Do Leniency Policies facilitate Collusion?
Experimental Evidence

Georg Clemens[*1] and Holger A. Rau[†2]

[1]NERA Economic Consulting
[2]University of Göttingen, Germany

November 2014

Abstract

This paper analyzes non-discriminatory and discriminatory leniency policies in a multi-stage cartel formation experiment where multiple ringleaders may emerge. Ringleaders often take a leading role in the coordination and formation of a cartel. A leniency policy which grants amnesty to all "whistleblowers" except for ringleaders may reduce the incentive to become a ringleader and thus disrupt cartel formation. Although theory predicts that cartels will always be reported, whistleblowing rarely occurs. Paradoxically we find that the discriminatory leniency policy induces more firms to become ringleaders, which ultimately facilitates coordination in the cartel.

JEL Classification: C92, K21, L41.

Keywords: Cartels, Experiment, Leniency Programs, Ringleader Discrimination.

[*]The content of the article is of the author's sole responsibility. It does not represent the views of Nera Economic Consulting. e-Mail: clemens@dice.hhu.de.

[†]Corresponding author, Platz der Göttinger Sieben 3, 37073 Göttingen (Germany), e-Mail: holger.rau@uni-goettingen.de.

1 Introduction

Over the last two decades corporate leniency programs have emerged as real "game changers" in the fight against hardcore cartels. The provision of amnesty to a cartel member that "blows the whistle" has ultimately proven to be an antitrust tool of the utmost efficacy.[1] However, the possibility to apply for leniency does not always extend to all firms within a cartel. In this regard discriminatory leniency programs have started to exclude ringleaders. These policies focus on players which are identified as the firms that instigated and organized the cartel[2] and exclude them from leniency applications. A leniency policy that excludes ringleaders is therefore classified as discriminatory. This is true for the US legislation and in most jurisdictions. An exception is the EU legislation where ringleades can apply for leniency.[3] The treatment of ringleaders is an ongoing debate in Antitrust policy as the US and the EU legislation treats ringleaders differently. Therefore we experimentally analyze and compare the effects of discriminatory and non-discriminatory leniency policies on cartel formation.

Leniency policies have a twofold disruptive effect on cartels. The first effect is the elicitation of confessions in an existing cartel. Cartels such as Lysine, Vitamins or Belgian brewers were uncovered following insider information reported by cartel members.[4] The second disruptive effect is the deterrence of cartel formation by leniency. In this respect the discrimination of cartel ringleaders is of significant importance. As leniency is denied to ringleaders, the formation of cartels is potentially mitigated, since the role of ringleader comes at the cost of amnesty. This generates a significant coordination problem in the formation of a cartel as every firm would be better off if the other was the ringleader. The discrimination of ringleaders, however, also has the potential to stabilize cartels.[5] A firm can signal its commitment by becoming a ringleader within the cartel. As leniency creates distrust among cartel members who may all betray each other, renouncing the right to report the cartel as a ringleader may re-inject trust.

Although it remains unclear whether the stabilizing or destabilizing effect prevails, empirical evidence reported in Davies and De (2013) suggests that ringleader discrimination has not fully prevented the emergence of ringleaders. Astonishingly, the EU Commission has identified more than one ringleader in most of the ringleader cases. Here, the respective firms shared duties such as the organization of meetings. Despite the fact that this phenomenon might only be driven by organizational issues, the decision by multiple firms to become ringleaders could also have trust-enforcing motives. An increasing number of ringleaders reduces the number of potential "whistleblowers" and therefore facilitates cartel formation. Thus, less is known about the coordination mechanism and organizational and behavioral roles of multiple firms acting as ringleaders.

---

[1]As has been pointed by the former director of DG Competition, Olivier Guersent: "As a result,since 1996, the Leniency Program has been the most effective generator of important cases. About 100 companies have filed leniency applications under this program and, since 1996, the Commission has taken 24 formal decisions in cartel cases in which companies co-operated with the investigations."

[2]See Davies and De (2013) who outline the organizational activities of ringleaders within a cartel.

[3]Since 2002 cartel ringleaders in the EU can qualify for leniency (Hesch, 2002).

[4]See European Commission 2002.

[5]This duality of a discriminating leniency policy was first addressed in Leslie (2006) and later in Chen and Rey (2013).

Our paper therefore also contributes to the literature studying ringleaders' motivations as it focuses on the emergence of one or more ringleader(s) and her/their impact on cartel coordination. An advantage of our design is that it incorporates the impact of ringleader discrimination on the emergence of ringleader(s) and cartel formation. Although economic experiments have their limitations, since firms' behavior is deducted from the decisions of subjects in the lab, their advantages are undeniable. Experiments can generate data for different legislation and policies, particularly with regard to coordination issues which are generally not observable in the field. More importantly, experiments allow the inference of aspects as trusting behavior in cartels which cannot be deducted from field data or from theory.[6]

This experiment compares the impact of different antitrust policies on cartelization. We implement a cartel formation game where the cartel is established in a multi-stage decision game preceded by a communication stage. The experiment abstracts from pricing decisions as cartel members are always bound to the joint-profit-maximizing strategy while outside firms play best-response. This simplification is necessary as defection from the cartel price by a shirking firm might influence the decision to form a cartel as much as the possibility to opt for leniency. In order to isolate the effect of price coordination and the effect of different leniency policies on cartel formation, we deliberately abstract from the former effect and focus on the latter effect. We introduce a benchmark treatment *Antitrust Authority* (*AA*) without leniency and two leniency treatments *Leniency* (*LEN*) and *Ringleader Discrimination* (*RD*). While cartel formation is sanctioned in all three treatments, leniency is only available to all firms in *LEN*. In *RD* only non-ringleaders are eligible to report the cartel. The introduction of *LEN* enables us to infer the general effect of leniency on cartel formation when compared with *AA*. More importantly, introducing the *RD* treatment allows us to disentangle the effects of a discriminatory and non-discriminatory leniency policy on the emergence of ringleaders and cartel formation.

Importantly, our experimental approach includes many aspects of cartels with ringleaders, which have so far been left untouched by the literature. Davies and De (2013) show that ringleaders take the leading role in the organization of large and asymmetric cartels. Our experimental results extend their findings by showing why one or more ringleaders may also emerge in smaller symmetric cartels. The latter finding is of importance as in these settings organizational burdens should have less of an impact. Following the results by Davies and De (2013) we model ringleaders which instigate a cartel by switching on a chat device that allows unlimited communication which facilitates collusion.[7] In practice a ringleader may also be the firm that initiates the communication.[8] As opposed to former experiments by Bigoni et al. (2012), Hesch (2012), and Wandschneider (2012), the emergence of a ringleader is not deterministic in our setting.

---

[6] See Armstrong and Huck (2010) for an overview of the behavioral literature as applied to firms' conduct in markets.

[7] This follows from Cooper and Kühn (2009) and Fonseca and Normann (2012) who show that unlimited communication facilitates collusion in cartels. Firms in these papers have to make price decisions and chat can be used to coordinate or threaten punishment. Note, that firms in our setup face a prisoner's dilemma as the equilibrium is forming the cartel and applying leniency. By contrast, all firms would be better off if the cartel is formed and not reported. Thus, allowing for chat is meaningful for firms' collusion strategies as they can threaten punishment by chat messages.

[8] Note, that in reality it may also be the case that more than one firm can be proven to initiated communication. For instance think of e-mails initiating meetings of price rigging.

This is in line with the observation by Bos and Wandschneider (2011) who find that cartels do not necessarily have to include a ringleader in order to coordinate the cartel implementation. Thus, our framework allows us to assess whether there would be one or more ringleaders under a leniency policy which discriminates against ringleaders.

Our findings can be summarized as follows: (i) A non-discriminatory leniency policy reduces the number of formed cartels compared to a system without leniency where ringleader discrimination achieves the highest cartel formation rates. (ii) Cartels are rarely reported under both leniency policies, where the lowest number of reports is observed in the ringleader discrimination case. (iii) Most strikingly, with ringleader discrimination we observe the highest number of ringleaders. The results may be of particular importance for antitrust policy as they suggest that the discriminatory leniency policy may facilitate cartel formation. In this regard the emergence of ringleaders may generate trust among cartel members, showing that firms can overcome the coordination challenge induced by the discriminatory leniency policy.

The remainder of this article proceeds as follows. Section 2 links our approach to the relevant literature and presents our experimental design. Section 3 presents the theoretical and behavioral predictions. Section 4 discusses the results, while section 5 concludes.

2 Literature Review and Design

2.1 Literature Review

The theoretical and empirical literature provides ambiguous results regarding the efficiency of leniency. Motta and Polo (2003) show that a leniency program may incentivize firms to enhance collusion because the fine reduction induced by the leniency program makes collusion more attractive. Spagnolo (2004) and Aubert et al. (2006) have shown that a reward system where whistleblowers obtain a bonus payment for reporting the cartel is superior to a leniency policy which reduces the fine. Empirical contributions by Miller (2009) and Brenner (2009) evaluate the efficiency of the US and EU leniency programs showing that the former (Miller, 2009) enhances cartel detection while the latter fails to destabilize cartels (Brenner, 2009). Harrington and Chang (2009) find that leniency may generate more cases than an antitrust authority can efficiently handle if the resources of the antitrust authority are limited. Moreover Chen and Rey (2013) show theoretically that leniency does not necessarily deters collusion but can be abused and can generate perverse effects. Both the theoretical and experimental literature provide important insights into the effect of whistleblowing in existing and in detected cartels. However, neither the theoretical nor the empirical literature can explain how firms face challenges induced by a leniency policy on cartels that are yet to be formed. Here, the experimental literature on leniency initiated by Apesteguia et al. (2007) may fill a gap.[9]

The latter paper provides the first experimental analysis of leniency programs. In a discretized one-shot Bertrand game similar to Dufwenberg and Gneezy (2000), Apesteguia et al.

---

[9]See Marvão and Spagnolo (2014) for a survey of the Empirical and Experimental Evidence on papers analyzing leniency policies.

(2007) analyze the formation of three-firm cartels and the pricing decision under different antitrust policies. The authors find that leniency not only deters cartel formation but also undermines price coordination, as cartel prices are significantly lower under leniency.[10] Hinloopen and Soetevent (2008) and Bigoni et al. (2012) extend the framework of Apesteguia et al. (2007) to a dynamic setting with repeated interaction among the firms. In Hinloopen and Soetevent (2008) the results of Apesteguia et al. (2007) are confirmed as leniency deters cartel formation and reduces prices alike. Bigoni et al. (2012) introduce a further intriguing change where firms get the right to report the cartel before and after its implementation.[11] This modification allows us to disentangle defection and punishment and ensures that leniency does not become a mere punishment tool against defecting firms. As opposed to Apesteguia et al. (2007) and Hinloopen and Soetevent (2008), Bigoni et al. (2012) find that leniency increases prices. Yet, the deterring effect of leniency on cartel formation found in Apesteguia et al. (2007) and Hinloopen and Soetevent (2008) is confirmed in Bigoni et al. (2012). Finally Dijkstra et al. (2014) conduct a leniencypolicy experiment where the antitrust authority may have different investigation characteristics. In "profound" it may start an investigation with a small probability, however, the probability of being successful is high. Whereas, in "superficial" the probability of an investigation is high and the probability of being successful is small. The authors find that cartel incidence is lowest under the profound investigation characteristic. Experimental evidence fills a gap as it clarifies the picture of the effect leniency has on the coordination of cartel formation. Our paper is in line with this approach as we also investigate the effect of leniency on cartel formation. However, our approach focuses on the effect of a discriminatory leniency policy where ringleaders are excluded from the leniency program. Thus, it contributes to the literature on ringleader discrimination.

Ringleader discrimination has only recently caught the attention of economic research. Bos and Wandschneider (2013) infer the impact of a ringleader-discrimination policy in a theoretical model based on Bos and Harrington (2010). They find that a discriminatory leniency policy may yield higher cartel prices as compared to a non-discriminatory policy.[12] Herre et al. (2012) suggest a different approach and model the ringleader as the cartel member with the highest amount of relevant information for the antitrust authority. In a theoretical framework based on Motta and Polo (2003) it turns out that, depending on the amount of information a ringleader has, ringleader discrimination may or may not be desirable. So far, the theoretical literature has fallen short of a clear-cut evaluation of ringleader discrimination.

Experimental evidence on ringleader discrimination is still scarce. The experiment by Bigoni et al. (2012) includes a leniency treatment with ringleader discrimination. The results suggest that the policy does not decrease cartel deterrence and that cartels become more harmful since

---

[10] The experimental framework is designed as a one-shot repetition which may overestimate the positive effect of leniency. In fact, leniency has no consequence with one-shot interactions as it eliminates the possibility to sanction whistleblowers by refusing to collude in future periods.

[11] Note that Bigoni et al. (2012) furthermore analyze leniency in a duopolistic differentiated Bertrand market and use a fixed fine, as opposed to Apesteguia et al. (2007) and Hinloopen and Soetevent (2008).

[12] This is the case if the cartel fails to implement the joint-profit-maximizing strategy, if there is a non-linear relation between the fines and the individual cartel gains of a firm and if the distribution of the firm size within the cartel is sufficiently heterogeneous.

prices increase.[13] In an experiment based on Hinloopen and Soetevent (2008), Hesch (2012) finds that ringleader discrimination facilitates cartel formation and increases prices for a low detection probability. The opposite holds for a high detection probability. Wandschneider (2012) confirms the result that ringleader discrimination does not deter cartel formation although cartel prices are lower with ringleader discrimination.

The experimental literature on discriminatory leniency policies mainly focuses on the implementation of the cartel prices and applies a deliberately simplified cartel formation. In all experiments presented above the entire cartel formation process corresponds to a unanimous decision to activate a communication device. Consequently, Bigoni et al. (2012) model the ringleader as the firm that is the first to activate the communication device. This approach guarantees that the ringleader plays a crucial role in the cartel formation process. Yet it only leaves one potential whistleblower as the cartel is formed in a duopoly. Hence the coordination challenge induced by a potential "run to the court house" cannot be inferred here. In Hesch (2012), the ringleader is randomly picked by the computer which, per se, excludes coordination problems in the formation of a cartel. Wandschneider (2012) models the ringleader as the firm that proposes the cartel price which is ultimately confirmed by the other cartel members.[14]

The aforementioned literature is built on an important feature, i.e., every cartel has to include one ringleader making the emergence of ringleaders deterministic. This ensures that the pricing decisions of every cartel member always depend on the presence of a ringleader. Yet these designs leave out the possibility to form a cartel without a ringleader although this is most commonly observed (see Davies and De, 2013). Hence the papers cannot explain to what extent a leniency policy influences the decision of a cartel to operate with or without ringleaders.[15]

The role of ringleaders is thoroughly analyzed in the empirical work by Davies and De (2013). One of their main findings is that ringleaders only emerge in certain cartels and that cartels often include more than one ringleader. The authors also find that a ringleader can be an "organizational" solution in large and asymmetric cartels to overcome classical cartel challenges.[16] However, this argument cannot explain why one or more ringleaders also emerge in small cartels with symmetric market shares who should face less obstacles in the cartel formation process. Although the amino acids, Belgian brewers or sorbates cartels included up to five members with relatively symmetric market shares they all operated with two ringleaders. This suggests that organizational issues may not be the only factor influencing the decision to become a ringleader.

Here, our paper may fill an important gap as it especially infers why ringleaders also emerge in cartels with limited organizational challenges. It applies a simplified cartel formation approach following the setup of Kosfeld et al. (2009). The latter analyzes the effect of an endogenously

---

[13]Note that the scope of these results is limited as Bigoni et al. (2012) exclusively analyze duopolies. Hesch (2012) and Wandschneider (2012) extend the analysis to a triopoly.

[14]This approach has a minor flaw as the designated ringleader cannot renounce his position if his price is accepted by the other members. Hence the decision to become a ringleader is not fully deliberate. Note, however, that a firm could avoid becoming the ringleader by choosing a price that will always be rejected by the other firms. Yet, this would in turn drive the results as low prices in the ringleader treatment would be obtained "by design."

[15]The emergence of multiple ringleaders as reported by Davies and De (2013) are also difficult to explain.

[16]This finding explains why ringleaders can often be observed in large cartels with asymmetric market shares.

formed institution which sanctions free-riding in a public-good game. A three-stage-decision game is implemented where in the first stage subjects have to vote whether to participate in an institution (see Selten, 1973). In the second stage all subjects that decided to participate learn about the number of potential participants. The institution is established if and only if *all* first-stage participants unanimously opt for the formation of the institution at the second stage. If established, the institution sanctions those that have refused to contribute their entire endowment at the third stage, ensuring cooperation within the institution. Since the baseline model in Kosfeld et al. (2009) (see Okada, 1993) is closely related to Selten (1973) its applicability to a cartel-formation case is undeniable.[17]

We follow Clemens and Rau (2013) who modify this mechanism to analyze the emergence of partial cartels in a Cournot market. In their paper a cartel is formed at the first and second stage where it works as an institution. Its members are the insiders, whereas non-participants are the outside firms. At the third stage, the cartel chooses the joint-profit-maximizing Cournot quantity for all members, whereas the outsiders always play best-response. Firms are given the possibility to use a communication device before voting to implement the cartel. The results suggest that partial cartels are rejected out-of-equilibrium if outside firms profit excessively from the formation of a cartel at the expense of insiders. The communication stage plays a significant role in this setup as it yields an increase of the cartel formation rates from 26% to 97% compared to the cases without communication. This insight is used in our setup as the role of the ringleader is tied to the activation of the communication device.

Our experiment adds two stages to the mechanism in Clemens and Rau (2013). Here, firms can apply for leniency and subsequently an antitrust authority may detect the cartel. Furthermore, firms do not communicate automatically but at the beginning of the game they have to choose to activate the communication device.[18] In our design at least one positive vote is needed to activate chat. Yet, there may be more than one firm willing to initiate the chat. This is of particular importance as those firms that instigate the cartel are treated as ringleaders.[19] Hence, we allow for the emergence of multiple ringleaders although the presence of a ringleader is not necessary to ensure the formation of a cartel. Note that one important advantage of this approach is that the activation of the communication device does not automatically lead to the formation of a cartel as in Apesteguia et al. (2007) but is only an option.

The introduction of a multi-stage-decision game where a joint-profit-maximizing institution (cartel) is formed is in contrast to the experimental cartel literature based on the Apesteguia et al. (2007) framework. It may be objected that joint-profit maximization does not satisfy the objective of a firm which wants to maximize its own profit. However, empirical evidence provided by Levenstein and Suslow (2006; 2011) suggest that cheating is not the main reason

---

[17]As Okada (1993) underlines: "The prototype of our institutional arrangement can be found in Selten (1973) where cartel bargaining in the symmetric Cournot oligopoly is investigated by using a noncooperative game model similar to ours."

[18]Cooper and Kühn (2009) and Fonseca and Normann (2012) have found that cartel formation is significantly enhanced with communication.

[19]Although this may not be the only task a ringleader has to fulfill, cartel instigation by ringleaders is observed in 14 out of 19 cases by Davies and De (2013).

for a cartel breakdown.[20] One possible explanation follows from Bernheim and Whinston (1985) who show that the implementation of institutional structures are of importance. For instance, this can be joint-sales agency incentivizes which enable competing firms to opt for the joint-profit-maximizing output. In fact cheating and cartel stability applies rather to tacit collusion than explicit collusion. This has been underlined by Davies and De (2013) who show that real-world cartels with explicit communication and institutional organizations are less constrained by stability issues resulting from cheating. Hence we may not contribute to the literature on tacit collusion but instead we experimentally analyze the effect of leniency on explicit cartels with institutional structures as observed in the real world.

Our experiment thus contributes to the literature on discriminatory and non-discriminatory leniency policies. Yet it provides additional insight, being one of the first experiments to tackle the incurring coordination challenge induced by a discriminatory leniency policy on the emergence of one or more ringleaders.

2.2   Experimental Design

In our experiments we implement three different treatments: *Antitrust (AA)*, *Leniency (LEN)* and *Ringleader Discrimination (RD)*.

Our AA treatment allows us to assess the formation of a cartel that can be detected with a probability of 15% by an antitrust authority yielding a 10% fine.[21] AA does not include the possibility to report the cartel and therefore serves as a benchmark for the general effects of leniency policies on the formation of cartels. Consequently, AA only involves the communication option and three cartel formation stages. Subsequently, established cartels can be detected by an antitrust authority.

We implement two further treatments where leniency is possible. The LEN treatment introduces a non-discriminatory leniency policy that allows a cartel member to report the cartel to the antitrust authority after its formation and implementation. All cartel members are equally eligible to apply for leniency in the LEN treatment. The treatment is composed of the same three stages as in AA but adds a further stage if a cartel was formed which precedes the detection activities of the computerized antitrust authority. The LEN treatment allows us to infer the general effects of whistleblowing on cartel formation and serves as a benchmark for the ringleader-discrimination treatment (RD).

A crucial modification is provided in the RD treatment. Here, firms that decide to activate the communication device for the entire group become ringleaders and are denied the right to apply for leniency. The stages in the RD treatment are the same as in LEN with the exception that those firms that activate the chat are excluded from leniency at the whistleblowing stage. This approach follows Bigoni et al. (2012) and is motivated by the insight that it is communication that largely facilitates the formation of cartels. The RD treatment allows us to analyze the emergence

---

[20]As Levenstein and Suslow (2006) outline "cartels break down in some cases because of cheating, but more frequently beacaues of entry, exogenous shocks, and dynamic changes within the industry."

[21]These values are in line with the experimental designs used by Apesteguia et al. (2007) and Hinloopen and Soetevent (2008), among others.

of ringleaders and the formation of cartels if a discriminatory leniency policy is implemented.

Table 1 provides an overview of the payoffs generated in our symmetric Cournot game with four firms for the different possible cartel constellations. Cartel members' payoffs are determined following the assumption that they maximize the joint profits while the outsiders play their best-response strategies which determines their payoffs. The terms in brackets indicate the fine a cartel member faces if the cartel is reported or uncovered, where we deduct the fine from the respective payoffs.

Composition		Firms' Payoffs	
# Insiders	# Outsiders	Insider	Outsider
0	4	na (na)	64
1	3	64 (na)	64
2	2	50 (-35)	100
3	1	59 (-34)	178
4	0	100 (-40)	na

Table 1: Cartel compositions and the resulting Cournot payoffs without and with cartel detection. The terms in brackets indicate the fine subtracted from the revenue a cartel member faces if the cartel is reported or uncovered.

Subjects in all treatments participate in three stages similar to those in Kosfeld et al. (2009). In *LEN* and *RD* the mechanism may involve four stages, which is the case when a cartel has been formed and subjects have the possibility to make use of the leniency option. In the following we explain in detail every stage of our mechanism.

Before the mechanism started all firms were given the possibility to activate a chat window for a total of 60 seconds. If one or more firms decided to activate the communication option, the chat window was activated for all firms in the market. If no firm decided to activate the chat, it was not initiated. The decisions of the firms were made simultaneously and were communicated to the entire market before the chat window started (or not). If the chat window was activated it automatically closed after 60 seconds and the *Participation stage* started immediately. Firms remained anonymous during the chat and were given neutral names like "firm 1–4" which did not change over the course of the experiment.[22] The stages can be summarized as follows:

1. **Participation Stage:** All subjects in a market had to decide whether or not to participate in a market agreement[23] by either clicking "yes-" or "no-". Those participants that clicked "yes" became *possible insiders* while those participants that clicked "no" became *ultimate outsiders*.

---

[22]Note that all subjects had to wait for 60 seconds until the start of stage one, irrespective of whether the chat was activated or not. This ensured that subjects would not switch off the chat in order to accelerate the cartel formation procedure.

[23]The treatments were neutrally framed using the German word "Marktabsprache" which means "market agreement."

2. **Implementation Stage:** The total number of possible insiders and ultimate outsiders was reported to all firms. While ultimate outsiders had no decision to make, possible insiders had to decide whether they wanted to implement the cartel. As the payoffs were conditional on the number of insiders and outsiders, possible insiders were presented the payoffs of insiders and outsiders if the cartel were to be implemented/not implemented. The cartel was only formed if all possible participants decided to implement it. Otherwise its formation was revoked and all firms became direct competitors and received the Cournot Nash equilibrium profits.

3. **Cartel Formation Stage:** In this stage subjects were informed regarding the cartel formation. If no cartel was formed the game ended in this period and the players received Cournot payoffs (each 64). When a cartel was formed, cartel members were bound to the cartel strategy while outsiders automatically played best-responses. Our approach deliberately abstracts from pricing decisions and neglects the possibility of defecting within the cartel. This simplification is necessary as ex-post defection from the cartel price may severely influence the decision to form the cartel or to report it through leniency.[24] Our approach largely simplifies the cartel formation process as cheating is left out. Yet it still tackles one of the core problems cartels have to overcome identified by Levenstein and Suslow (2006), which is coordination of the behavior to a collusive agreement.

4. **Leniency Stage:** This stage only took place in the LEN and RD treatments and it only started if a cartel was established. In the LEN treatment a sequence of the four firms was randomly drawn by the computer, which determined the order in which the firms could report the cartel. This random sequence guaranteed that all firms were designated as a potential whistleblower with the same likelihood and reflected equal chances of winning the run to the court house in the case of symmetry. If the first firm in the sequence decided to report the cartel, all firms except the whistleblower were sanctioned by the antitrust authority, yielding a fee corresponding to 10% of the revenues (see terms in brackets in Table 1). Otherwise the right to report the cartel was handed over to the next firm of the random sequence, until the cartel was either reported or the last firm in the sequence refused to report the cartel. If no firm decided to report the cartel, it was not revealed at this stage. A modification was introduced in the RD treatment which prevented those firms who activated the communication device from reporting the cartel. Accordingly, these firms were excluded from the random sequence of possible whistleblowers.

---

[24]Hinloopen and Soetevent (2008) show that defection from the cartel price triggers leniency applications. This is confirmed by Bigoni et al. (2012) who furthermore show that leniency might be used as a punishment device against defecting firms. Hence it might not be possible to figure out whether changes in the cartel formation rates should be attributed to the effects of a (non-)discriminatory leniency policy or to defection if a pricing stage were to be included here.

Finally, when a cartel was formed and not reported the antitrust authority began its investigation, i.e., the cartel could be revealed with a probability of 15%.

2.3 Experimental procedures

We used a fixed matching protocol with four firms in a market playing the multi-stage game repeatedly for 16 periods.[25] We conducted three sessions of every treatment, where every session was composed of 12 participants forming three matching groups of four firms each. Thus, our data involves 27 independent matching groups, i.e., we have nine independent matching groups in AA, LEN, and RD. The experiment was conducted at the $DICE\ Lab$ of the University of Düsseldorf in May and June 2013 with 108 subjects from various fields. The profits achieved by the participants were converted at an exchange rate of 1 Taler = 0.01€. On average, every participant earned 15.81€ and an additional show-up fee of 4€. The experiments were programmed in z-Tree (Fischbacher, 2007) and our subjects were recruited with the online recruitment system ORSEE (Greiner, 2004).

3 Theoretical and Behavioral Predictions

3.1 Underlying Theory: The Cournot Game

We consider a symmetric Cournot market where $n = 4$ firms sell a homogeneous product. The linear demand function for the product corresponds to $P = 100 - \sum_{i=1}^{4} Q_i$. Firms face marginal cost of production $c = 60$.

A complete overview of the Cournot payoffs and antitrust fines depending on the respective cartel outcomes is provided in Table 1. Stages 1–3 ensure that a cartel emerging with four firms is "internally" and "externally" stable in equilibrium. We now determine the equilibrium strategies for the AA, the LEN, and the RD treatments using backward induction.

Antitrust Treatment: Equilibrium Strategies

Given our experimental design outlined above we start our analysis by determining the equilibrium strategies in the AA treatment. The only stable cartel is the all-inclusive cartel which encompasses the four firms. This is guaranteed in the *implementation stage* (stage two), as possible cartel members are first informed of the size of a cartel as it would be implemented. Hence possible cartel members can reject any out-of-equilibrium strategies, guaranteeing an all-inclusive cartel is implemented. We thus limit our analysis to this cartel. The expected payoffs of a firm i which participates in the four-firm, all-inclusive

---

[25] Following Clemens and Rau (2013) a fixed-matching protocol was used in order to resemble repeated interaction between the same firms in oligopolistic markets.

cartel corresponds to:

$$E(\pi_i^4) = 0.15 \times 60 + 0.85 \times 100 = 94$$

Comparing the payoffs of the firms for an all-inclusive cartel and in the case of Cournot competition ($94 > 64$) we conclude that risk-neutral firms choose to form an all-inclusive cartel.

Proposition 1: The cartel formation in the AA treatment has a unique strict subgame perfect equilibrium. As four-firm cartels will always be implemented at the second stage, all firms decide to be insiders of the cartel at the first stage.

In this case the decision to activate the communication device in the beginning does not influence the payoffs and is therefore obsolete regarding the formulation of our Proposition.

Leniency Treatment: Equilibrium Strategies

Our LEN treatment differs slightly from the AA treatment with regard to the *Leniency stage* (stage four). All former stages up to the *Implementation stage* (stage two) are equal in AA and LEN. In stage four, all cartel members are given the possibility to report the collusive agreement. Since revelation guarantees a firm that it will obtain the collusive profit, it always decides to report the cartel. Hence the decision to report the cartel or not corresponds to a prisoner's dilemma game.[26] The first firm in the randomly determined sequence at stage four consequently reports the cartel. The chance of being the first firm in the sequence corresponds to 25% yielding profits of 100, while another firm is picked out as the first potential whistleblower with a converse probability of 75% yielding payoffs of 60. Hence, the expected payoffs of forming a cartel corresponds to:

$$E(\pi_i^4) = 0.75 \times 60 + 0.25 \times 100 = 70$$

Comparing the payoffs of the firms in the case of an all-inclusive cartel and in the case of Cournot competition ($70 > 64$) we conclude that firms choose to form the all-inclusive cartel.

Proposition 2: The cartel formation game in the LEN treatment has a unique strict subgame perfect equilibrium, where an all-inclusive cartel is formed and always reported.

Note that this prediction is outlined for a static framework although the game is repeated for 16 rounds. Yet, the finite repetition of this game has no impact on the firms' decisions since we obtain unique subgame perfect equilibria in all treatments (see Benoit and

---

[26] As Leslie (2006) points out: "The prisoner's dilemma is usually a game theoretical model used to explain behavior having nothing to do with prosecutors or prisoners. But in the case of cartel investigations, the language of the model maps the reality of our inquiry."

Krishna, 1985 and Friedman, 1985). Therefore, the theoretical prediction is also valid in a finitely repeated framework.

Ringleader Treatment: Equilibrium Strategies

The RD treatment introduces a modification to the LEN treatment, with regard to the eligibility of becoming a whistleblower at the *Leniency stage*. A firm that activates the communication device renounces its right to report the cartel to the authority and is therefore excluded from the random sequence determined at stage four. Assuming that all firms decide to activate the communication device, all firms would obtain the profits generated in the AA treatment, i.e., a payoff of 94. If a firm chose not to activate the communication device and to therefore become the only possible whistleblower, its profit would increase from 94 to 100, while the profits of the other firms would be 60. As this payoff is inferior to the competitive payoff (64) firms prefer not to form a cartel at all rather than activate communication and form a cartel thereafter. We thus postulate the following corollary:

Corollary 1: Firms renounce the activation of the communication device in the RD treatment.

If all firms renounce the activation of the communication device, they all become eligible for leniency after cartel formation. All firms would be better off not activating the communication device, forming the cartel and reporting it if they are given the possibility to do so. Hence firms face the same prisoner's dilemma as in LEN and obtain the same expected payoffs.[27] We therefore formulate the following proposition:

Proposition 3: The cartel formation game in the RD treatment has a unique strict subgame perfect equilibrium, where an all-inclusive cartel is formed and always reported.

3.2   Behavioral Predictions

In this section we derive behavioral predictions. We use the results obtained in the former section as a starting point and extend them to behavioral predictions by considering results obtained in the experimental literature.

Cartel formation in AA

Focusing on cartel formation in the AA treatment, Proposition 1 predicts that firms form cartels despite the probability of being detected. The reason is that higher expected

---

[27]Note that firms may adopt a collusive strategy where they collude only if all group members also activated the chat. The adoption of this strategy may sustain collusion preventing "whistleblowing" in equilibrium similar as to AA where no leniency is possible. However, this strategy is not an equilibrium as the game is finitely repeated.

payoffs (94 Talers) occur by forming cartels compared to the non-collusive case (64 Talers). This suggests that the antitrust authority should not impact on firms' willingness to form cartels. Experiments conducted by Apesteguia et al. (2007) and Hinloopen and Soetevent (2008) among others report high rates of cartel formation in similar treatments. In the following we derive behavioral predictions for our leniency treatments where *AA* serves as a benchmark.

Cartel formation in *LEN*

In the *LEN* treatment, all subjects are given an equal chance to report the cartel. Proposition 2 suggests that cartels are always formed and reported by the whistleblowers. Apesteguia et al. (2007), Hinloopen and Soetevent (2008), and Bigoni et al. (2012), however, show that a non-discriminatory leniency policy deters cartel formation in experimental settings. In comparison to a treatment without leniency the rate of cartel formation is always lower. Although this phenomenon is not explained in any of these experiments, Leslie (2006) suggests that fear of betrayal by whistleblowers may deter cartel formation.[28] We therefore expect that if cartels have been reported by "whistleblowers," less firms are willing to form a cartel in subsequent periods as compared to *AA*. We summarize our predictions for *LEN* as follows:

Behavioral Prediction 1: Leniency Treatment
Leniency will deter the formation of cartels in LEN, leading to less cartels than in AA.

Cartel formation in *RD*

In the *RD* treatment Proposition 3 outlines that all-inclusive cartels are always formed. The communication option may also be a powerful institution increasing cartel formation rates as suggested in Cooper and Kühn (2009) and Fonseca and Normann (2012). However, in our treatment chat activation comes at a cost, i.e., firms dismiss the chance to report the cartel in the leniency stage. In our experiment, activating the chat device comes at the cost of losing the right to blow the whistle. Thus, subjects should be reluctant to activate chat. The results of Andersson and Wengström (2007) suggest that this will lead to a lower cartelization rate. As firms make use of the leniency option cartelization rates will further be deterred. We therefore predict that in *RD* less cartels occur compared to *AA* and *LEN*. We summarize our predictions for *RD* as follows:

---

[28]This observation is in line with Bohnet and Zeckhauser (2004) who suggest that subjects are prone to betrayal aversion, i.e., they dislike situations where another agent may turn the outcome of the game to one's disadvantage.

Behavioral Prediction 2: Ringleader Treatment
(a) Leniency will deter the formation of cartels in RD, leading to less cartels than in AA.
(b) As the activation of the chat option comes at a cost, less firms will active the chat in RD. This complicates coordination and leads to less cartels than in LEN.

The Emergence of Ringleaders

One of the key aspect of our analysis is the emergence of multiple ringleaders. In this regard we infer the effect of a discriminatory leniency policy on the total number of ringleaders in a market. As outlined in the former paragraph, the activation of the communication device implies a renunciation in the treatment with the discriminatory leniency policy. Here, firms renounce a right when acting as ringleaders before the mechanism starts since they cannot "blow the whistle" at stage four anymore. This should lead to a decrease in the number of ringleaders following Corollary 1. By contrast, in *AA* and *LEN* chat activation does not come at a cost. Therefore we expect more ringleaders to occur in these treatments leading to the smallest amount of ringleaders in *RD*.

Behavioral Prediction 3: Emergence of Ringleaders
In RD the activation of the chat comes at a cost in contrast to AA and LEN. Therefore, we expect the smallest number of ringleaders in RD.

4   Results

We report our results in three parts. The analysis starts with an overview of static and dynamic summary statistics on the number of established cartels. In a second step we test our behavioral predictions with regressions analyzing possible treatment effects. Finally, we run additional regressions for the *LEN* and *RD* treatment to shed light on the specific effects of the non-discriminatory and discriminatory leniency policies. When using non-parametric tests, we always report two-sided *p-values* which are based on nine independent observations (nine markets) for each of the three treatments.

4.1   Summary statistics

Figure 1 depicts the static results of the average fraction of cartels established in our three treatments: *AA*, *LEN*, and *RD*. It reports the frequency of cartels which were not revealed (*survived*), the frequency of cartels which were reported (*whistleblow*), and finally how often cartels were *detected* by the random mechanism.

The diagram reveals that 82% of cartels are established in *AA*, whereas under the non-discriminatory leniency policy the fraction of established cartels decreases to 63%. Interestingly, the discriminatory leniency policy leads to an increase of established cartels.
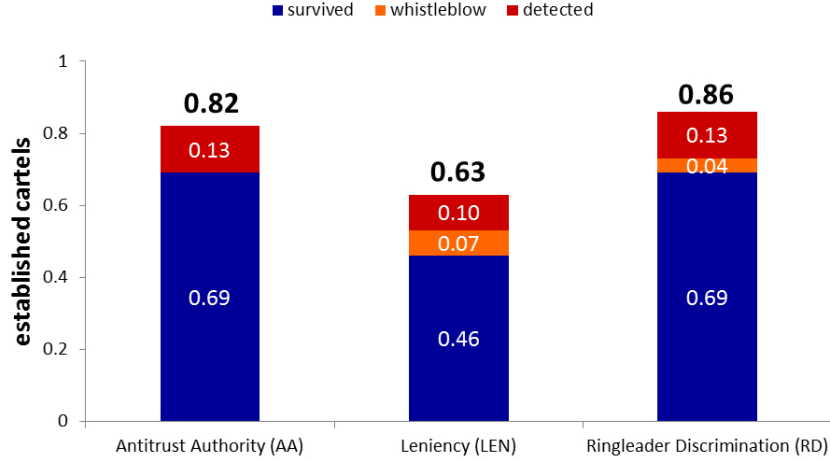
14

Figure 1: Established cartels and the frequencies of survived, reported, and detected cartels.

That is, 86% cartels are formed in *RD*. Nearly all established cartels in *AA* (91%), *LEN* (99%) and *RD* (97%) involve all firms in the market.[29] Whereas cartels are more often reported in *LEN* (7%) compared to *RD* (4%) where ringleaders are discriminated against. In *RD* clearly less cartels are reported as firms can activate the chat which leads to the exclusion from leniency. If we restrict the analysis of reported cartels to the cases where whistle-blowing was possible,[30] we find for *LEN* that 11% are reported. By contrast, only 5% of cartels are reported in *RD*. The overall low rate of reported cartels in *LEN* can be explained by the fact that firms may anticipate that reporting a cartel could lead to the disruption of trust, i.e., firms will renounce cartel formation in *LEN* when they realize that a firm has exploited the trust.[31] Firms seem to realize that it pays to focus on a collusive strategy where a cartel is always formed and not reported as it yields an expected payoff of 94. Most cartels survive under *AA* and *RD* (69%), whereas in *LEN* only 46% of the markets are cartelized. It can be summarized that the discriminatory leniency policy seems to create distrust when cartels have been reported. By contrast, in *RD* trust can be restored again by activating the chat which leads to the exclusion from the leniency program.

We proceed by focusing on the dynamic results of established cartels. Figure 2 depicts the average fraction of established cartels over time.

A conspicuous finding in *LEN* is the sharp decrease of established cartels between periods 1 and 2, i.e., firms establish 78% of cartels in the first period and subsequently 29% of those cartels are reported. This leads to a significant decrease of firms' willingness

---

[29]Few cartels are established with two firms, i.e., in *AA* (9%) and *LEN* (1%). In *RD* we find that 3% of the established cartels involve three firms.

[30]That is, in *LEN* and *RD* we only investigate cases where cartels were established. In *RD* we also take into account whether firms could report the cartel, i.e., when less than four firms acted as ringleaders.

[31]Our results in section 4.3 support this assumption: we find that in *LEN* firms hardly manage to form a cartel in the subsequent period after a cartel was reported.
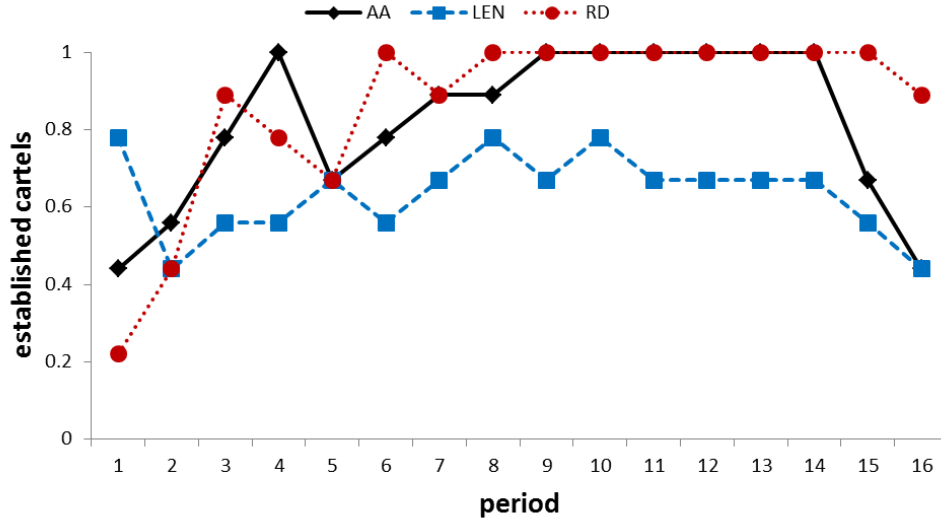
Figure 2: Average development of established cartels over time.

to form cartels in period 2 where only 44% cartels are established (Wilcoxon Matched-Pairs test *p-value* = 0.083). Overall, no significant correlation of established cartels and period can be found in *LEN* (Spearman's rank correlation coefficient, $\rho = 0.069$, *p-value* = 0.565). The opposite is true when focusing on *RD*, i.e., there is ample evidence of a significant positive correlation of established cartels and period (Spearman's rank correlation coefficient, $\rho = 0.488$, *p-value* < 0.001). The same is true for *AA*, where firms are prone to learning behavior, i.e., the average rate of established cartels significantly increases over time (Spearman's rank correlation coefficient, $\rho = 0.280$, *p-value* = 0.017).[32]

This gives us a first indication that time dynamics crucially matter, i.e., the fraction of established cartels significantly increases under a discriminatory leniency policy (*RD*) and in the absence of leniency (*AA*). By contrast, it remains constant in *LEN*. Here, the fraction of established cartels is lower compared to *AA* and *RD*, in 13 out of 16 periods. Figure 2 also reveals that firms seem to be prone to an end-game effect in periods 15-16 in all treatments.

4.2   Main treatment effects

In this section we test our Behavioral Predictions. The analysis starts by reporting non-parametric tests. Subsequently, we run regressions to clarify the picture of the treatment effects and the time dynamics.

The previous subsection has shown that firms in our experiment are prone to a pronounced learning behavior and are affected by an end-game effect (periods 15–16). As firms learn in the beginning, their decisions become more stable after a while. Hence we

---

[32]A deeper investigation of time dynamics and cartel establishment is provided in section 4.2 where we use probit regressions to test for treatment effects.

observe less heterogeneity in the second half of the game, i.e., our non-parametric tests focus on periods 9–14.

The non-discriminatory leniency policy seems to disrupt cartelization, i.e., in LEN significantly less cartels are established (69%) compared to AA (100%) (Mann-Whitney test, $p\text{-}value = 0.066$) and RD (100%) (Mann-Whitney test, $p\text{-}value = 0.066$). No difference can be observed when focusing on the average amount of established cartels between RD and AA.

We now infer treatment effects and the Behavioral Predictions by estimating a probit model of cartel establishment. The model is clustered at the group level for 27 independent groups. The variables are as follows: LEN and RD are dummy variables which are equal to one in the respective treatments (AA is the omitted treatment variable). We include control variables inferring the impacts of the time dynamics, i.e., *periods 1–8* is a dummy variable which is positive (zero) when the data of periods 1–8 (periods 9–16) is analyzed. Furthermore *periods 15–16* controls for the end-game effect. We report two regressions: Regression (1) infers the impact of the treatment variables and the time dynamics. Regression (2) controls for the interaction effects of the treatment variables with the time variables. Table 2 presents the results of the regressions on the probability of cartel establishment.

The regressions show that the non-discriminatory leniency policy always leads to less established cartels compared to AA. Ignoring treatment interaction with time dynamics, Regression 1 points out that a moderate number of cartels is established under the leniency policy. We also find that *periods 1–8* is negative and highly significant, i.e, less cartels are established in LEN and RD in the first part of the game. The latter result documents that time dynamics play an important role. Thus, firms in AA show a pronounced learning behavior and significantly more cartels are established in periods 9–16. Regression 2 further confirms the importance of time dynamics. It again emphasizes that significantly less cartels are formed in LEN. The coefficient is negative and highly significant. The findings thus support Behavioral Prediction 1.

Result 1:
In LEN significantly less cartels are formed than in AA.

	established cartels	
	(1)	(2)
LEN	-0.658*	-4.940***
	(0.383)	(0.433)
RD	0.178	0.000
	(0.222)	(0.088)
periods 1-8	-0.826***	-4.748***
	(0.221)	(0.268)
periods 15-16	-0.924***	-5.282***
	(0.315)	(0.323)
LEN×periods 1-8		4.584**
		(0.327)
RD×periods 1-8		-0.043
		(0.315)
LEN×periods 15-16		4.800***
		(0.586)
RD×periods 15-16		1.454**
		(0.579)
Constant	1.543***	5.422***
	(0.221)	(0.063)
Pseudo R^2	0.113	0.174
Observations	432	432

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2: Clustered probit regression on cartel establishment. The regression is clustered on 27 independent match groups. The omitted treatment dummy is *AA* and robust standard errors are reported in parentheses.

Strikingly, the treatment with the discriminatory leniency policy does not lead to significantly less cartels as compared to *AA*. Regressions 1–2 document that the coefficient of *RD* is never significantly different from zero. This suggests that the leniency policy with ringleader discrimination does not reduce the probability of cartel establishment compared to *AA*. Regression 2 emphasizes that the only slight difference between *RD* and *AA* relates to the more pronounced end-game effect in *AA*. Hence, controlling for the interaction effect of *RD×period 15-16* yields a coefficient of 0 for *RD*. The latter finding is in contrast to Behavioral Prediction 2a.[33]

Result 2a:

The discriminatory leniency policy does not lower the rate of established cartels compared to AA.

---

[33]Note, we analyze this contradictory result in detail in section 4.3.

A Wald test reveals that the likelihood of cartel formation is significantly higher in *RD* compared to *LEN* (*p-value* < 0.001). The latter finding suggests that ringleader discrimination seems to have an important impact on the likelihood of cartel establishment. Thus, we find that contrary to Behavioral Prediction 2b the discriminatory ringleader policy increased the rate of formed cartels. The non-discriminatory and the discriminatory leniency policies obviously have converse effects on the number of formed cartels. In contrast to the *LEN* treatment (where less cartels are established) ringleader discrimination enhances cartel establishment. We infer the aforementioned effects in section 4.3. where we present regression analyses with separated samples of *LEN* and *RD* to interpret the differences in the results.

Result 2b:
The discriminatory leniency policy leads to significantly more cartels than in LEN.

We now focus on the dynamics of ringleader activity which is depicted by Figure 3. A notable finding is the asymmetric development of ringleaders for *AA* and *RD*. In the absence of a leniency policy the average number of ringleaders significantly decreases over time,[34] whereas it increases for *RD* in the course of the game.[35] We thus conclude that the ringleader discrimination policy seems to induce firms to become ringleaders over time.
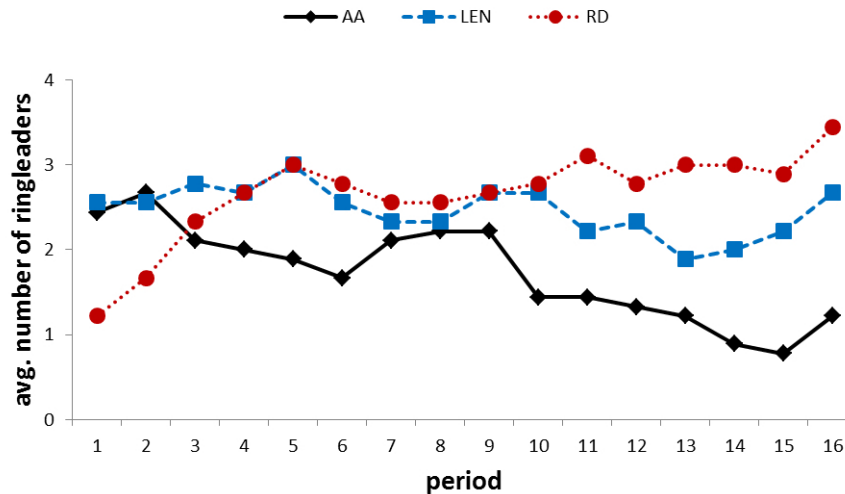

Figure 3: Development of ringleader activity over time.

As we observe less heterogeneity in the second half of the game, we focus on periods 9–16 to test for the treatment effects in the number of ringleaders. The *RD* treatment leads to a significantly higher fraction of ringleaders (2.96) compared to *AA* (1.32) (Mann-Whitney test, *p-value* = 0.027). The smaller fraction of ringleaders suggests that coordination can be easier established in the absence of a leniency policy. Here, there

---

[34]Spearman's rank correlation coefficient, $\rho = -0.281$, *p-value* < 0.001.
[35]Spearman's rank correlation coefficient, $\rho = 0.316$, *p-value* < 0.001.

is a smaller necessity for firms to communicate than in RD where firms face a greater coordination challenge.[36] The fraction of ringleaders is even insignificantly higher in RD (2.96) than in LEN (2.33). We thus do not find the smallest number of ringleaders in RD which stands in contrast to Behavioral Prediction 3. The higher fraction of ringleaders in RD suggests that the decision to activate chat may not only be motivated by the wish to communicate. Under the discriminatory leniency policy firms may act as ringleaders to signal trust, i.e., firms activating the chat will be excluded from the leniency and thus cannot report the cartel afterwards. Hence, all firms who activate the chat in RD will ultimately signal trust.

Result 3:
Most firms act as ringleaders in the RD treatment.

4.3 The impacts of leniency and ringleader activity on cartel disruption and trust

Why does the non-discriminatory leniency policy reduce cartel formation? How do firms manage to enhance cartel formation under the discriminatory leniency policy? To answer these questions we focus on the trusting behavior of firms in LEN and RD. We therefore infer how firms may misuse different leniency policies for their own purposes. First, we analyze the effect of reporting a cartel on firms' willingness to form a cartel in the subsequent period. Second, we study the impact of the number of firms which activated the chat (ringleaders) on cartel formation. Finally, we run probit regressions testing for the impacts of reporting cartels and activating the chat on the probability of established cartels in LEN and RD.

Figure 4 depicts the development over time of established cartels for all LEN markets (markets 10–18; left panel) and RD markets (markets 19–27; right panel).

The figure also displays the cases when a cartel was reported (red crosses).[37] The diagrams emphasize that the non-discriminatory leniency policy leads to a higher variance in the rate of established cartels (standard deviation: 0.48) compared to RD (standard deviation: 0.35). The overall picture of LEN reveals that heterogeneous patterns exist between the different groups, i.e., some groups behave collusively when firms do not make use of leniency (markets 10, 14, and 16). Other groups seem to have serious problems in forming cartels (markets 11, 12, and 15). The disruptive effect of the non-discriminatory leniency policy is especially documented in the LEN markets 11 and 15. Here, firms do not manage to form cartels in subsequent periods after a cartel was reported. Overall, we

---

[36]To shed more light on firms' strategies when using the chat option we analyze the content of the chat protocols in section 4.4

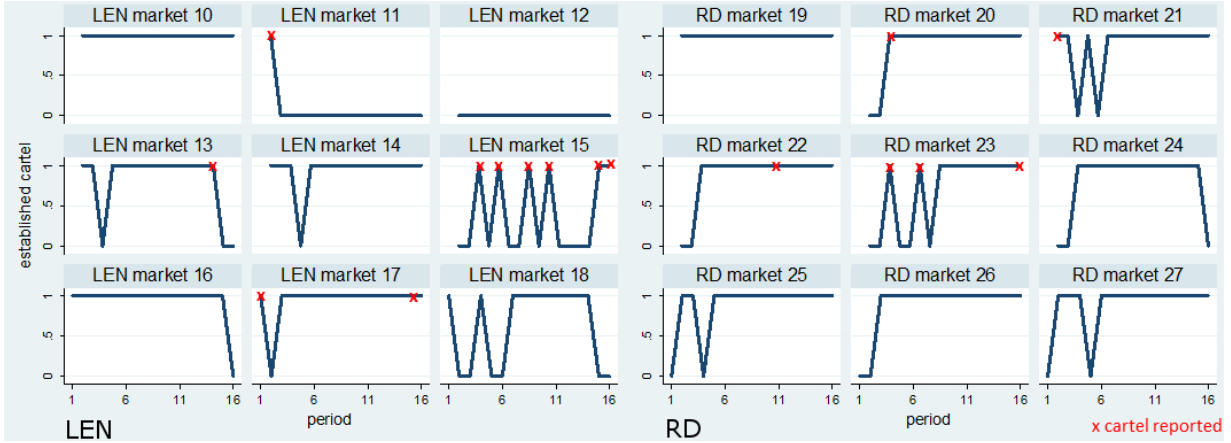[37]See the appendix for an overview of all AA markets.

Figure 4: Development of established cartels and whistleblower activity in *LEN* and *RD* markets.

find for the *LEN* treatment that in 70% of the cases cartels are not formed in subsequent periods after a cartel was reported. A striking example of the disruptive effect of exploiting trust is *LEN* market 11 where the cartel was reported in period 1 and afterwards a cartel was never established again. In *LEN* market 12, firms may not have formed a cartel because of betrayal aversion.

Focusing on the *RD* markets (markets 19–27; right panel) it turns out that fewer cartels are reported (6) than under the non-discriminatory leniency policy (10). In the early periods of *RD* we find markets to be either very collusive from the beginning (market 19, 20, 22, 24, and 26) or gradually over time (market 21, 23, 25, and 27). Under the discriminatory ringleader policy reporting a cartel does not necessarily lead to less cartels in the subsequent period. For instance, the rate of established cartels remains constant after cartels were reported in markets 20 and 22. The same is true for market 21 where at least a cartel is established in period 2 after a cartel was reported in period 1. The only exception is market 23 where no cartel is established in the subsequent periods when a cartel was reported. It can be summarized that the non-discriminatory leniency policy was very effective in half of the *LEN* markets where it had a disruptive effect on cartel formation after a cartel was reported. By contrast, less cartels are reported in the *RD* markets and most of the reported cartels do not disrupt collusion.

In the previous section, Result 3 emphasized that the highest number of ringleaders can be observed in *RD*. Therefore we now investigate whether firms in *RD* systematically use the possibility to become a ringleader in order to signal that they do not intend to "blow the whistle." Thus, firms may use the ringleader membership as an insurance against whistle-blowing. This would imply that in *RD* most cartels should be established whenever a high number of firms act as ringleaders. Table 3 presents the fraction of established cartels conditioned on the number of firms which activated the chat (ringleaders) in *LEN* and *RD*.

The table shows that a similar fraction of established cartels (70%–78%) is formed when

	number of ringleaders (RL)									
	0 RL	n	1 RL	n	2 RL	n	3 RL	n	4 RL	n
LEN	78%	23	71%	21	70%	20	54%	26	56%	54
RD	75%	20	76%	21	74%	19	85%	13	96%	71

Table 3: Established cartels conditioned on the number of ringleaders (RL) in *LEN* and *RD*.

0–2 firms activate the chat (0–2 RL) in both treatments.

A conspicuous pattern can be observed when at least three firms (3–4 RL) activate the chat. Here, a treatment difference occurs, i.e., in *RD* the high number of ringleaders leads to more established cartels, whereas in *LEN* the rate of established cartels decreases. Thus, with three ringleaders we find a higher rate of formed cartels in *RD* (85%) than in *LEN* (54%).

In both treatments we find that most often all four firms activate the chat (54 times in *LEN*; 71 times in *RD*). When four firms activate the chat, the rate of established cartels is crucially increased in *RD*. By contrast, in *LEN* four ringleaders lead to a low rate of formed cartels. We provide an in-depth analysis of the negative correlation of chat activators and formed cartels in *LEN* when we review the content of the chat protocols in section 4.4. Summarizing our results we find that the rate of established cartels when four firms act as ringleaders (96% in *RD* and 56% in *LEN*) may explain the substantial overall treatment difference in formed cartels between *RD* (86%) and *LEN* (63%).

To test the impact of ringleader activity on cartel establishment, we run probit regressions analyzing the likelihood of cartel establishment in *LEN* and *RD*. Furthermore, the regressions control for the effects of reporting a cartel in *LEN* and *RD*. Therefore we use subsamples with separated data of these treatments. Our independent variables are: *one ringleader*, *two ringleaders*, *three ringleaders*, and *four ringleaders* which are dummy variables testing for the impact of a certain number of firms which initiated the chat. The dummies are positive when the corresponding number of firms activated the chat. Furthermore, we use another dummy testing for the impact of whistle-blowing on the likelihood of cartel establishment in subsequent periods: *l.cartel reported*. The dummy is positive when the cartel was reported in the previous period. Again we include dummy variables testing for the time dynamics: *periods 1–8* which is positive (negative) in periods 1–8 (9–16) and *periods 15–16* which accounts for the impacts of the end-game effect. We report two regressions: Regression 1 which focuses on data of the *LEN* treatment and Regression 2 which infers the data of *RD*. Both regressions are clustered on nine independent match groups each.

Regression 1 highlights that all ringleader dummies are insignificant in *LEN*. Here, the likelihood of cartels being established is not increased when firms activate the chat. By contrast, Regression 2 points out that in *RD*, *four ringleaders* is significant with a positive sign. This indicates that it is only under the discriminatory leniency policy that

acting as a ringleader may lead to more established cartels. This is true when four firms activate the chat in *RD* which leads to significantly more established cartels and confirms the observed pattern in Table 3. Under the discriminatory leniency policy a cartel is nearly always established whenever four firms activate the chat. This behavior not only signals trust, it moreover creates an environment similar to *AA* where cartels cannot be reported.

established cartels	LEN (1)	RD (2)
one ringleader	-0.254	0.350
	(0.287)	(0.728)
two ringleaders	-0.162	0.222
	(0.571)	(0.460)
three ringleaders	-0.681	0.876
	(0.705)	(0.577)
four ringleaders	-0.727	1.046**
	(0.714)	(0.532)
l.cartel reported	-1.023***	-0.835
	(0.351)	(0.630)
periods 1–8	-0.0784	-5.432***
	(0.242)	(0.578)
periods 15–16	-0.361	-4.795***
	(0.522)	(0.846)
constant	0.968**	5.599***
	(0.492)	(0.508)
Pseudo R^2	0.069	0.298
Observations	144	144
Robust standard errors in parentheses		
*** $p<0.01$, ** $p<0.05$, * $p<0.1$		

Table 4: Clustered probit regressions of the impact of cartel reports and ringleader activity in *LEN* (reg. 1) and *RD* (reg. 2)

We now focus on the impact of whistle-blowing on the probability that a cartel is established in the subsequent period. Regression 1 shows that *l.cartel reported* is negative and highly significant, i.e., reporting a cartel leads to significantly less established cartels in *LEN* which confirms the observed pattern in markets 11, 13, and 15 of Figure 4. By contrast, in *RD* we find no significant effect for whistle-blowing.

Result 4:

(a) In RD, firms signal trust by acting as ringleaders. Under the discriminatory leniency policy, four firms acting as ringleaders leads to significantly more established cartels.
(b) The leniency policy disrupts cartel formation, i.e., significantly less cartels are established after a cartel has been reported.

4.4 Analysis of the chat protocols

In order to understand the role chat activity plays and its impact on firms' decisions we provide an in-depth analysis of the chat protocols. Table 5 depicts the chat activity in the treatments. Here, the periods of the experiment are divided into block 1 (periods 1–4), block 2 (periods 5–8), block 3 (periods 9–12), and block 4 (periods 13–16). The table gives an overview of the average number of the ringleaders (# chat activators) and the number of chat messages sent (# chat messages sent). Furthermore, the messages are classified under different categories. In the first category "collusion/coordination" we use a method similar to Andersson and Wengström (2007). Here, we count all messages where firms discussed collusive agreements or coordination issues. In the "threats" category all messages are counted where firms threaten other firms for not behaving cooperatively. The third category is "other" where all messages which do not fit in the aforementioned categories are summarized, e.g., when subjects discussed things other than the experiment. Finally, for the *RD* treatment the table includes the category: "signaling." Here, we highlight messages which focus on signaling trust in the ringleader-discrimination treatment.

treatment	chat activity	block 1	block 2	block 3	block 4	avg.
AA	# chat activators	2.3	2.0	1.6	1.0	1.7
	# chat messages sent	25	18	14	9	16
	collusion/coordination	91%	75%	46%	15%	57%
	threats	3%	0%	3%	0%	1%
	other	6%	25%	51%	85%	42%
LEN	# chat activators	2.7	2.6	2.5	2.2	2.5
	# chat messages sent	70	53	62	57	60
	collusion/coordination	78%	36%	20%	13%	37%
	threats	8%	12%	9%	13%	9%
	other	15%	52%	69%	79%	54%
RD	# chat activators	2.0	2.8	2.9	3.1	2.7
	# chat messages sent	60	65	53	57	59
	collusion/coordination	68%	48%	39%	23%	45%
	threats	7%	2%	1%	2%	3%
	signaling	7%	3%	5%	1%	4%
	other	18%	47%	55%	75%	49%

Table 5: Overview of chat activity and content of the chats in our treatments.

It turns out that on average firms send the smallest number of chat messages (16) in the AA treatment. By contrast, firms send an average of 60 messages in LEN and 59 in RD. This suggests that the leniency policies increase the coordination problem in these treatments. Therefore, firms are not only forced to talk about collusive agreements (as in AA), moreover they also have to discuss the impact of the leniency option or the discrimination of ringleaders. Thus, they send more messages in the treatments with non-discriminatory and discriminatory policies. A related finding is that the average number of chat messages decreases by 64% between block 1 and block 4 of the AA treatment.

In block 1 of AA nearly all messages fall into the category "collusion/coordination" (91%), i.e., firms use the communication option to discuss coordination issues and establish collusive agreements. The fraction of collusion/coordination messages decreases to 15% in block 4 where 85% of the chat content falls into the category "other." The same pattern can be observed in LEN where firms send 78% collusion/coordination messages in block 1 and 13% in block 4. In RD we find a less pronounced decrease of collusion/coordination messages, i.e., the fraction is 68% in block 1 and 23% in block 4. In LEN and RD there is also a high fraction of messages which fall into the "other" category (LEN: 79%; RD: 75%).

In LEN we find an average fraction of 9% chat messages which are used for "threats," i.e., firms threaten other firms not to deviate from the collusive strategy. By contrast, only 1% of the average messages sent fall into this category in AA. This emphasizes that firms may have a different usage of the chat in these treatments. A similar pattern occurs in RD where only 3% of the chat messages are "threats."

A conspicuous finding in RD is that firms frequently use the communication option for a different purpose to those in AA and RD. It turns out that firms discuss the activation of the chat to enhance trust. The data reveals that firms suggest acting as a ringleader which signals that the ringleader cannot report the cartel. Firms talk about becoming a ringleader for signaling issues in 4% of the cases in RD. This activity is more pronounced in block 1 (7%) than in block 4 (1%) of RD. This suggests that firms get rid of the signaling strategy in the course of the game.

To shed more light on the content of discussions we follow Kimbrough et al. (2008), Fonseca and Normann (2012), and Clemens and Rau (2013) and present the content of representative chat protocols. These papers have shown that quoting chat protocols may reveal important details about subjects' behavior in chat communications.

In the following we present examples of typical first-period chat communications in AA, LEN, and RD to reach collusive agreements:

Market 4, period 1: AA
```
firm 3:  EVERYBODY SHOULD ALWAYS TAKE PART
firm 2:  highest possible payoff for everybody:  ALWAYS market agreement
firm 3:  Then, everybody would maximally get 100 and at least 60
firm 3:  Absolutely
firm 3:  15% is not much for a detection rate
```

```
firm 2:  It won't work with a 15% chance in every of the 16 periods but this does not
         matter
firm 3:  so true
firm 2:  perfect!
firm 4:  I would also agree
firm 2:  firm1?
firm 3:  Hopefully nobody will defect from the agreement :D
firm 1:  Ok, alright!
firm 3:  Works out!
```

This emphasizes that firms in period 1 of *AA* discuss the fact that the expected payoff of taking part in the agreement is higher than refusing to form cartels. Moreover, firms refuse to talk about cartel formation in the subsequent periods. This is also documented by the declining fraction of collusion/coordination.

Market 8, period 1: LEN
```
firm 2:  Shall we work together so that everybody takes part?  Then everybody should
         not reveal the cartel and we should hope that this is also not done by the
         authority..
firm 1:  If everybody always takes part and nobody whistleblows we could end up with
         20 euros
firm 2:  Sounds good
firm 3:  Correct ;)
firm 4:  yes!
```

The first-period chat protocols of LEN appear to be quite similar compared to AA. Yet, a crucial difference is that firms discuss the leniency option and state that it should not be used.

Market 3, period 1: RD
```
firm 2:  I would propose that everybody always activates the chat, then we could skip
         the leniency phase
firm 1:  And always form a market agreement.  Then everybody would get 100
firm 3:  Except if the agreement would be revealed
firm 1:  Otherwise we would only get 64
```

In most of *RD*'s first-period discussions firms tend to talk about revealing cartels and activating the chat. The protocol presented above is an example of a group which at an early stage of the experiment realized that chat activation could be used as an instrument to trigger collusion in *RD*.

To get more insights into the potential disruptive effect of the leniency policy in *LEN*, we present a *LEN* chat protocol right after a cartel was reported.

Market 6, period 4: LEN
```
firm 3:  Oh my god, looks like we have the most honest participants in this experiment
firm 2:  yes, this is how you could do it
firm 1:  This is only a suspicion, but I believe that firm 4 works against us!
firm 3:  very nice
firm 4:  sorry, but I love capitalism!
firm 4:  your pain is my gain
firm 3:  Congratulations
firm 1:  There goes our cooperation
firm 1:  40 cent more for you!
```

This example shows that firms immediately discuss when a cartel was reported. Furthermore it illustrates that "blowing the whistle" by firm 4 leads to an end of cooperation. In subsequent periods this group barely managed to form cartels. We now present the chat protocol of period 5.

Market 6, period 5: LEN
```
..
firm 1:  Now you earned for the second time 40 Talers more than all of us.
         But from now on you will receive 40 Talers less..  firm 4, is that what you
         would call "capitalism"?
firm 3:  Unbelievable how bold people can be..
firm 3:  sad enough
firm 4:  We are not a team!
```

The latter example again highlights how the leniency policy operates in order to disrupt trust between firms. By contrast, in the RD treatment there is evidence that firms use chat activation to signal that they want to "lay down their arms." Which positively stimulates trust, leading to more collusion.

Market 19, period 3: RD
```
firm 3:  I decided to always activate the chat in order to signal that I am not
         interested in whistleblowing the agreement
firm 3:  :-)
firm 1:  Yes true, this is in deed a good idea
firm 3:  :-)
```

This finding supports the intuition that firms were able to develop strategies in RD to stabilize/increase collusion by using the chat-activation option. We find evidence that firms interpret the activation of the chat as signaling trust. The protocol also reveals that firms actively become ringleaders to strengthen trust:

Market 25, period 3: RD
```
firm 2:  firm 1, you never activate chat, I hope you will not report us.
         However, this will not give you an advantage.
firm 3:  If firm 1 would additionally activate the chat, then the trust would be
         strengthened
firm 1:  Has worked out very well in former periods.  Hopefully the success will
         maturate very soon.  However, from now on I will also take part.
```

This illustrates that firms in the beginning of RD are undecided regarding the chat activation. However, successful cartel establishment and chat communications in subsequent periods also encourage them to become ringleaders.

5   Discussion

Do leniency policies facilitate cartel formation? Our results are ambivalent: The data clearly shows that a non-discriminatory leniency policy more successfully prevents the formation of a cartel. On the other hand our results of the discriminatory leniency policy suggests an answer in the positive. Here, a leniency program that denies ringleaders the

right to file for leniency leads to more cartels. While the possibility to report the cartel within a leniency program may deter the formation of a cartel, the exclusion of ringleaders from leniency programs has a converse effect. A leniency policy that discriminates against ringleaders not only facilitates the formation of cartels but also induces firms not to report the cartel to an antitrust authority. The majority of the subjects renounce their right to blow the whistle by becoming ringleaders. This induces other subjects to not report the cartel and in some cases to become ringleaders as well. Our results thus provide an explanation for the question how firms can overcome the coordination challenge, induced by the discriminatory leniency policy.

Our experiment is conducted in a simplified stylized setting with four symmetric firms which may not encompass the full complexity of a cartel formation process. Furthermore, the entire scope of the ringleaders' responsibilities reported in Davies and De (2013) cannot be covered in one experiment so that more evidence of the effect of ringleader discrimination is unmistakably needed. Yet, we provide important evidence of the emergence of multiple ringleaders in cartels, a phenomenon that has been widely neglected by the economic literature. Paradoxically, the emergence of multiple ringleaders is most recurrently observed when there is a discriminatory leniency policy that denies amnesty to ringleaders. Our experiment therefore provides a direct connection between the emergence of multiple ringleaders and a discriminatory leniency policy.

So far, the economic literature has revealed a possible mixed picture of the effect of ringleader discrimination on leniency. On the one hand it deters firms from becoming ringleaders as it implies a renunciation of the leniency option. On the other hand it signals commitment to the cartel by the ringleader and may therefore serve as a positive signaling device. Our results contribute to the literature as we find support for a stabilizing effect of ringleader discrimination on cartel formation. We not only observe more cartels in the ringleader treatment but also find that cartels are rarely reported. This stabilizing effect may be attributed to the decision to become a ringleader which implies a renunciation of blowing the whistle. The increasing number of ringleaders in our discriminatory treatment hints at a possible trust-facilitating effect of the ringleader discrimination policy as the risk of being reported decreases with an increase in ringleaders. In 2002 and 2006 a paradigm shift took place in the EU leniency notice limiting the discrimination only to "an undertaking which took steps to coerce other undertakings to join the cartel or to remain in it." This significantly mitigates the strategic abuse of a discriminatory policy since antitrust authorities rarely identify coercion within a cartel. Yet our results show that renouncing discrimination in general, per se, most effectively prevents firms from turning the policy against the antitrust authorities and makes leniency policies more effective in deteriorating cartel formation. The findings of this study therefore suggest a leniency policy in the direction of the EU type.

References

[1] Andersson, O., Wengström, E., 2007. Do antitrust laws facilitate collusion: experimental evidence on costly communication in duopolies. The Scandinavian Journal of Economics, 109, 321–339.

[2] Armstrong, M., and Huck, S. 2010. Behavioral economics as applied to firms: a primer. CESifo Working Paper 2937.

[3] Aubert, C., Rey, P., and Kovacic, W., 2006. The impact of leniency and whistle-blowing programs on cartels. International Journal of Industrial Organization, 24, 1241–1266.

[4] Apesteguia, J., Dufwenberg, M., Selten, R., 2007. Blowing the whistle. Economic Theory, 31, 143–166.

[5] Benoit, J.-P., and Krishna, V., 1985. Finitely Repeated Games. Econometrica, 53, 905–922.

[6] Bernheim, B.D., Whinston M.D., 1985. Common marketing agency as a device for facilitating collusion. The RAND Journal of Economics, 16, 269–281.

[7] Bigoni, M., Fridolfsson, S.-O., le Coq, C. Spagnolo G., 2012. Fines, leniency and rewards in antitrust: An Experiment. Forthcoming in RAND Journal of Economics.

[8] Bohnet, I., Zeckhauser, R., 2004. Trust, risk and betrayal. Journal of Economic Behavior & Organization, 55, 467–484.

[9] Bos, I., and Harrington Jr, J. E., 2010. Endogenous cartel formation with heterogeneous firms. RAND Journal of Economics, 41, 92–117.

[10] Bos, I., Wandschneider, F., 2011. Cartel ringleaders and the corporate leniency program. Working Paper, Center for Competition Policy, 11–13.

[11] Bos, I., Wandschneider, F., 2013. A note on cartel ringleaders and the corporate leniency programme. Applied Economics Letters, 20, 1100–1103.

[12] Brenner, S., 2009. An empirical study of the European corporate leniency program. International Journal of Industrial Organization, 27, 639–645.

[13] Chen, Z., Rey, P., 2013. On the Design of Leniency Programs. Journal of Law and Economics, 56, 917-957.

[14] Clemens, G., Rau., H.A., 2014. Cartel Coordination and the Role of Payoff Asymmetries: Experimental Evidence on Partial Cartels. Working Paper.

[15] Cooper, D., and Kühn, K. U., 2014. Communication, renegotiation, and the scope for collusion. American Economic Journal: Microeconomics, 6, 247-78.

[16] Davies, S., De, O., 2013. Ringleaders in larger number asymmetric cartels. Economic Journal 123, 524–544.

[17] Dijkstra, P. T., Haan, M. A., and Schoonbeek, L., 2014. Leniency Programs and the Design of Antitrust: Experimental Evidence with Rich Communication. Working Paper.

[18] Dufwenberg, M., and Gneezy, U., 2000. Price competition and market concentration: an experimental study. International Journal of Industrial Organization, 18, 7–22.

[19] Fischbacher, U. (2007). z-Tree: Zurich Toolbox for Readymade Economic Experiments - Experimenter's Manual. Experimental Economics, 10, 171–178.

[20] Fonseca, M., Normann, H.-T., 2012. Explicit vs. Tacit Collusion - The Impact of Communication in Oligopoly Experiments. European Economic Review, 58, 1759–1772.

[21] Friedman, J.W., 1985. Cooperative equilibria in finite horizon noncooperative supergames. Journal of Economic Theory, 35, 390–398.

[22] Greiner, B., 2004. An online recruitment system for economic experiments. In: Kremer, K., Macho, V. (Eds.), Forschung und wissenschaftliches Rechnen. 2003, GWDG Bericht 63. Ges. für Wiss. Datenverarbeitung, Göttingen, 79–93.

[23] Guersent, O., 2003. The Fight Against Secret Horizontal Agreement in the EC Competition Policy. Fordham International Antitrust 2003, 43–54.

[24] Harrington, J. and Chang, M., 2009. Modelling the Birth and Death of Cartels with an Application to Evaluating Antitrust Policy. Journal of the European Economic Association, 7, 1400–1435.

[25] Herre, J., Mimra, W., and Rasch, A., 2012. Excluding Ringleaders from Leniency Programs. Working Paper.

[26] Hesch, M. 2012. The Effects of Ringleader Discrimination on Cartel Deterrence and Stability - Experimental Insights. Journal of Advanced Research in Law and Economics, 3, 5–58.

[27] Hinloopen, J., Soetevent, A.R. 2008. Laboratory evidence on the effectiveness of corporate leniency programs. RAND Journal of Economics 39, 607–616.

[28] Kimbrough, E.O., Smith, V.L., Wilson, B.J., 2008. Historical Property Rights, Sociality, and the Emergence of Impersonal Exchange in Long-Distance Trade. American Economic Review, 98, 1009–39.

[29] Kosfeld, M., Okada, A., Riedl, A., 2009. Institution formation in public goods games. American Economic Review, 99, 1335–1355.

[30] Leslie, C.R. 2006. Antitrust amnesty, game theory, and cartel stability, Journal of Corporation Law, 31, 453–488.

[31] Levenstein, M.C., Suslow, V., 2006. What determines cartel success? Journal of Economic Literature, 44, 43–95.

[32] Levenstein, M.C., Suslow, V., 2011. Breaking Up is Hard to Do: Determinants of Cartel Duration, Journal of Law and Economics, 54, 455–492.

[33] Marvão, C. M. P., and Spagnolo, G., 2014. What Do We Know about the Effectiveness of Leniency Policies? A Survey of the Empirical and Experimental Evidence. Working Paper.

[34] McCutcheon, B., 1997. Do meetings in smoke-filled rooms facilitate collusion? Journal of Political Economy, 105, 330–350.

[35] Miller, N.H., 2009. Strategic leniency and cartel enforcement. American Economic Review, 99, 750–768.

[36] Motta, M., Polo, M., 2003. Leniency policy and cartel prosecution. International Journal of Industrial Organization, 21, 347–379.

[37] Okada, A., 1993. The possibility of cooperation in an n-person prisoners' dilemma with institutional arrangements. Public Choice, 77, 629–656.

[38] Selten, R., 1973. A simple Model of imperfect competition, where 4 are few and 6 are many. International Journal of Game Theory, 2, 141–201.

[39] Spagnolo, G., 2004. Divide et Impera: Optimal leniency programmes. Center for economic policy research discussion paper 4840.

[40] Wandschneider, F., 2012: Ringleader Exclusion from Leniency Programmes-An Experimental Analysis. Working Paper.

Acknowledgments

We are especially grateful to Hans-Theo Normann for his input at various stages of this project. We are grateful to Florian Baumann, Miguel Fonseca, Fabian Herweg, Kenan Kalayci, Gordon Klein, Nikos Nikiforakis, Lilia Zhurakhovska and seminar participants of the ESA world meeting 2013 in Zurich and the 2014 meeting of the German Society in Hamburg. We also want to thank the Anton-Betz Foundation and the Düsseldorf Institute for Competition Economics (DICE), University of Düsseldorf for financial support.
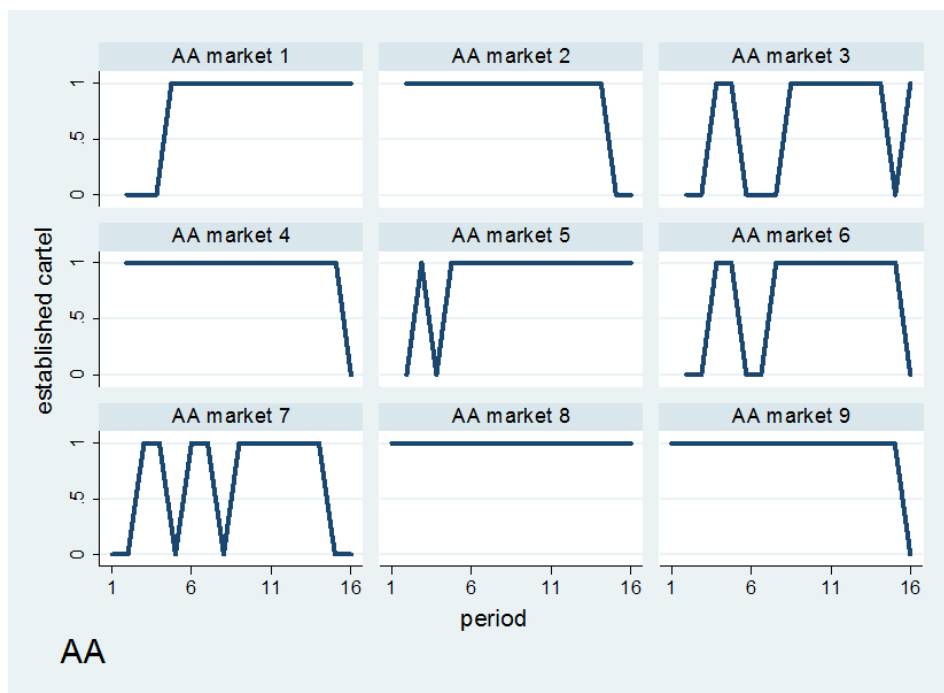
6 Appendix

Figure 5: Development of established cartels in AA markets.

APPENDIX – not intended for publication

Experimental Instructions (translated from German into English)*:*

"Ringleader Discrimination (RD)" Treatment

General Information

Welcome to this decision experiment. Please read the instructions carefully. You will find a questionnaire at the end of these instructions in order to double check if you understand the instructions. Please answer those questions. When you answered them correctly, the experiment will start. During the experiment you can earn Taler depending on your decisions and the decisions of the other participants. At the end of the experiment, the gained Taler are exchanged at a rate of
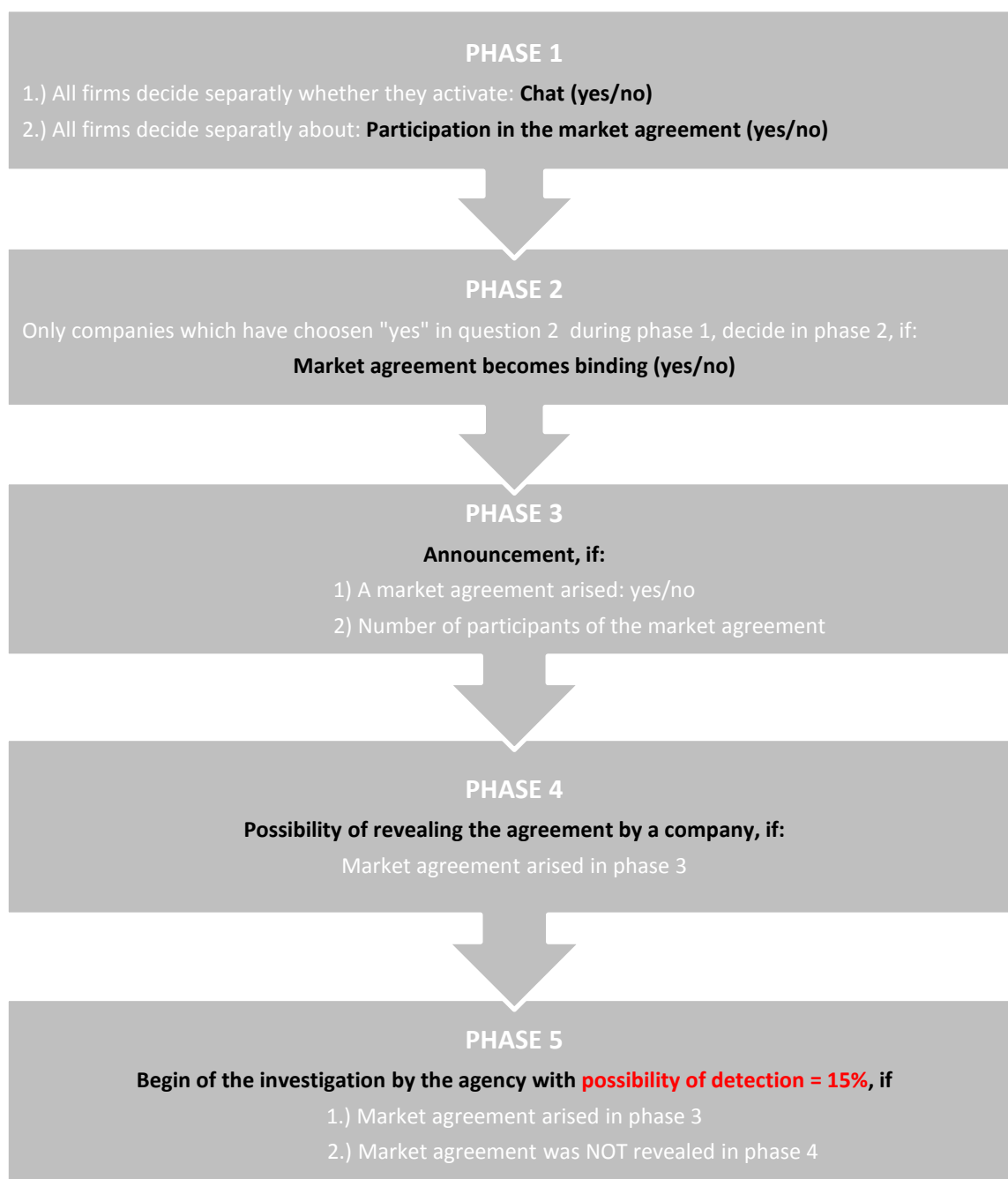
100 Taler = 1€

and paid out to you. In order to do so, please wait in your booth until you are called forward to collect your earnings. Please bring all your documents, which were given to you, to the payoff after the experiment.

Please note that from now on and during the entire experiment, you must not talk to any other participant. We are forced to call off the experiment, should it happen. If there are any questions, please raise your hand and we will come to you to answer your question.

The experiment consists out of **16 rounds**. In these rounds you take up the role of a company on a market together with three other companies played by the other participants. This market totally consists of these four companies. The constitution of these markets is set at the beginning of the experiment. During the experiment the constitution of the market will not change. Hence you are acting in a four-company market every round, which consists of exactly the same companies. Moreover in every market there exists an agency which is represented by the computer. During the experiment you will not be able to gain information about the identity of the other companies. This is also the case after the experiment. The other participants are unable to gain any personal information about you, too. Thus all interactions during the experiment are anonymous. We do not record any data linked to your name.

Detailed Information on the Experiment

The experiment consists of **16 rounds.** All rounds are identical and are divided into **five phases** (see diagram):

PHASE 1
1.) All firms decide separately whether they activate: **Chat (yes/no)**
2.) All firms decide separately about: **Participation in the market agreement (yes/no)**

PHASE 2
Only companies which have choosen "yes" in question 2 during phase 1, decide in phase 2, if:
Market agreement becomes binding (yes/no)

PHASE 3
Announcement, if:
1) A market agreement arised: yes/no
2) Number of participants of the market agreement

PHASE 4
Possibility of revealing the agreement by a company, if:
Market agreement arised in phase 3

PHASE 5
Begin of the investigation by the agency with possibility of detection = 15%, if
1.) Market agreement arised in phase 3
2.) Market agreement was NOT revealed in phase 4

In each round you can achieve earnings („round earnings"), which depend on the implemented actions. Your round earnings depend on the total number of participants (non-participants) of the market agreement. Moreover, your earnings depend on the detection or non-detection of the agreement by the agency. In order to get a more detailed explanation how the round earnings are composed in the single cases, please take a look at the below-mentioned tables.

The table shows the earnings which arise from the formation of a market agreement. It illustrates all possible combinations of the several participants and non-participants. Thereby it shows which payoff opportunities arise for the participants and the nonparticipants of the market agreement depending on these combinations. Furthermore, the table indicates (in brackets) which amount of the payoff is subtracted, if the market agreement is revealed or detected. **The probability of detection amounts to 15%.**

Possible combinations and resulting payoffs

Participants of the market agreement	Non-participants of the market agreement	Earnings, Participant (<u>EVERY</u> participant gets under the assumption that the market agreement arises)	Earnings, Non-Participant (<u>EVERY</u> non-participant gets under the assumption that the market agreement arises)
0	4	No participants exist	64 Taler
1	3	64 Taler	64 Taler
2	2	50 Taler (-35 Taler)	100 Taler
3	1	59 Taler (-34 Taler)	178 Taler
4	0	100 Taler (-40 Taler)	No non-participants exist

<u>Example 1:</u>

Suppose, **only** you and one other company participates in the market agreement. Thus, there are two participants and two non-participants. This situation is described in row 3. If furthermore - after the end of the second phase - the market agreement is achieved and it is neither detected nor revealed, you gain 50 Taler, the same amount as the other participants. The non-participants will **both** earn 100 Taler. If the agreement is detected by the agency in phase 5, you will get a discount of 35 Taler and hence a payoff of 15 Taler. The payoff of the non-participants remains constant with 100 Taler.

Phase 1

1.) In the **first round** you and all other companies in phase 1 can decide to activate a **chat-window.** The chat-window is **activated for all companies in the market** if at **least one company** decides to activate the chat-window. Thus, it might be the case that several companies decide simultaneously to open the chat-window. Before the chat-window starts all firms are informed about the decisions

of the other firms, to activate the chat or not. If the companies want to communicate in the chat, the text can be tipped into the bottom bar. After **60 seconds** the chat window closes automatically. If none of the participants decides to activate the chat window, no chat will take place and thus the chat-phase ends.

2.) Now you can decide whether you **intend to participate in a market agreement.** Once each participant has made his decision the next phase starts.

Phase 2

In this phase you will get information about the total number of companies in your market, which intend to participate in a market agreement.

In phase 2 two possibilities exist:

<u>**Either:**</u>

1. **In the first phase you affirmed your potential willingness to participate the market agreement.**
   Hence, you now must decide if you really want to commit to the market agreement in phase 3. First of all, you get information about the total number of potential participants and definite non-participants and about possible earnings. Now you have to decide if you still want to participate in the market agreement; thereby the following holds:
   <u>**ONLY**</u> if **all the companies of your market, which announced in phase 1 their willingness to participate in a market agreement, confirm this again (click "yes"),** the commitment becomes binding. If **even one** of these companies does not confirm (click "no"), this commitment is not binding anymore:
   If the commitment becomes binding, then all companies which committed to implement the market agreement in phase 3 automatically stick to the agreement. **If the commitment becomes non-binding all 4 firms** of the market **automatically** behave **as non-participants of the market agreement** and get 64 Taler.

   Phase 2 ends, once you have announced whether to commit or not.

<u>**OR:**</u>

  2. **You announced in the first phase that you do not want to participate in a market agreement**

   In this case you do not make a decision in phase 2. You will only be given information about how many companies intend to commit and how many companies definitively will not participate.

Phase 3

In this phase you will find out if the market agreement became binding. You will also be informed on the total number of companies which decided to finally commit to the market agreement.

Phase 4

This phase only starts if the market agreement becomes binding. Then a sequence of all participating firms is determined, which indicates in which order firms can announce the market agreement. The first company of this sequence can decide whether it wants to inform the agency about the market agreement or not. **<u>A company which has activated the chat in phase 1 has not the opportunity to reveal the market agreement.</u>** If the first firm in the sequence **reveals the market agreement** no amount is subtracted from its payoff.

In this case phase 5 is skipped and **all other firms are subjected to a subtraction of the terms in brackets from their payoffs.**

If the market agreement is not revealed by the first company, the second company in the sequence can decide whether it reveals the market agreement. This will be continued as long as one firm reveals the market agreement or the sequence ends and no information was revealed. If none of the firms **reveals the market agreement** it stays undetected in this phase.

Phase 5

This phase only starts if a market agreement becomes binding and is not revealed. In this phase the agency starts its investigation. The market agreement is detected with a probability of 15%. If the **market agreement is not detected** all firms get the payoffs which are stated in the table. If the **market agreement is detected** the amount in the brackets is subtracted. Afterwards the game ends.

Check-up questionnaire

Now you are asked to answer the following questions. The questions are only designed to check if you understand the instructions correctly. All questions are based on random examples. For simplicity, we sign the four group members with the letters "A", "B", "C" and "D".

If there are any questions up to now, please raise your hand.

Check-up questions 1/2

a) *Assume you are company A.*
   - Company D, B and C decide to activate the chat window for everyone. Assume you decide to activate the chat window for everyone, will the chat window be activated for all companies? (yes/no)?

     _____

   - Assume no firm decides to activate the chat window for everyone. Will the chat window be activated for all companies? (yes/no)? _____
   - Assume only you decide to activate the chat windows for everyone. Will the chat window be activated for all companies? (yes/ no)? _____

b) *Assume you announce in phase 1, that you do <u>not</u> participate in the market agreement. Furthermore the companies B, C and D announce, that they intend to participate in a market agreement.*

   - Which firms are allowed to decide in phase 2 whether to finally commit to adhere to the market agreement?_____

   - Assume the market agreement is conducted, which earnings would be made if the market agreement would neither be reported in phase 4 nor be detected in phase 5:
     You_____   Company B_____   Company C_____

     Company D_____

   - Assume the market agreement will <u>not</u> be implemented, which earnings would result for:

     You_____   Company B_____   Company C_____

     Company D_____

c) *In phase 2 only one of the potential members (who decided in phase 1 **to participate in the market agreement)** wants to definitely commit to adhere to the market agreement.*

   - Will the market agreement be implemented (yes/no)?_____

d) *Assume now that phase 3 begins and the computer assesses the final participants and non-participant of a potential market agreement.*

- Who is finally assessed as non-participant? _____

- Who is finally assessed as participant? _____

- Which earnings result from this in phase 3 for:

  You_____   Company B _____   Company C_____

  Company D_____

Check-up questions 2/2

a) *Assume you are company A. Company D and C decide to activate the chat window for all. You and company B decide not to do so.*
- Will the chat window be activated for all firms? (yes/no)? _____

b) *Assume that in phase 1 you announce that you decide to participate in the market agreement. Furthermore, company B, C and D announce that they intend to participate in the market agreement as well.*

- Which firms are allowed to decide in phase 2 whether to finally commit to adhere to the market agreement?_____

- Assume the market agreement is conducted, which firms participate in the market agreement?

  Company A ☐ Company B ☐   Company C ☐ Company D ☐

- Assume the market agreement is <u>not</u> implemented, which earnings would result from this in phase 3 for:

  You_____   Company B_____   Company C_____

  Company D_____

c) *In phase 2 all members (who **decided** in phase 1 **to participate in the market agreement**) want to finally commit to adhere to the market agreement.*

- Will the market agreement be implemented? (yes/no)? _____

d) *Now assume that phase 3 begins and the computer assesses the final participants and non-participant of a potential market agreement.*

- Who is finally assessed as non-participant? _____

- Who is finally assessed as participant?_____

e) *Assume now that in phase 4 a sequence is determined, which states in which order the companies can reveal the market agreement. Which firms will be excluded from this sequence?*

Company A ☐   Company B ☐   Company C ☐ Company D ☐

f) *Assume company B is the first company in the sequence. Company B decides to **reveal** the market agreement to the agency*

- How much does company B get? _____

- Does phase 5 take place? (yes/no)? _____

- What do you, company C and D get?

    You_____   Company C_____

    Company D_____

g) *Assume now that company B decides **not to reveal** the market agreement to the agency*

- Which company has now the choice to reveal the market agreement? _____
  ___

- What do you, company B, C and D get if this company reveals the market agreement?
  You_____   Company B_____   Company C_____

    Company D_____

h) *Assume now that you and company B decided <u>not</u> to reveal the market agreement in phase 4. Now, phase 5 starts in which the market agreement can be detected by the agency.*

- What do all firms get if the agency detects the market agreement?

    You_____   Company B_____   Company C_____

    Company D_____

- What do all firms get if the agency does <u>not</u> detect the market agreement?

    You_____   Company B_____   Company C_____

    Company D_____

How high is the detection probability? _____