The Effects of Private Damage Claims on Cartel Stability: Experimental Evidence

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Abstract

Private damage claims against cartels may have negative effects on leniency: whereas whistleblowers obtain full immunity regarding the public cartel fines, they have no or only restricted protection against private third-party damage claims. This may stabilize cartels. We run an experiment to study this issue. Firms choose whether to join a cartel, may apply for leniency afterwards, and then potentially face private damages. We find that the implementation of private damage claims decreases cartel formation but makes cartels indeed more stable. The overall impact of private damage claims is positive: cartel prevalence declines.

**Keywords:** Private damage claims, cartel stability, laboratory experiment, leniency

**JEL classification numbers:** C90, L41, L44

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1 Introduction

In the airline-cargo cartel case, Lufthansa was the whistleblower and received full immunity from fines but was soon after sued privately by Deutsche Bahn for damages amounting to 1.76 billion euros. Would Lufthansa have blown the whistle had they anticipated these damage claims? Do such private damages not provide a strong disincentive to report cartels and apply for leniency? In this paper, we try to answer these questions with evidence from laboratory experiments.

Largely driven by the introduction of leniency programs, cartel authorities can look back at successful years of public cartel enforcement. Leniency policy offers companies involved in a cartel who self-report either total immunity from fines or a reduction in the fines, which the authorities would have otherwise imposed on them (European Commission, 2006). As theoretical, empirical, and experimental work shows, leniency policy has a deterrent effect on cartel formation and, as it yields distrust among cartel members, it destabilizes the operations of existing cartels (see, for example, Bigoni et al., 2012; Brenner, 2009; Harrington and Chang, 2009; Miller, 2009; Motta and Polo, 2003; Spagnolo, 2003). For a survey of the research on leniency programs, see Spagnolo (2008).

Damage claims—customers of a cartel may sue convicted wrongdoers for the loss they suffer in civil lawsuits—add an element of private enforcement to anti-cartel policy. Private damage claims have only recently gained attention in Europe. The European Commission started to consider private enforcement with its 2005 Green Paper (European Commission, 2005). It was signed into law in November 2014. In 2018 the last member states implemented the directive on antitrust damages actions into national law (European Commission, 2014, 2018). In the US, private damage claims exist since the early 20th century. Private enforcement is viewed as an important and long-standing antitrust policy tool since public enforcement is restricted to litigation in order to

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1 See Kiani-Kreß and Schlesiger (2014) and Michaels (2014). At least initially, private damages far exceeded the fines which, eventually, summed up to 776 million euros (see European Commission, 2017a).

2 For example, MAN revealed the EU-wide truck cartel (1997–2011) and received full immunity from the European Commission (EC). Further examples are the vitamins cartel (around 1985–1999) and the air cargo cartel (1999–2006), in which the EC and the US Department of Justice granted full immunity to Rhône-Poulenc, respectively Lufthansa, for revealing the cartel (Department of Justice, 2007; European Commission, 2001; Rn.(124), 2016; Rn.(31), 2017b; Rn.(28)).
impose fines on cartel members [Canenbley and Steinvorth 2011]. Despite these differences, private damages now constitute a significant dimension of cartel policy both in the EU and the US.

At first sight, it seems that private damage claims nicely complement public enforcement. They raise the expected penalty for forming a cartel and therefore add to the deterrent effect of the fines imposed by antitrust authorities. In the 1960s, Becker (1968) argued that increased sanctions decrease criminal activity. Private damage suits constitute a sanction and should accordingly reduce the criminal activity of explicit collusion.

There are, however, growing concerns about the negative effects of private enforcement. As the Lufthansa example shows, the detrimental impact that compensation payments for damaged parties have on the attractiveness of leniency programs are evident. Whereas penalties are waived or reduced for cooperating leniency applicants, leniency programs give only restricted protection against third-party damage claims in the EU. The effect is severed by the fact that cartel members are jointly liable for the entire damage caused by the cartel, and compensation payments are not capped, in contrast to fines which may not exceed 10% of annual turnover [European Commission 2011]. With respect to private damage claims, the European legislation restricts the leniency applicants’ liability to the harm caused to their own direct and indirect purchasers. In any event, applicants remain fully liable when non-applicants are not able to entirely compensate the injured parties [European Commission 2014, Rn(38)]. In comparison, the US antitrust law limits the leniency applicants’ liability to single, instead of treble, damage compensation payments.

The literature appears to largely acknowledge this trade-off between private damages claims and public leniency programs. Canenbley and Steinvorth (2011), Cauffman and Philipsen (2014), 3 Private damage claims account for 90 to 95 percent of US cartel cases (Knight and Ste. Claire 2019). US law incentivizes private lawsuits, for example, by making the infringer liable for treble damages and by admitting class action suits (4 Clayton Act, 15 U.S.C. 15; Jones, 2016).

More recently, Bigoni et al. (2015) and Chowdhury and Wandschneider (2018) provide experimental evidence of the deterrent effect of penalties on cartels. See also below.

5 An additional point in favor of private damages, raised by Knight and Ste. Claire (2019), is that private damages can reduce the profitability of sustained collusion. Cartels are no longer monitored by time- and money-constrained competition authorities only, but also by possible private plaintiffs. A higher detection probability reduces the profitability of a cartel, accordingly. This argument is also supported in the work by Land and Davis (2011).

6 We will henceforth take a European perspective on this issue in that an existing leniency program was possibly weakened by the introduction of private damages. In the US, private damages predate leniency programs and so the existing anti-cartel policy was strengthened by the introduction of leniency. Nevertheless, the trade-off private damages imply apply also to US antitrust policy.

7 Antitrust Criminal Penalty Enhancement and Reform Act of 2004, Sec. 213.
Kirst and van den Bergh (2016), Knight and de Weert (2015), Migani (2014), Wils (2003), Wils (2009) find that it is less desirable for firms to apply for leniency when they are liable for private damage claims. The higher the expected third-party claims, the lower the incentives to apply for leniency. As this is also anticipated by other cartel members, it could have a stabilizing effect on cartels (Hüschelrath and Weigand 2010). Buccirossi et al. (2015) argue that a leniency applicant might become an easy target of damage suits due to its self-identification as guilty. This raises the question of whether applying for leniency remains attractive after the introduction of private damage claims.

In the end, it is an empirical question whether private damage claims strengthen or weaken the deterrence effects of public enforcement. On the one hand, higher fines should increase deterrence. On the other hand, they may render leniency ineffective. Somewhat surprisingly, we have not been able to find any sound empirical assessment of the effects of private enforcement. Figure 1 shows the number of EU cartel cases since 1990. Cartel cases rose sharply in 2000–2004 with the introduction of leniency programs but they are now in decline. This recent drop in cartel cases coincides with the EU’s introduction of private damage claims in 2014. Could this decline have been triggered by private damages? The descriptive numbers in figure 1 cannot identify a causal effect of private damages as many factors are uncontrolled for; foremost, because there are no undetected cartels in the sample, of course.
We propose an experimental approach to study the effects of private damages empirically. Laboratory experiments present a readily available testbed which is unaffected by the sample-selection problems which may bias field-data studies. \cite{Bigoni2012} mention that it is difficult to evaluate the deterrent or stabilizing effects of antitrust policies compared to other law enforcements because the number of cartels and changes in cartel formation is unobservable. Experiments can be a useful instrument for the evaluation of new policy tools and for analyzing the effects of cartel stability \textit{ceteris paribus}.

We build on – and extend – an established experimental literature on the effects of leniency programs. \cite{Apesteguia2007} examine the effect of leniency programs in one-shot Bertrand games. They find that the implementation of the leniency rule tends to increase self-reporting and decrease cartel formation, and leads to significantly lower market prices. \cite{Bigoni2012} and \cite{HinloopenSoetevent2008} analyze the repeated game in Bertrand duopolies and triopolies, respectively. The main result of this literature is that an introduction of leniency leads to a reduction in cartel formation. This literature has not studied the effect of private damage claims.
on leniency programs.

A second dimension along which we extend the literature is that we compare structured and free chat-like communication between participants. Some experiments analyze structured communication in the form of price announcements among players where subjects have available boilerplate messages [Bigoni et al., 2012; Hinloopen and Soetevent, 2008]. In the context of cartels, both structured communication and chat seems plausible. Cheap talk is recognized as an important tool for the coordination of cooperative outcomes in experiments [Blume and Ortmann, 2007; Camera et al., 2011; Cooper et al., 1992]. In the field of antitrust, experiments identify this kind of chat as a powerful device for fostering collusion [Brown Kruse and Schenk, 2000; Cooper and Kühn, 2014; Fonseca and Normann, 2012; Waichman et al., 2014]. While the comparison of chat to structured price announcements has been made for collusion experiments without leniency (recently, Harrington et al., 2016), it seems promising to conduct this comparison including leniency. Likewise, Apesteguia et al., 2007 and Dijkstra et al., 2018 conduct leniency experiments with chat communication but do not compare to non-chat forms of communication.

Our experiment is designed to analyze the effects of private damage claims on leniency, cartel formation, and cartel stability. We have the following main research questions. First, do we observe fewer cartels being established following the introduction of private damage claims? Second, is there a decreasing rate of leniency applications due to private damages? Third, what is the overall balance in terms of cartel prevalence?

The experimental design is largely based on Apesteguia et al., 2007, Bigoni et al., 2012 and Hinloopen and Soetevent, 2008. Subjects play a repeated homogeneous-goods Bertrand triopoly game. They decide whether they want to engage in collusive behavior by communicating about prices, and we vary the communication format available to subjects. We investigate settings with and without private damage claims.

Our results are as follows. We show that cartel formation at the individual and the group level leniency policies that discriminate against ringleaders and find that this, paradoxically, stabilizes collusion. Andres et al., 2019 add an innovative element to the experimental leniency literature by having participants play the role of the cartel authority. In a cartel experiment without leniency, Gillet et al., 2011 investigate how the managerial decision-making process affects cartel formation and pricing. Landeo and Spier, 2009 demonstrate anticompetitive effects of communication in the context of exclusive dealing.
is significantly lower with private damage claims. When private damage claims apply, leniency application rates are lower and, therefore, cartels are more stable. Overall, the balance is positive as there is an altogether lower level of cartel prevalence. The effect on consumer welfare depends on the form of communication. Private enforcement decreases average prices and therefore increases consumer surplus when communication is structured. In a treatment with chat communication, prices tend to significantly increase with private enforcement.

The article is organized as follows: The subsequent section describes the experimental design and explains the treatments in detail. Section 3 presents our hypotheses which are the basis for our further analyses in section 4. We conclude in section 5.

2 The experiment

2.1 General setup

The market model underlying the experiment is a symmetric three-firm homogeneous-goods Bertrand oligopoly. Demand is inelastic and \{101, ..., 110\} is the choice set of prices. Firms have constant marginal costs of 100. There is repeated interaction: the three players stay together in one market (or group) for the entire duration of the experiment (at least 20 periods).

In our experiment, firms can form cartels, report any existing cartel to a fictitious cartel authority in order to get leniency, and may face penalties and private damage claims. Our treatments vary with the implementation of private damage claims and the form of communication. The sequence of events in our experiment is as follows:

1. Decision whether to form a cartel; if all firms agree, communication is enabled and (non-binding) agreements on prices are possible,

2. Price decision,
3. Decision whether to report a cartel; unreported cartels may be detected by the cartel authority; in either case a fine is imposed,

4. Private damage claims.

We now explain these stages in turn.

### 2.2 Detailed account of the stages of the experiment

**Stage 1.** The three firms simultaneously and independently decide whether they want to establish a cartel. They press either the *discuss price* or the *do not discuss price* button on the computer screen. Only if all three firms decide to participate in price discussions is a cartel established, and a communication window opens. Depending on the treatment, firms have access to either structured or free chat communication (see 2.3).

**Stage 2.** Firms simultaneously and independently choose an integer price from the set \{101, ..., 110\}. The lowest price among the three ask prices \( p_i \) with \( i \in \{1, 2, 3\} \) is the market price, denoted by \( p \). Only firms that bid \( p \) are able to sell their product (Bertrand competition). The inelastic demand is normalized to one, so firm \( i \)'s profit is:

\[
\pi_i = \begin{cases} 
  p_i - 100 \quad & \text{if } p_i = p \\
  0 \quad & \text{if } p_i > p
\end{cases}
\]

where \( n \in \{1, 2, 3\} \) is the number of firms charging \( p \) and, as mentioned, 100 is the per-unit cost. Firms learn \( p \) and their own profit as feedback afterwards. “Profit” is the gain resulting from the market interaction, which may subsequently be reduced by penalties and private damage claims.

**Stage 3.** Firms decide whether to report any existing cartel to the authority and thereby apply for leniency. Reporting costs \( r = 1 \) “point” (the experimental currency unit) that represent legal fees for filing a leniency application. There is a “race to report”: the first leniency applicant gets a 100% fine reduction and the second applicant gets 50%; the third applicant does not receive a reduction.\(^{12}\) If no participant reports the cartel, it may still be detected by the authority, namely

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\(^{12}\) This race to report replicates actual European competition law because fine reductions are granted according to the
with a probability of $\rho = 0.15$ in each period. If a cartel is detected (either through a whistleblower or the random draw of the authority), each cartel member has to pay a fine, $F$, equal to 10% of the current period revenue, minus the leniency reductions.\(^{13}\)

Stage 4. Private damage claims may occur after a cartel is detected. Since we do not include cartel customers in our experiment, this stage is not a decision. Rather, the damage claims are simply enforced with a probability of $\sigma = 0.95$.\(^{14}\) If the private enforcement case is won in favor of the injured party, the cartel has to compensate 60% of the total damage.\(^{15}\) The damage inflicted is the difference between the cartel price $p^C$ and the Nash competitive price, 101 (European Commission 2014 Rn(39)), summed over the number of periods, $T$, where the cartel exists. According to European Commission (2014 Rn(37)) cartel members are jointly liable for the whole damage, therefore, each cartel member has to pay one third of the damage compensation:

$$D = \frac{1}{3} \cdot \sum_{t=1}^{T} (p^C_t - 101) \cdot 0.6$$

where $p^C_t$ is the collusive price in some period $t$ and 101 is the counterfactual price that would have been charged if there had been (Nash) competition. For example, fixing the cartel price at 110 (the maximum possible price), the compensation each cartel member has to pay for each period of the cartel’s duration is $\frac{1}{3} \cdot (110 - 101) \cdot 0.6 = 1.8$. Table 1 summarizes the calculation for the damages and draws a comparison to damages and fines.

\(^{13}\) These fines are consistent with European policy, including the “race to report” (European Commission 2002, Rn(23)b). Leniency applicants are immune or eligible to reductions of fines levied on infringers by the commission (European Commission 2006). Those who are first to report are fully relieved from cartel fines; “subsequent companies can receive reductions of up to 50% on the fine that would otherwise be imposed (European Commission 2011)” In line with European competition law, fines shall not exceed a maximum of 10% of a firm’s overall annual turnover when the respective firm is not eligible to reductions of fines (European Commission 2011). These parameters are also used in Bigoni et al. (2012) and Hinloopen and Soetevent (2008). Different from Hinloopen and Soetevent (2008) and our setup, Bigoni et al. (2012) introduce the possibility of reporting at any stage, even before the price-announcement stage.

\(^{14}\) If damage claims are brought to court, the probability that a case is won is presumably relatively high because one goal of the Directive on antitrust damages actions (European Commission 2014) is to make it easier for injured parties to get evidence (European Commission 2015). A large share of private damage claims are also settled out of court. According to Bourjade et al. (2009) cases are mainly settled out of court.

\(^{15}\) For two reasons it is reasonable to assume that not the total damage is compensated. First, not all buyers will claim damages, for example, because the buyer structure might be fragmented or because it is costly to open a case. Second, it could be the case that part of the damage is passed on in the value chain. The passing-on argument can serve as a strategy of defense of the cartel members against a claim for damages (European Commission 2014 Rn(39)).
2.3 Treatments

Our main treatment variable is the presence of private damage claims in stage 4. In the treatment labeled NOPDC, they are absent (there is no stage 4). In treatment PDC, they are potentially imposed. We conduct these two treatments within subjects: participants first play NOPDC and then PDC. The chief attraction of this within-subjects design is that it allows us to observe not only cartels that are formed after the implementation of the new rule, but also cartels that were set up before the introduction of the PDC rule (such that the new PDC come unexpectedly for existing cartels).

<table>
<thead>
<tr>
<th>Periods</th>
<th>1 ... 9</th>
<th>10</th>
<th>11 ... end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>NOPDC</td>
<td>NOPDC, introduce PDC after stage 2</td>
<td>PDC</td>
</tr>
<tr>
<td>Stages</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2: Within-subjects variation of private damages. Participants first play nine periods of NOPDC (stages 1–3). In period 10, the new PDC rule (stage 4) is announced after stage 2. Then, subjects play PDC (stages 1–4) for the remainder of the experiment.
mentioned that the rules might change during the course of the experiment, but they did not indicate when the change would occur nor what it would entail.\footnote{An alternative setup would have been to repeat the supergames in order to facilitate learning. This, however, would have precluded the within-subjects “before and after” evaluation of private damages which we considered essential for external validity.}

In the field, private damage claims were introduced after and in addition to existing public enforcement, justifying the sequence NOPDC-PDC on which we focus in our experiment. For the sake of completeness, the reverse order PDC-NOPDC may seem warranted. We accordingly conduct sessions with the reverse order of treatments. In the reverse order variant, stage 4 is removed (rather than added) in period 10.

As mentioned, we also modify the communication format in two treatments. This treatment variable is analyzed between subjects, that is, the treatment of different communication designs is done in separate experimental sessions. Potential carry-over effects (hysteresis) of the different communication formats make a within-subjects design unappealing in this case.

The communication formats are labeled CHAT and STRUC. In sessions with structured communication (STRUC), participants are only able to suggest a price range for which the good could be sold. Specifically, subjects can enter a minimum and a maximum price (within the range of \{101, ..., 110\}) in the communication window. In subsequent rounds of price discussions (in the same period), subjects can choose prices from the intersection of all three suggested price ranges from the preceding discussion. This iterative process lasts until either the subjects (non-bindingly) agree on a common price or after 60 seconds have passed.\footnote{Hinloopen and Soetevent\cite{hinloopen2008price} report that 60 seconds are sufficient.} After the communication phase has ended, subjects get feedback on the agreed upon price or the price interval. This procedure closely follows Hinloopen and Soetevent\cite{hinloopen2008price}. It resembles experiments where subjects may announce prices non-bindingly but cannot communicate otherwise\cite{harrington2016private,holt1990price}. In CHAT, subjects can freely communicate in a chat window. There are no restrictions (except for offensive messages, or messages identifying participants). We allow for open communication, letting subjects exchange any information they want. After 60 seconds, the chat window closes.
and subjects enter stage 2. Among others, Cooper and Kühn (2014), Fonseca and Normann (2012) and Harrington et al. (2016) have used similar chat devices in oligopoly experiments. Brosig et al. (2003) generally investigate the issue of the communication format on cooperation.

Table 3 summarizes our treatments. It also indicates the number of groups and participants for each treatment.

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Communication</th>
<th>Number of indep. groups</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOPDC - PDC</td>
<td>STRUC</td>
<td>16</td>
<td>48</td>
</tr>
<tr>
<td>NOPDC - PDC</td>
<td>CHAT</td>
<td>16</td>
<td>48</td>
</tr>
<tr>
<td>PDC - NOPDC</td>
<td>STRUC</td>
<td>16</td>
<td>48</td>
</tr>
<tr>
<td>∑</td>
<td></td>
<td>48</td>
<td>144</td>
</tr>
</tbody>
</table>

Table 3: Overview of treatments.

2.4 Procedures

The experimental sessions were conducted in the summer and fall of 2018 at the DICE-Lab of Duesseldorf University. We had a total of 144 participants. Subjects were students from all over campus. They had previously indicated their general willingness to participate in lab experiments by registering for our database and were then recruited for this experiment using ORSEE (Greiner, 2015).

Upon arrival at the DICE-Lab, subjects were welcomed and allocated to isolated computer cubicles. We used a randomization device to assign the cubicles. After all participants were seated, they were given written instructions. Subjects were given ample time to read the instructions and they had the opportunity to ask questions (in private, to the experimenter). Then the actual experiment began.

During period 10, the experiment was interrupted and a second set of written instructions (which explained the change regarding private damages) was distributed. The change of rules was also announced on the computer screen and was checked with control questions.

The experiment was programmed using z-Tree software (Fischbacher, 2007). Sessions lasted about one hour on average. Payments were as follows. Participants received an initial capital of 5 euros. Cumulated payoffs are added to or subtracted from the initial capital. The exchange rate
was one point equal to 0.3 euros. The average payment was 13.08 euros.

3 Hypotheses

Let the collusive profit per firm be $\pi^c$. In the static Nash equilibrium, firms earn $\pi^n$. Using the notation introduced in section 2), reporting costs are $r$. Unless reported, a cartel is detected by the authority with a probability $\rho$ and, if so, the authority imposes a fine $F$ on each firm. A bust cartel faces damage claims, $D$, as defined above. Damages are cumulated over time and are enforced with probability $\sigma$. Fines and damages depend on the cartel price and thus differ in periods of collusion (superscript $c$) and defection (superscript $d$).

Our first hypothesis is based on the economic theory of crime. It predicts that criminal activity decreases in the expected costs of the criminal activity (Becker, 1968). Private damage claims increase the expected costs of cartel formation and should therefore reduce the number of cartels. Formally, the cartel participation constraint (which must hold necessarily) without private damages reads

$$\pi^c - \rho F^c \geq \pi^n.$$ 

With private damages, the cartel participation constraint becomes more severe

$$\pi^c - \rho (F^c + \sigma D^c) \geq \pi^n.$$ 

For our experimental parameters, both incentive constraints are met. Assuming some heterogeneity between participants (attitudes towards risk, for example), we maintain that:

**Hypothesis 1 (Cartel formation)** Private damage claims reduce the number of cartels.

The following three hypotheses concern the effects of private damages on cartels that were formed despite the increased penalty. Private damages constitute an increased exit cost for firms:

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18 In the context of cartels and leniency, our experiment may be the first to investigate the effect of increased fines (through damage claims). Bigoni et al. (2015) analyze how leniency and various levels of fines and detection probabilities interact, keeping the expected fine constant. Also, Chowdhury and Wandsnieder (2018) keep the expected fine constant, but vary the fine magnitude and detection rate. In their variants with leniency, they find that a low detection rate and high fines lowers cartelization. Generally, different combinations of detection rate and fines do not affect cartel stability.
it is now more expensive to terminate the criminal activity. Suppose a colluding firm wants to report the cartel. Depending on leniency, it may or may not have to pay, $F$, but, no matter what the fine is, an additional (expected) damage of $\sigma D$ has to be paid by the reporting firm with private damages. Thus, the cost of reporting increases with private damages.

**Hypothesis 2 (Leniency)** Private damage claims reduce the frequency of leniency applications.

We now analyze the dynamic incentives to collude. Assume that the market game is repeated infinitely many times and that firms discount future profits with a discount factor $\delta$. Furthermore, suppose that firms collude on the maximum price and use a simple Nash trigger to support collusion, such that the static Nash profit, $\pi^n$, is the punishment profit after a deviation. The profit of a defecting firm is denoted by $\pi^d$.

Further details regarding the interplay of collusion, defection, fines, and leniency are as follows. Cartel firms remain liable for the agreement in future periods. We assume that successful cartels immediately resume the collusion after a detection, so the expected fine, $\rho F^c$, matters in every period of collusion and the expected per-period profit from colluding is hence $\pi^c - \rho F^c$. As for a deviating firm, it undercuts the collusive price, reports the cartel (which is strictly better than not reporting), and does not pay a fine due to leniency. Firms who did not deviate, by contrast, have no incentive to report after another firm deviated because they do not pay a fine anyhow (due to zero revenue), so reporting would only involve the cost, $r > 0$. Following the deviation, the cartel is never set up again.

We now solve the incentive constraints for the minimum discount required for collusion with and without private damages. Without private damages, sticking to the collusive agreement is better than defecting if

$$\frac{\pi^c - \rho F^c}{1 - \delta} \geq \pi^d - r + \frac{\delta \pi^n}{1 - \delta}$$

Let the $\delta$ that solves this equation be $\delta_{\text{NOPDC}}$ and note $\delta_{\text{NOPDC}} \in (0, 1)$ for the parameters used.

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19 Colluding on the maximum price seems plausible as this maximizes joint profits and requires the smallest minimum discount factor. Punishments more severe than Nash triggers are not feasible here because the Nash price is also the lowest price firms may charge.
in our experiment. With private damages, a defecting firm also applies for leniency during the period of defection.\footnote{A non-deviating firm will never apply for leniency because reporting costs money ($r > 0$) and, moreover, due to a “sucker” payoff of zero, it does not face a fine anyhow. Given potential private damages, a deviating firm will report if it is sufficiently patient (recall, damages are cumulated over time even after a breakdown of an undetected cartel), as is the case for our parameters.} Colluding is better than defecting if

$$\frac{\pi^c - \rho (F^c + \sigma D^c)}{1 - \delta} \geq \pi^d - r - \sigma D^d + \frac{\delta \pi^n}{1 - \delta}$$

The $\delta$ that solves this equation is denoted by $\delta^{\text{PDC}}_{\text{min}}$ and, as above, we find $\delta^{\text{PDC}}_{\text{min}} \in (0, 1)$ for our parameters. We find that

$$\delta^{\text{PDC}}_{\text{min}} < \delta^{\text{NOPDC}}_{\text{min}}.$$

That is, private damage claims facilitate collusion. For our parameters, we have $\delta^{\text{NOPDC}}_{\text{min}} = 0.68$ and $\delta^{\text{PDC}}_{\text{min}} = 0.64$. With a continuation probability of 0.8, both incentive constraints are met in the experiment and collusion is a SGPNE in either case. We follow the frequently adopted interpretation that a lower minimum discount factor makes collusion “easier” which we translate into cartel stability (the number of periods a cartel is stable). We state

**Hypothesis 3 (Cartel stability)** Private damage claims make cartels more stable.

An interesting observation is that the incentive constraint changes over time because damages are cumulated. Deviations become more costly in later periods with increasing damages. Private damages accordingly have a self-enforcing effect on collusion. In theory, this effect is immaterial: all that matters is whether the incentive constraint is met in period zero. The fact that the bill for reporting gets becomes higher and higher could be important, though. For example, unanticipated shocks to collusion may be absorbed only with the high exit cost the cumulated damages imply.

Hypothesis 3 should hold in particular for cartels that existed before private damage claims are introduced. The design of the experiment allows us to analyze the reaction of collusive firms to the introduction of private damage claims. Following up on hypothesis 3, we expect that firms which engage in collusive behavior before they know that private damage claims are going to
be implemented will be more reluctant to apply for leniency when private damage claims are applicable. We summarize this thought in hypothesis

**Hypothesis 4 (Stability of existing cartels)** Cartels set up before private damage claims are introduced will be more stable than previous cartels without private damage claims.

Our hypotheses suggest an overall ambiguous effect of private damage claims. On the one hand, there should be fewer cartels. On the other hand, existing and remaining cartels should be more stable. The overall balance in terms of cartel prevalence is ex ante not clear and we do not maintain a directed hypothesis here.

**Statement 5 (Cartel prevalence)** The overall effect of private damage claims on cartel prevalence is ambiguous.

As with cartel prevalence, we do not maintain a directed hypothesis about market prices (the measure for consumer welfare). Market prices (the lowest of the three ask prices) are affected by (at least) two channels. First, market prices may decrease because, according to hypothesis fewer cartels are formed with private enforcement, leading to more competitive prices. Second, any existing cartels would suffer less from leniency (hypothesis and last longer (hypothesis) and should therefore have higher market prices on average. The overall effect is ambiguous. Of course, we can look at the effect of PDC for cartelized markets only. But, even here, the effect is ex ante ambiguous. On the one hand, cartels under PDC may have colluded more successfully in the past (selection effect). On the other hand, cartel members could fear damage claims and therefore lower the prices.

**Statement 6 (Market prices)** The overall effect of private damage claims on market prices is ambiguous.

Our final hypothesis is about the impact of the different forms of communication. Existing experimental evidence (Cooper and Kühn, 2014; Fonseca and Normann, 2012) suggests cartels are more stable when subjects can communicate. It appears that open communication fosters trust between players. Also, subjects can communicate entire strategies rather than just price targets. Furthermore, chat communication can enhance the understanding of the mutual benefits
of collusion in their group. Brown Kruse and Schenk (2000) observe that only one group member
has to understand the profit-maximizing strategy and can use the chat to convince its group
members to comply.

**Hypothesis 7 (Impact of communication)** Compared to STRUC, the unrestricted communication in
CHAT increases cartel formation and stability.
4 Results

To analyze the impact of private damage claims, we foremost analyze the data within-subjects. That is, we compare the first 10 periods (NOPDC) to the subsequent 10 periods (PDC). We restrict the analysis to observations from periods 1 to 20 in order to exclude potential end-game effects. With the help of the reverse order control treatment, we then compare the data between subjects (both PDC and NOPDC data from periods 1 to 10). We use non-parametric tests like the Wilcoxon matched-pairs test (WMP) for the within-subject analysis and the Mann-Whitney-U test (MWU) for the between-subjects analysis.

We complement the non-parametric tests with linear regression models (ordinary least squares), often linear probability models, with and without time fixed effects. We run the estimations separately for each communication treatment. Due to the fixed group structure, we cluster standard errors at the group level. We bootstrap the standard errors with 1,000 replications. Statistical significance levels are indicated by asterisk, where + ($p < 0.15$), * ($p < 0.1$), ** ($p < 0.05$), *** ($p < 0.01$). We report two-sided $p$-values throughout.

An overview of the summary statistics of our main results is displayed in table 4. The exact values underlying figure 2 to 10 can be found in table 4. We will repeatedly refer to this table.

<table>
<thead>
<tr>
<th></th>
<th>STRUC</th>
<th>CHAT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOPDC</td>
<td>PDC</td>
</tr>
<tr>
<td>Propensity to collude</td>
<td>0.627 (0.058)</td>
<td>0.396 (0.046)</td>
</tr>
<tr>
<td>Share cartel</td>
<td>0.225 (0.083)</td>
<td>0.031 (0.031)</td>
</tr>
<tr>
<td>Share report</td>
<td>0.400 (0.102)</td>
<td>0.133 (0.166)</td>
</tr>
<tr>
<td>Cartel stability</td>
<td>1.000 (0.000)</td>
<td>2.167 (0.855)</td>
</tr>
<tr>
<td>Cartel prevalence</td>
<td>0.231 (0.080)</td>
<td>0.056 (0.044)</td>
</tr>
<tr>
<td>Market price</td>
<td>102.706 (2.619)</td>
<td>101.681 (2.122)</td>
</tr>
</tbody>
</table>

Table 4: Summary statistics of the results in treatments NOPDC–PDC (STRUC and CHAT); average results per treatment (standard deviations in parentheses).

---

With the WMP-Test, we match the NOPDC with the PDC observations of each individual, or group, in order to compare if their population mean ranks differ. In the MWU-Test we compare randomly selected individuals respectively groups for each treatment as independent observations.
4.1 Cartel formation

Hypothesis 1 states that cartel formation decreases as private damage claims are introduced. Consider the individual level first: how often do subjects press the *discuss price* button when they have the chance to do so? Without private damages, the average propensity to collude in STRUC (CHAT) is 62.7% (40.8%), see figure 2 and table 4. With PDC, the average propensity to collude decreases significantly (STRUC and CHAT: WMP, \( p – value = 0.0001 \)) to 40.8% (18.1%). For both communication treatments, the individual propensity to form a cartel declines by about 21–22 percentage points when PDC are possible. The estimation results of the linear probability model in table 5 are also consistent with hypothesis 1. We see that the dummy variable PDC is highly significant and economically substantial.

![Figure 2: The impact of PDC on the individual propensity to collude in STRUC (left) and CHAT.](image)

<table>
<thead>
<tr>
<th></th>
<th>(1) Collude</th>
<th>(2) Collude</th>
<th>(3) Collude</th>
<th>(4) Collude</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDC</td>
<td>-0.231***</td>
<td>-0.227***</td>
<td>-0.208***</td>
<td>-0.604***</td>
</tr>
<tr>
<td></td>
<td>(0.0374)</td>
<td>(0.0509)</td>
<td>(0.0497)</td>
<td>(0.0926)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.627***</td>
<td>0.408***</td>
<td>0.583***</td>
<td>0.729***</td>
</tr>
<tr>
<td></td>
<td>(0.0326)</td>
<td>(0.0620)</td>
<td>(0.0537)</td>
<td>(0.0648)</td>
</tr>
<tr>
<td>Time FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample STRUC</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sample CHAT</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>960</td>
<td>960</td>
<td>960</td>
<td>960</td>
</tr>
<tr>
<td>R²</td>
<td>0.054</td>
<td>0.062</td>
<td>0.064</td>
<td>0.112</td>
</tr>
</tbody>
</table>

Table 5: Individual decisions to communicate – linear regression (standard errors in parentheses).

Next, consider the market (or group) level. Here, we ask the question how often a cartel
is actually established. This is the case when all three group members press the *discuss price* button. Figure 3 shows the results. We observe that, with PDC, cartel formation is massively and significantly (STRUC and CHAT: *WMP*, \( p - value = 0.0001 \)) reduced. As above, this holds for both communication treatments, STRUC and CHAT. The regressions in table 6 confirm that the effect is significant.

![Figure 3: The impact of PDC on the number of cartels in STRUC (left) and CHAT.](image)

<table>
<thead>
<tr>
<th></th>
<th>(1) Collusion</th>
<th>(2) Collusion</th>
<th>(3) Collusion</th>
<th>(4) Collusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDC</td>
<td>-0.194***</td>
<td>-0.0750***</td>
<td>-0.125</td>
<td>-0.375***</td>
</tr>
<tr>
<td></td>
<td>(0.0390)</td>
<td>(0.0136)</td>
<td>(0.0817)</td>
<td>(0.116)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.225***</td>
<td>0.0938***</td>
<td>0.125</td>
<td>0.375***</td>
</tr>
<tr>
<td></td>
<td>(0.0396)</td>
<td>(0.0223)</td>
<td>(0.0817)</td>
<td>(0.116)</td>
</tr>
<tr>
<td>Time FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample STRUC</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sample CHAT</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>320</td>
<td>320</td>
<td>320</td>
<td>320</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.084</td>
<td>0.026</td>
<td>0.117</td>
<td>0.161</td>
</tr>
</tbody>
</table>

Table 6: Group decisions to communicate – linear regression (standard errors in parentheses).

As a control, we ran sessions with the reverse sequence PDC-NOPDC with structured communication, such that PDC were present in the first nine periods and were eliminated from period 10 onward. In the analysis of reverse order we compare the first 10 periods of the NOPDC-PDC sequence with the first 10 periods of PDC-NOPDC sequence. This allows us to additionally conduct the comparison NOPDC and PDC between subjects, thereby excluding order effects.\(^{22}\) Figure 4 shows that the possibility of PDC reduces cartel formation in STRUC both at the individual (a)

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\(^{22}\) Due to bankruptcy we exclude one group in the reverse-order treatment from our analysis.
and at the group (b) level. The reduction is statistically significant ((a) MWU, \( p - \text{value} = 0.0226 \) (b) MWU, \( p - \text{value} = 0.0169 \)).

Figure 4: Cartel formation in STRUC: between-subjects comparison with PDC data from treatment with reverse order (PDC-NOPDC).

**Result 1 (Cartel formation)** With PDC, there are significantly fewer attempts to form a cartel (individual level) and significantly fewer successfully formed cartels (group level).

Figures 2, 3, and 4 and table 4 seem to suggest that there is less cartel activity in CHAT. We will see below, however, that this is not the case. Subjects typically use the free chat to coordinate not activating the communication device in future periods. In other words, merely taking the decisions to form a cartel underestimates the degree of cartelization in CHAT where subjects tend to communicate only once at the very beginning.

### 4.2 Leniency applications and cartel stability

Hypotheses 2 to 4 are about leniency behavior and cartel stability which require that cartels are actually formed in the first place. In what follows, the analysis is conditional on a cartel existing.\(^{23}\)

\[^{23}\] Linear regressions, available upon request, yield the same result.

\[^{24}\] For the analysis of cartel stability, we exclude period 10. Subjects decide whether to report a cartel after private damage claims are introduced. Thus, period 10 belongs to neither PDC nor NOPDC. For the analysis of variables other than stability this problem does not exist because decisions about cartel formation or price setting were made before the introduction of private damage claims.
Leniency applications

Hypothesis 2 suggests that there will be fewer leniency applications with PDC. We first analyze the share of individual reporting decisions, that is, we consider the sum of subjects revealing the cartel over all periods that any cartel exists. Figure 5 shows that PDC significantly decreases the share of individual leniency applicants (STRUC: WMP, $p-value = 0.0001$; CHAT: WMP, $p-value = 0.014$). In the case of STRUC, the effect is economically substantial.

![Figure 5: The impact of PDC on the individual reporting decision in STRUC (left) and CHAT.](image)

Table 7 reports a linear regression of PDC on the individual decision to report a cartel. In STRUC as well as in CHAT the number of cartel members applying for leniency decreases as PDC occur. However, this effect is only significant in the STRUC regressions without time fixed effects. The between-subjects comparison indicates that the share of leniency applications does not differ between NOPDC and PDC. Our interpretation is that subjects may have had too little time–only one repetition of the supergame–to learn the impact of private damages and are thus not more disinclined to report than in NOPDC.
Table 7: Individual decision to report a cartel – linear regression (standard errors in parentheses).

Result 2 (Leniency rate) Comparing NOPDC and PDC within subjects, there are fewer leniency applications with PDC.

Cartel stability

Hypothesis 3 is that cartels become more stable as we introduce private damage claims. In order to analyze cartel stability, we compare the mean number of periods when a cartel was stable in NOPDC and PDC, conditional on cartel existence in both treatments. We do this comparison for the first nine periods NOPDC and period 11 to 19 PDC. Cartels that are formed and uncovered in the same period count as stable for one period. Descriptive results show that the mean of cartel stability roughly doubles in both treatments as private damage claims are introduced (see figure 6).

A cartel is stable until it is reported or detected by the authority. Of course, cartels may continue to set a high price after being reported or detected. For such pricing behavior, they cannot be penalized.

We cannot make any statement about significance because there are too few groups, which have cartels in NOPDC and PDC, which is in line with hypothesis 1. For the same reason, we cannot conduct survival estimates.
Result 3 (Cartel stability) With PDC, cartels are more stable.

In connection with hypothesis 3, we noted above that private damages have an enforcing effect on stability over time because damages cumulate. Cartels should, accordingly, be more strongly discouraged from reporting the longer they exist. Two groups in our CHAT treatment seem to have recognized this and followed an interesting strategy. They reported the cartel immediately when it was formed, but continued to charge the maximum price without further agreements and communication. See groups 4 and 8 in figure 12 in Appendix A.1.

Cartel stability when introducing PDC in period 10

We introduce private damage claims as an unexpected change of rules after the second stage in round 10. That is, subjects are exposed to PDC after they decide whether to collude and after they set their prices, but before they get the chance to report the cartel. Due to this design feature we can analyze how behavior changes in groups that are already involved in a cartel when PDC are introduced in period 10 (groups that form a cartel before or in period 10 and that last at least until stage 3, the reporting stage of period 10).

In STRUC, four of the 16 groups collude in period 10, and two of them behave consistently
with hypothesis 3. In NOPDC, cartels break down immediately because of leniency reports. One of these groups had three of the aforementioned one-period cartels. They experience long stability, however, only after PDC are introduced. The other groups immediately collapse due to leniency even though PDC were introduced in that period. In CHAT, we have three groups where a cartel exists in period 10. In two of these three groups the cartel still remains stable although PDC were introduced.

**Result 4 (Stability of existing cartels)** The implementation of private damage claims has a stabilizing effect on cartels that formed before the implementation.

Results 2 to 4 summarize effects that are, even though sometimes economically substantial, statistically insignificant. As mentioned (and unexpectedly), we have only few groups that establish cartels with private damages and an accordingly low statistical power.

### 4.3 Cartel prevalence

We finally look at cartel prevalence, defined as the percentage of periods where a stable cartel existed. Result 1 on the one hand, and results 2 to 4 on the other, suggest an overall ambiguous effect of PDC on cartel prevalence: fewer cartels are formed but these remaining cartels are more stable. (Due to this ex-ante ambiguity, statement 5 in section 3 is not a directed hypothesis about prevalence.) What is the overall balance?

Figure 7 shows the results. For communication treatment STRUC, we find cartels present in 23.13% (NOPDC) and 5.63% (PDC) of all groups over all periods. In CHAT, we see 32.5% (NOPDC) and 15.63% (PDC). That is, there is a strong and significant reduction in cartels due to PDC in both communication treatments (STRUC and CHAT: WMP, \( p - value = 0.0001 \)). The linear regressions in table 8 confirm this.
To control for order effects, we again analyze the treatment with the reverse order, PDC-NOPDC. When the PDC treatment is run in the first 10 periods, the results are very similar. The between-subjects test is significant (MWU, \( p - \text{value} = 0.0190 \)).

**Result 5 Cartel prevalence** There are fewer cartelized periods with PDC.

---

**Table 8: Cartel Prevalence – linear regression (standard errors in parentheses).**

<table>
<thead>
<tr>
<th></th>
<th>(1) Prevalence</th>
<th>(2) Prevalence</th>
<th>(3) Prevalence</th>
<th>(4) Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDC</td>
<td>-0.175***</td>
<td>-0.169***</td>
<td>-0.0625</td>
<td>-0.313***</td>
</tr>
<tr>
<td></td>
<td>(0.0473)</td>
<td>(0.0763)</td>
<td>(0.106)</td>
<td>(0.111)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.231***</td>
<td>0.325***</td>
<td>0.125</td>
<td>0.375***</td>
</tr>
<tr>
<td></td>
<td>(0.0422)</td>
<td>(0.0915)</td>
<td>(0.0817)</td>
<td>(0.116)</td>
</tr>
<tr>
<td>Time FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample STRUC</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sample CHAT</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>320</td>
<td>320</td>
<td>320</td>
<td>320</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.062</td>
<td>0.039</td>
<td>0.096</td>
<td>0.067</td>
</tr>
</tbody>
</table>

---

**Figure 7:** The impact of PDC on cartel prevalence in STRUC (left) and CHAT.

**Figure 8:** Cartel prevalence in STRUC: between-subjects comparison with PDC data from treatment with reverse order (PDC-NOPDC).
4.4 Prices and Consumer Welfare

To complete the analysis of cartel behavior, we examine the market price. This is the lowest price of the three individually entered prices in stage 2). The market price is the relevant factor for consumer welfare (see statement 6).

<table>
<thead>
<tr>
<th></th>
<th>STRUC</th>
<th></th>
<th>CHAT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOPDC</td>
<td>PDC</td>
<td>NOPDC</td>
<td>PDC</td>
</tr>
<tr>
<td>Market price non-cartels</td>
<td>101.885 (1.674)</td>
<td>101.600 (2.090)</td>
<td>104.102 (3.586)</td>
<td>106.470 (4.250)</td>
</tr>
<tr>
<td>Market price cartels</td>
<td>105.342 (2.193)</td>
<td>102.900 (0.986)</td>
<td>109.673 (1.108)</td>
<td>109.902 (0.049)</td>
</tr>
<tr>
<td>Market price all markets</td>
<td>102.706 (2.619)</td>
<td>101.681 (2.122)</td>
<td>105.930 (4.345)</td>
<td>107.038 (4.195)</td>
</tr>
</tbody>
</table>

Table 9: Market price – averages per treatment (standard deviations in parenthesis).

We compare the average market price without and with private damage claims across the CHAT and STRUC treatments as shown in table 9 and figure 9. We see that PDC reduce prices in STRUC, but CHAT shows the opposite pattern. This concerns the overall average (“all markets”) as well as the market prices of cartelized and non-cartelized markets. The differences are statistically significant in both treatments (STRUC: WMP, \( p \text{-value} = 0.001 \); CHAT: WMP, \( p \text{-value} = 0.0043 \)).

As a control, we conduct the between-subjects comparison based on PDC data from the treatment with the reversed order PDC-NOPDC. Figure 10 verifies the lower overall market prices in PDC with STRUC communication (WMU, \( p \text{-value} = 0.0001 \)).

![Figure 9: The impact of PDC on market prices in STRUC and CHAT.](image)

27 For an analysis of individual ask prices see Appendix A.3.
Table 10 reports the results from regression analysis on the dependent variable *MarketPrice*. The results confirm previous observations that market prices significantly decrease in the subsample of STRUC if private damage claims are introduced (table 10 column 1). They significantly increase in CHAT.

<table>
<thead>
<tr>
<th></th>
<th>(1) MarketPrice</th>
<th>(2) MarketPrice</th>
<th>(3) MarketPrice</th>
<th>(4) MarketPrice</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDC</td>
<td>-1.025**</td>
<td>1.125*</td>
<td>-1.563***</td>
<td>1.750+</td>
</tr>
<tr>
<td></td>
<td>(0.256)</td>
<td>(0.588)</td>
<td>(0.468)</td>
<td>(1.174)</td>
</tr>
<tr>
<td>Constant</td>
<td>102.7***</td>
<td>105.9***</td>
<td>102.8***</td>
<td>104.5***</td>
</tr>
<tr>
<td></td>
<td>(0.482)</td>
<td>(0.957)</td>
<td>(0.415)</td>
<td>(0.981)</td>
</tr>
<tr>
<td>TIME FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample STRUC</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sample CHAT</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>960</td>
<td>960</td>
<td>960</td>
<td>960</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.044</td>
<td>0.017</td>
<td>0.060</td>
<td>0.031</td>
</tr>
</tbody>
</table>

Table 10: Market price – Linear Regression (Standard errors in parentheses).

**Result 6 (Market prices)** With STRUC communication, PDC significantly decrease average ask and market prices and therefore increase consumer surplus. With CHAT communication, PDC significantly increase ask and market prices (and consumer surplus).

What could be the intuition for the contradicting effects in CHAT and STRUC? Recall that statement 6 is not a directed hypothesis in the first place. Prices could be lower when private damage claims apply because there are fewer cartels and remaining cartels might be reluctant to set higher prices because of the risk of paying damage claims. This is what might be going on in STRUC. We suggest that the counter-intuitive result in CHAT is triggered by a hysteresis effect. In CHAT, subjects have the chance to coordinate their behavior even beyond a cartel breakdown.
Since CHAT allows for threats, cartels are more stable and cartel members stick to the cartel price even after cartels break down. According to our definition, cartels that break down represent a competitive market although the market price is equal to the former collusive price. The number of periods covering this behavior is higher in the private damage claim treatment. Therefore, we can conclude that hysteresis explains the higher competitive and overall market prices in CHAT as well as the increasing prices with the treatment of private damage claims. Due to hysteresis the competitive prices are biased upwards in the PDC and CHAT treatment.

4.5 Structured vs. chat communication

Our experimental design enables us to analyze not only the effect of private damage claims but also the impact of different types of communication designs on cartel formation and stability. As expected by hypothesis [7], we see higher stability in CHAT compared to STRUC (figure [6]). This is also emphasized by the result that infringers apply less often for leniency, thus cartel stability increases in CHAT.

Our results concerning cartel prevalence are in line with the literature (e.g., Fonseca and Normann, 2012; Fonseca et al., 2018). Communication facilitates collusion (see e.g., Cooper et al., 1992; Cooper and Kühn, 2014; Waichman et al., 2014) such that cartel prevalence is higher in CHAT than in STRUC (figure [7], independent of the PDC treatment (NOPDC: WMU, $p-value = 0.0617$; PDC: WMU, $p-value = 0.0038$).

Interestingly, the share of propensity to collude is significantly higher in STRUC compared to CHAT (figure [2], with and without private enforcement (NOPDC and PDC: WMU, $p-value = 0.0001$). This is also expressed in a lower share of cartelized markets in CHAT compared to STRUC (figure [3], (NOPDC: WMU, $p-value = 0.0014$; PDC: WMU, $p-value = 0.4746$). The lower fraction of deciding in favor of price discussion in the CHAT design is explained by agreements to stick to the collusive price after cartel breakdown. Subjects in CHAT are able to agree on setting the same price as under collusion after they have been detected and without renewing their price discussion. This can be seen from the following excerpts of communication (translated from the
By analyzing prices, we also find a significant difference across the communication treatments. Market prices are higher in CHAT compared to STRUC across all types of markets and independent of private damage claims taking place or not (table 9) (NOPDC and PDC: WMU, $p - \text{value} = 0.0001$). The higher prices in CHAT can be explained by a hysteresis effect that keeps prices high even after cartels break down. Additionally, we see much less variation in collusive market prices in CHAT compared to STRUC (table 9) (NOPDC and PDC: WMU, $p - \text{value} = 0.0001$).

To conclude, CHAT allows subjects to better coordinate their practice compared to STRUC, which leads to higher cartel prevalence, an increased stability, and hysteresis of cartel prices.

**Result 7 (CHAT vs. STRUC)** In CHAT cartel prevalence is significantly higher although propensity to collude and share of cartelized markets are lower than in STRUC. Cartel stability is higher in CHAT.

### 5 Conclusion

Private damage claims, introduced into European law through Directive 2014/104/EU (European Commission [2014]), are controversially discussed. This is especially the case regarding the well established and successful tool of leniency application. A leniency applicant’s fines are waived or reduced, but their damage claim payments are, not completely reduced then certainly capped to a certain degree. Private enforcement may therefore decrease incentives to apply for leniency and results in more stable cartels.
Our work contributes to the existing literature in two ways. The main goal of our paper is to provide a first quantification of the trade-off between leniency and private damage claims. Our design extends the literature on leniency experiments (Apesteguia et al., 2007; Bigoni et al., 2012; Dijkstra et al., 2018; Hinloopen and Soetevent, 2008). We analyze a repeated cartel game where firms can discuss prices and may later apply for leniency. We extend the literature by allowing for private damages when a cartel is uncovered. Our treatments further vary the form of communication by analyzing structured price announcements vs. unrestricted chat.

The results are as follows. First, we show that the propensity of cartel formation decreases as private enforcement is introduced. Second, when private damage claims exist, the number of leniency applications is reduced. Third, the implementation of damage claims has a stabilizing effect on cartels in total and on cartels that were formed prior to the implementation. Fourth and perhaps most importantly, overall there are fewer cartels with private damage claims. Fifth, we find ambiguous results regarding consumer surplus depending on the type of communication. Private enforcement decreases prices in a structured communication treatment yielding a rise in consumer surplus, whereas prices tend to increase when subjects are not restricted in communication implying a decrease in consumer welfare. Sixth, chat-type communication not only lowers the incentives for leniency applications and increases cartel formation, it also increases cartel stability and market prices.

Since overall cartel prevalence is lower with private damages, our main take on the new instrument is positive: private damages have a beneficial impact. Nevertheless, the fact that they involve a negative effect on leniency and cartel stability suggests a careful reconsideration of the tool of private enforcement. Better protection of whistleblowers is one option. Kersting (2014) proposes an approach in which the leniency applicant can obtain full compensation for damage payments from its co-infringers to remove the tension between private and public enforcement. A recent experiment by Mechtenberg et al. (2017) analyzes whistleblowing in the context of corporate fraud. They find that an increase in reports can be triggered by better whistleblower protection.

One disclaimer is that we only analyze one set of parameters for the damages. Different
magnitudes and likelihoods of the damages may lead to different results. Further experiments along this line are promising for future research. Another aspect of private enforcement that is not captured in our experimental design is that buyers have higher incentives to uncover cartels themselves when damage claims are possible. This is a likewise interesting question for future research.
References


A Appendix

A.1 Groups dynamics over time

Figures 11 and 12 give an overview of the cartelizing behavior of each group in the STRUC and CHAT. The blue line plots the binary group dependent variable \textit{collusion}, which becomes one when a group forms a cartel and zero when at least one group member decides against cartelization. The red line shows the course of the market price. The dots mark the reason for a cartel breakdown: while the black dot indicates a breakdown because of leniency application by at least one group member, the green dot characterizes a breakdown due to discovery by a cartel authority. Consequently, a cartel is stable for more than one period if the blue line moves along its upper boundary without being interrupted by any dots.

Figure 11: Collusive activity and marketprice by group for the treatment in STRUC.
Figure 12: Collusive activity and market price by group in CHAT.

A.2 Deviations from agreed price

Figure 13 and 14 give an overview of the agreed-upon price during the communication stage and the (independently set) ask price. If subjects decide to discuss prices and agree on a single price, this is displayed by the blue line. In STRUC, price discussion can result in an interval of agreed prices. Figure 13 indicates this by the upper and lower bound of agreed prices (see e.g., group 9).

In figure 14, we can observe more stable price setting following the agreed price even in periods without a cartelized market in CHAT. Figure 13 which considers STRUC, provides an indication of lack of trust in collusive markets (this does not apply to group 16). For example, although group 2 in STRUC agrees on setting a price of 110, all three subjects never simultaneously set the agreed price as their individual ask price, instead they continuously undercut the agreed price. In contrast to that, in figure 14 group 7 gives a perfect example of subjects sticking to the agreed price although price discussion has not taken place in this period. This behavior emphasizes our explanation of hysteresis regarding subjects not communicating but setting high prices.
Figure 13: Agreed price and set price by subject in STRUC.
Note: Groups that do not discuss prices or could not agree on an interval other than 101 to 110 are excluded.
A.3 Ask Prices

In this section we investigate the ask (or offer) price. The ask price is the price firms individually demand in stage 2. Figure 15 (and the top line in table 11) illustrate the overall change in ask prices. We see the same pattern as in the above analysis of overall market prices. It shows for treatment STRUC an average overall ask price of 103.67 in NOPDC and 101.94 in PDC. This is statistically significantly different (STRUC: WMP, \( p \)-value = 0.0001). The difference in ask prices of NOPDC and PDC in CHAT is not statistically significant (CHAT: WMP, \( p \)-value = 0.3370).

<table>
<thead>
<tr>
<th></th>
<th>STRUC</th>
<th></th>
<th>CHAT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NOPDC</td>
<td>PDC</td>
<td>NOPDC</td>
<td>PDC</td>
</tr>
<tr>
<td>Ask price all markets</td>
<td>103.669 (3.237)</td>
<td>101.937 (2.424)</td>
<td>106.277 (4.219)</td>
<td>107.110 (4.170)</td>
</tr>
<tr>
<td>Ask price non-cartels</td>
<td>102.680 (2.607)</td>
<td>101.784 (2.318)</td>
<td>104.599 (4.127)</td>
<td>106.552 (4.341)</td>
</tr>
<tr>
<td>Ask price cartels</td>
<td>106.842 (3.024)</td>
<td>104.233 (2.837)</td>
<td>109.763 (1.187)</td>
<td>110.000 (0.000)</td>
</tr>
</tbody>
</table>

Table 11: Ask price - averages per treatment (standard deviations in parenthesis).
In Table 12 we estimate an ordinary least squares (OLS) model with the dependent variable *Askprice* (all markets). The results show that PDC have a negative effect on ask prices in the subsample of STRUC (Table 12 column 1), whereas PDC have a positive impact on ask prices in CHAT on a 15 percent level (Table 12 column 2).

<table>
<thead>
<tr>
<th></th>
<th>(1) Price</th>
<th>(2) Price</th>
<th>(3) Price</th>
<th>(4) Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDC</td>
<td>-1.731**</td>
<td>0.833+</td>
<td>-3.542***</td>
<td>0.458</td>
</tr>
<tr>
<td></td>
<td>(0.317)</td>
<td>(0.573)</td>
<td>(0.460)</td>
<td>(1.046)</td>
</tr>
<tr>
<td>Constant</td>
<td>103.7***</td>
<td>106.3***</td>
<td>105.0***</td>
<td>106.1***</td>
</tr>
<tr>
<td></td>
<td>(0.492)</td>
<td>(0.916)</td>
<td>(0.417)</td>
<td>(0.748)</td>
</tr>
<tr>
<td>TIME FE</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sample STRUC</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Sample CHAT</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>960</td>
<td>960</td>
<td>960</td>
<td>960</td>
</tr>
<tr>
<td>R²</td>
<td>0.084</td>
<td>0.010</td>
<td>0.116</td>
<td>0.014</td>
</tr>
</tbody>
</table>

Table 12: Ask price – linear Regression (standard errors in parentheses).

Figure 16 shows the analysis of the sequence of reverse order PDC-NOPDC in STRUC. The robustness check confirms the significantly lower ask prices in PDC (WMU, *p*-value = 0.0001).
A.4 Instructions

Instructions for the experiment with structured communication:

Welcome to our experiment. Please read these instructions carefully. Please do not talk to your neighbor and be quiet throughout the experiment. If you have any questions, please raise your hand. We will come to your place and answer your question in private. In this experiment, you have to take decisions repeatedly. In the end, you can earn money. How much you earn depends on your decisions and the decisions of two other participants who are randomly assigned to you. At the end of the experiment, you will receive your earnings in cash. All participants receive (and are reading) the same instructions. You remain completely anonymous for us and for the other participants. We do not store any data connected with your name.

Overview:

The experiment lasts for at least 20 periods, each period consists of seven steps. These steps are the same in each period. Below you will find an overview of the experiment as well as an explanation of all seven steps of each period.

At the beginning of the experiment, all participants will be randomly distributed into groups of three. The group composition does not change during the experiment. Group members remain anonymous. During the experiment you will have no contact to participants of the experiment outside your group.

You can collect points in any period of the experiment. At the end of the experiment these points will be converted into euros, where: 1 point = 0.3 euros. At the beginning of the experiment you will receive a starting capital of 15 points. At the end of each period, all the points collected during that period will be credited to your account. If you score a negative number of points in a period, this number of points will be deducted from your starting capital.

Like the other two group members, you are a supplier of the same good in a market. In each period you must choose a price for the good. This price must be one of the following: 101, 102, 103, 104, 105, 106, 107, 108, 109 or 110. You and the other two group members choose your price at the same time.

You only earn points if your price is the lowest of the three prices. Your profit will then be equal to your price minus the cost of 100. However, if one or both other group members have chosen the same lowest price, you must share the profit with them.

It is possible to discuss the price you want to set. Price discussion is only possible if all group members agree to discuss the prices. If there has been a communication about prices, you might
risk that points will be deducted later, either through reports from the group members (step 5) or a random move (step 6).

Each period has seven steps. Below is a more detailed explanation of each step.

In step 1 of each period the following question is asked: "Do you want to discuss the price with your group members? To answer this question, press the “DISCUSS PRICE” or “DO NOT DISCUSS PRICE” button. The other two group members will make the same decision at the same time.

Only if all group members press the button “DISCUSS PRICE,” a communication window opens and step 2 (the communication phase) will begin. If one or more group members click on the button “DO NOT DISCUSS PRICE” there will be no communication. In this case step 2 (the communication phase) will be skipped and you will proceed to step 3 (the pricing phase).

If a communication has taken place, there is a risk that points will be subtracted from your account in step 5 or 6. See below.

Step 2: Communication. After opening the communication window, you can talk about the price as explained in the following: You can choose a minimum price and a maximum price that is acceptable to you from the following price range: 101, 102, 103, 104, 105, 106, 107, 108, 109, 110. If only one price is acceptable to you, choose the same value for the minimum price and the maximum price.

If all group members have chosen their minimum price and maximum price, each group member is informed about the overlap of the three price ranges. If the overlap consists of one price, this is the agreed price and step 2 is completed.

If there is no overlap, this procedure is repeated until the overlap consists of only one price or 60 seconds have passed. If no price agreement is reached after 60 seconds, the discussion screen closes. In this case, the last overlap is the agreed price interval.

Communication about anything other than the price is not possible.28

Step 3: Pricing phase. You chose your market price. You are again restricted to prices from 101 to 110. The other two group members make the same decision at the same time. Results of any communication is not binding.

Step 4: Market price. In step 4, you learn the market price that has been set in your group.

28The instructions for the OPEN treatment differ from the CLOSED-instructions with respect to step 2. The OPEN-instructions read the following: After opening the communication window, you can discuss the price with your group members by entering a text in the communication field and pressing Enter. During the communication you remain anonymous. The communication window closes after 60 seconds. After the communication window has closed, communication in the current period is no longer possible.
The market price corresponds to the lowest entered price in step 3 in your group. You only earn points if your price is the lowest of the three prices.

The turnover corresponds to the market price without a reduction of costs (100):

- If your price is the lowest price and no other group member has chosen the same price: Turnover = market price.
- If the price you chose is the lowest price and one other group member has set the same price: Turnover = market price / 2.
- If the price you have chosen is the lowest and the other two group members have set the same price: Turnover = market price / 3.
- If your price is not the lowest price: Turnover = 0.

Your profit corresponds to the market price after deduction of costs (100):

- If your price is the lowest and no other group member has chosen the same price: Profit = market price - 100, i.e., you alone get the profit.
- If the price you chose is the lowest and one other group member has set the same price: Profit = (market price - 100) / 2, i.e., you both share the profit.
- If the price you chose is the lowest and the other two group members have set the same price: Profit = (market price - 100) / 3, i.e., you share the profit with the two other group members.
- If your price is not the lowest: Profit = 0 points.

The experiment continues with step 5 (reporting decision) when a communication about prices in step 1 has taken place. If not all group members have agreed to a communication in step 1, the experiment will continue with step 7 (end of period).

**Step 5: Point deduction through reporting.** If communication has taken place, you must decide in this step whether you want to report the communication. You can report price discussion by pressing the "REPORT" button. If you do not want to report, press the "DO NOT REPORT" button. The other group members must take the same decision at the same time. Reporting always costs one point.

Step 5 only takes place if (i) there was a communication in the current period or (ii) there was a communication in one or more of the previous periods and since then none of the group members pressed the REPORT button and no point deduction by a random move (step 6) has taken place.

After a communication has been reported by you or one of your group members, the ability to report in future periods will expire until there communication about prices is renewed.

In the event of one or more group members reporting the communication, each group member
will receive a point deduction of the following amount: The point deduction generally is 10% of your profit in that period.

If you report the communication, your point deduction can be prevented or reduced in the following:

- You will not receive a point deduction if you are the first to press the REPORT button.
- If you are the second to press the REPORT button, your point deduction is cut by half.
- If you are the third to press the REPORT button, your point deduction will not be reduced.

The experiment will continue with step 6 (Random Points) if all group members have pressed the “DO NOT REPORT” button. If one or more group members have reported the communication, the experiment continues to step 7.

**Step 6: Points deducted by random draw.** In this step, a random draw decides whether points will be deducted from you and your group members’ account. The probability of a point deduction is 15%; with 85% probability no points will be deducted.

Step 6 will only take place if (i) there has been communication about prices in the current period and there has been no random point deduction, or (ii) there has been communication in one or more of the previous periods and since then none of the group members pressed the REPORT button and no random point deduction has taken place so far.

After the random draw you will be informed whether you and your group members received any point deductions in that period.

If there is a point deduction by chance, the point deduction will be 10% of your current period revenue.

If the random draw results in point deduction, there will be no further point deductions again until communication is renewed and (i) and (ii) are fulfilled (see above).

**Step 7: Period End.** In this step you will receive the information of your accumulated points from the current period and from previous periods. The total score (the sum of the points from all periods played) is also displayed. Your accumulated points in the current period correspond to your profit after possible point deductions:

\[
\text{Accumulated points in a period} = \text{profit} - \text{possible deduction of points}
\]

The points are calculated in the same way for each group member. Your points will be credited to your point account after each period. If there has been a deduction of points, the reason for the deduction of points (report or random draw) is shown for all group members.

Next step: Sudden change of rules. In the course of the experiments, there may be a rule change. You will be informed of such a change at the appropriate point.
New period: You play at least 20 periods. From period 20 the experiment ends at the end of each period with 20% probability. With a probability of 80% the next period will start with step 1.

**Instructions for the change of rules in period 10**

**Introduction of step 8:** In addition to the point deduction in step 6, there is now a 95% probability that there will be another point deduction if:

1. you or some other of your group members have reported the communication, or
2. in step 6, chance decides that you and your group members will receive a deduction of points.

This point deduction is in addition to the point deduction from step 6 which covers 10% of your current period revenue. The additional point deduction for each group member is 20% of the difference between the group’s market price and 101 (the lowest price to choose). The point deduction is added up over all periods in which you communicated but the communication was not discovered or reported.
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