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# The EU Leniency Programme and Recidivism

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**ABSTRACT:** The EU Leniency Programme (LP) aims to encourage the dissolution of existing cartels and the deterrence of future cartels, through spontaneous reporting and/or significant cooperation by cartel members during an investigation. However, the European Commission guidelines are rather vague in terms of the factors that influence the granting and scale of fine reductions. As expected, the results shown that the first reporting or cooperating firm receives generous fine reductions. More importantly, there is some evidence that firms can “learn how to play the leniency game”, either learning how to cheat or how to report, as the reductions given to multiple offenders (and their cartel partners) are substantially higher. These results have an ambiguous impact on firms’ incentives and major implications for policy making.

JEL Classification: K21, K42, L4, L51

Keywords: Cartels, competition policy, Leniency Programme, self-reporting

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# 1 Introduction

Article 101<sup>1</sup> of the EU Treaty prohibits explicitly the existence of cartels. However, recent antitrust cases provide evidence that cartel agreements are a perennial problem in the EU: in 2011 and 2012, a total of 23 groups of firms were put under formal cartel investigation by the European Commission DG-Competition.<sup>2</sup>

Following the example of the “successful” US Leniency Programme of 1978, the European Commission launched, in July 1996, the *European Leniency Programme (LP)* (European.Commission, 1996). This programme grants immunity or reduction of fines to individual firms that are members of a cartel, in exchange for the initial reporting of the cartel and/or relevant cooperation with the Commission during a cartel investigation. Revisions to the LP occurred in 2002 and 2006 (European.Commission, 2002, 2006), making it more detailed and, in general, more “generous”.<sup>3</sup>

The procedures are fairly simple: leniency applicants have to submit a fax application, but are advised to call the Commission officials beforehand to obtain some assistance, either directly or through a legal adviser. During the contact, the firm can find out if there is an ongoing investigation in the relevant market. If the firm is not first in line, it may cooperate and qualify for a fine reduction under the LP if, besides additional behavioral conditions, it provides “*significant added value with respect to the evidence already in the Commission’s possession*”. This is rather vague, since the applicant does not know, when applying, what information the European Commission (EC) has and/or to which extent it can meet the “added value” requirement.

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<sup>1</sup>Article 101 of the Treaty on the Functioning of the European Union, formerly Article 81 of the European Community Treaty.

<sup>2</sup>Cartel members can report either to the national competition authority or directly to the European Commission. The cases are then dealt with by the EC (DG-Competition) if they have an appreciable effect on interstate trade or by the national competition authority if they are national cases. This paper only deals with international cartel cases.

<sup>3</sup>The 2002 guidelines are much more detailed than those of 1996 and provide, in general, for higher reductions for the reporting firms. The major changes in the LP of 2006 were in terms of clarification and additional flexibility to the previous LP Notice, regarding the immunity thresholds and the conditions for fine reductions, as well as the introduction of a discretionary marker system, so as to preserve an informant’s position as being the first to come forward and disclose the cartel.

The present paper attempts to address the following question: what incentives does a firm have to apply to the LP? In other words, which firm or cartel characteristics influence the leniency decision by the Commission? Ideally, the expectations by firms are such that the programme creates a destabilizing effect for existing cartels and deters future cartels, but there may exist a divergence between law and the stated guidelines and practice.

The empirical literature is recent and includes several papers that merely analyze descriptive statistics on the LP (e.g. Connor (2007), Berinde (2008), Veljanovski (2010) and Asker (2010)). One of the first empirical papers using econometric methods is by Borrell and Jimenez-Gonzalez (2008), who look at the drivers of antitrust effectiveness and find it to be increased by the LP. Levenstein and Suslow (2011) estimate the impact of organizational mechanisms such as moral hazard problems, which are discussed in more detail below, while Miller (2009) finds that the number of cartels discovered increases in the periods around the introduction of the LP and decreases to pre-LP levels afterwards.

The empirical works that most closely relate to this paper are by Sjoerd (2005) and Brenner (2009). Sjoerd uses data on 67 EU cartel cases between 1990 and 2004, while Brenner uses data on 61 EU cartels in the period 1990 to 2003. Sjoerd finds that the LP, measured by a dummy for whether a firm received maximum leniency or not, is positively correlated with the number of words in the decision (it is assumed that this is an appropriate proxy for the amount of information the Commission already had) and the gravity of the infringement. The size of the reduced fine as a share of the firm's turnover is also found to be higher after the LP is introduced. Brenner finds a similar result when looking at the average of the absolute values of both the reduced and total fines. Additionally, both authors find that the duration of the investigation decreases once the LP is in place.

The present paper contributes to the existing literature by empirically examining which factors give incentives to cartel members to self-report. This is also the first paper to specifically examine the case of recidivism and to use a Tobit model to analyze firm-level data, which was collected by the author.

Not surprisingly, the empirical results confirm that the first reporter receives significantly higher reductions. More importantly, they illustrate how the 67 multiple offending firms can apparently play the “leniency game” and receive predicted reductions, on average, 20 percentage points higher than single offending firms. Although the LP creates an incentive to report the cartel, there may exist at least a temporary incentive to collude and then be the first reporter. To reinforce this finding, it is shown that the number of repeat (and multiple) offenders in a cartel also has a significant, positive and large impact on the predicted individual leniency reduction. The implications of these findings are discussed further in the paper, suggesting that the fines for repeat and multiple offenders should be unrestricted or, at least, more severe.

From a policy point of view, at present, more cartels appear to be dissolving. This is either due to an effective LP that is able to encourage the dissolution of current cartels, or to a LP which causes more cartels to form and, as a result, more cartels to be discovered and/or reported. The long-run aim is, or should be, to deter new cartels from forming, but the LP carries a potential problem of moral hazard in the sense that a cartel member might behave differently from if it were to receive no fine reduction and competition authorities (CAs) may be placing too much weight on increasing the number of convictions, to the detriment of increased deterrence. The long-run effect of the LP is not explicitly measured or evaluated in this paper, but the fact that there are several multiple and repeat offenders and that these, within the current LP, seem to receive additional fine reductions, suggests that the long-run underlying trade-off may not be set in an ideal manner.

The organization of the rest of the paper is as follows. In the next section, the dataset is described and the specific case of multiple and repeat offenders is discussed. The empirical methodology is described in *Section 3* before the results are presented in *Section 4*. *Section 5* offers concluding comments.

## 2 Data

### 2.1 Data collection

The data employed in the empirical analysis were collected by the author using publicly available summary reports and associated press releases of the antitrust cases handled by the European Commission and accessible via the Commission's website. Within the set of all cartel cases since 1996 (107 cartels), only those in which there was at least one successful LP application were selected (93 cartels were fined in 71 EU decisions).<sup>4</sup> The final decisions on the setting of fines, for the cases under analysis, were taken between 1998<sup>5</sup> and 2013 and include the universe of cases making use of the LP, up to October 10<sup>th</sup> 2013. The starting dates of the investigation of these cases range between 1994 and 2012. The investigation year is the official date in which the Commission started the investigation and hence not necessarily the same date/year in which the cartel was reported. The 93 cartels involve 439 cartel members, in a total of 553 firm-level observations, as several firms took part in more than one cartel and are therefore labeled multiple or repeat offenders. This is discussed in the next section. Other datasets have been used by other authors in the description and analysis of cartels. A summary of these can be found in *Table 8* in the Appendix.

*Tables 1* and *2* define and describe the variables for use in the model specifications. The percentage of leniency reduction is used since, according to the current legislation, the absolute amount of the fine is capped at 10% of the firm's worldwide turnover in the previous year and comprehensive information on the relevant turnover is not available.<sup>6</sup> Also, the percentage values are more representative when comparing across

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<sup>4</sup>It is important to note that cartels, and not cases, are analyzed in the chapter, since within the same case there may be several cartels, possibly with different members and different fines and fine reductions. The 93 cartels correspond to 71 cases. See *Table 3* for further details.

<sup>5</sup>The first decision applying the LP to a cartel case was in 1998, on a cartel involving British Sugar. The complaint was made in 1994 and after the introduction of the LP; all four cartel members applied for leniency. Three reductions of 10% and one of 50% were granted.

<sup>6</sup>The highest fines imposed, after leniency and other reductions, on a cartel member were for *Saint-Gobain SA*, which was fined 896 million euros after having received, in 2009, 50% leniency reduction, for its participation in a car glass cartel; and for *F.Hoffmann-La Roche AG*, in 2001, of 462 million euros (again, after a 50% leniency), for being a member of a vitamins cartel.

firms and cases. For each cartel, information was gathered on the duration of both the cartel and the investigation carried out by the Commission, the number of firms and of multiple or repeat offenders per cartel, the geographic area in which the cartel impacted customer prices (EEA or extra-EEA countries), the specific LP in use (1996, 2002 or 2006), whether or not the case was initiated due to a leniency application, the type of cartel infringement, and the years in which the cartel was reported to the Commission, the investigation was initiated and final decision was made. There is also information on whether a Court of Justice judgement occurred and led to a re-imposition of fines, subsequent to a decision by the Commission. The cartel infringements in the cases under analysis are mainly price-fixing, but also relate to the allocation of tenders, the fixing of quotas and sales conditions, the sharing of geographic markets, the exchange of sensitive information on prices, sales volumes and procurement tenders, the elimination of price discounts, and bid-rigging. Firm-level information was also collected and includes information on the individual fine both before and after the leniency reduction, whether the firm is the first reporter (either pre or post-investigation) and other fine reductions or increases obtained previously to and independently of the application of the LP, due to mitigating or aggravating circumstances.

[Table 1 here]

[Table 2 here]

## **2.2 Data description**

The number of cartels discovered since 1998 has been growing each year, as has the total number of firms involved in cartels. This is shown in *Table 3*, which reports the number of cartel cases closed, the number of firms fined in each year and the number of leniency reductions, for the period between 1998 and October 2013. It is important to bear in mind that the figures presented for the number of cases using the LP may differ slightly from the actual values, due to the cases under investigation (open) and those for which public information was not yet available in October 2013. The figures for “open cases” correspond to the latest update on a case, i.e., the year in which a given case had its last development, as of October 2013. The cases are also differentiated by what

led to the discovery of the cartel. The number of cases found through pre-investigation leniency applications has increased dramatically, reaching as high as 83% in 2008 (5 of 6 cases), 86% in 2009 (6 of 7 cases) and 100% in 2010 to October 2013, and thus the number of leniency reductions granted has also increased. However, some of these reports may have been triggered by US investigations and/or decisions. In fact, at least 25% of the cases which were reported to the EU Commission by a cartel member, were first convicted in the US, and at least another 20% were convicted by US and EU authorities in the same year<sup>7</sup>. The remaining cases were discovered due to other reasons, such as reporting by a third party (e.g. a customer or rival firm) or under the Commission's own initiative, perhaps by observing the evolution of prices. It is also shown that, on average, 38 cartel members are fined and 18 leniency reductions and 7 reductions for mitigating circumstances are granted each year.

[Table 3 here]

*Table 4* reports the allocation of the percentage of leniency reductions granted, in periods of 5 years. The “generosity” and willingness to provide incentives to self-reporting have visibly increased: 31% of the reductions correspond to immunity in the period of 2008 to October 2013, while full immunity corresponded to a very small share in the initial period (9%). Conversely, reductions below 10% became very scarce (falling from 23% to 7%).

Over half of the firms in cartels with leniency applicants (56%) received a fine reduction and 12% received full immunity.<sup>8</sup> These numbers illustrate the increasing importance of the programme, not only in terms of the amount of reductions granted in each cartel case, but also in the number of pre-investigation leniency applications. It also highlights the need to understand the main factors affecting the Commission's leniency decisions.

[Table 4 here]

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<sup>7</sup>A further 4% of the cases were also convicted in the EU and US but there is no information on the year of conviction in the US.

<sup>8</sup>The discontinuity in the amount of fine reductions is due to the range of leniency reductions set in the guidelines, for each reporting or cooperating firm.



The value of the paid fine is calculated by deducting leniency and other reductions and adding fine increases to the initial value of the fine. Both total and average fines have been increasing, as the total number of cartel members fined in each year has also been increasing, in particular following the introduction of the Leniency Programme in 2006. Additional fines increase the revenue for the authorities, which can then be used to carry out unannounced inspections, and to investigate and prosecute firms.

The chemicals' sector, and in particular pharmaceuticals, involves a great deal of intellectual property rights, which makes collusive agreements more attractive, in the sense that these would delay the entry of cheaper generic medicines. This is the sector where the vast majority of leniency applications occurred. It is followed by the industrial inputs and transport sectors (32% and 13% of the cases, respectively).

### 2.3 Multiple and Repeat Offenders

The LP Notice is not explicit as to whether or not multiple or repeat offenders should receive a lower reduction. Chen and Rey (2012) suggest that they should, while Houba et al. (2009) and the Greek competition authority<sup>9</sup> suggest the opposite. *Tables 5 and 6* show the distribution of the firms fined according to the number of cartels in which they have taken part. The numbers may even be underestimated since there is no information on unknown cartels, both past and present. Most firms (84.8%) have been found to participate in only one cartel, but more serious are the cases of *Akzo Nobel*, *F.Hoffman-La Roche* and *BASF*, which in the past 11 years have been fined for their roles in 9 cartels each, and which received significant leniency reductions in most of the cases.

[Table 5 here]

[Table 6 here]

It is challenging to define the term “repeat offender” precisely in the present context. Three firms (*Akzo*, *Degussa* and *Sumitomo*) started to participate in a new cartel

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<sup>9</sup>Available at: [www.epant.gr/faqs.php](http://www.epant.gr/faqs.php).

after being previously fined. Four other firms (*Mitsubishi, ABB, FMC and Thyssen Krupp*) only ended their participation in a cartel after being fined for participation in another cartel. Finally, a total of 67 firms have participated, contemporaneously or otherwise, in at least two cartels.

The 2006 Leniency Notice states that a repeat offender is any firm that was previously found to infringe Articles 101 or 102 of the EU Treaty, which corresponds to seven of the firms included in this paper (definition 1, *RO*). Nonetheless, if an investigation into a cartel member is initiated after all the cartels in which it participated have ended, the firm still has an incentive to report the other cartel(s) and apply for the LP if it believes that there is a high probability of conviction of those cartels. The data show that it does not seem to be the case that firms report cartels in different markets, as happens with the US Amnesty Plus Programme. Instead, it seems that firms learn how to use the LP to their benefit, either by learning what and when to report or how to be the first reporter. Therefore, a broader definition of the term is also considered, including any firm that was convicted for collusion at least twice, which corresponds to 15.84% of the firms in the analysis (67 out of 441) (definition 2, *ROI*). Including both definitions in the empirical analysis allows to distinguish between simultaneous and sequential cartels, as these can imply very distinct problems in the design of the leniency rules.

*Akzo Nobel N.V.* is one of the main players in the chemicals' sector and one of the main repeat offenders. Details on its involvement in collusive agreements are included in *Table 9* in the *Appendix*, as an example of a repeat offending firm.

### **3 Empirical Model**

The econometric work provides insight into how the Commission makes decisions regarding the leniency reductions granted to cartel members. This work does not attempt to identify the characteristics of the reporting firm, to discuss the optimal design of the Leniency Programme.

Two main criteria influenced the choice of the specific empirical method. First, it

is likely that the decisions to grant a leniency reduction and on its amount are directly related. Second, the purpose of this paper is to examine which factors incentivize a cartel member to apply to the LP and the differences between the LP Notice and reality. Since the LP only allows for fine reductions, the zeros in the dependent variable need to be modeled. This is a problem of censoring rather than of sample selection bias, so using a censoring model on the data for all the firms in cartels with at least one leniency applicant, should provide consistent results. The appropriate approach is a Tobit which jointly models the factors affecting the decisions to grant a fine reduction and on its amount, and takes into account the censoring of the zeros.

Jointly modeling the three leniency programmes (of 1996, 2002 and 2006) provides a very small scope for conclusions, as the programmes have changed over time. Separate estimations for each LP produce a more accurate analysis as they allow one to study its evolution. This paper focuses on the current LP (of 2006), since it is the most relevant for policy making. Nevertheless, the same analysis is carried out for the two previous LPs and, while these results are not discussed, they are included in *Table 12* in the Appendix.

According to the LPs of 2002 and 2006, the first firm to report a secret cartel receives full immunity<sup>10</sup>, so firms who self-reported and received immunity from fines are excluded. This will better illustrate the characteristics of firms who received higher fines and of the cartels in which they took part.

Under this approach, the leniency reduction for each cartel member is identified by *Firm1post*, *Firm2* and *Firm3*, depending on their place in the “reporting queue”, and the number of firms in the cartel is given by *firms*. According to the legislation,<sup>11</sup>

<sup>10</sup>Immunity is granted provided the firm complies with the CA’s conditions. Since the LP of 2002 was put in place, only one initial applicant firm has not received full immunity, as its reporting was not completely voluntary (according to the case press release). Instead, a 90% reduction was granted.

<sup>11</sup>According to the current “Guidelines on the method of setting fines” imposed pursuant to Article 23(2)(a) of Regulation No 1/2003, 2006/C, 210/02, the individual cartel fine is imposed as  $F = F_0 + A - M = [k(g_t)sales_{t-1}][a\%cartel\ duration + b\% + (A - M)]$ . In the formula,  $t$  represents the time period,  $k(g_t)$  is a multiplier of proportional penalty that depends on the gravity of the offense ( $g_t$ ),  $a \leq 30\%$  depends on the degree of gravity of the infringement and  $b \in [15\%, 25\%]$  aims at deterring undertakings from entering horizontal price-fixing, market-sharing and output limitation agreements. The main changes to the previous Guidelines are a new entry fee, higher fines for repeat offenders and a

the fine depends on the duration of the cartel (*cartel.dur*) and is adjusted by aggravating circumstances (*fine.increase*), including recidivism (*RO*, *RO1*), and mitigating circumstances (*oth.red*), so these variables are all included in the model. The number of multiple and repeat offenders is also included (*NRO*, *NRO1*). Finally, additional variables are included to account for the geographic area of impact by the cartel's activities (*eea*), the duration of the investigation (*inv.dur* and *inv.dur2*) and the accuracy of the decision (*C.J.Inc.*), as the court of Justice has altered the set penalties in several cases. Therefore, the canonical specification of the model takes the following form:

$$\begin{aligned}
LRed_{ijt} = & \beta_0 + \beta_1 Firm1post_{ijt} + \beta_2 Firm2_{ijt} + \beta_3 Firm3_{ijt} \\
& + \beta_4 RO_{ijt} + \beta_5 NRO_{jt} + \beta_6 RO1_{ijt} + \beta_7 NRO1_{jt} \\
& + \beta_8 fine.increase_{ijt} + \beta_9 oth.red_{ijt} \\
& + \beta_{10} firms_{jt} + \beta_{11} eea_{jt} + \beta_{12} cartel.dur_{jt} \\
& + \beta_{13} inv.dur_{jt} + \beta_{14} inv.dur2_{jt} + \beta_{15} C.J.Inc._{jt} + \varpi T_t + \varrho S_s + \varepsilon_{ijt}
\end{aligned}$$

where  $i$  and  $j$  are the indices for firm and case, respectively;  $\varepsilon$  is the error term, which is assumed to be *i.i.d.*;  $\varpi$  is the vector of year dummies ( $T$ ), where  $t$  is the decision year in each cartel case; and  $\varrho$  is the vector of sector dummies ( $S$ ), where  $s$  denotes each sector.

### 3.1 Sample Selection Bias

One concern with the data is the possibility of sample selection bias. Four possible biases may arise:

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link between fines and cartel duration. For further information refer to the Guidelines, available at: <http://ec.europa.eu/competition/antitrust/legislation/fines.html>. The fine is adjusted according to aggravating ( $A$ ) and mitigating ( $M$ ) circumstances. Aggravating circumstances apply in the cases of recidivism (i.e. repeat offenders), absence of cooperation, obstruction to the investigation, or role of cartel leader or instigator. Mitigating circumstances relate to termination of the infringement at the time of the investigation, negligence as the cause of the cartel, limited involvement in the cartel, cooperation with the Commission outside the LP, or proof of having been encouraged by public authorities or legislation. The final value of the fine is capped at 10% of the total turnover of the firm in the previous year and special conditions are set in the case of inability to pay.

(i) Since cartels are prohibited by the EU Treaty, they are secret so the available data only include cartels that were prosecuted and convicted. Past cartels may have remained secret because their members did not have a strong enough incentive to report them. This problem of selection on the unobservables cannot be overcome, but its existence is acknowledged in the interpretation of the results.

(ii) One other issue which may generate selection on the unobservables is the case of “repeat offenders”. There may be individual unobservable characteristics of these firms that determine their repeated participation in cartels. In the empirical analysis, dummy variables controlling for multiple and repeat offenders are included so as to discover whether recidivism is relevant or not in the setting of the leniency reductions. This issue requires a more complex analysis of repeat offenders and is discussed further in the next section.

(iii) The term “single offender” may be misleading, either because the firm also took part in an undiscovered cartel or because the cartel for which it is being prosecuted has not yet been convicted. Again, there is nothing that can be done with regards to this issue, but to acknowledge that the number of repeat offenders may be underestimated.

(iv) The cases in which there was no successful LP application are excluded (14 cases for the period concerned), which makes the data a non-random subset of the total of discovered and secret cartels. Cases without LP applications are, however, irrelevant for this paper’s research question. Nevertheless, a Heckman two-stage model<sup>12</sup> is used to examine the possibility of sample selection bias in the data for leniency reductions and the inverse mills ratio is not significant, which means that there is no selection bias on the observable variables that have been included in the selection step. The results are shown in Tables 10 and 11 in the Appendix.

### **3.2 Endogeneity**

One other concern with the data is the possibility of reverse causality regarding the variable accounting for the duration of the cartel and which is likely to be linked to

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<sup>12</sup>In the Heckman two-stage model (Heckman, 1979), the first stage corresponds to a Probit modeling of the probability of receiving a leniency reduction, and the second stage is a fixed effects model which measures the amount of leniency reduction granted.

whether or not a leniency application was received by the competition authority. For this reason, an instrumental variable is introduced in the Tobit estimation. To instrument for cartel duration, the value of the initial fine set by the Commission is used, as it is directly related to the duration of the cartel but is unlikely to be related to the percentage of leniency reduction granted to each cartel member. Nonetheless, it is shown that this is not a serious issue as the results are robust throughout the specifications. This is also supported by the analysis of the qualitative information on these cartels, where it is clear that the duration of the cartel is not directly correlated with the level of leniency reductions granted or with the application for a leniency reduction (see Figures 1 and 2 in the Appendix).

## 4 Results

*Table 7* presents the Tobit results for the current LP. The values reported correspond to the marginal effects calculated at the sample means of the data, since the coefficients from the Tobit model measure the change in the latent dependent variable. Clustering is done at the cartel level, but the results are robust to clustering at the case level and there is no serious issue of sample selection bias on the observable variables, as tested by the Heckman two-stage model. The possible existence of a selection bias on unobservables is of course acknowledged.

To control for a possible endogeneity issue in the cartel duration variable, column (3) consists of an instrumental variable Tobit estimation. Columns (5) and (6) present an alternative definition of repeat offenders. Columns (4) and (5) include the individual fine increase, which is due to recidivism or other aggravating circumstances. Columns (4) to (6) are the preferred specifications.

The majority of the variables are not robust or are statistically insignificant. The surprising exceptions are the variables that control for recidivism, which present negative and statistically significant coefficients.

[Table 7 here]

## 4.1 Reporting and Cooperating

The first firm to report the cartel before the CA launches an investigation receives full immunity from fines, so this is not included in the results. Once an investigation is in place, the first reporting or cooperating firm should be entitled to receive a 30 to 50% leniency reduction. However, the results show that the predicted leniency reduction is higher, at around 76 to 80% (see columns (4)-(6)), at the mean values of the remaining explanatory variables. The second and third firms cooperating with an investigation should receive 30-50% and 20-30% reductions, respectively, but in fact receive around 58% and 44%, respectively. These results are significant and consistent throughout the specifications and although the order of the percentage of leniency reductions is in line with the leniency legislation, the magnitude of the reductions is larger, even when taking into account the size of the standard errors. Higher expected leniency reductions increase firms' incentive to report, and these results reveal the generosity of the LP of 2006, towards reporting and cooperating firms. Table 12 in the Appendix shows that these values have also increased since the initial LP of 1996.

As previously mentioned, it is worth noting that 52 of these cartels (56%) were also prosecuted by US competition authorities. In fact, 23 cartels (25%) were first prosecuted in the US, which may mean that the reporting of the cartel to EU authorities would have not occurred otherwise.

## 4.2 Repeat Offenders

The LP Notice excludes firms with a leading role from receiving immunity, but it makes no statement regarding repeat offenders.<sup>13</sup> This is why the most interesting result in this paper relates to the variables that account for repeat offenders.

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<sup>13</sup>Note that recidivism is included in the aggravating circumstances in the setting of the original fine, as stated in *Section 2.2*. However, the setting of fine and leniency reductions are, according to the legislation, independent as the fine guidelines are very strict and appear to allow very little, if any, "discretion".

As previously mentioned, *RO* includes any cartel member who has been found to collude at least twice, whereas *ROI* accounts for cartel members who colluded sequentially in at least two cartels. This is important in distinguishing between multiple and repeat offenders, which imply different problems in the design of the leniency rules. The variable *fine.increase*, instead, includes recidivism and any other factors that lead to fine increases.

It is found that, for the observed cartel cases and despite the fact that leniency reductions should not be affected by recidivism, the predicted leniency reduction is 19 to 26 percentage points higher for multiple offenders (*RO*) than for single offending firms, at the mean values of the remaining explanatory variables. In addition, the number of multiple offenders per cartel (*NRO*) also has a positive and significant impact on the firm's predicted leniency reduction.

When the analysis takes into account sequential offences (*ROI*), it is the number of repeat offenders per cartel (*NROI*) that drives the main effect on the leniency reduction granted. While repeat offenders seem to receive reductions which are 35 percentage points lower than for other firms, for each repeat offender in a cartel the predicted leniency reduction is around 50 percentage points higher (for a maximum number of two repeat offenders per cartel), at the sample mean values. It is also worrying that these effects are more serious in the current LP than in the previous programmes, where repeat offending firms seemed to receive lower leniency reductions.

The leniency reduction should also be independent from the fine increase, as it is shown for the data in the analysis. However, Sjoerd (2005) finds that the gravity of the infringement increases the leniency reduction. While Sjoerd's result is not corroborated in this analysis, it is shown that, in the LPs of 1996 and 2002, the leniency reductions were around 11 and 6 percentage points smaller if the original fine was increased, at the mean values. Again, these results are likely to be underestimated and may carry a problem of selection in the unobservables.

The above discussed results are robust, causal and possibly suggest some strategic behavior: a previously fined firm can arguably learn "the rules of the game" and take advantage of the LP by being the first reporter or by providing better or more extensive information.



In the cases analyzed, fewer than half of the repeat or multiple offenders were the first reporter (32% and 20%, respectively) but a large share received a leniency reduction (59% and 68%, respectively). Repeat offending firms often collude with the same set of firms (eg. *Akzo*, *Arkema France* and *Degussa Evonik*) and they seem to take turns in the reporting of the cartel to the Commission. It is surprising that a firm would collude in a new cartel (although for a different product) with a firm who reported their previous collusive agreement.

As mentioned in *Section 2*, some multiple and repeat offending firms also merge with or acquire a firm with whom they previously colluded. It is not clear why firms would enter a collusive agreement if they could merge. A merger is, in theory, a better strategy than collusion since while both may give rise to monopoly gains, a collusive agreement comes with the inherent risk of detection. Moreover, a merger also allows cost savings by increasing efficiency. Hence, firms would be expected to choose to merge instead of colluding, when the two options are available. The existence of the LP may, however, change firms' incentives as the risk of detection is higher but the reporting of the cartel may grant the firm immunity from fines. One example of this scenario is Akzo and BASF. Between 1992 and 1998, Akzo, BASF and four other firms participated in a cartel in choline chloride. When Chinook (one of the cartel members) reported the cartel to the Commission, in 1998, and the firms were fined (with a 20% leniency reduction for BASF and 30% for AKZO), Akzo acquired BASF's decorative coatings business in Europe, increasing its market share in coatings from 5% to 60%. Although examples of recurrent cartel partners and mergers or acquisitions of previous partners can be found in several industries, these practices are particularly evident in the pharmaceutical industry, which is the industry where most EU cartels occur and in which Akzo is one of the largest players.

It is difficult to understand why repeat and multiple offenders receive larger leniency reductions. It may be that, due to their previous experience, these firms are faster to react as a second reporter or once the investigation is initiated in order to mitigate the effects of having to pay the fine. It could also be that these firms gather more

information so as to add significant value to a possible investigation. This could signify that firms learn how to report, and not necessarily how to cheat. To shed some light on this issue, the econometric model is restricted to the set of multiple offenders. The results are shown in Table 13 in the Appendix. While the results in the LP of 2006 are fairly similar to those for all cartel members, the impacts of being a repeat offender, of the geographical area and of receiving other reductions are much larger. The number of cartel members becomes significant and its coefficient is negative. The leniency reduction for a multiple offender is 5 to 10 percentage points smaller with each additional firm taking part in the cartel, at the mean values of the remaining variables. This finding suggests that larger cartels are less stable and multiple offenders may not be as fast in reporting, or they may have less information which adds value to the investigation. The decision by the Court of Justice is also significant in explaining the leniency reductions for multiple offenders. In the cases where the fine is later amended by the Court of Justice, multiple offenders seem to receive larger reductions. The opposite is true for single offending firms, as can be seen in the results for all the cartel members. Finally, a variable which controls for the number of cartels in which each multiple offender took part is included. Although the result is not robust, it seems that the amount of leniency reduction is larger for firms which have taken part in more cartels.

There may also be specific characteristics of these firms which make them more prone to colluding. Multiple and repeat offending firms tend to be big in terms of their sales or market share, which may provide them with the means to orchestrate a cartel. They may also be more skillful and thus, better at colluding, even if the firm would have high rates of return without the collusive agreement. One other possibility is the firm's corporate culture or the market in which they act. In India, for example, perhaps because of the lack of fear of sanctions, there is a culture of cartelizing. Depression cartels are allowed in many countries, in industries which require price and production stability. In Japan, such arrangements have been permitted in the steel, aluminum smelting, ship building and various chemical industries.

It is in the EU's interest that firms self-report so that cartel members can be con-

victed, but it may be that repeat offending firms are, or are becoming, particularly good at providing relevant information and that the LP is actually encouraging collusion. This may also relate to the US Amnesty Plus Programme, where firms report contemporaneous cartels in other markets, once they are being investigated for collusion. Although this does not apply to the EU rules, firms may fear being fined in other cartels and so they report them in advance of a possible investigation.

Recidivism is a serious problem and may well require a different and/or tougher approach in the future calculation of appropriate leniency reductions. The LP should ideally create ex-post deterrence or a desistance effect, which could possibly be achieved through unrestricted and, thus, greater expected sanctions for repeat and multiple offenders, at the cost of fewer reported cartels. This trade-off needs to be carefully assessed. A desistance effect does not seem to exist, since 15% of the fined cartel members, in the period 1998 to October 2013, have taken part in more than one cartel. In fact, 8% of the firms have participated in at least 3 cartels. Repeat offenders may also be defined by specific firm characteristics, such as industry, nationality and firm size, but this analysis is outside the scope of this paper.

### **4.3 Other variables**

The LP requires that the European Commission is notified of all the jurisdictions where a leniency application was made. Brenner (2009) finds that the number of countries in which the cartel members are based is not correlated with the fine reductions, while Borrell and Jimènez-Gonzalez (2008) find that the average antitrust effectiveness depends on country-specific characteristics. For these reasons, a dummy controlling for cartels that affect exclusively EEA-based customers of the cartel's product(s) is included. Firms in cartels which exclusively concern EEA customers are likely to receive a higher leniency reduction, although this result is not robust to all the specifications. When other jurisdictions are also affected, they can impose fines (and fine reductions), such that the total fine paid by the cartel member is larger. In this way, EU authorities can grant larger leniency reductions and have the same impact, in terms of absolute value of the individual fine (in the various jurisdictions). The results from the first stage

of the Heckman regression also shed some light on the effect of this variable, showing that when the cartel only impacts EEA countries, leniency reductions are less likely to be granted.

Although the magnitude of the fine adjustments for mitigating circumstances (*oth.red*), and therefore outside the LP, should be independent from the setting of the leniency reduction, it is shown that the predicted leniency reduction is much lower when other reductions are also granted. This result is also verified for the LP of 2002 and it supports the reasoning that the reporting firms tend to have a determinant role in the cartel and are larger or financially stable firms, which are thus not entitled to other reductions.

In some cartel cases, there was hidden information or lack of evidence and, therefore, untruthful or incomplete reporting by the cartel members which led to a subsequent decision by the Court of Justice. In this scenario, the leniency reductions granted seem to be smaller (see *C.J.Inc*). Since there is a lower level of cooperation, this result is as expected. However, under the previous LP of 2002 the reverse is true, perhaps to provide an additional incentive for cooperation with an ongoing investigation.

Larger cartels tend to be less stable, as there is a larger probability that at least one firm will report the cartel and it is more difficult to monitor all the members. Nonetheless, in smaller cartels, firms have more and/or better information on the cartel's activity and so these two effects may cancel each other out since the results show that the number of cartel members (*firms*) does not affect the amount of leniency reductions granted.

Harrington (2008) argues that the cartel duration (*cartel.dur*) may be informative as to the change in the total (discovered or not) number of cartels, and Levenstein and Suslow (2011) conclude that fluctuations in firm-specific discount rates significantly affect the cartel duration. The LP, however, stipulates that if the first reporter gives further information that enables a CA to establish additional facts which increase the duration of the infringement, those will not be taken into account for that specific firm. To control for possible endogeneity, an instrumental variable is introduced, but the coefficients for cartel duration (*cartel.dur*) are not significant, which is not surprising as the duration of the cartel is already accounted for in the setting of the initial fine. However, the results from the first stage Heckman regression, show that firms are slightly more likely to apply and receive a leniency reduction in shorter cartels.

Sjoerd (2005) and Brenner (2009) both conclude that the duration of the investigation is decreased by the introduction of the LP, as leniency applicants reveal more information to aim for a higher fine reduction. Nonetheless, the coefficients of the duration of the investigation (*inv.dur* and *inv.dur2*) are consistently zero in the LP of 2006, and are therefore not included in the table of results.

## 5 Discussion

What really matters for the setting of the percentage of fine reductions within the Leniency Programme? What incentives do firms have to self-report and does the reality match the guidelines? To what extent and in what ways can firms use and possibly abuse the LP?

There are no doubts as to the increasing importance of the LP and the number of firms applying for leniency reductions in exchange for information on secret cartels to which they belong. It is thus of major importance to guarantee that the programme is efficient in preventing and dissolving cartels and that it does not constitute an easy way to escape a fine. The first step to ensuring this is making the guidelines very clear and explicit, in an attempt to guarantee that firms clearly know the consequences they face and what they can expect.

The analysis carried out in this paper confirms the main expected result: the first reporter receives much higher fine reductions, whether or not the reporting of the cartel takes place before the Commission started an investigation. This supports both the guidelines and the aim of the LP in providing a significant incentive to reporting, although the reductions seem to be more generous than is outlined in the guidelines.

It is interesting to note that the predicted leniency reductions seem to be smaller for firms who received other fine reductions outside the LP, in cartels with a geographical impact beyond the EEA, and when there is such a lack of cooperation or evidence which leads to a subsequent decision by the Court of Justice.

However, arguably the main result is that repeat offenders receive higher leniency reductions, which shows some evidence that firms can learn the “rules of the game”,

repeatedly colluding and reporting the cartels in which they take part, thus substantially damaging their partners. This result is reinforced by the finding that a higher number of repeat offenders per cartel also increases the average leniency reduction, by the mergers and/or acquisitions which occur between firms who previously colluded and by the fact that firms often collude with the same partners in different cartels. While the prospect of high leniency reductions may incentivize cartel members to report, it may also create an incentive for them to participate in a cartel and then be the first reporter, thus learning how to “cheat”. Due to the ambiguous impact of the LP on firms’ incentives, repeat offenders’ penalties should be carefully assessed so as to create a desistance effect and the leniency reductions should be independent of recidivism, or else this link should be made explicit in the guidelines.

The existence and application of such a programme has major impacts on society in general and it seems that firms are able to use it in their own benefit, in some unintended ways. This is supported by the previous theoretical and empirical research and seems apparent in the data. It is likely that this means the desired long-term effect of the LP is not being achieved. Although the number of reported cartels has been increasing, it is difficult to measure the rate of success of the programme as the total number of existing cartels is unknown and more cartels may be initiated due to the prospect of a more lenient penalty.

From the point of view of a firm, it may seem better to enjoy higher profits of collusion, up to the moment of reporting to the Commission, and then pay a small or no fine, since the reductions granted are generally very high, and enjoy the damage caused by the fines imposed on the other cartel members, i.e., competing firms. From the point of view of policy makers, the existence of firms that have participated in more than four cartels in the last eleven years should be seen as a warning sign that, despite the increase in the number of cartels reported, the LP may also have pro-collusive effects, which are reinforced by the fact that the cartels reported by a given firm are often in a single market. In summary, it appears clear that the guidelines should be more explicit and less generous, especially regarding how repeat offenders are treated.

## 6 Tables and Figures

Table 1: Description of the variables

Variable:	Definition:
<i>LRed</i>	dependant variable: percentage of leniency reduction given to a single firm, or a group of firms jointly fined $= 1 - \theta = \frac{\text{leniency reduction (euro)}}{\text{total fine (F) (euro)} - \text{other reductions (M) (euro)}}$
Firm1pre	dummy (=1) if firm was the first pre-investigation reporter
Firm1post	dummy (=1) if firm was the first post-investigation reporter
Firm2	dummy (=1) if firm was the second to cooperate with an investigation
Firm3	dummy (=1) if firm was the third to cooperate with an investigation
RO	dummy (=1) if firm participated in at least 2 cartels
NRO	number of repeat offenders per cartel
RO1	dummy (=1) if firm participated in at least 2 non-contemporaneous cartels
NRO1	number of sequential repeat offenders per cartel
oth.red	reductions received by a firm, outside the LP
fine.increase	fine increases received by a firm
eea	dummy (=1) if cartel only affects the EEA market
cartel.dur	cartel duration, in months
cartel.dur2	squared cartel duration
inv.dur	investigation duration, in months
inv.dur2	squared investigation duration
firms	number of cartel members
C.J.Inc.	dummy (=1) if the Court of Justice adjusted the fine
def.fine.M	initial fine for each cartel member, deflated, in millions
def.paid.M	fine paid by each cartel member, deflated, in millions
$T_i$	year fixed effects
$S_s$	sector fixed effects

Table 2: Summary statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
<i>LRed</i>	0.245	0.327	0	1	553
Firm1pre	0.099	0.300	0	1	553
Firm1post	0.197	0.398	0	1	553
Firm2	0.275	0.447	0	1	553
Firm3	0.025	0.157	0	1	553
RO	0.307	0.462	0	1	553
NRO	1.837	2.011	0	9	470
RO1	0.036	0.187	0	1	553
NRO1	0.195	0.491	0	2	553
oth.red	0.031	0.097	0	1	553
fine.increase	0.225	0.518	0	2.9	553
eea	0.687	0.464	0	1	553
cartel.dur	90.443	72.521	2	419	553
cartel.dur2	13429.670	24623.800	4	175561	553
inv.dur	46.647	21.242	3	96	553
inv.dur2	2626.401	2241.239	9	9216	553
firms	8.049	4.119	2	17	553
C.J.Inc	0.192	0.394	0	1	553
t	2006.468	4.067	1998	2013	553
def.fine.M	35.976	76.112	0.1	689.98	483
def.paid.M	33.142	72.001	0	981.03	553



Table 3: Statistics on cartel cases (using the LP), by decision year

Year	Closed cartels (cases)	Open cases	Cartels found by LP	No.firms	No.LP reductions	No.other reductions
1998	2 (2)	-	-	18	10	6
1999	1 (1)	-	-	24	2	8
2000	2 (2)	-	1	28	5	8
2001	14 (7)	-	8	25	25	1
2002	9 (9)	-	7	48	36	3
2003	4 (4)	-	3	26	18	0
2004	3 (3)	-	3	29	8	1
2005	4 (4)	-	4	39	18	2
2006	5 (5)	-	6	67	16	2
2007	10 (7)	-	5	67	21	14
2008	6 (6)	-	5	34	11	4
2009	10 (6)	0	6	49	23	3
2010	6 (6)	3	6	68	35	26
2011	4 (4)	6	4	13	11	10
2012	8 (4)	10	8	62	29	3
October 2013	5 (1)	3	5	13	13	13
total	93 (71)	22	71	610	281	104
mean	5.8 (4.4)	-	4	38	18	7

Source: Author's calculations, using data from EC's website.

Table 4: Frequency of leniency reductions granted in January 1998-October 2013

Reduction	Frequency	1998-2002	2003-2007	2008-2013
0%	224	38	76	130
1-9%	5	24 (23%)	7 (9%)	6 (5%)
10-49%	185	46 (43%)	44 (54%)	63 (52%)
50%	49	25 (24%)	10 (12%)	14 (12%)
51-99%	3	2 (2%)	0 (0%)	1 (1%)
100%	67	9 (9%)	20 (25%)	38 (31%)
Sub-total	309	106 (100%)	81 (100%)	122 (100%)
Total	553	144	157	252

Source: Author's calculations, using data from EC's website.

Table 5: Number of cartels per firm, January 1998-October 2013

	Multiple Offender	No.Cartels (No.cases*)	No.Leniency reductions	No.Full Leniency	No.Other Reductions
firms: (RO1)	Akzo	9 (8)	7	3	0
	Sumitomo	6 (5)	5	5	1
	Degussa Evonik	5	5	2	0
	Mitsubishi	4	0	0	2
	Thyssen Krupp	4 (2)	2	0	0
	ABB	4	1	1	0
	FMC	3 (2)	1	0	1
firms: (RO)	F.Hoffman-La Roche	9 (2)	9	0	0
	BASF	9 (2)	8	0	0
	Elf Aquitaine (Arkema)	6	5	0	0
	Takeda Chemical Industries	6 (2)	6	1	0
	Aventis	5	5	4	1
	Bayer	5	4	2	0
	Prym	5 (2)	4	1	0
	Toshiba	4	0	0	1
	Total	4	2	0	0
	Samsung	4 (3)	4	1	1
	Coats	4 (3)	2	0	0
	SGL	4 (3)	2	0	0
	KONE	4 (1)	3	2	1
	Otis	4 (1)	4	1	3
	Schindler	4 (1)	1	0	4
	AC Treuhand	3	0	0	0
	Archer Daniels Midlands	3	3	0	1
	Asahi Glass (AGC)	3	1	0	1
	Chunghwa	3	3	2	0
	DuPont, Dow	3	3	0	0
	ENI	3	0	0	0
	EKA Chemicals (now part of Akzo)	3	2	1	0
	Hitachi	3	0	0	2
	Repsol	3	3	0	1
	Shell	3	1	1	0
	Solvay	3	2	0	0
	Chemtura (ex-Crompton)	3 (2)	3	2	0
	Exel	3 (1)	3	3	0
<i>sub-total</i>	67 Multiple Offenders				
	374 Single Offenders				
<i>total</i>	441 firms				

Table 6: Number of cartels per firm, January 1998-October 2013 (continued)

	Multiple Offender	No.Cartels (No.cases*)	No.Leniency reductions	No.Full Leniency	No.Other Reductions
	Yazaki	3 (1)	3	0	3
	YKK Group	3 (1)	2	0	0
	Ajinomoto	2	2	0	0
	Alstom	2	0	0	1
	ArcelorMittal	2	1	0	0
	Areva	2	0	0	2
	Boliden	2	2	1	0
	BP	2	2	2	0
	Carbone Lorraine	2	2	0	0
	Chiquita	2	2	2	2
	Daesang	2	2	0	1
	Danone	2	1	0	0
	Fuji Electric	2	1	0	0
	Hoechst AG	2	1	0	0
	IMI	2	2	0	0
	Interbrew	2	1	0	0
	Kemira	2	1	1	0
	KME group	2	2	0	1
	LG Electronics	2	0	0	0
	Merck Kga	2	2	1	0
	Mueller Ind.	2	2	2	0
	Nippon Steel	2	1	0	1
	Nynas	2	0	0	1
	Outokumpu	2	2	0	0
	Panasonic	2	1	0	1
	Pilkington	2	0	0	0
	SAS	2	1	0	1
	Siemens	2	1	1	0
	Tokai Carbon	2	1	0	0
	Elementis	2 (1)	0	0	0
	Furukawa	2 (1)	2	0	2
	SYS	2 (1)	2	0	2
<i>sub-total</i>	67 Multiple Offenders				
	374 Single Offenders				
<i>total</i>	441 firms				

Source: Author's calculations, using data from EC's website.; (\*) denotes the number of Cases if it differs from the number of cartels

**Table 7: Tobit results: Leniency Programme of 2006**

(ired)	LP.2006 (1)	LP.2006 (2)	LP.2006 (3) IV	LP.2006 (4)	LP.2006 (5)	LP.2006 (6)
Firm1post	0.65*** (0.11)	0.70*** (0.12)	0.74*** (0.11)	0.76*** (0.12)	0.80*** (0.13)	0.80*** (0.13)
Firm2	0.62*** (0.13)	0.62*** (0.12)	0.66*** (0.13)	0.59*** (0.12)	0.58*** (0.11)	0.58*** (0.11)
Firm3	0.31*** (0.10)	0.42*** (0.12)	0.42*** (0.13)	0.40*** (0.11)	0.46*** (0.13)	0.44*** (0.13)
RO	0.20** (0.10)	0.19* (0.10)	0.26*** (0.09)	0.11 (0.11)		
NRO				0.05* (0.03)		
RO1						-0.35* (0.19)
NRO1					0.49*** (0.12)	0.50*** (0.11)
fine.increase				0.22 (0.30)	0.40 (0.34)	
eea		0.19** (0.09)	0.15 (0.12)	0.23* (0.12)	-0.05 (0.09)	-0.07 (0.09)
oth.red		-1.21 (0.96)	-0.34 (1.29)	-2.54** (1.26)	-2.14* (1.29)	-2.26** (1.12)
cartel.dur		-0.00 (0.00)	0.01 (0.01)	. (.)	0.00 (0.00)	0.00 (0.00)
C.J.Inc		0.23 (0.30)	-0.11 (0.61)	-0.60*** (0.22)	-0.65* (0.36)	-0.40 (0.35)
firms				-0.02 (0.02)	-0.01 (0.02)	-0.01 (0.01)
year effects	yes	yes	yes	yes	yes	yes
sector effects	yes	yes	yes	yes	yes	yes
pseudo $R^2$	39.02%	44.34%		45.80%	47.80%	48.80%
Log-likelihood	-75.71	-69.11	-1029.00	-67.29	-64.80	-63.57
$\widehat{ired}$	-6.17%	-6.06%	-6.22%	-7.48%	-7.43%	-7.15%
$Chi^2$			791.83			
Iterations			8			
Instrument			fine			
N censored	101	101	101	101	101	101
N uncensored	85	85	85	85	85	85
N total	186	186	186	186	186	186

\*\*\*, \*\*, \* correspond to 1, 5 and 10% significance level, respectively. Standard errors reported in parenthesis. The  $R^2$  corresponds to McFadden's pseudo R-squared.

## 7 Appendix

Table 8: Dataset and analysis of Cartels

Author	Data	Number Cartels	Number Firms	Analysis	Time Period
Connor (2007)	Asia	377		<i>Descriptive Statistics</i>	1990-2007
Berinde (2008)	EU	78		<i>Descriptive Statistics</i>	1990-2008
Veljanovski (2010)	EU	63		<i>Descriptive Statistics</i>	1999-2007
Asker (2010)	US	1		<i>Descriptive Statistics</i>	2001-2002
Connor (2010)	US	799	2310	<i>Descriptive Statistics</i>	1984-2009
Borrell and Jimènez-Gonzalez (2008)	world	47		Antitrust effectiveness	2003-2004
Levenstein and Suslow (2011)	EU,US	81		Cartel duration	1990-2007
Sjoerd (2005)	EU	67	399	Fine, Gravity, Inv.Duration	1990-2005
Brenner (2009)	EU	61	232	Fine, Investigation Duration	1990-2003
<b>Marvao (2012)</b>	EU	81	385	Leniency Reduction	1998-2011
Miller (2009)	US	342		Cartel discoveries	1985-2005

Table 9: Statistics on cartel cases (with LP applications) where Akzo took part, by decision year.

Akzo										
decision year	invest. year	cartel duration	Len. Red.	Oth. Red	Fine Increase	no. Firms	Product	Reduction 000€	Fine 000€	
2001	1997	1987-1995	20%	0%	0%	5	Sodium Gluconate	1,800	7,200	
2003	2001	1971-1999	100%	0%	0%	6	Organic Peroxyde	214,500	0	
2004	1999	1992-1998	30%	0%	50%	3	Choline chloride jointly with EKA Chemicals	9,000	20,990	
2005	2000	1984-1999	25%	0%	50%	4	MCAA acid	28,127	84,380	
2006	2003	1994-2000	40%	0%	0%	9	Hydrogen peroxide jointly with EKA Chemicals	16,680	25,200	
2008	2003	1994-2000	100%	0%	0%	8	Sodium Chlorate jointly with EKA Chemicals	116,000	0	
2009	2003	1991-2000	0%	0%	0%	8	Heat stabilizers jointly with Elementis and Akcros	0	40,600	
2009	2007	2004-2007	100%	0%	100%	15	Calcium carbide jointly with Carbide Sweden	17,400	0	

Source: Author's calculations, using data from EC's website.

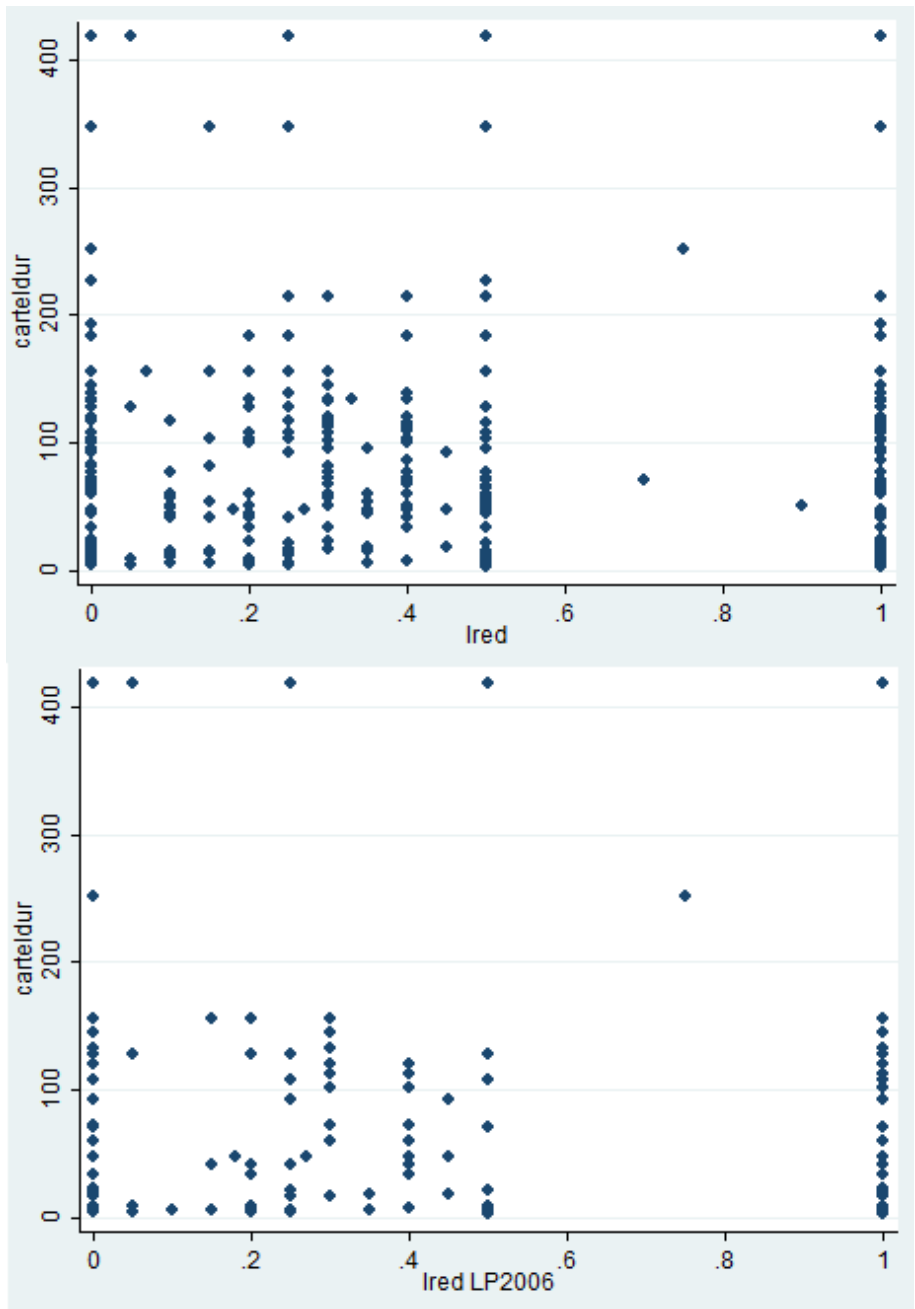


Figure 1: Cartel duration and amount of leniency reductions, 1/1998-10/2013.  
 $\text{Corr}(\text{carteldur}, \text{lred}) = -5.42\%$ ;  $\text{corr}(\text{carteldur}, \text{lred})[\text{LP 2006}] = -6.61\%$

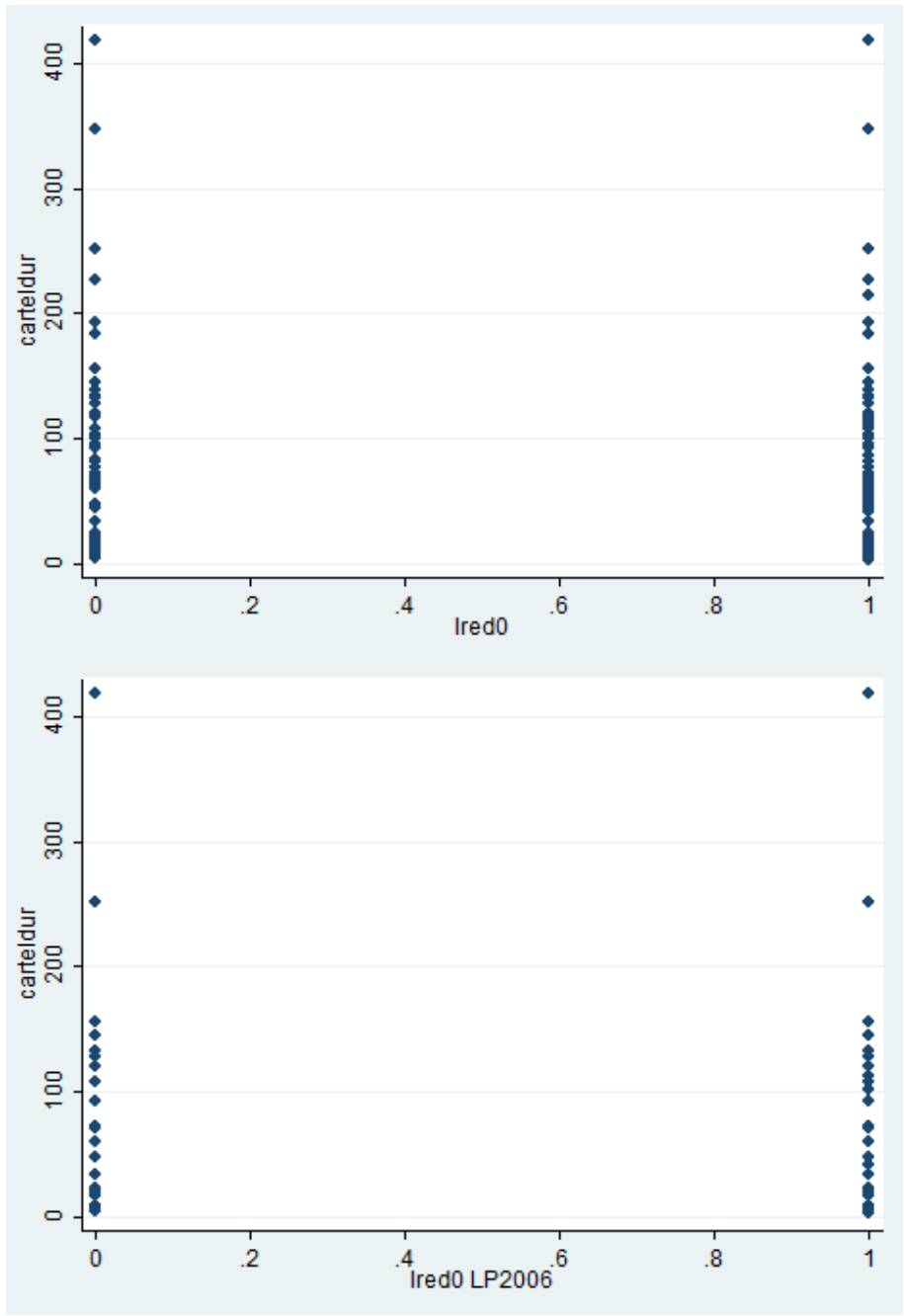


Figure 2: Cartel duration and decision to grant a leniency reduction, 1/1998-10/2013.  
 $\text{Corr}(\text{carteldur}, \text{lred}) = -13.86\%$ ;  $\text{corr}(\text{carteldur}, \text{lred})[\text{LP 2006}] = -11.89\%$

Table 10: Heckman results

STAGE 1 (lred0)	LP.2006 (1)	LP.2006 (2)	LP.2006 (3)	LP.2006 (4)	LP.2006 (5)	LP.all (6)	LP.all (7)	LP.all (8)
Firm1post	15.42 (6546.55)	13.86 (28474.04)	13.16 (1585.30)	14.03 (3144.87)	18.27 (3807.04)	4.83*** (0.71)	4.19*** (0.50)	4.18*** (0.49)
Firm2	15.35 (5911.36)	13.11 (22200.76)	11.55 (1330.37)	11.65 (2697.57)	18.15 (3824.97)	4.97*** (0.62)	4.50*** (0.49)	4.68*** (0.51)
Firm3	8.94 (7709.51)	8.14 (30352.61)	7.46 (3292.69)	7.53 (8797.23)	7.55 (11670.20)	10.12 (2098.42)	9.40 (44192.44)	10.51 (48517.03)
RO	0.06 (0.40)	-0.02 (0.37)	-0.05 (0.42)			0.42 (0.29)	0.29 (0.28)	
NRO			-0.08 (0.12)				0.04 (0.08)	
RO1					-6.25 (2231.29)			-1.12* (0.64)
NRO1				1.72** (0.82)	2.03** (0.84)			0.10 (0.31)
fine.increase			2.04 (1.89)	1.85 (1.91)			-0.01 (0.42)	0.09 (0.41)
eea		-0.53 (0.51)	-1.08* (0.58)	-1.77** (0.79)	-2.22** (0.88)		-0.68* (0.35)	-0.71** (0.35)
oth.red		-3.36 (3.58)	-2.22 (4.54)	-5.86 (4.93)	-7.35 (5.42)		-1.49 (1.87)	-1.22 (1.80)
cartel.dur		-0.02*** (0.01)	0.00 (0.00)	-0.00 (0.00)	-0.00 (0.00)		-0.01*** (0.01)	-0.01** (0.01)
carteldur2		0.00*** (0.00)					0.00*** (0.00)	0.00*** (0.00)
C.J.Inc		-5.55 (16273.72)	-4.03 (2822.46)	-6.30 (10752.25)	-5.97 (1742.93)		0.47 (0.51)	0.44 (0.53)
firms			-0.11* (0.07)	-0.02 (0.08)	-0.02 (0.07)	-0.04 (0.05)	0.02 (0.05)	-0.00 (0.05)
lp_step						0.14 (0.68)	-0.00 (0.57)	-0.02 (0.58)
constant	-0.35 (0.77)	-14.89 (34.14)	-1.67 (1.81)	-2.43 (2.65)	-2.94 (3.43)	-0.64 (0.63)	-13.12 (351.85)	-12.83 (334.74)
year effects	yes	yes	yes	yes	yes	yes	yes	yes
N	208.00	208.00	208.00	208.00	208.00	553.00	553.00	553.00
lnsig2u	7.88 (6196.50)	9.06 (29107.65)	8.12 (1970.78)	6.99 (3977.20)	7.28 (4974.06)	6.22 (1618.54)	8.10 (34783.05)	8.41 (35920.40)
log-likelihood	-65.01	-56.79	-61.20	-58.58	-56.72	-101.28	-95.23	-94.73
chi2	5.65	.	14.36	17.68	19.42	81.22	.	.
iterations	5	7	3	3	4	4	9	9

\*\*\*, \*\*, \* correspond to 1, 5 and 10% significance level, respectively. Standard errors reported in parenthesis. *lnsig2u* is the logged variance of the random effect.



Table 11: Heckman results

STAGE 2 (ired)	LP.2006 (1)	LP.2006 (2)	LP.2006 (3)	LP.2006 (4)	LP.2006 (5)	LP.all (6)	LP.all (7)	LP.all (8)
Firm1post	0.37*** (0.10)	0.38*** (0.09)	0.39*** (0.10)	0.40*** (0.11)	0.33*** (0.09)	0.46*** (0.08)	0.46*** (0.08)	0.38*** (0.08)
Firm2	0.69*** (0.08)	0.69*** (0.08)	0.70*** (0.08)	0.66*** (0.08)	0.61*** (0.07)	0.55*** (0.08)	0.55*** (0.08)	0.46*** (0.08)
Firm3	0.19* (0.11)	0.19* (0.10)	0.20* (0.11)	0.19* (0.11)	0.15 (0.10)	0.18* (0.10)	0.17* (0.10)	0.10 (0.10)
RO	0.21*** (0.06)	0.21*** (0.06)	0.20*** (0.06)			0.11*** (0.03)	0.11*** (0.03)	
NRO2								
RO1					0.07 (0.09)			0.07 (0.06)
NRO1								0.01 (0.20)
fine.increase			0.07 (0.20)	0.18 (0.20)			-0.04 (0.04)	-0.03 (0.04)
eea								
oth.red		-0.70 (0.59)	-0.68 (0.60)	-0.82 (0.61)	-0.89 (0.61)		-0.09 (0.15)	-0.06 (0.15)
cartel.dur								
carteldur2							0.00 (0.00)	0.00 (0.00)
C.J.Inc								
firms						-0.00 (0.07)	-0.00 (0.07)	0.02 (0.07)
lp_step								
imr	0.01 (0.04)	0.02 (0.03)	0.02 (0.03)	0.01 (0.03)	-0.02 (0.02)	0.02 (0.03)	0.02 (0.04)	-0.02 (0.04)
constant								
year effects	yes	yes	yes	yes	yes	yes	yes	yes
N	208.00	208.00	208.00	208.00	208.00	553.00	553.00	553.00
r2	50.57%	51.06%	51.07%	47.60%	47.70%	41.16%	41.36%	40.02%
chi2								
F-stat	35.40	29.91	25.49	26.04	26.14	52.93	35.34	30.02
$\widehat{ired}$	26.09%	26.09%	26.09%	26.09%	26.09%	25.54%	25.54%	25.54%

\*\*\*, \*\*, \* correspond to 1, 5 and 10% significance level, respectively. Standard errors reported in parenthesis. imr is the inverse mills ratio.

Table 12: Tobit results: Leniency Programmes of 1996 and 2002

(ired)	LP_all (1)	LP_all (2)	LP_all (3)	LP_2002 (1)	LP_2002 (2)	LP_2002 (3)	LP_1996 (1)	LP1996 (2)	LP_1996 (3)
Firm1post	0.85*** (0.06)	0.87*** (0.06)	0.87*** (0.06)	0.79*** (0.13)	0.77*** (0.12)	0.78*** (0.12)	0.62*** (0.15)	0.56*** (0.00)	0.61*** (0.00)
Firm2	0.93*** (0.06)	0.94*** (0.07)	0.94*** (0.07)	0.57*** (0.11)	0.55*** (0.10)	0.56*** (0.10)	0.30** (0.15)	0.30*** (0.00)	0.30*** (0.00)
Firm3	0.43*** (0.07)	0.45*** (0.08)	0.45*** (0.08)	0.26*** (0.07)	0.26*** (0.07)	0.26*** (0.07)	0.10 (0.15)	0.10*** (0.00)	0.10*** (0.00)
RO	0.17*** (0.05)			0.05* (0.03)			-0.05 (0.04)		
NRO	-0.01 (0.01)			0.03* (0.01)			-0.05 (0.03)		
RO1		0.04 (0.10)			-0.06* (0.03)			0.02*** (0.00)	
NRO1		-0.05 (0.03)	-0.04 (0.03)		-0.04* (0.02)	-0.05* (0.03)		-0.47*** (0.00)	-0.41*** (0.00)
fine.increase	-0.01 (0.03)		0.01 (0.03)	-0.06* (0.03)		-0.02 (0.02)	-0.10** (0.04)		-0.11*** (0.00)
firms	-0.02** (0.01)	-0.03*** (0.01)	-0.03*** (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.03 (0.03)	0.00*** (0.00)	-0.02*** (0.00)
eea	0.00 (0.06)	-0.01 (0.06)	-0.01 (0.06)	-0.05 (0.10)	-0.06 (0.12)	-0.06 (0.12)	0.04 (0.09)	-0.13*** (0.00)	-0.03*** (0.00)
oth.red	-0.19 (0.28)	-0.16 (0.30)	-0.18 (0.30)	-0.20** (0.08)	-0.41*** (0.11)	-0.34*** (0.11)	0.08 (0.99)	0.32*** (0.01)	0.02*** (0.01)
cartel.dur	0.00* (0.00)	0.00** (0.00)	0.00** (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00*** (0.00)	0.00*** (0.00)
C.J.Inc	-0.02 (0.06)	-0.01 (0.07)	-0.01 (0.07)	0.06 (0.06)	0.16*** (0.05)	0.15*** (0.05)	-0.31*** (0.08)	0.02*** (0.00)	-0.01*** (0.00)
inv.dur	0.00 (0.01)	-0.00 (0.00)	-0.00 (0.00)	0.02* (0.01)	0.01 (0.01)	0.01 (0.01)	-0.07* (0.04)	-0.03*** (0.00)	-0.07*** (0.00)
invdur2	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00* (0.00)	-0.00 (0.00)	-0.00 (0.00)	0.00* (0.00)	0.00*** (0.00)	0.00*** (0.00)
year effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
sector effects	yes	yes	yes	yes	yes	yes	yes	yes	yes
pseudo $R^2$	60.13%	61.71%	60.11%	140.19%	141.19%	139.97%	240.97%	255.81%	252.42%
Log-likelihood	-167.68	-161.07	-167.79	50.49	51.74	50.21	54.02	59.70	58.41
$\widehat{ired}$	4.07%	4.03%	4.04%	-3.51%	-4.12%	-3.72%	12.03%	12.85%	12.48%
Clusters	93	93	93	42	42	42	21	21	21
N censored	244	244	244	112	112	112	29	29	29
N uncensored	309	309	309	97	97	97	74	74	74
N total	553	553	553	209	209	209	103	103	103

\*\*\*, \*\*, \* correspond to 1, 5 and 10% significance level, respectively. Standard errors reported in parenthesis. The  $R^2$  corresponds to McFadden's pseudo R-squared.

Table 13: Tobit Results - Multiple Offenders only

(ired)	LP.2006 (1)	LP.2006 (2)	LP.2002 (3)	LP.2002 (4)	LP.all (5)	LP.all (6)
Firm1post	0.50*** (0.01)	0.51*** (0.09)	0.81*** (0.17)	0.84*** (0.18)	0.64*** (0.09)	0.66*** (0.09)
Firm2	0.08*** (0.02)	0.16 (0.14)	0.56*** (0.13)	0.58*** (0.13)	0.48*** (0.08)	0.48*** (0.08)
Firm3	0.35*** (0.01)	0.34** (0.12)	0.29*** (0.10)	0.29*** (0.09)	0.30*** (0.09)	0.30*** (0.08)
NRO2	0.20*** (0.00)	0.11*** (0.04)	0.03 (0.03)	0.04 (0.03)	-0.01 (0.02)	-0.01 (0.02)
RO1	-0.78*** (0.01)		-0.09** (0.04)		-0.23*** (0.08)	
fine.increase		-0.35 (0.38)		-0.04 (0.03)		0.03 (0.02)
firms	-0.10*** (0.00)	-0.05*** (0.01)	-0.01 (0.02)	-0.01 (0.02)	-0.02 (0.02)	-0.03* (0.02)
eea	0.71*** (0.01)	0.64** (0.26)	-0.01 (0.14)	0.02 (0.11)	0.00 (0.12)	0.01 (0.12)
oth.red	-15.05*** (0.16)	-10.41*** (1.39)	-0.31*** (0.08)	-0.22*** (0.06)	-0.20 (0.26)	-0.23 (0.29)
cartel.dur	0.00*** (0.00)	0.00 (0.00)	0.00 (0.00)	-0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
C.J.Inc	1.81*** (0.01)		0.12 (0.10)		0.06 (0.08)	
inv.dur	-0.01*** (0.00)	-0.01* (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00* (0.00)
No.Cartels	0.04*** (0.00)	0.02 (0.01)	0.00 (0.02)	-0.01 (0.01)	0.01 (0.01)	-0.01 (0.01)
year effects	yes	yes	yes	yes	yes	yes
sector effects	yes	yes	yes	yes	yes	yes
pseudo $R^2$	146.41%	135.96%	123.44%	122.44%	103.13%	99.12%
Log-likelihood	15.29	11.85	13.55	12.97	3.29	-0.93
$\widehat{ired}$	-2.12%	8.22%	6.09%	6.33%	11.67%	11.99%
N censored	21	21	39	39	65	65
N uncensored	28	28	51	51	108	108
N total	49	49	90	90	173	173

\*\*\*, \*\*, \* correspond to 1, 5 and 10% significance level, respectively. Standard errors reported in parenthesis. The  $R^2$  corresponds to McFadden's pseudo R-squared.

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