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

Olivia Bodnar Melinda Fremerey Hans-Theo Normann Jannika Schad
Duesseldorf Institute for Competition Economics (DICE)

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Abstract

Recently, private damage claims in cartel cases have gained attention and triggered a debate about potentially negative effects they may have on leniency, hitherto a prime tool to uncover cartels. Private damage claim actions can lead to a trade off between public and private enforcement and harm the attractiveness of leniency programs because whistleblowers only obtain no or only restricted protection against third-party damage claims. This may actually stabilize cartels. We run a repeated homogeneous-good Bertrand triopoly experiment to study this trade off. Firms can choose whether to join a cartel and may apply for leniency afterwards. Our design extends existing leniency experiments by adding a stage with possible private damages after a cartel has been uncovered (either through a whistleblower or by the cartel authority). We further investigate two communication formats. We compare unrestricted chat to the structured announcements (of “acceptable” prices or price ranges) the literature has focussed on. We find that the implementation of private damage claims decreases cartel formation but makes cartels more stable. The impact on consumer welfare depends on the form of communication.

Keywords: Private damage claims, cartel stability, laboratory experiment, leniency
JEL classification numbers: C90, L41, L44

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†Contact details all authors: Heinrich-Heine University, DICE, University Street 1, 40225 Duesseldorf, Germany; email: [surname]@dice.hhu.de.
1 Introduction

European cartel authorities can look back at successful years of cartel detection largely driven by
the introduction of leniency programs. Leniency policy offers companies involved in a cartel
who self-report either total immunity from fines or a reduction of fines, which the Commission
would have otherwise imposed on them. As theoretical, empirical (Klein, 2010; Miller, 2009) as
well as experimental work shows, leniency policy has a deterrent effect on cartel formation and it
destabilizes the operation of existing cartels as it yields distrust among cartel members (see, for
example, Bigoni, Harrington, Chang, and Spagnolo, 2012; Harrington and Chang, 2009; Spagnolo,
2003).

While antitrust leniency programs are viewed as an important public cartel enforcement
tool, private enforcement in Europe has only recently gained attention. In its 2005 Green Paper
(European Commission, 2005), the European Commission started to consider private enforcement
in individual member states and in November 2014 it was signed into law. The 2014 guideline on
antitrust damages actions (European Commission, 2014) is going to be fully implemented into
national law for all EU member states.

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. Already, Becker (1968) argued that increased sanctions, as
it would be the case with private damage suits, decrease the number of cartels. More recently,
Chowdhury and Wandschneider (2018) provide a detailed analysis in which they account for the
deterrent effect of penalties for cartels.

There are, however, growing concerns about negative effects of private enforcement. Especially,
the detrimental impact that compensation payments for damaged parties have on the attractiveness
of leniency programs are discussed. Whereas penalties are waived or reduced for cooperating
leniency applicants, leniency programs give only restricted protection against third party damage
claims. 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 regards to private damage
claims, the European legislation restricts the applicants’ liability to the harm caused to their own
direct and indirect purchasers. In any event, applicants remain fully liable when non applicants

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1 Examples for leniency application in large EU cartel cases: MAN as leniency applicant in truck cartel (1997–2011),
Barclays and UBS as applicants in Libor-Cartel (2005–2008 (EIRD) and 2007–2010 (YIRD)), Chunghwa as leniency applicant

2 Under European policy first applicants are eligible to full immunity, while second applicants who “provide significant
added value” (European Commission, 2006, Rn(26)) benefit from reductions of 30 to 50% (European Commission, 2006,
Rn(8), Rn(26)).

3 In addition, Knight and Claire (2018) argue that 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).
are not able to entirely compensate the injured parties (European Commission, 2014, Rn(38)).

The literature appears to largely acknowledge this trade off between private damages claims and public leniency programs. Canenbly and Steinworth (2011); Cauffman and Philipsen (2014); Kirst and van den Bergh (2016); Knight and de Weert (2015); Migani (2014); Wils (2003, 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. For example, Deutsche Bahn sued Lufthansa for 1.76 billion euros of damage in December 2014 right after Lufthansa applied for leniency in the airline-cargo cartel case (Kiani-Kreß and Schlesiger, 2014). This raises the question whether applying for leniency remains attractive after the introduction of private damage claims.

In the end, it seems an empirical question whether private damage claims raise or lower the deterring 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 empirical assessment of the introduction of private enforcement.

We propose the 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. Bigoni et al. (2012) 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 to analyze effects of cartel stability ceteris paribus.

We build on—and extend—established experimental literature on the effects of leniency programs (Apesteguia et al., 2007; Bigoni et al., 2012; Hinloopen and Soetevent, 2008). This literature has, to the best of our knowledge, not studied the effect of private damage claims on leniency programs. Apesteguia et al. (2007) 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 to decrease cartel formation and leads to significantly lower market prices. Bigoni et al. (2012) and Hinloopen and Soetevent (2008) analyze the repeated game with Bertrand duopolies and triopolies, respectively. The main result of this literature is that an introduction of leniency leads to a reduction in cartel formation.

A second dimension along which we extend the literature is that we allow for free chat-like chat-like

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See Miller (2009) and Harrington and Chang (2009) for empirical identifications of policy effects on the number of detected cartels or cartel duration.
communication between participants (Dijkstra et al., 2018). Some of existing leniency 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). (Apesteguia et al., 2007; Dijkstra et al., 2018) combine leniency experiments with chat communication. In the context of cartels, chat and structured communication seems plausible, however to best of our knowledge there is no comparison of structured and chat communication in the context of leniency experiments. In general cheap talk is recognized as an important tool for the coordination of cooperative outcomes (Blume and Ortmann, 2007; Camera et al., 2011; Cooper et al., 1992) in experiments. In the field of antitrust, experiments identify this kind of chat as a powerful device to foster 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.

Our experiment is designed to analyze the effects of private damage claims on leniency, cartel formation and cartel stability. We have two main research questions. First, do we observe fewer cartels after the introduction of private damage claims? And, second, can we observe a decreasing rate of leniency applications ex-post? Our experimental design is largely based on 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. Thereby, we focus on the case relevant in the field where, to begin with, no private damages exist but are later introduced as a policy regime change (within-subjects design).

Our results are as follows. We show that cartel formation at the individual and the group level is significantly lower with private damage claims. When private damage claims apply leniency application rates are lower and therefore, cartels are more stable. Cartel prevalence demonstrates that in total there are fewer cartel with private enforcement. 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 increase with private enforcement suggesting a negative effect of private damage claims on consumer welfare.

The article is organized as follows: The subsequent section describes the experimental design and explains the treatments in detail. Section 3 presents our hypothesis which are the basis for our further analysis 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 cartel; unreported cartels may be detected by 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 a cartel is established and a communication window opens. Depending on the treatment, firms either have access to structured or free chat communication (see below).

Stage 2. Firms simultaneously and independently choose prices from the set \( \{101, ..., 110\} \). The lowest price among the three ask prices 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:

\[
\pi_i = \begin{cases} 
\frac{p_i - 100}{n} & \text{if } p = p \\
0 & \text{if } p > p 
\end{cases}
\]
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. There is a “race to report”: the first leniency applicant gets a 100% fine reduction and the second applicant gets 50%; the third applicant receives no reduction. If no participant reports the cartel, it may still be detected by the authority, namely with a probability of 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 equal to 10% of the current period revenue, less the leniency reductions.\(^5\)

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 95% probability.\(^6\) If the private enforcement case is won in favor of the injured party, the cartel has to compensate 60% of the total damage.\(^7\) 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:

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

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

\[
\frac{1}{3} \cdot (110 - 101) \cdot 0.6 = 1.8.
\]

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 not only allows to observe

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5 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).

6 If damage claims are brought to court, the probability that a case is won is presumed very relatively high because one goal of Directive 2014/104/EU (European Commission, 2014) on antitrust damages actions is to make it easier for injured parties to get evidence such that the suing party or even third parties can ask for disclosure of categories of evidence (European Commission, 2015). A large share of private damage claims are also settled out of court. According to Bourjade et al. (2009) most of the cases that are settled out of court take place when a firm is guilty.

7 For two reasons it is reasonable to assume that not the total damage is compensated. First, not all buyers will claim damage 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. This argument of passing-on can serve as a strategy of defense of the cartel members against a claim for damages (European Commission, 2014, Rn(39)).
cartels that are formed after the implementation of the new rule, but also of cartels that were set up before the introduction of the PDC rule (such that the new PDC come unexpectedly for existing cartels).

Each experimental session consists of at least 20 rounds. From period 20 onwards, the session ends with a probability of 20%. Such random termination rule is suitable to avoid end-game effects [Normann and Wallace 2012]. As Table 1 shows, subjects play nine periods of NPDC. In period 10, the rules of the game change as we introduce private damage claims, after stage 2 (see Table 1). From period 11 on, they play PDC for the rest of the experiment. The instructions 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.

<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</td>
<td>PDC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PDC after stage 2</td>
<td></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></td>
</tr>
</tbody>
</table>

Table 1: 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.

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 on 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. Since we have a strong motivation for conducting NOPDC and PDC within subjects, plain reasons of practicability made us decide to compare the communication variants between subjects. It just seems too complicated to force subjects to do four different treatments.

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, \ldots, 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 process lasts until either the subjects (non-bindingly) agree on a common price or after 60 seconds have passed. After the communication phase ended, subjects get feedback about the agreed upon price or the price interval. This procedure closely follows Hinloopen and Soetevent (2008). It resembles experiments where subjects may announce prices non-bindingly but cannot communicate otherwise (Harrington et al., 2016; Holt and Davis, 1990).

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 the 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.

Table 2 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 2: 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. The assignment to the cubicles was done using a randomization device. 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.

Hinloopen and Soetevent (2008) report that 60 seconds are sufficient.
During period ten, 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 receive an initial capital of 5 euros. Cumulated payoffs are added to or subtracted from the initial capital. The experimental currency was the called ECU, with an exchange rate of one ECU being 0.3 euros. The average payment was 13.08 euros.

3 Hypotheses

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]. A recent paper by Chowdhury and Wandschneider (2018) makes this point in detail for the case of cartels. Private damage claims increase the expected costs of cartel formation and should therefore reduce the number of cartels.

**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: it is now more expensive to terminate the criminal activity. The reason is that private damages cannot be condoned for whistle blowers.

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

With fewer leniency applications, cartels should last longer with PDC. That is, they should be more stable. Accordingly, an immediate implication of hypothesis 2 is that

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

Hypothesis 3 should hold in particular for cartels that existed before the PDC are introduced. The design of the experiment allows 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 apply. We summarize this thought in hypothesis four:

**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 PDC. 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, accordingly, an open (empirical) question and we do not maintain a directed hypothesis here.

**Hypothesis 5 (Cartel prevalence)** The overall effect of PDC 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 1, fewer cartels are formed with private enforcement, leading to more competitive prices. Second, any existing cartels suffer less from leniency (Hypothesis 2) and last longer (Hypothesis 3) 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.

**Hypothesis 6 (Market prices)** The overall effect of PDC 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 to be 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 ten periods (NOPDC) to the subsequent ten periods (PDC). We restrict the analysis to observations from rounds 1 to 20 in order to exclude potential end-game effects. With the help of the reverse order control treatment, we can also compare the data between subjects (both PDC and NOPDC data from periods 1 to 10).

We use non-parametric tests (Wilcoxon matched pairs, WMP; Mann-Whitney U, MWU) where, due to the possible dependency of observations within one market, we aggregate the data at the group level. We complement the non-parametric tests with linear regression models (Ordinary Least Squares) 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 10,000 replications. Statistical significance levels are indicated by asterisk, where * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$). We report two-sided $p$-values throughout.

An overview of summary statistics of our main results is displayed in table 3. We will repeatedly refer to this table.

<table>
<thead>
<tr>
<th>STRUC</th>
<th>CHAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOPDC</td>
<td>PDC</td>
</tr>
<tr>
<td>PDC</td>
<td>NOPDC</td>
</tr>
<tr>
<td>Propensity to collude</td>
<td>0.627 (0.058)</td>
</tr>
<tr>
<td>Share cartel</td>
<td>0.225 (0.083)</td>
</tr>
<tr>
<td>Ask non-cartel markets</td>
<td>102.680 (2.607)</td>
</tr>
<tr>
<td>Ask cartel market</td>
<td>106.842 (3.024)</td>
</tr>
<tr>
<td>Ask all markets</td>
<td>103.669 (3.237)</td>
</tr>
<tr>
<td>Market price non-cartel markets</td>
<td>101.885 (1.674)</td>
</tr>
<tr>
<td>Market price cartel markets</td>
<td>105.342 (2.193)</td>
</tr>
<tr>
<td>Market price all markets</td>
<td>102.706 (2.619)</td>
</tr>
<tr>
<td>Cartel prevalence</td>
<td>0.231 (0.080)</td>
</tr>
<tr>
<td>Cartel stability</td>
<td>1.23</td>
</tr>
</tbody>
</table>

Table 3: Summary statistics of main results – average results per treatment (standard errors in parentheses)

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 the STRUC (CHAT) is 62.7% (40.83%), see figure 1. With PDC, the average propensity to collude decreases significantly (STRUC and CHAT: WMP, $p-value = 0.0001$) to 39.58% (18.13%). 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 an Ordinary Least Square model (OLS) in table 4 are also consistent with Hypothesis 1. We see that the dummy variable PDC is highly significant and economically substantial.

![Figure 1: PDC reduce the individual propensity to collude, in STRUC (left) and CHAT](image)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<tbody>
<tr>
<td>collude</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<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>
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<td>Constant</td>
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<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>
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<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>
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</tr>
<tr>
<td>adj. $R^2$</td>
<td>0.053</td>
<td>0.061</td>
<td>0.045</td>
<td>0.094</td>
</tr>
</tbody>
</table>

Table 4: Individual decisions to communicate – linear regression (standard errors in parentheses)

Now we 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 2 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

---

9Recall that subjects have the opportunity to decide to form a cartel only when, in the previous period, either no cartel existed or when an existing cartel was busted.
communication treatments, STRUC and CHAT. The regressions in table 5 confirm that the effect is significant.

![Figure 2: PDC reduce the number of cartels, in STRUC (left) and CHAT](image)

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</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>adj. $R^2$</td>
<td>0.081</td>
<td>0.023</td>
<td>0.061</td>
<td>0.108</td>
</tr>
</tbody>
</table>

Standard errors in parentheses  
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: 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 on (see table 2). In the analysis of reverse order we compare the first ten periods of the NOPDC-PDC sequence with the first ten periods of PDC-NOPDC sequence. This allows us to additionally conduct the comparison NOPDC and PDC between subjects, thereby excluding order effects. Due to bankruptcy we exclude one group from our analysis. Hence, we analyse 15 groups in the treatment of reverse order.
\( p - \text{value} = 0.0226 \) (b) MWU, \( p - \text{value} = 0.0169 \)\(^{11}\)

Figure 3: PDC reduce cartel formation in a between-subjects comparison in STRUC. The PDC data are taken from the treatment with the reverse sequence PDC-NOPDC.

**Result**\(^{11}\) (Cartel formation) With PDC, there are fewer attempts to form a cartel (individual level) and fewer successfully formed cartels (group level).

Aside, figures 1, 2 and 3 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 to activate the communication device in future periods. In other words, taking merely the decisions to form a cartel underestimates the degree of cartelization in CHAT where subjects tend to communicate only once at the very beginning. This can be seen from the following excerpts of communication (translated from the original German), groups agree to communicate only once: “Without in future rounds without [sic] communication then?” (Group 5, period 1), “When rules change communicate again” (Group 7, period 1), Group member 3 (GM3): “Yes but not more communication in the next rounds”, GM2: “Ok, no more communication and 110”, GM1: “Alright. Yes. Always 110, no more communication and no reports.” (Group 13, period 1).

4.2 Leniency applications and cartel stability

Hypotheses 2 to 4 are about leniency behavior and cartel stability which, however, require that cartels are actually formed in the first place. In what follows, we provide an analysis conditional on the groups which formed a cartel.

**Leniency applications**

Hypothesis 2 suggests that there will be fewer leniency applications with PDC because whistle-blowers cannot get amnesty for private damages. We analyze the number of leniency applications

\(^{11}\)Linear regressions, available upon request, yield the same result.
for a market (or group) divided by the number of periods where that group was cartelized, conditional on that group having formed at least one cartel. In treatment STRUC, we find an average of 83.6 percent leniency applications per cartel period in NOPDC (13 groups), but this reduces to 44.4 percent leniency applications with PDC (3 groups). Figure 4 shows the cumulative distribution functions (CDFs) of the leniency measure across groups. In NOPDC, more than 53 percent of all groups had a 100 percent leniency rate (that is, these cartels existed for one period only and immediately broke down due to leniency) and not a single group never applied for leniency. With PDC, one group never applied for leniency, one did apply in a moderate 33 percent of the cases, and the third group had a 100 percent likelihood of leniency (one one-period cartel).

Result 2 (Leniency rate) With PDC, there are fewer leniency applications.

In CHAT, we have an average of 21.2 percent leniency rate in NOPDC and this somewhat reduces to 0 percent with PDC. Eight of the 11 groups in NOPDC never apply for leniency; one group has a 33.3 percent leniency rate and two groups form one-period cartels (100 percent). With PDC, we only have three groups, which all never applied for leniency (the CDF is accordingly not informative in CHAT).

Figure 4: CDF of the leniency rate in STRUC across groups that establish at least one cartel (13 groups in NOPDC, three in PDC)

---

12 For example, suppose a group formed a cartel lasting three periods and reported by one of the group members in period three, than the leniency rate of this group would be $1/3 = 0.33$. Suppose a second group set up a cartel for two periods and was busted by the authority. The respective leniency rate would be $0/2 = 0$. 

15
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. We do this comparison for the first nine periods NOPDC and period eleven to 19 PDC\footnote{For the analysis of cartel stability, we exclude period ten from the analysis. Subjects decide whether to report a cartel after private damage claims are introduced. Thus, period ten neither belongs to PDC nor to 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.}. Cartels that are formed and uncovered in the same period count as stable over one period. As can be seen in figure\footnote{For the analysis of cartel stability, we exclude period ten from the analysis. Subjects decide whether to report a cartel after private damage claims are introduced. Thus, period ten neither belongs to PDC nor to 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.} the mean of cartel stability roughly doubles in both treatments as private damage claims are introduced.

![Figure 5: The impact of PDC on cartel stability in STRUC (left) and CHAT](image)

**Result\footnote{For the analysis of cartel stability, we exclude period ten from the analysis. Subjects decide whether to report a cartel after private damage claims are introduced. Thus, period ten neither belongs to PDC nor to 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.} 3 (Cartel stability) With PDC, cartels are more stable (last longer).

**Cartel stability when introducing PDC in period ten**

Recall that we introduce private damage claims as an unexpected change of rules after the second stage in round ten. That is, subjects are exposed to PDC only after they decided 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 ten (groups that form a cartel before or in period ten and that last at least until stage 3, the reporting stage of period 10).

In STRUC, four of the sixteen groups collude in period ten, 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 those one-period cartels. They experience long stability, however, 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 group were a cartel exists in period ten. In two of these three groups the cartel still remains stable although PDC was introduced.
Result 4 (Stability of existing cartels) The implementation of private damage claims has a stabilizing effect on cartels that formed before the implementation.

Again, we wish to emphasize that we have only few cartels with PDC. As a result, we cannot make any statements regarding statistical significance concerning Results 2 to 4.

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 hand 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, we did not set up a hypothesis about prevalence in section 3.)

Figure 6 shows the results. For communication treatment STRUC, we find cartels present in 23.13 percent (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 6 confirm this.
<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prevalence</td>
<td>Prevalence</td>
<td>Prevalence</td>
<td>Prevalence</td>
</tr>
<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>adj. $R^2$</td>
<td>0.059</td>
<td>0.036</td>
<td>0.038</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Table 6: Cartel Prevalence – linear regression (standard errors in parentheses)

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 ten periods, the results are very similar. The between-subjects test is significant (MWU, $p-value = 0.0190$).

![Cartel prevalence in STRUC: between-subjects comparison with PDC data from treatment with reverse order (PDC-NOPDC)](chart)

**Result 5**  Cartel prevalence There are fewer cartels with PDC.

### 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).\(^{14}\) The market price is the relevant factor for consumer welfare.

We compare the average market price without and with private damage claims across the CHAT and STRUC treatments as shown in table\(^7\). We see that PDC lower prices in STRUC,

\(^{14}\)For an analysis of individual ask prices see Appendix.
but CHAT shows the opposite pattern. This concerns the overall average (“all markets”) as well the market prices of cartelized and non-cartelized markets. Figure 8 (and bottom line in table 7) confirm the decrease of overall market prices with possible PDC in STRUC. However, in CHAT overall market prices are higher with PDC. Differences are statistically significant in both treatments (STRUC: WMP, $p = 0.001$; CHAT: WMP, $p = 0.0043$). As an control, we analyze the sequence of reverse order PDC-NOPDC. Figure 8 verifies the lower overall market prices in PDC with STRUC communication (WMU, $p-value = 0.0001$).

Table 8 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 8 column 1). They insignificantly decrease in CHAT.
<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>Market price non-cartels</td>
<td>101.885 (1.674)</td>
<td>101.600 (2.090)</td>
</tr>
<tr>
<td>Market price cartels</td>
<td>105.342 (2.193)</td>
<td>102.900 (0.986)</td>
</tr>
<tr>
<td>Market price all markets</td>
<td>102.706 (2.619)</td>
<td>101.681 (2.122)</td>
</tr>
</tbody>
</table>

Table 7: Market price - averages per treatment (standard deviations in parenthesis)

What could be the intuition for the contradicting effects in CHAT and STRUC? Recall that we did not state a directed hypothesis here in the first place (Hypothesis 6). 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 to pay damage claims. This is what might be going on in STRUC. We suggest that the counter-intuitive effect in CHAT is triggered by a hysteresis effect. In CHAT, subjects have the chance to coordinate their behavior even beyond a cartel breakdown: “only discuss one time, EVERYONE ALWAYS 110 NO report, more profit is not possible, otherwise we will only earn 101 and noone earns anything” (group 3, period 1). Since CHAT fosters trust and 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.

**Result (Market prices)** With STRUC communication, PDC significantly decrease average ask and market prices and therefore increases consumer surplus. With CHAT communication, PDC insignificantly increase ask and market prices.
4.5 Structured vs. chat communication

Our experimental design enables us not only to analyse 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 5). This is also emphasized by the result that infringer 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 cooperation (see e.g. Blume and Ortman, 2007; Cooper et al., 1992; Cooper and Kühn, 2014; Waichman et al., 2014) such that cartel prevalence is higher in CHAT than in STRUC (figure 6), independently of whether of private damage claims to apply (WMU NOPDC \( p-value = 0.0617 \); PDC \( p-value = 0.0038 \)).

Interestingly, the share of propensity to communicate is significantly higher in STRUC than in CHAT (figure 1), 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 2) (WMU NOPDC \( p-value = 0.0014 \); PDC \( p-value = 0.4746 \)). 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.

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 7) (NOPDC and PDC, WMU, \( p-value = 0.0001 \)). The higher prices in CHAT can be explained by a hysteresis effect that keeps prices high.

Table 8: Market price - Linear Regression

<table>
<thead>
<tr>
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<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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<tbody>
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<td></td>
<td>MarketPrice</td>
<td>MarketPrice</td>
<td>MarketPrice</td>
<td>MarketPrice</td>
</tr>
<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>
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<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>adj. R²</td>
<td>0.043</td>
<td>0.016</td>
<td>0.041</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Standard errors in parentheses
* \( p < 0.05 \), ** \( p < 0.01 \), *** \( p < 0.001 \)
even after cartels break down. Additionally, we see much less variation in collusive market prices in CHAT compared to STRUC (table $\overline{7}$) (NOPDC and PDC, WMU, $p$ – 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 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 waved or reduced, but their damage claim payments are, if at all reduced, just capped to a certain extent. Private enforcement may therefore decrease incentives to apply for leniency and result in more stable cartels.

Our work contributes to existing literature in two ways. First and to the best of our knowledge, our paper is the first to quantify the trade off between the leniency and private damage claims. Our design builds on and extends the literature on leniency experiments (Apesteguia et al. 2007; Bigoni et al. 2012; Hinloopen and Soetevent 2008). We analyze a repeated homogeneous-good three-player Bertrand 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. Second, our treatments further vary the form of communication by analyzing structured price announcements vs. unrestricted chat (whereas the existing literature was only employing structured communication).

Our results confirm our hypotheses regarding cartel formation, cartel stability, consumer welfare and chat communication. First, we find that propensity of cartel formation decreases as private enforcement is introduced. Second, when private damage claims exist, the number of leniency application is reduced. Third, the implementation of damage claims has a stabilizing effect on cartels in total an on cartels that formed before the implementation. Fourth, 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 but also increases cartel stability and market prices.

These results suggest policy makers may reconsider the tool of private enforcement carefully. Following the theory of crime formulated by Becker (1968), increasing punishment leads to lower
crime. Indeed see an decreasing rate of cartel formation. Taking into account that cartels become more stable and potentially decrease consumer welfare, private damage claims are not without costs. Leniency is a rather successful tool to uncover cartels, so a possible decrease in applications is likely to decrease overall detection of cartels. Private enforcement in our experimental design does not capture the possibly increased effort of private firms to uncover cartels induced through the possibility to claim damages. This is an interesting question for future research.
References


A Appendix

A.1 Groups dynamics over time

Figure 10 and figure 11 give an overview of the cartelizing behaviour of each group in the STRUC and CHAT. The blue line plots the binary group dependent variable *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 break down 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.

In STRUC, four out of sixteen groups collude in period ten. Two of these cartels (group 2 and 15) collapse in the same period. Group 8 and 11 exactly reflect the behaviour forecasted in hypothesis 3. They experience their longest stability, after private damage claims are introduced. As can be seen in figure 10 both groups already agreed to cartelize before the introduction of private damage claims. These cartels only lasted for one period each. In the treatment without damage claims, the cartels break down, because of reporting in retaliation to undercutting of the agreed upon price in all cases.

After private damage claims are introduced, cartel members still undercut the agreed upon price in all periods of the cartel. Now the cartel-members stop to retaliate against this behaviour by reporting the cartel. In consequence, the cartels last longer than one period for the first time; group 8 reports the cartel after four periods and the authority detects group 11 after four periods. Group 11 forms another cartel under private damage claims that lasts from period 18 to 19 and again breaks down because of detection by the authority. It appears like the incentive to apply for leniency decreases with the introduction of damage claims. To summarize, we see that the introduction of private damage claims can have ambiguous effects on the behaviour of cartelists. While the implementation does not influence some cartels at all, others remains stable, even though cartel members deviate from the collusive agreement. These observations suggest that the implementation of private damage claims can have a stabilizing effect on cartels.

As in STRUC, four out of 16 groups are collusive in period ten of the experiment. The explicit cartel of group 8 breaks down after one period as part of the collusive plan to circumvent an accumulation of damages. The cartels from group three, seven and nine start in period one of the

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15In both cartels the reason for the breakdown is leniency applications, which are strategically used in retaliation for deviation from the agreed upon price.
16Group 8 was active in two cartels before private damage claims were introduced and group 11 engaged in three cartels.
17Group 2 is the only group that, next to group 8 and 11, formed cartels without private damage claims and with private damage claims and experienced a cartel break down right after the first period.
experiment and end because of detection by the cartel authority. The cartel of group 3 is detected in period 20, the cartel of group 7 is detected in period 16 and group nine is uncovered in period 10. Even though, the explicit cartel of group seven and nine ends before period 20, the prices remain at the collusive level. In group nine one cartel member slightly undercuts the collusive price in period 20. Again, we suggest because of final round effects.

Group two is the only group that forms a new cartel after the introduction of private damage claims. The cartel in the treatment with private damage claims lasts for 10 periods, which is considerably longer than the cartels in the treatment without damage claims. The first cartel lasted from period one until period 4. In period four the cartel was detected by the authority. A new cartel was formed in period six. This cartel broke down in retaliation for deviating from the agreed upon price. Furthermore, we can see from figure 11 that the main reason for a cartel breakdown in the treatment without private damage claims are leniency applications, while the cartel of group eleven only breaks down because of detection by the authority.

In CHAT, cartels are in general more stable compared to STRUC. This is also reflected in the share of cartels that are uncovered due to reporting. In both treatments, all cartels are discovered before or in period 20. In CHAT this is mainly due to discovery by the authority (60%). In stark contrast, roughly 91% of all cartels in STRUC are uncovered due to leniency applications. We conclude, that the possibility to communicate in a chat increases trust and the commitment to stick to the agreed upon price, which results in less leniency applications.

Hardcore cartels, which we define as a cartel that forms in an early period and lasts longer than the average cartel in CHAT (around 6 periods), do not break down because of a change in rules. We can find such cartels in group three, seven (and price-wise we could also include group four, five, nine, ten, twelve, thirteen and fifteen).

As hypothesized in section 3 we find three reasons for this phenomenon. Firstly, communication improves the subjects understanding of the mutual benefits of collusion because subjects obtain the chance to explain to each other. Secondly, CHAT increases the trust between group members. Third and most importantly, group members can threat each other.

---

18 All other groups either stick to their former cartel or remain at the competitive level.
19 The deviation from the agreed upon price is the main reason for leniency applications in the treatment with CHAT communication.
20 “I calculated it we earn the most when we always enter 110” (Group 2, period 6), “Let’s all take 110, then we will get 3 points every round” (Group 13, period 1).
21 “from now on always trust each other blindly” (Group 2, period 12), “Trust each other” (Group 2, period 11).
22 “If someone deviates, I will put 101” (Group 8, period 11), “otherwise everyone takes 101 and it will get very bleak” (Group 13, period 1) “if someone betrays, we will report” (Group 2, period 11).
Figure 10: Collusive activity and market price by group for the treatment with structured communication.

Figure 11: Collusive activity and market price by group for the treatment with chat communication.
Figure 12: 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.2 Deviations from agreed price

Figure 12 and 13 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 12 indicates this by the upper and lower bound of agreed prices like applied for example in group 9.

In figure 13, we can observe more stable price setting following the agreed price even in periods without a cartelized market in CHAT. Figure 12 which considers STRUC, provides an indication of lack of trust in collusive markets. 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 undercut the agreed price continuously. In contrast to that, in figure 13 group 7 gives a perfect example of subjects sticking to the agreed price although price discussion has not taken place in this period. This behaviour emphasizes our explanation of hysteresis regarding subjects not communicating but setting high prices.

\[\text{This does not include group 16.}\]
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 14 (and the bottom line in table 9) 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, \( p = 0.001 \)). A comparison of ask prices NOPDC vs. PDC in CHAT reveals that the ask price is not statistically significantly different (CHAT: WMP, \( p = 0.337 \)).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>NOPDC</th>
<th>PDC</th>
<th>NOPDC</th>
<th>PDC</th>
</tr>
</thead>
<tbody>
<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>109.987 (0.113)</td>
</tr>
</tbody>
</table>

Table 9: Ask price - averages per treatment (standard deviations in parenthesis)
In table 10 we estimate an Ordinary Least Square (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 10, column 1), whereas PDC have no significant impact on ask prices in CHAT (table 10, column 2).

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</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>adj. $R^2$</td>
<td>0.083</td>
<td>0.009</td>
<td>0.098</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 10: Ask price – linear Regression (standard errors in parentheses)

Figure 15 shows the analysis of the sequence of reverse order PDC-NOPDC in STRUC. The robustness check confirms the significant lower of ask prices in PDC (WMU, p-value=0.0001).
Figure 15: Ask price in STRUC: between-subjects comparison with PDC data from treatment with reverse order (PDC-NOPDC)