge at around 29% per year. With such margins over the competitive prices, one may expect antitrust fines to result in considerable under-deterrence.}

In this paper, we carry out (by using event study techniques) an empirical analysis to explore the effect of antitrust investigations on the share prices of firms which have infringed European competition law (for abuse of dominance, cartels, or other anticompetitive agreements). There are two main novelties in our work. Firstly, this is the first work which estimates the impact of European antitrust investigations on offending firms, and to this purpose we have constructed an original database.\footnote{See Duso et al. (2006) and Duso et al. (2006) for empirical analyses of the effects of EU merger notifications and decisions. They also make use of the event study methodology.} Bosch and Eckard (1991) carried out a similar exercise for the US, to estimate the effect on the firm's stock market price of an indictment for price fixing.\footnote{Bizjak and Coles (1995) carry out another event study analysis on US data relative to private antitrust litigation. They find that, on average, defendants lose approximately 0.6 percent of their equity value (and plaintiffs gain less than what defendants lose). See also Detre and Golub (2004) for an analysis on recent US antitrust data.} They find that the shares of indicted firms in their sample on average lose a cumulative 1.08% of their value in the days immediately after the public announcement of the indictment.\footnote{An indictment by the US Department of Justice should be 'news' to the markets, as the indictment is preceded by investigations which are supposed to be secret.}

Secondly, since we analyze the effect of different but related events, we
propose a simple model of the antitrust procedure which captures the relationships between these antitrust events. The model allows us to predict the sign that each of these events would have on the firm’s share prices, and to see why each event brings new information to the market.

Our estimates suggest that on average the total effect of an antitrust action is a fall in the firm’s stock market value by about 6.4%. Importantly, only a small part of this effect is due to the fine, and we conjecture that most of the loss is due to the fact that the market anticipates that after an antitrust action an anticompetitive practice will cease, leading to lower profits. In the case of cartels (which account for nearly 90% of our observations), the cessation of the practice will imply that collusive prices cannot be sustained any longer. This can be seen as indirect evidence that antitrust actions might be effective in decreasing market prices.

The EU competition law institutional framework, in a nutshell

Since our objective is to estimate the effect of antitrust investigations in the European Union, it is appropriate to briefly remind the reader of the main actors in the field of EU competition law, and of the main events which occur in a typical investigation. The European Commission is the main competition authority for the enforcement of EU competition law, whose main provisions are contained in articles 101 (anticompetitive agreements) and 102 (abuse of dominant positions) of the Treaty establishing the European Community. Fines can be imposed on firms which have infringed articles 101 or 102, and they are decided at the discretion of the Commission, whose decisions are however subject to the review of the Community Courts, i.e. the Court of First Instance (CFI - now renamed General Court) and the European Court of Justice (ECJ). Fines can never be higher than 10% of the firm’s worldwide turnover in the previous year; they should be proportional to the gravity and duration of the infringements; and they cannot consist of criminal penalties.

In 1998, the Commission published a Notice containing the Guidelines (i.e. a code of practice) that it would follow in deciding fines.\textsuperscript{5,6}

However calculated, commentators (and the Commission itself) agree that, until 1979 (with the Pioneer Decision, which is also the first Decision

\footnotetext{5}{On 28 June 2006, the European Commission revised the Guidelines for setting antitrust fines. However, the vast majority of our observations refer to cases which were initiated under the old Notice.}

\footnotetext{6}{Since relevant market turnover data are typically not published in the Commission Decisions for confidentiality reasons, it is not possible to identify whether the base fine is computed as a percentage of turnover. This should change in the future: the 2006 Guidelines provide that the base fines may be up to 30% of the company’s annual sales in the market to which the antitrust infringement relates, multiplied by the number of years of participation in the infringement, provided the total is within the limit of 10% of the firm’s total annual turnover.}
in our sample), the Commission was very lenient when imposing fines.\textsuperscript{7} Table \ref{table_fines} in the Appendix provides information about the fines given to the firms in our sample: they range from 0 to over one billion euro.\textsuperscript{8}

\subsection*{How an antitrust investigation proceeds}

The European Commission, or more precisely its Directorate General for Competition (DG-COMP), begins its investigation either at its own initiative or on the basis of a complaint from a third party (although, if complaints occur, the Commission has no obligation to start an antitrust procedure). There is typically no announcement that an investigation has started, and no precise time frame for it. If during the preliminary stages the Commission has serious suspicions that there has been an antitrust infringement, it can carry out a \textit{surprise inspection}, also called a \textit{dawn raid}, on the premises of the firm(s), to gather documentary evidence (which is absolutely crucial for anticompetitive agreement cases, but relevant for abuse cases too).\textsuperscript{9} This

\textsuperscript{7}See for instance Geradin and David (2005, p. 20 and ff.).

\textsuperscript{8}A noteworthy element of the Commission’s fining policy is the possibility to grant, under its Leniency Programme, reductions in fines to firms which cooperate in cartel investigations. A zero fine is due to the fact that the Commission can grant a 100\% fine reduction to a firm which reports information allowing the Commission to have sufficient evidence to convict firms involved in a cartel. See Motta (2004) for a textbook analysis of leniency programmes. At date of writing the maximum fine given by the Commission reached a record 1.06 billion euro. The fine was given to Intel for violating antitrust rules in the computer chip market.

\textsuperscript{9}Pursuant to Regulation 1/2003, the Commission can also conduct surprise inspections at the homes (and private vehicles) of firms’ managers and employees.
inspection should represent a genuine surprise for the investors. To verify that this is really an unexpected event, we examined past issues of the Financial Times for any news about the (potential) investigation before the inspection took place, and we could not find any, for any of the firms for which we have dates of the raid.\footnote{It is of course possible that investors may nonetheless anticipate that an investigation will take place. This may be the case in particular for some of the international cartel cases which appear in our sample, where a US antitrust case precedes the EU investigation. To deal with this issue we shall report separate estimates for dawn raids when the same cartel had already been investigated in another jurisdiction and when there have been applications for leniency.}

A well-established jurisprudence obliges the Commission to take steps to respect the rights of the defendants during the investigation.\footnote{Indeed, several Commission Decisions have been annulled by the Community Courts on various procedural grounds.} Among these, the Commission has to send a "statement of objections" to the firms under investigation, where it states its allegations regarding the practices of the firm and asks for the firm’s response.\footnote{We also carried out an empirical analysis of the effects of the Statement of Objections, but as expected - it is largely a procedural step which does not reveal substantial new information to the market - we did not find any significant effect of this event on the value of the firm. Accordingly, we shall not discuss it any longer.}

After having analyzed all the evidence and having heard from the parties, the Commission might either take a formal infringement Decision or decide to close the case. If the latter, there may be a non-infringement Decision, an announcement through a press release, or - the most common outcome - no public statement at all (so that there is little or no information about it). Whatever the Commission’s verdict, it may be reached a long time after

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure2.png}
\caption{Yearly average fine/capitalisation ratio, 1979-2009}
\end{figure}
the dawn raid (on average, three to four years to an infringement Decision, see also Table 4 below).

A relevant feature of our analysis is that the Decision is a collegial decision of the whole European Commission, not of DG-COMP, and before taking it several bodies are consulted, such as representatives of national competition authorities and members of other directorates general. Although all the people involved are bound by confidentiality clauses, leakages about (or speculations on) the content of the Decision and the level of the fines are common.\footnote{By examining past issues of the Financial Times we found that rumors on the potential infringement Decision, and speculation on the magnitude of the fines, may occur but - if they do - are typically concentrated in a period of one month before the date of the Decision.}

Firms which have been fined can appeal to the Community Courts, which can rule upon the merits of the Commission Decision, and whose\footnote{In older cases, the firms' appeal was decided by the ECJ. In more recent years, it is the CFI which decides; firms can also appeal the CFI's judgment. We do not look at this 'second' judgment, and only consider the first judgment, whichever Court takes it. Table ?? in the Appendix also reports the fines as they appeared in the first judgment.} Judgments can annul, uphold or modify the fine, as well as of course annul or uphold, completely or partly, the overall Decision.\footnote{In particular the opinion of the Advocate General often (though not always) anticipates the judgment of the Court. However, Advocates General are only involved in the ECJ's procedures and not the CFI's.} The decisions taken by the Court are not made public until the moment they are announced, although in some cases there may be signs of the judges' views.\footnote{We shall use standard event study methodology to estimate the effect on the firm's share price of the three main events in the investigation procedure identified above: (i) the dawn raid, (ii) the Commission Decision, and (iii) the Court's judgment. Note, however, that while we know all the Commission Decisions and their dates, surprise inspections do not always take place or sometimes their date is not made public by the Commission (we dropped several dawn raids observations because their dates were not revealed or were not made precise); also, firms may decide not to appeal. Therefore, we have a different number of observations for the three different antitrust events.}

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The paper continues in the following way. Section 2 presents a model of the antitrust procedure. Section 3 describes our data and explains our estimation procedure. Section 4 reports the results of our analysis and discusses their robustness. Section 5 concludes the paper by assessing the results obtained and discussing policy issues.
2 A simple model, to obtain testable predictions

Since the antitrust procedure involves different events which take place successively and are related, we propose a simple model of this procedure. Although very stylised, the model guides our analysis by offering some testable predictions on the effects of the events.

Assume that a firm has to decide whether to engage or not in a certain anticompetitive business practice, and that if such a practice is undertaken the Commission Decision and the Court Judgment are probabilistic. This may be rationalised as a situation where the outcome of a certain investigation depends on some factors - such as the discovery of documental evidence and the respect of the procedures - that may be casual. Assume also that there is no investigation if the firm decides not to infringe antitrust law. For simplicity, we also ignore the fact that time elapses between one event and the following one, and accordingly we consider neither discount factors nor interest rates. These assumptions are admittedly very crude, but they allow us to emphasise some simple relationships among the antitrust events.

A simple formalisation of the antitrust procedure is given in Figure 3. At time 1, Nature determines whether the firm will be subject to a surprise inspection - event which takes place with probability $m$ - or not. If no raid is undertaken, though, we assume that the firm will never be investigated any longer, and it will have (anticompetitive) net present value $V^M$. The practice may concern either abusive behaviour or cartel participation. We have chosen to consider a firm’s infringement decision in isolation for simplicity. The model could be extended to deal with cartel decisions, by analysing the incentive constraint for collusion of the firms involved, but this is beyond the scope of the present paper.

One may extend this simple model to consider the firm’s choice between violating or complying. It would be sufficient to include a time 0 node where the firm decides whether to violate the law or not in a particular market. If it does not, its (competitive) present discounted value will be $V^C$. The model could then be used, for instance, to identify the optimal fine necessary for deterrence.

A slightly more sophisticated version of the model would be that in each period the Commission could do a surprise inspection from the pool of the firms which have not been investigated previously, but this would not qualitatively change the results.
If a raid takes place at time 1, the Commission will investigate the practice further. With probability $1 - p$, the Commission will not find proof of the infringement and the case will be dropped. The firm will not be investigated any longer and it will have value $V^M$. With a probability $p$ the Commission will find proof of an infringement and at time 2 it will issue an Infringement Decision imposing a fine, $F$, and ordering the firm to cease the anti-competitive practice. In this case, though, we assume that the firm always appeals the infringement decision. (This is largely consistent with what happens in reality - where most Decisions are appealed -, and of course it makes sense in the model because the cost of appealing is taken to be zero for simplicity.)

At time 3, the Court upholds the Commission’s Decision with probability $q$ and annuls the fine with the remaining probability $1 - q$. Of course, the Court is free to set any level of the fines it deems correct, so the fine should be a continuous variable. To simplify matters, though, we assume that it has a binary choice.\(^\text{19}\)

If the Judgment is in favour of the Commission, the firm will pay the fine $F$ and will have competitive profits forever, resulting in a firm’s net present value $V^C$. Otherwise, the firm will not have to pay any fine and will have expected value $\alpha V^C + (1 - \alpha)V^M$, with $\alpha \in [0,1]$, included between two extreme cases. (i) The Court may annul or drastically reduce the fine while agreeing with the Commission that there has been a violation, resulting in the firm having to cease the practice at hand despite the (relatively) favourable judgment. In this case, $\alpha = 1$, with the firm having a value $V^C$. (ii) The Court may not only annul the fine, but also disagree with the analysis of the Commission, rejecting its allegations of anticompetitive behaviour. In this case, $\alpha = 0$, with the firm having a value $V^M$. We believe that case (i) corresponds with what would happen in cartel cases where the Commission is unlikely to arrive at an infringement decision unless it has very strong documental evidence, while case (ii) might fit cases of abuse of dominance or anticompetitive agreements (other than cartels) where economic and legal analysis play a bigger role than factual evidence and where discretion therefore matters more. (In fact, though, the Community Courts are typically in agreement with the Commission’s analyses.)

In order to investigate how the occurrence of a certain antitrust event affects the valuation (that is, the net present value) of the firm, let us find first the value of the firm after a particular event.

The expected value of a firm that violates competition law is:

\(^\text{19}\)In our event study analysis, we define as ‘annulment’ a Court judgment which reduces the fine to below the 1/2 of the fine proposed by the Commission, and ‘upholding’ when either firms do not appeal (there are a few such cases in our sample) or the Court fine is above 1/2 of the original one.
\[
V_{\text{Violation}} = mpq (V^C - F) + [1 - mp] (1 - q)(\alpha V^C + (1 - \alpha) V^M) + (1 - mp)V^M.
\]

After a dawn raid, and before a Decision, it is:
\[
V_{\text{Raid}} = V^M - pqF - p (V^M - V^C) (q (1 - \alpha) + \alpha).
\]

After an infringement Decision, it is:
\[
V_{\text{Decision}} = q(V^C - F) + (1 - q) \left( \alpha V^C + (1 - \alpha) V^M \right).
\]

Finally, after a judgment upholding or annulling the Commission’s Decision, the firm’s expected value will respectively be:
\[
V_{\text{Upheld}} = V^C - F; V_{\text{Annulled}} = \alpha V^C + (1 - \alpha) V^M.
\]

We can now compute the effect of an event on the expected value of the firm. First of all, the occurrence of a dawn raid will change the firm’s value as follows:
\[
\Delta_{\text{Raid}} = \frac{V_{\text{Raid}} - V_{\text{Violation}}}{V_{\text{Violation}}} = \frac{p(1 - m)(qF + (V^M - V^C) (q (1 - \alpha) + \alpha))}{V^M - mpqF - mp (V^M - V^C) (q (1 - \alpha) + \alpha)} < 0.
\]

When a dawn raid takes place, the market correctly understands that the probability that the firm may be obliged to stop the lucrative anticompetitive conduct and pay the fine is now higher than before the dawn raid took place, resulting in the firm’s expected market value to decrease. This leads to:

**Prediction 1:** If the event "Commission undertakes a dawn raid" is observed, then we should expect the share price of the firm to decrease.

An infringement decision will change the expected firm’s value as:
\[
\Delta_{\text{Decision}} = \frac{V_{\text{Decision}} - V_{\text{Raid}}}{V_{\text{Raid}}} = \frac{(1 - p) \left( qF + (V^M - V^C) (q (1 - \alpha) + \alpha) \right)}{V^M - pqF - p (V^M - V^C) (q (1 - \alpha) + \alpha)} < 0.
\]

In words, if the Commission issues a negative Decision, the firm’s expected market value will decrease because it is more likely that the firm will have to stop anticompetitive conduct and it will ultimately have to pay the fine. We can then state:
**Prediction 2:** If the event "Commission issues an infringement Decision" is observed, then we should expect the share price of the firm to decrease.

After a Court’s Judgment which upholds the Decision, the change in the firm’s value will be:

\[
\Delta_{\text{Upheld}} = \frac{V_{\text{Upheld}} - V_{\text{Decision}}}{V_{\text{Decision}}} = -\frac{(1 - q) (F + (V^M - V^C) (1 - \alpha))}{q(V^C - F) + (1 - q) (\alpha V^C + (1 - \alpha) V^M)} < 0, \tag{8}
\]

whereas after a judgment which annuls the Decision, it will be:

\[
\Delta_{\text{Annulled}} = \frac{V_{\text{Annulled}} - V_{\text{Decision}}}{V_{\text{Decision}}} = \frac{q (F + (V^M - V^C) (1 - \alpha))}{q(V^C - F) + (1 - q) (\alpha V^C + (1 - \alpha) V^M)} > 0. \tag{9}
\]

This results in the following:

**Prediction 3:** If the event "Judgment upholds the fine" is observed, then we should expect the share price of the firm to decrease. If the event "Judgment annuls the fine" is observed, then we should expect the share price of the firm to increase.

Our stylised description of the antitrust procedure also allows us to perform some comparative static analysis. In particular, we are interested in studying the effects of \( q \) and \( F \), since there are clear indications that in the period we consider these variables change value over time. It is easy to see that the probability that the Court upholds the Commission’s decision affects the expected changes in the firm’s value as follows (let us focus on absolute values of the changes):

\[
\frac{\partial |\Delta_{\text{Raid}}|}{\partial q} > 0, \quad \frac{\partial |\Delta_{\text{Decision}}|}{\partial q} > 0, \quad \frac{\partial |\Delta_{\text{Upheld}}|}{\partial q} < 0, \quad \frac{\partial |\Delta_{\text{Annulled}}|}{\partial q} > 0,
\]

That is, if the court upheld the Commission’s Decision with a higher probability one would expect to find a stronger effect both of the raid and of the Decision (since the market would anticipate that the infringement is more likely to be confirmed in appeal). As for the judgment, a higher probability that a Decision is upheld will imply a lower effect on share returns from upholding (since the market has already discounted it), but a stronger effect from annulling the Decision (which would now ‘surprise’ more the market).

The severity of the fines imposed by the Commission affects the expected changes as follows:
\[
\frac{\partial |\Delta_{\text{Raid}}|}{\partial F} > 0, \frac{\partial |\Delta_{\text{Decision}}|}{\partial F} > 0, \frac{\partial |\Delta_{\text{Upheld}}|}{\partial F} > 0, \frac{\partial |\Delta_{\text{Annulled}}|}{\partial F} > 0.
\]

That is, a higher fine would ceteris paribus increase the magnitude of the effects of all antitrust events: the more important the fine the stronger the impact of the events on the firms’ profits, and thus on their market values.

Several commentators have expressed the view that the probability that the Court approved the Commission’s decisions has increased after the early enforcement period, reflecting the fact that the Commission has dealt with the rights of defence of the firms more carefully, and that it has imposed fines in a less arbitrary way (for instance by issuing guidelines), both leading to higher upholding rates by the Courts. Indeed, it appears from our sample that the probability of the Court upholding a Decision raises in the period considered (see Table 4).

Similarly, as we have seen above (see Figures 1 and 2) it is well established that fines have increased over time.

Unfortunately, though, the fact that around the year 1998 (when the first Guidelines on the imposition of fines were issued) both \(q\) and \(F\) increase makes it difficult to evaluate separately the role played by these two variables. However, we can identify the following prediction.

**Prediction 4:** If both the probability that the Court upholds the fine, \(q\), and the fines imposed by the Commission, \(F\), increase, then we should expect the events "Raid", "Infringement Decision", and "Judgment annuls the Decision" to result in a stronger effect on the share price.

Finally, note that in principle it is also possible to look at how the probability \(p\) of an infringement Decision affects the magnitude of the changes in share values. By taking the derivatives we obtain that:

\[
\frac{\partial |\Delta_{\text{Raid}}|}{\partial p} > 0, \frac{\partial |\Delta_{\text{Decision}}|}{\partial p} < 0.
\]

Therefore, the model would predict that a higher probability \(p\) would increase the expected change in market value following a raid (since it is more likely that the bad news of the investigation will end up in an infringement Decision) and would decrease the (negative) effect of a Decision (since the market has already discounted that it is more likely that a violation will be found). However, the Commission does not systematically release information about firms which have been raided, so in our database nearly all the firms have been raided and have received an infringement Decision, which makes it impossible to calculate \(p\). Only recently has the Commission started to publish information about cases which have been dismissed after an investigation, which will make it possible to analyse the role of \(p\) in future data.
3 Estimation of abnormal returns

In this Section, we first describe our data, and then the estimation procedure we follow.

3.1 Data

Our data come from Commission Decisions, published in the Official Journal of the European Communities, and judgments of the Court of First Instance and the European Court of Justice, published in the European Court Reports and other sources. The data refer to all the infringement Decisions from 1969 until 2009. In the Decisions the Commission describes the investigation and often reports the date of the surprise inspection, if it was made.

We have retained only decisions involving the firms listed in a stock exchange for which data on share price are available in the Datastream database.\(^{20}\) Our final sample refers to 91 cases (the first of which dates from 1979) involving 183 firms (some are repeat offenders), for a total of 243 Commission Decisions finding infringement of either article 101 or 102 (or both). We also have dates of Court judgments for 99 infringements (42 annulments),\(^{21}\) as well as exact dates of surprise inspections for 130 infringements.

Table 4 offers a description of the sample, while Table ?? in the Appendix lists the firms in our sample, indicates the type of antitrust infringement, the dates of the relevant events, the fines, and other relevant information.

The firms in our sample are listed on different stock exchanges. The majority are listed in Frankfurt and Tokyo, followed by New York, London and Paris. The remaining stock exchanges where the firms from our sample are listed are Amsterdam, Korea, Hong Kong, Singapore, Stockholm, Oslo, Brussels, Copenhagen, Milan, Luxembourg, Taiwan, Malaysia, Athens and Vienna.\(^{22}\)

\(^{20}\)We are aware that sample selection is a possible concern of our analysis, to the extent that publicly listed firms tend to be large, multiproduct, and possibly multinational firms, for which the effect of a fine related to one particular product and geographic market may well be smaller than for a smaller, single-product firm operating in a domestic market. However, it should also be recalled that the Commission can impose fines up to 10\% of the total (world) turnover of a firm, so that for any given violation a larger multiproduct and multinational firm would generally be given a larger fine.

\(^{21}\)The share prices data for three of the firms were no longer available at the time of the judgment, even though these were available at the time of the Commission Decision.

\(^{22}\)In case of multiple listing we select the stock exchange with higher capitalization.
3.2 Event Study Methodology and Estimation Procedure

The central concept in the event study methodology is the efficient market hypothesis (EMH). Under this hypothesis, the price of the security reflects the value to investors of all the relevant available information about the fundamentals of the firm. Moreover, under the EMH, any news about the fundamentals are immediately reflected in the share price.

The question that the event study attempts to answer is: what is the value of a change of a particular fundamental? Under the EMH, if we knew the exact time at which the news became available to investors and the security price that would have prevailed in the absence of this news we could compute the value of the change of the fundamental that is reflected in the news, as the difference between the counterfactual and the actual price.

We use standard event study methodology to estimate the effect of the three above mentioned events in the antitrust investigation on the value of the firm. Our main references for the event study methodology are Campbell et al. (1997) and MacKinlay (1997).

To obtain a counterfactual return we use a simple market model of returns:\(^24\)

\[
R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it},
\]

where \(R_{it}\) and \(R_{mt}\) are the period-\(T\) returns on security \(i\) and the leading index of the stock exchange where the security is listed, respectively. We

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\(^{23}\)See also Brown and Warner (1980, 1985).

\(^{24}\)A convenient assumption that we will make is that the \((N \times 1)\) vector of asset returns, \(R_t\), is independently multivariate normally distributed with mean \(\mu\) and covariance matrix \(\Omega\) for all \(t\). Under this assumption, given that the model is correctly specified, the abnormal returns, conditionally on the market return, are jointly normally distributed. This result is the basis of our inference.
compute the returns as $\ln P_{it} - \ln P_{it-1}$, where $P_{it}$ is the price of the share on trading day $t$.

$$R_{it} = \alpha_i + \beta_i R_{m,t} + \epsilon_{it}$$

$$\hat{\epsilon}_{it}^* = R_{it}^* - \left( \hat{\alpha}_i + \hat{\beta}_i R_{m,t}^* \right)$$

Figure 5: Timeline: Estimation and event windows

Figure 5 illustrates our approach. We define $\tau = 0$ as the event date, $\tau = T_2$ to $\tau = T_3$ form the event window and the periods from $\tau = T_0$ through $\tau = T_1$ form the estimation window. Let $L_1 = T_1 - T_0 + 1$ and $L_2 = T_3 - T_2 + 1$. We estimate parameters $\alpha_i$ and $\beta_i$ for the firm $i$ security using 101 trading days in the period $T_0 = -130$ to $T_1 = -30$.

Then we use the estimated model as the model of counterfactual returns in the periods of interest to construct abnormal returns in the event window as

$$\hat{\epsilon}_{it}^* = R_{it}^* - \left( \hat{\alpha}_i + \hat{\beta}_i R_{m,t}^* \right),$$

where $R_{it}^*$ and $R_{m,t}^*$ are $L_2 \times 1$ vectors of actual returns on the security $i$ and of the leading index of the stock market where $i$ is listed.

We aggregate individual daily abnormal returns by averaging them over securities and summing them over the days of the event window to obtain cumulative average abnormal returns (CAR) for the event.

$$CAR = \sum_{\tau = T_2}^{T_3} \left( \frac{1}{N} \sum_{i=1}^{N} \hat{\epsilon}_{it}^* \right)$$

Under the null hypothesis the event has no effect on the mean returns and we use the test statistic below to draw inference about the cumulative abnormal return

$$J_1 = \frac{CAR}{\hat{\sigma}_{CAR}(\tau_1, \tau_2)}$$

Subject to number of securities and length of estimation window). For a detailed derivation of the test see the Appendix A.1.
As an alternative specification, to verify the robustness of our results, we use the mean model, where the mean return of the individual security is used as the counterfactual return. In this case the model is simply \( R_{i\tau} = \alpha_i + \varepsilon_{i\tau} \). In principle, it is possible that a change in the share price of a very large firm may cause a change in the relevant stock market index, giving rise to endogeneity problems. Using the mean model rather than the market model avoids this problem. In Section 4.4 we estimate the mean model to deal with this issue.

## 4 Results

In this Section, we first describe our main results, then we report the various robustness checks we have carried out, and finally we discuss the issue of cross-sectional correlation and argue that it is not a problem in our case.

Table 6 reports daily average abnormal returns for the different events; it also reports cumulative average abnormal returns for different event windows, all along with their \( J \)-statistics. All tests are one-sided unless specifically stated otherwise. In what follows, we discuss the estimates of the effects for each event.

### 4.1 A first look at the results

The average abnormal return on the day of the raid is negative and highly statistically significant, suggesting a .64% drop in the firm’s share price the day the dawn raid is carried out. This implies a very quick relay of the news to investors.\(^{27}\) We also find statistically significant effects both after and before the raid. While the former is expected (typically the markets will continue to adjust to the news in the following days), the latter is more surprising, since dawn raids are widely considered truly unexpected events (and since we had found no mention of possible investigations in newspapers before the raids took place). Note, though, that the strongest effect takes place on the day of the inspection.

If we aggregate the abnormal returns, we find highly significant (at 1% significance level) negative returns for the dawn raid. For instance, by choosing the 31-day event window, the raid is estimated to lead on average to a 2.89% drop in the investigated firm’s stock market valuation (significant at 1%).

\(^{27}\)A large number of studies indicate that stock markets react very quickly to unexpected news. Brooks et al. (2003) investigate a sample of 21 fully unexpected negative news events - such as the Exxon-Valdez oil disaster, plant explosions, plane crashes, deaths of executives - and find that share prices fall by an average of 1.6% after a mere 15 minutes. They stress that they find longer response times than reported by previous studies.
### Figure 6: Base results: Estimates of daily and cumulative average abnormal returns

<table>
<thead>
<tr>
<th>Date to event</th>
<th>Raid 130</th>
<th>J Com.D.</th>
<th>243</th>
<th>J Annul.</th>
<th>42</th>
<th>J Upheld</th>
<th>57</th>
<th>J</th>
</tr>
</thead>
<tbody>
<tr>
<td>t = -25</td>
<td>0.02</td>
<td>0.17</td>
<td>-0.14</td>
<td>-2.23</td>
<td>-0.27</td>
<td>-1.14</td>
<td>-0.10</td>
<td>0.08</td>
</tr>
<tr>
<td>t = -24</td>
<td>-0.16</td>
<td>-0.38</td>
<td>0.19</td>
<td>1.80</td>
<td>-0.06</td>
<td>0.27</td>
<td>-0.08</td>
<td>0.25</td>
</tr>
<tr>
<td>t = -23</td>
<td>-0.21</td>
<td>-0.57</td>
<td>0.14</td>
<td>0.86</td>
<td>-0.15</td>
<td>-0.66</td>
<td>0.02</td>
<td>-0.37</td>
</tr>
<tr>
<td>t = -22</td>
<td>-0.37</td>
<td>-1.56</td>
<td>-0.03</td>
<td>-0.58</td>
<td>0.18</td>
<td>-0.14</td>
<td>0.01</td>
<td>-0.91</td>
</tr>
<tr>
<td>t = -21</td>
<td>0.22</td>
<td>1.14</td>
<td>-0.22</td>
<td>-2.26</td>
<td>0.70</td>
<td>2.38</td>
<td>-0.36</td>
<td>-1.02</td>
</tr>
<tr>
<td>t = -20</td>
<td>-0.21</td>
<td>-1.29</td>
<td>-0.37</td>
<td>-2.59</td>
<td>0.04</td>
<td>1.07</td>
<td>-0.06</td>
<td>-0.20</td>
</tr>
<tr>
<td>t = -19</td>
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<td>-0.76</td>
<td>-0.14</td>
<td>-1.37</td>
<td>-0.44</td>
<td>-0.93</td>
<td>0.15</td>
<td>0.24</td>
</tr>
<tr>
<td>t = -18</td>
<td>-0.18</td>
<td>-0.07</td>
<td>-0.07</td>
<td>-0.31</td>
<td>-0.23</td>
<td>-0.77</td>
<td>-0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>t = -17</td>
<td>0.00</td>
<td>0.15</td>
<td>-0.18</td>
<td>-1.28</td>
<td>0.28</td>
<td>0.74</td>
<td>-0.39</td>
<td>-2.06</td>
</tr>
<tr>
<td>t = -16</td>
<td>-0.06</td>
<td>-0.41</td>
<td>0.09</td>
<td>-0.56</td>
<td>-0.67</td>
<td>-0.78</td>
<td>-0.24</td>
<td>-0.64</td>
</tr>
<tr>
<td>t = -15</td>
<td>0.04</td>
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<td>0.02</td>
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<td>-0.26</td>
<td>-0.20</td>
</tr>
<tr>
<td>t = -14</td>
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<td>-0.58</td>
<td>-0.11</td>
<td>-0.38</td>
<td>-0.18</td>
<td>-0.26</td>
<td>-0.34</td>
<td>-1.03</td>
</tr>
<tr>
<td>t = -13</td>
<td>0.12</td>
<td>0.36</td>
<td>-0.15</td>
<td>-0.08</td>
<td>0.02</td>
<td>0.63</td>
<td>-0.31</td>
<td>-1.18</td>
</tr>
<tr>
<td>t = -12</td>
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<td>-0.15</td>
<td>-0.16</td>
<td>-1.84</td>
<td>-0.06</td>
<td>0.17</td>
<td>0.12</td>
<td>0.60</td>
</tr>
<tr>
<td>t = -11</td>
<td>-0.26</td>
<td>-1.66</td>
<td>-0.19</td>
<td>-1.28</td>
<td>0.42</td>
<td>0.58</td>
<td>0.00</td>
<td>0.70</td>
</tr>
<tr>
<td>t = -10</td>
<td>-0.12</td>
<td>-0.94</td>
<td>-0.01</td>
<td>0.60</td>
<td>-0.36</td>
<td>-1.35</td>
<td>0.07</td>
<td>0.94</td>
</tr>
<tr>
<td>t = -9</td>
<td>-0.34</td>
<td>-1.65</td>
<td>-0.29</td>
<td>-1.96</td>
<td>-0.16</td>
<td>-0.68</td>
<td>0.13</td>
<td>0.09</td>
</tr>
<tr>
<td>t = -8</td>
<td>-0.37</td>
<td>-1.59</td>
<td>-0.32</td>
<td>-2.19</td>
<td>-0.77</td>
<td>-1.60</td>
<td>-0.07</td>
<td>0.32</td>
</tr>
<tr>
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<td>0.51</td>
<td>0.90</td>
<td>0.02</td>
<td>-0.14</td>
<td>-0.16</td>
<td>0.07</td>
<td>0.22</td>
<td>0.36</td>
</tr>
<tr>
<td>t = -6</td>
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<td>-1.10</td>
<td>-0.08</td>
<td>-0.60</td>
<td>-0.51</td>
<td>-0.37</td>
<td>0.37</td>
<td>1.91</td>
</tr>
<tr>
<td>t = -5</td>
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<td>0.50</td>
<td>-0.18</td>
<td>-0.79</td>
<td>-0.24</td>
<td>-0.14</td>
<td>-0.20</td>
<td>0.87</td>
</tr>
<tr>
<td>t = -4</td>
<td>0.13</td>
<td>0.08</td>
<td>-0.09</td>
<td>-0.19</td>
<td>0.19</td>
<td>-0.01</td>
<td>-0.26</td>
<td>0.82</td>
</tr>
<tr>
<td>t = -3</td>
<td>-0.20</td>
<td>-0.18</td>
<td>-0.03</td>
<td>-0.52</td>
<td>0.33</td>
<td>1.05</td>
<td>0.11</td>
<td>0.82</td>
</tr>
<tr>
<td>t = -2</td>
<td>-0.01</td>
<td>0.15</td>
<td>-0.11</td>
<td>-1.05</td>
<td>0.20</td>
<td>1.09</td>
<td>-0.22</td>
<td>-0.92</td>
</tr>
<tr>
<td>t = -1</td>
<td>0.17</td>
<td>0.24</td>
<td>-0.02</td>
<td>0.31</td>
<td>0.27</td>
<td>0.36</td>
<td>-0.29</td>
<td>0.97</td>
</tr>
<tr>
<td>t = 0</td>
<td>-0.64</td>
<td>-2.08</td>
<td>-0.19</td>
<td>-1.07</td>
<td>0.35</td>
<td>0.71</td>
<td>-0.32</td>
<td>-1.08</td>
</tr>
<tr>
<td>t = 1</td>
<td>-0.43</td>
<td>-1.45</td>
<td>-0.12</td>
<td>0.08</td>
<td>0.66</td>
<td>1.60</td>
<td>0.50</td>
<td>1.31</td>
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<tr>
<td>t = 2</td>
<td>-0.31</td>
<td>-1.48</td>
<td>0.01</td>
<td>0.60</td>
<td>0.58</td>
<td>2.02</td>
<td>0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>t = 3</td>
<td>-0.15</td>
<td>-0.62</td>
<td>-0.05</td>
<td>-1.03</td>
<td>0.08</td>
<td>0.10</td>
<td>0.29</td>
<td>0.85</td>
</tr>
<tr>
<td>t = 4</td>
<td>0.26</td>
<td>0.32</td>
<td>-0.11</td>
<td>-0.50</td>
<td>0.04</td>
<td>-0.27</td>
<td>-0.15</td>
<td>0.06</td>
</tr>
<tr>
<td>t = 5</td>
<td>-0.04</td>
<td>0.30</td>
<td>-0.03</td>
<td>-0.19</td>
<td>-0.76</td>
<td>-1.85</td>
<td>-0.22</td>
<td>-0.23</td>
</tr>
<tr>
<td>t = 6</td>
<td>-0.14</td>
<td>-0.96</td>
<td>-0.16</td>
<td>-1.75</td>
<td>0.15</td>
<td>0.67</td>
<td>-0.36</td>
<td>-1.21</td>
</tr>
<tr>
<td>t = 7</td>
<td>-0.18</td>
<td>-1.25</td>
<td>-0.17</td>
<td>-0.63</td>
<td>0.11</td>
<td>0.06</td>
<td>-0.04</td>
<td>-0.08</td>
</tr>
<tr>
<td>t = 8</td>
<td>0.21</td>
<td>0.68</td>
<td>-0.10</td>
<td>-0.59</td>
<td>-0.38</td>
<td>-1.37</td>
<td>0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>t = 9</td>
<td>-0.09</td>
<td>-0.40</td>
<td>0.14</td>
<td>1.25</td>
<td>0.23</td>
<td>1.51</td>
<td>-0.27</td>
<td>-0.81</td>
</tr>
<tr>
<td>t = 10</td>
<td>0.00</td>
<td>0.43</td>
<td>-0.40</td>
<td>-1.99</td>
<td>0.55</td>
<td>1.65</td>
<td>0.31</td>
<td>1.57</td>
</tr>
<tr>
<td>t = 11</td>
<td>-0.18</td>
<td>-0.84</td>
<td>-0.21</td>
<td>-1.15</td>
<td>0.36</td>
<td>0.44</td>
<td>-0.23</td>
<td>-0.77</td>
</tr>
<tr>
<td>t = 12</td>
<td>0.30</td>
<td>1.42</td>
<td>0.24</td>
<td>1.36</td>
<td>1.19</td>
<td>3.46</td>
<td>-0.27</td>
<td>-0.36</td>
</tr>
<tr>
<td>t = 13</td>
<td>-0.11</td>
<td>-0.43</td>
<td>0.39</td>
<td>2.90</td>
<td>-0.16</td>
<td>-0.35</td>
<td>-0.23</td>
<td>-0.59</td>
</tr>
<tr>
<td>t = 14</td>
<td>-0.09</td>
<td>-0.89</td>
<td>-0.13</td>
<td>-1.22</td>
<td>-0.21</td>
<td>-0.08</td>
<td>0.17</td>
<td>0.84</td>
</tr>
<tr>
<td>t = 15</td>
<td>-0.38</td>
<td>-1.57</td>
<td>-0.15</td>
<td>-0.83</td>
<td>-0.68</td>
<td>-2.02</td>
<td>0.07</td>
<td>-0.11</td>
</tr>
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<td>t = 16</td>
<td>0.32</td>
<td>1.09</td>
<td>0.06</td>
<td>-0.34</td>
<td>0.10</td>
<td>0.16</td>
<td>0.48</td>
<td>1.89</td>
</tr>
<tr>
<td>t = 17</td>
<td>-0.16</td>
<td>-0.87</td>
<td>-0.16</td>
<td>-0.62</td>
<td>-0.14</td>
<td>0.44</td>
<td>-0.31</td>
<td>-1.01</td>
</tr>
<tr>
<td>t = 18</td>
<td>0.05</td>
<td>0.11</td>
<td>-0.06</td>
<td>-0.27</td>
<td>-0.06</td>
<td>0.39</td>
<td>-0.21</td>
<td>-0.76</td>
</tr>
<tr>
<td>t = 19</td>
<td>-0.30</td>
<td>-0.89</td>
<td>0.12</td>
<td>0.60</td>
<td>-0.08</td>
<td>-0.85</td>
<td>0.28</td>
<td>1.78</td>
</tr>
<tr>
<td>t = 20</td>
<td>-0.07</td>
<td>0.06</td>
<td>0.19</td>
<td>1.22</td>
<td>-0.37</td>
<td>-1.25</td>
<td>0.20</td>
<td>1.41</td>
</tr>
</tbody>
</table>

**Top panel:** Average abnormal returns (%), by date to the event, and by event

**Bottom panel:** Cumulative average abnormal returns (%), by length of event windows and by event

Top and bottom panels: One-sided test, significance levels: ***1%; **5%; *10%.
In the column for the Commission Decision we have negative abnormal returns for some particular days before and after the event. In the case of the Decision, though, finding significant estimates before the event is not entirely unexpected, since - as explained above - there are rumours and possible anticipations before the Decision. As for the cumulative average abnormal return, we find the strongest effect for the 31-day window, where the Decision is estimated to reduce the returns by $-3.53\%$, effect which is statistically significant at the level of 1%.

The last two columns in Table 6 show the effects of the Court judgments. We define as “annullments” all judgments which either annul the fine or reduce it by more than 50%, and “upheld” all remaining judgments.

Although for some particular days we find some statistically significant effects, they do not all carry the same sign. Moreover, when aggregating over a certain number of days, we find no statistically significant effect, for all different event windows, and no matter whether we consider annulments or upholding judgments.

These are the base results. We now discuss them more thoroughly and refine our estimates, dealing with each of the antitrust events in turn.

4.2 Analysis and refinement of the results

4.2.1 Dawn Raids

Antitrust experts and practitioners would agree that - apart from exceptional cases - "dawn raids" do come unexpectedly and surprise commentators and markets. It is difficult to reconcile this fact with our finding of negative (statistically significant) returns before the dawn raid. In case of investigations already under way in other jurisdictions, it is possible that the market knows - or suspects - that the European Commission may also investigate similar infringements in the EU. It is also conceivable that news of an investigation being under way may occur when a firm participating in a cartel has applied for leniency to the European Commission, and rumours about the application may have filtered to the market. For these reasons, we have carried out separate estimates of the effects of raids by excluding all cases which had already been investigated in the US (we did not find any prior investigations in other jurisdictions), as well as those where leniency applications were made. Table 7 shows that the estimated effects of the raid do become stronger after excluding all such cases. However, there is still added significance when using the long 31-day window which includes a period well ahead of the raid, instead of shorter windows (the $J$ is the highest in the former window). Clearly, our results suggest that some traders may be suspecting that investigations may soon take place.

Overall, these results show that the surprise inspection has a strong negative effect on the investigated firm’s valuation, although the precise
Excluding US and Leniency

<table>
<thead>
<tr>
<th>Event Window</th>
<th>All cases</th>
<th>Excl. US and leniency</th>
</tr>
</thead>
<tbody>
<tr>
<td>31 days (-20,+10)</td>
<td>-2.89</td>
<td>-2.50</td>
</tr>
<tr>
<td>11 days (-5...+5)</td>
<td>-1.17</td>
<td>-1.53</td>
</tr>
<tr>
<td>6 days (-1...+5)</td>
<td>-1.14</td>
<td>-2.34</td>
</tr>
<tr>
<td>3 days (-1...+1)</td>
<td>-0.90</td>
<td>-2.18</td>
</tr>
</tbody>
</table>

Figure 7: Estimate of CARs of the raids, all sample and excluding cases previously investigated in the US and with leniency applicants

The magnitude of the effect is sensitive to the length of the event window used. The choice of a particular event window is always to some extent arbitrary, but in what follows we shall choose the 31-day window because it is always very highly statistically significant for both the raid and the Decision events. We can then state the following result.

*Prediction 1 seems consistent with the data: If the event "Commission undertakes a dawn raid" is observed, then the share price of the raided firm decreases on average by 2.89%.*

### 4.2.2 Commission Decisions

We have verified the impact of the infringement Decision of the Commission by considering different event windows. The results reported in Table 6 indicate that omitting to consider what happens several days ahead of the Decision lowers the significance of the results considerably. This is not surprising, since it is well known that there are informational leakages occurring prior to the date of the Decision. Accordingly, our favourite estimate remains the one obtained with the 31-day window: cumulative average (across firms) abnormal return for this event window is -3.53% and is significant at 1%.

*Prediction 2 seems consistent with the data: If the event "Commission issues an infringement Decision" is observed, then the share price of the firm decreases on average by 3.53%.*

### 4.2.3 Court judgments

As seen in Table 6 above, neither judgments annulling the Commission Decision, nor those upholding them, are statistically significant for all event windows. The lack of a significant effect may be attributed to different reasons. One possibility is that through the hearings and the reports of the
witnesses, the public may form a correct expectation of the judge’s view, so that at the time the judgment comes the market has already discounted for it. Another possibility is that - as discussed in Section 5 below - the fine itself is only part of the loss that a firm incurs because of the antitrust investigation. For instance, suppose the judgment annuls a cartel decision for procedural reasons: the firms might have won the case, but it is unlikely that they could continue colluding: despite the annulment, they will still bear the loss in market value due to the ceasing of a lucrative (anticompetitive) activity.

We therefore state the following:

**Prediction 3 does not find support from the data:** Neither the event "Court annuls the Commission Decision" nor the event "Court upholds the Commission Decision" have any statistically significant effect on the firm’s share price.

### 4.2.4 Variability across firms

To give a better idea of the variability of the effects across firms, Figures 8 and 9 show the estimated cumulative abnormal returns for each firm in the sample (notice that there are several points corresponding to the same date whenever there is a cartel case). Visual inspection shows that overall the raids and the decisions negatively affect the share prices, but there is a lot of variability across firms (and positive abnormal returns are not rare).

### 4.3 Effects, by type of infringement

The overall effects of the raid and of the decisions may hide differences across types of infringement. In Table 10 we show the separate estimates of CARs by infringement. The data show a very strong effect of both the raid and the
Commission decisions in abuse of dominance cases, even though we should stress that there are only few observations in our sample. The effects of raids and decisions are also strong in cartel cases (not surprisingly, since they account for the vast majority of our observations), whereas the estimates of the effects of the events on the remaining cases (anticompetitive agreements other than cartels) are not statistically significant, perhaps reflecting the fact that there are very different types of infringements here.

4.3.1 Changes over time

Our sample spans over 30 years, during which antitrust policy has consolidated and changed. In particular, all parties involved have gained considerable experience in dealing with competition law issues, markets have become increasingly aware of the role played by antitrust law and the risks faced by firms, and the European Commission’s antitrust policy has evolved.

28We do not report estimates for Court judgments because they are not significant for nearly all event windows and types of infringement. To be precise, we found a negative (-2.45%) and statistically significant effect (at 10%) only for judgments upholding abuse cases (7 observations) in the 11-day event window (-5,+5).
This has been a continuous process, but one can conceivably identify in the 1998 "Guidelines on the imposition of the fines" a landmark in European competition policy, giving rise to a more transparent (less arbitrary) imposition of fines as well as an increased severity in handing them out. The fact that 1998 represents an important benchmark in the EU antitrust is also confirmed by the fines/capitalisation ratio, which is the highest that year.

Accordingly, we have split our data in two sub-samples, the first for events which took place between 1979 and 1997, and the second for events from 1998 onwards. As one can see from the first two columns of Table 11, the estimates suggest that both the raid and the Commission’s decision have a stronger effect in the second part of the sample (the Decision is not even statistically significant in the first part of the sample), as suggested by our formalisation above in response of an increase of both $q$ and $F$. (We do not report the breakdown of judgments over time because no estimates are statistically significant, in any period considered.)

**Prediction 4 finds support from the data:** The increase in both $q$ and $F$ which took place in 1998 leads to the expected increase in the effects on firms’ share prices of both dawn raids and Commission’s decisions.\(^{29}\)

Another notable - although admittedly less critical - policy change in antitrust policy in the EU took place in 2003, when the Office of the Chief Economist at the DG-Competition was created, in response of a series of CFI judgments which quashed Commission decisions in merger cases, and heavily criticised the economic reasoning of the Commission. Little by little, the Chief Economists and their team influenced not only merger policy but also antitrust policy in general, leading to a more cautious approach in abuse cases.

Breaking the second subsample further and somehow arbitrarily (since there is no clear landmark decision or policy), we carried out separate estimates for the periods 1998-2004 and 2005-2008. The results show that the

\(^{29}\) Notice that there is no effect on judgments, but as we know neither annulment nor upholds seem to have any effect on share prices in any period.
effect of the antitrust events on share prices is much stronger in the period immediately after 1998, while it decreases in the second period.

4.3.2 Estimates by sector and nationality: TO BE DONE

To be done.

4.3.3 Market predictions

The fact that Court judgments are never statistically significant make it difficult to evaluate the overall effect of antitrust investigations (one would like to see what is the effect on share prices after the fine has been upheld, or annulled).

To gain some insight in this direction, though, we have split the sample into two subsets: that of firms whose fines have been eventually upheld, and that of firms whose fines have been eventually annulled. Table 12 shows that in the former case the effect of raids and decisions is much stronger (both statistically and economically), whereas in the latter the effect of raids is not statistically significant, while that of Decisions is significant at the 5% level but is less strong.

It is difficult to interpret this result, but at the very least it shows that the market tends to have some reasonably good expectations about what is likely to be the final outcome of the antitrust proceedings.

4.4 Possible sources of endogeneity and bias

The fact that the firms in our sample are often large companies that enter in the composition of stock market indices, which in turn appear as independent variables in the model of counterfactual returns, may be a source of endogeneity bias in the estimates. As a further check of robustness of our estimates, we ran regressions using the mean-model of the counterfactual, described at the end of Section 3 above. Table ?? reports the cumulative abnormal return estimates, for the same event windows used in Table ??.

The results go in the same direction as the market model.
Although the OLS estimation of the market model is the traditional choice in the majority of event studies Dombrow et al. (2000) show that when the normality condition (in the stock return distribution) fails to hold other non-linear estimators may be preferred. Indeed, under non-normality, OLS is only the best linear unbiased estimator. Hence the same authors argue for the adoption of robust statistics when the underlying distribution of the errors is uncertain. They then propose the joint use of a nonparametric estimator, developed by Theil (1950), for its high efficiency and ease of computation and implementation, and non-parametric test statistics. As a robustness check we then also perform a complete non-parametric event study implementing Theil’s non-parametric estimator in combination with a non-parametric test statistic (the rank test suggested by Corrado (1989)). Table 1 presents the estimates for the non-parametric event studies at the four main event windows of interest. The non-parametric estimates confirm the main results of the OLS event study for all of the events. In the case of the raids and the Decisions, non-parametric estimates are highly significant (at 1%) with estimates having a comparable magnitude to the OLS estimates, whereas the judgments are still statistically insignificant.

4.4.1 Cross-sectional correlation

In the presence of cross-sectional correlation the inference on the base of the derived $J$ statistic may be biased upwards. The bias is a function of the number of the observations in the sample and the average correlation coefficient. In an influential paper, Bernard (1987) gives some empirical evidence on the seriousness of the problems of inference in the presence of cross-sectional correlation. He argues that the problem can become serious at the values of mean correlation coefficient of a magnitude of around 0.2 for a sample of the size of ours.

Because the firms in a cartel typically operate in the same industry, and as they are often raided on the same day (see Table ?? in the Appendix), we have some clustering of abnormal returns across firms. However, the extent of clustering for our sample is not likely to cause a serious inference problem, according to Bernard’s results: in our case, the mean correlation
is 0.01, and is thus not likely to present a serious source of bias in our estimations of the standard error. Moreover, the distribution of covariances, summarised in Table 1 for all pairs of firms demonstrates that a relatively small fraction of all pairs of surprise inspections exceeds the reference 0.2 correlation coefficient for the mean correlation.

<table>
<thead>
<tr>
<th>Quant.</th>
<th>0%</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r^2$</td>
<td>-0.28</td>
<td>-0.12</td>
<td>-0.07</td>
<td>-0.04</td>
<td>-0.02</td>
<td>0.01</td>
<td>0.03</td>
<td>0.06</td>
<td>0.09</td>
<td>0.13</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 1: Distribution of correlation between abnormal returns of firms

**4.5 The role of the fines in explaining market losses**

Our estimations indicate that a firm which is the object of an antitrust investigation by the European Commission has an estimated loss of 6.42% of its stock market value, calculated by adding the loss in value due to the dawn raid (−2.89%) and to the infringement Decision (−3.53%).

In the US, Bosch and Eckard (1991) estimate that fines and damages account for only 13% of the total loss of stock market value caused by the firm’s antitrust indictment. Perhaps the main reason why an antitrust investigation may create a loss in the firm’s value which goes well beyond the fine is that the firm will likely have to put an end to a profitable activity (be it a cartel, an abusive practice, or any other business practice considered illegal by the antitrust agencies and the courts). Other possible sources of loss in value, in addition to the direct effect of the fines, could be: (i) legal and consulting fees for antitrust proceedings; (ii) the firm may have to give up profitable projects either because the management is distracted by the antitrust investigations, and/or because, in case of large fines, the firm will have lower retained earnings and cash: in imperfect financial markets, lower assets will limit the firm’s ability to obtain credit; and (iii) the firm may be hurt by the negative publicity following an antitrust investigation.

In our sample, the fine represents on average around 2.3% of the firms’

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30 This is likely to be an underestimation of the effects of the investigations. If the market expects some of the antitrust events (perhaps because there are rumours that a firm is involved in violations and that might be subject to a Commission’s investigation), these news may be reflected in the share price weeks or months before the actual date of the event.

31 Furthermore, in some cases, the firm may also have to comply with (structural or behavioural) remedies which could lower its profits even more.
market value as reported by Datastream.\textsuperscript{32,33} Since the estimated total negative effect on the share price is $-6.42\%$, the fine accounts for around $35\%$ of the total loss.\textsuperscript{34}

Also, the fact that Court judgments are found not to be statistically significant may be interpreted as indication that whether the firms have or not to pay the fines eventually may little compared with the fact that it is unlikely that they can continue to engage in anticompetitive conduct.

To determine whether the magnitude of a negative market reaction at the time of the surprise inspection depends on the relative magnitude of the fine later imposed on the firm by the Commission, we regress the abnormal returns on a constant, the ratio of the fine over the total capitalisation of the firm, and a number of controls.\textsuperscript{35} The results are summarised in Table 2. We find that the coefficient on the relative size of the fine is not statistically significant for the raid, but it is highly significant for the Commission Decision. Perhaps this is not entirely surprising, since at the time the raid is carried out, the market still does not know how large the fine is going to be. This may be seen as an indication that fines do have some impact on the loss of market value due to the antitrust investigation, although they do not explain all of it.

<table>
<thead>
<tr>
<th></th>
<th>coeff. Raid</th>
<th>t</th>
<th>coeff. Decision</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>651.74</td>
<td>1.20</td>
<td>84.74</td>
<td>0.12</td>
</tr>
<tr>
<td>Fine/Cap</td>
<td>-0.4373</td>
<td>-0.05</td>
<td>-55.44</td>
<td>-7.23</td>
</tr>
</tbody>
</table>

Table 2: Regression of abnormal return on fine/cap ratio

\textbf{Effects of the investigation on firms which have received immunity} To investigate further the role played by the fines, we see whether firms which have been the object of an infringement Decision but have received no fines experience systematically different effects than firms which did receive a fine. To do so, we focus on cartels and we split the sample into firms which have received immunity from fines within the leniency

\textsuperscript{32}We were unable to retrieve data for capitalisation at the date of the raid; instead we have the outstanding value of shares that we use in computation of abnormal returns for the given firm and capitalisation in September 2006. To approximate capitalisation at the time of the raid we multiply the outstanding shares value at the time of the raid with the ratio of capitalisation in 2006 and outstanding value of the same share edition in 2006.

\textsuperscript{33}It depends on how we compute it: if we compute it as $\frac{\sum (F_i/Y_i)}{n} = 2.3\%$ . If we compute it as $(\sum F_i)/ (\sum Y_i) = .27\%$ (and the median would be .22%).

\textsuperscript{34}But if we compute it with the other method, it would be around 4.2%.

\textsuperscript{35}The variables we included as controls included the type of infringement, a trend, a dummy for the period from 1998 onwards. None of them were statistically significant. We also carried the same regressions with the absolute level of the fine (rather than the fine/capitalisation ratio) as explanatory variable, and the estimated coefficient was not significant. Details available from the authors upon request.
programme and all other firms. All these firms - those which have won leniency and their rivals - have been found guilty of cartel, and accordingly we can conjecture that the cessation of illegal profits will occur for all of them, but only the latter will have to pay the fine. In the extreme case, if the level of the fines did not matter at all, we should expect a similar impact of investigations independently of the value of the fines. Table 14 though, shows this is not the case: whereas both the raid and the decision significantly decrease the share prices of the firms which do receive the fines (column "Excl. Leniency"), they do not affect in any statistically significant way those of firms which have received immunity within the leniency programme.

The different impact on these two groups of firms may be explained in different ways. First, fines may affect the relative ability of firms to finance investments and projects. Suppose for instance that firms were financially constrained. If some firms in the industry had to pay the fines whereas one of their rivals did not have to, the former may have lower assets and therefore lower access to credits than the latter, which would therefore benefit from this. Second, it may be not the level of the fines themselves but rather the fact that one firm is guaranteed immunity that explains this differential impact: while other firms and their managers have to devote resources and assets to the antitrust investigation, the firm with immunity may forget about legal issues, and focus on operations. Third, it is in principle possible that there is a reputational effect in the market, with the firm having 'spilled the beans' receiving a favourable treatment by consumers, who want instead to punish the others. (Our gut feeling, though, is that in Europe these reputational effects do not play a big role.)

In other words, there may be two effects at play when a cartel investigation is based on evidence gathered within a leniency programme. First, the inability to continue colluding affects negatively all the firms. Second, there is a "redistributinal" effect whereby (because of credit constraints effects,

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36 We also carried out another estimation by separating the whole sample into firms which - whatever their infringement - received a very small fine (that we defined as less than .01% of their capitalisation ratio, and compare it with all other firms. The results are very similar to those reported here for the case of immunity firms only.
deviation of managerial resources to less productive activities, or loss of reputation) some market shares move from the firms which receive the fines to the firm which has received immunity.

To understand more in depth these differential effects, though, we should analyse more carefully the interaction between firms in each cartel case, and find additional information on them, something which is beyond the scope of the present paper.

5 Summary and conclusions

We have modelled the effects of successive events in an antitrust investigation on a firm’s stock market value and we have estimated, by using event study techniques, these effects by making use of an original database on EU antitrust law proceedings. Our main result is that the dawn raid (i.e., the surprise inspection of the firm’s premises carried out by the Commission), which is the first piece of information received by market operators indicating that the European Commission intends to investigate an antitrust infringement, has a strong and statistically significant effect on the firm’s share price: on average, on the same day as the dawn raid the firm’s return is around 64% lower than the counterfactual return provided by the market model; the cumulative average abnormal return due to the dawn raid is estimated to be −2.89%. We also find that the Commission’s infringement Decision results in a (statistically significant) cumulative abnormal return of about −3.53%.

Instead, we do not find evidence of statistically significant effects of the Court’s judgments.

Economic significance of the estimated effects To see whether the estimated effects of the antitrust investigations on the firms’ share prices should be considered large or small, it may be useful to compare our results with those obtained in works estimating the effects of events with characteristics similar to those of antitrust events. Gunthorpe (1997) uses event study techniques to investigate the effect of the first announcement in the Wall Street Journal that a firm is involved in some form of illegal behaviour, such as racketeering, patent infringements, or fraud (for instance, misleading advertising and securities fraud). She finds that on the very same day of the announcement, the average abnormal return is -1.32%, and that the cumulative average abnormal return is -2.3%. The magnitude of these effects is similar to that of the dawn raids, which are also unexpected events.

Since Commission Decisions are not entirely unexpected events, we need to find events sharing this feature for the sake of making comparisons. MacKinlay (1997) analyses the effects on share prices of announcements that actual earnings are more than 2.5% less than expected. On the same
day as this announcement is publicly made, the firm’s share drops by -.68%, while the cumulative average abnormal return on the 41-day event window (comparable to the length of the long event window we used for the Decision) is of about -1.26%. The estimated effects of such relatively minor ‘bad news’ are therefore of an order of magnitude not so different from the estimated effects of the news that the European Commission has decided to fine a firm for an antitrust infringement.

However, in our case the overall impact of the antitrust investigation is determined by the sum of the effects of the dawn raid and of the Decision. When combined, they result in a 6.42% drop in share prices, a rather sizeable effect on the investigated firms, especially if one considers that some of the firms in our sample are huge conglomerates which have been investigated in markets which represent a very small subset of their business operations. As we have seen, it turns out that only a fraction of this loss in capitalisation is due to the fines. Our conjecture is that most of the loss is due to the cessation of anticompetitive profits, but other factors - for instance the management having to focus on legal rather than on operational issues, legal expenses, or a loss of reputation - may also play a role. The fact that Court judgments are not found to have statistically significant effects may also indicate that what matters most is that after an antitrust investigation firms may not be able to continue to engage in unlawful conduct, independently of whether the fines are eventually annulled or upheld.

In a recent book, Whinston (2008) expresses doubts on the effectiveness of antitrust intervention, referring to some empirical work which suggests that anti-cartel activities may have not led to a price decrease in the markets at hand. We regard our paper as offering instead some indirect evidence on the effectiveness of antitrust intervention. In our sample, composed predominantly by cartels, most of the drop in the share prices is probably due to the cessation of profitable cartel activity. In turn, this should imply that investors expect investigated and fined firms not to be able to sustain such high prices as in the past. Therefore, although we cannot offer direct evidence on this issue, our paper indirectly suggests that antitrust intervention does have an effect on market prices.37

37 In case of abuse of dominance cases, as well as (non-cartel) horizontal or vertical agreements, the effects on prices would depend on whether the antitrust decision has duly taken into account efficiency justifications and overall effects on consumer welfare. To the extent that an abuse, say, would have led to higher profits of the violator and higher consumer prices, the antitrust actions would decrease both of them.
References


Detre, J. and A. Golub (2004, February). A reexamination of the profitability of price fixing using stock price movement: Has new antitrust legislation been a more effective deterrent of price fixing? *Staff Paper 04-03 - Department of Agricultural Economics - Purdue University*.


A Appendix

A.1 Event Study Methodology and Estimation Procedure

This section briefly derives the Abnormal Return estimator and the relevant test statistics. Our main references for the event study methodology are Campbell et al. (1997) and MacKinlay (1997). 

Using the market model, the vector of abnormal returns for the event window for firm $i$ is given by

\[ \hat{\epsilon}_i = R_i^* - \left( \hat{\alpha}_i \mu - \hat{\beta}_i R_m^* \right) \]  

\[ = R_i^* - X_i^* \hat{\Theta}_i \]  

(14)

(15)

where $R_i^*$ is a $(L_2 \times 1)$ vector of event window returns and $X_i^*$ is a $(L_2 \times 2)$ matrix of ones and event window market returns. $\hat{\Theta}_i$ is the vector of parameter estimates $[\hat{\alpha}_i \hat{\beta}_i]'$.

Under the null hypothesis “the abnormal returns for an individual security are equal to zero”, the following simple results are shown to hold in Campbell et al. (1997)

\[ E[\hat{\epsilon}_i] = 0 \]  

(16)

and

\[ V_i = I \sigma^2_{\hat{\epsilon}_i} + X_i^* (X_i X_i)'^{-1} X_i' \sigma^2_{\hat{\epsilon}_i} \]  

(17)

where $I$ is an $L_2 \times L_2$ identity matrix.

We aggregate individual daily abnormal returns by averaging them over securities and thus obtain daily average abnormal returns

\[ \bar{\epsilon}^* = \frac{1}{N} \sum_{i=1}^{N} \hat{\epsilon}_i, \]  

(18)

and correspondingly the variance is

\[ \text{Var}[\bar{\epsilon}^*] = V = \frac{1}{N^2} \sum_{i=1}^{N} V_i. \]  

(19)

Since $\sigma^2_{\epsilon_i}$ in (17) is not known we use instead its consistent estimate

\[ \sigma^2_{\epsilon_i} = \frac{1}{L_1 - 2} \bar{\epsilon}_i \hat{\epsilon}_i. \]  

(20)

Finally we also aggregate the average abnormal returns over the days of the event window to obtain cumulative average abnormal returns ($\text{CAR}$) for the event. With $\iota$ a unit $(L_2 \times 1)$ vector we have

\[ \text{CAR}(\tau_1, \tau_2) \equiv \iota^* \bar{\epsilon}^* \]  

(21)

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\(^{38}\)See also Brown and Warner (1980, 1985).
and
\[ \text{Var}[\overline{\text{CAR}}(\tau_1, \tau_2)] = \hat{\sigma}^2(\tau_1, \tau_2) = \ell' \text{V}_\ell. \] (22)

Again, \( \hat{\sigma}^2(\tau_1, \tau_2) \) is unknown and we use its consistent estimate
\[ \hat{\sigma}^2(\tau_1, \tau_2) = \frac{1}{N^2} \sum_{i=1}^{N} \ell' \text{V}_i \ell. \] (23)

We use the following result
\[ J_1 = \frac{\overline{\text{CAR}}}{\hat{\sigma}^2(\tau_1, \tau_2)} \overset{\text{a}}{\sim} \mathcal{N}(0, 1), \] (24)

to test the null hypothesis.\textsuperscript{39}

\textsuperscript{39}The distributional result is for large samples and is not exact because an estimator of the variance appears in the denominator.