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Rebels without a clue? Experimental evidence on partial cartels

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Rebels without a Clue?
Experimental Evidence on Partial Cartels

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April 2013

Abstract

This paper provides experimental evidence on the formation of partial cartels with endogenous coordination. Firms face a coordination challenge when a partial cartel is to be formed as every firm is better off if it is not inside the cartel but is a free-riding outsider. We introduce a three-stage mechanism with communication which facilitates the formation of a cartel and respectively allows the formation of a partial cartel. All-inclusive cartels are always formed. We find that partial cartels are frequently rejected out-of-equilibrium if outside firms profit excessively from the formation of the cartel.

JEL Classification numbers: C92, D02, L41.

Keywords: Partial Cartels, Coordination, Communication, Experiment.

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What is a rebel? A man who says no, but whose refusal does not imply a renunciation-
Albert Camus

1 Introduction

The emergence of partial cartels remains a highly debated phenomenon in the theory of collusion which, in spite of numerous contributions to the subject, still leaves a host of questions unanswered. The cartel stability literature provides important insight on the market conditions which are necessary for a partial cartel to emerge, but deliberately leaves the subject of coordination challenges within the partial cartel untouched. Evidence from antitrust cases such as the vitamin C cartel, the district heating pipe cartel or the sugar institute cartel suggests that cartel members had to coordinate their behavior in order to confront the disruptive effect of those firms operating outside the cartel.[1] The failure to adequately coordinate actions among the cartel members, in order to respond to the competitive pressure of the outside firm, may ultimately lead to the breakdown of the collusive agreement. This phenomenon has been observed in the vitamin C cartel and the heating pipe cartel.

A significant coordination challenge for a partial cartel may be generated by the fact that outside firms make excessive profits at the expense of the cartel members. As d'Aspremont et al. (1983) underline "...however by free-riding, fringe firms enjoy higher profits than cartel members." In fact the outside firms have many points in common with the rebel, as "saying no" to the cartel does not imply a renunciation at all for them. This raises the following research question: *How do firms coordinate the formation of a partial cartel when a firm would be better off if it was the free-riding outsider?* We tackle this problem as we provide an experimental analysis on how firms coordinate the formation of a partial cartel. Therefore, a mechanism that facilitates the formation of a stable partial cartel is designed which allows us to infer the formulated coordination challenge.

This paper departs from the experimental cartel formation approach where a unanimous decision to communicate constitutes cartel formation.[2] Instead we analyze a cartel with an institutional structure as in Selten (1973) which adequately copes with the coordination challenge in the cartel formation process. We therefore use a modified version of a three-stage mechanism first experimentally introduced by Kosfeld, Okada, and Riedl (2009)(henceforth KOR, 2009) which works as follows: the formation process is split into two stages, where only those firms that attempt to establish a cartel in a first stage are allowed to form it in the second stage.

[1] In the vitamin C cartel, cartel members decided to purchase the excess supply of non-cartel members, in order to ensure that the quotas fixed by the cartel would be fulfilled. The heating pipe cartel opted for a collective boycott against the customers and suppliers of the outside-firm Powerpipe in order to drive it out of the market (both cases see Harrington, 2006 and Harrington and Skrzypacz, 2011). A similar strategy was observed in the sugar institute cartel case, where sugar refiners from Florida suggested that the cartel should either force the outside firm Hershey to stop its "unethical" behavior or convince it to join the cartel (see Genesove and Mullin, 1999).

[2] See, for instance, Apesteguia et al. (2007), Hinloopen and Soetevent (2008) and Bigoni et al. (2012). This literature is discussed comprehensively, in the next section.

Firms observe the number of potential cartel members and thus the cartel size in the second stage before they unanimously decide to form the cartel. The third stage binds all cartel members to a quantity decision while the outsiders play the best-response strategy. By contrast, if the cartel is not formed, all firms play their competitive best-response strategies. We introduce an innovation to the KOR (2009) framework by allowing the firms to communicate before the mechanism starts.

This mechanism not only provides a clear partition between insiders and outsiders in the first stage, it furthermore allows potential participants to check which firms are inside and outside of the cartel, before its formation. Undesirable constellations may thus be rejected in the second stage. Making the agreement binding is a simplification of the cartel implementation challenge as it guarantees the cartel's stability and ensures that it will not be jeopardized by cheaters within the cartel. This approach provides assurance of the profits insiders and outsiders will make and generates the profit asymmetry which is the subject of the research question at stake. The introduction of communication is crucial in the context of cartels (see McCutcheon, 1997; Genesove and Mullin, 2001; among others) and may furthermore reveal what motives drive the firms' decisions in the presence of profit asymmetries between cartel insiders and outsiders. The combination of an institutional structure provided by the KOR (2009) mechanism and communication not only allows us to answer our research question but also reflects practices observed in cartel cases. As Genesove and Mullin (2001) point out: "Studying the Sugar Institute refocuses our attention on detection, in revealing how firms may enhance it by altering their environment through both specific rules and institutional structure, including communication." We are among the first to provide experimental evidence on the formation of a partial cartel.

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 predictions and the hypotheses we postulate. Sections 4 and 5 discuss the results, while Section 6 concludes.

2 Literature and Experimental Design

2.1 Related Literature

The predominant experimental literature on endogenous cartels mainly focuses on the disruptive effect of antitrust policies on the implementation of all-inclusive cartels. Apesteguia et al. (2007), Hinloopen and Soetevent (2008) and Bigoni et al. (2012) therefore leave out the endogenous cartel formation process and focus on the coordination of prices and the subsequent implementation of the cartel strategy. This approach allows us to infer the role of defection and "whistleblowing" of cartel members that file for leniency on the implementation of cartels. The formation of the cartel is deliberately simplified, since a one-stage decision to activate a communication device corresponds to the entire cartel formation process. Moreover, only all-inclusive cartels can be formed and partial cartels are ruled out per se, which neglects possible cartel stability concerns.[3]

[3]Apesteguia et al. (2007) and Hinloopen and Soetevent (2008) abstract from stability concerns as one of their requirements is that all firms decide to activate communication in order to establish a cartel. Bigoni et al. (2012) analyze a duopolistic market, which rules out the emergence of stability problems.

As opposed to the approach followed in this literature, we tackle the cartel formation challenge and abstract from the cartel implementation challenge. We introduce a multi-stage mechanism that allows the firms to assess if the critical mass of firms willing to participate in a cartel is reached before the cartel is implemented. This guarantees the emergence of stable cartels and allows us to infer how firms coordinate the formation of a partial cartel.

The theoretical literature on cartel stability determines the necessary market conditions that guarantee the emergence of stable cartels and their respective subsets of partial cartels. Accordingly the existence of partial cartels is established in a static setting for price-leadership (e.g., d'Aspremont et al., 1983; Donsimoni, 1985; d'Aspremont and Gabszewicz, 1986; Donsimoni et al., 1986), for quantity-leadership (e.g., Shaffer, 1995) and in a dynamic capacity-constrained price game (e.g., Bos and Harrington, 2010). Most of the papers, however, focus on the structure of the cartel, neglecting the coordination challenge firms face in the formation of these cartels.

A notable exception in this strand of literature is Selten (1973) who introduces institutional assumptions on the operation of a cartel characterized by a multi-stage coordination mechanism. Here, firms that decide on the formation of a cartel at the first stage bargain over its implementation via a quota scheme at the second stage.[4] The coordination challenge is therefore composed of a formation and a bargaining challenge since the cartel bargaining problem can only be solved and subsequently implemented if a sufficient number of firms decide to form the cartel beforehand. Selten (1973) infers the impact of market size on the stability of the collusive agreement, focusing on the bargaining solution which allows the implementation of the cartel. Our paper differs in this aspect as it abstracts from this implementation challenge. Instead it focuses on the formation challenge, analyzing how payoff asymmetries and the subsequent free-rider problem generated in partial cartels impact on coordination. This formation challenge has been tackled by the experimental literature on endogenous institutions in the context of public-good provision as, for instance, in KOR (2009).[5]

Here, an experimental analysis on the formation of an endogenous institution which sanctions free-riding in the context of a public good game is provided. In a three-stage decision game, the first stage of the KOR (2009) experiment consists of a vote to participate in an institution, as in Selten (1973). In the second stage all subjects that decided to participate at the first stage 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. The outsiders may contribute whatever they want to the public good. We apply this three-stage mechanism to a Cournot market, where the first and second stages are equivalent to KOR (2009). At the third stage, we depart from their framework as the cartel chooses the joint-profit-maximizing Cournot

[4] In Selten (1973), the solution of the cartel bargaining stage implies that firms will stick to the agreement and not cheat on the cartel. Hence the successful coordination of the quotas guarantees that the cartel is implemented afterwards.

[5] Note that the theoretical model implemented experimentally in KOR (2009) developed in Okada (1993) is closely related to Selten (1973). 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."

quantity for all its members, whereas the outsiders always play best-response. Hence we assume that the cartel may be able to prevent cartel members from cheating. Here, one might raise the objection that joint profit maximization does not satisfy the incentive compatibility constraint of a firm that wants to maximize its own profit. However, evidence from several cartel cases as presented in Levenstein and Suslow (2006) confirm the theoretical finding revealed by Bernheim and Whinston (1985) which shows that a joint-profit maximizing strategy may be sustained in a cartel.

Levenstein and Suslow (2006) group the problems cartels have to overcome in three categories: coordination of the behavior to a collusive agreement, cheating on the collusive agreement and market entry. As our research focuses on the first category, namely coordination, our analysis abstracts from the second and third categories. On the one hand this approach therefore introduces a technical simplification of the cartelization challenge. Stage three guarantees that the potential payoff asymmetries generated by outside firms are not jeopardized by cartel members that decide to cheat on the cartel agreement. Hence the effect of cheating within the cartel is neglected in our framework. On the other hand the effect of cheating may be neglectable in the context of explicit collusion as empirical evidence provided by Levenstein and Suslow (2006) suggests.[6] Furthermore, Bernheim and Whinston (1985) show that the implementation of a joint-sales agency incentivizes competing firms through an indirect mechanism to opt for the joint-profit-maximizing output. Experimental evidence by Cooper and Kuhn (2011) highlights that the implementation of an effective retaliation mechanism that punishes cheating efficiently induces full cooperation in an infinitely repeated coordination game. Hence our setup does not literally require enforceable cartel contracts or a binding agreement to guarantee that cartel members maximize joint profits.

As the coordination of the cartel formation process in our experiment is composed of a three-stage mechanism with a chat option, we contribute to the literature on the pro-collusive effect of communication. Economic theory by Crawford and Sobel (1982) and Farrell and Rabin (1996) underlines that coordination may be facilitated by communication, which is furthermore experimentally confirmed (e.g., Cooper et al., 1989; Cooper et al., 1992; Charness and Dufwenberg, 2006). Recent papers in the experimental antitrust literature by Cooper and Kuhn (2011) and Fonseca and Normann (2012), who thoroughly analyze the impact of communication on cartelization, confirm its pro-collusive effect. We contribute to this literature as we analyze how communication impacts on the formation of partial cartels. The communication device is of particular importance here, as it may allow us to understand the underlying motivations of colluding firms. We therefore evaluate communication following the approaches used in Andersson and Wengström (2007) and Kimbrough et al. (2008) in order to infer whether or not payoff asymmetries influence the formation of partial cartels.

[6]Note however that Levenstein and Suslow (2006) find that market entry is one of the biggest challenges cartels face.

2.2 Experimental Design

In our experiments we implemented four different treatments: *Standard Endogenous Cartels with Chat* (SECC), *Standard Endogenous Cartels* (SEC), *Modified Endogenous Cartels with Chat* (MECC), *Modified Endogenous Cartels* (MEC).

TABLE 1 Treatments

		communication	
		chat	no chat
payoff structure	Standard Endogenous Cartels	**SECC**	**SEC**
	Modified Endogenous Cartels	**MECC**	**MEC**

SECC, serves as a starting point. Here, we first infer how firms coordinate the formation of a stable cartel. The treatment SEC is without chat and allows us to infer the role of communication on coordinating the formation of a stable all-inclusive cartel. Both SECC and SEC are our baseline treatments. The MECC treatment introduces a crucial modification of the payoff structure for a partial cartel in the standard treatment, which facilitates the emergence of a partial cartel (see next section for a detailed theoretical description of the game). Again we introduce a treatment MEC without chat, which allows us to evaluate the role of communication on the implementation of a stable partial cartel. Note that the MECC treatment and the SECC treatments are implemented for exactly the same market constellations, which let us compare how firms coordinate the formation of a stable all-inclusive cartel and a stable partial cartel. Thus we can infer if there is a coordination challenge when partial cartels are formed and answer our research question.

Table 2 provides an overview of the payoffs generated in a symmetric Cournot game with four firms for every cartel constellation.[7] In the table, cartel members' payoffs are determined following the assumption that they maximize the joint profits. Furthermore, we assume that the outsiders play their best-response strategies which determines their payoffs. In the following we explain our mechanism.

[7] We modify the payoffs for a three-firm cartel from 59 to 70 Taler in the modified treatments in order to analyze the formation of partial cartels. Although this modification is exogenous it allows us to compare the formation process of a partial and an all-inclusive cartel in a symmetric four-firms Cournot market. Furthermore, the increase of payoffs within a three-firm cartel may also be justified in the context of association formation as in Bloch (2010) where synergies within a partial cartel yield a comparable increase in payoffs.

TABLE 2 Payoffs in the Treatments

Composition		Payoffs in SECC/SEC		Payoffs in MECC/MEC	
# insiders	# outsiders	insider(s)	outsider(s)	insider(s)	outsider(s)
0	4	na	64	na	64
1	3	64	64	64	64
2	2	50	100	50	100
3	1	59	178	**70**	178
4	0	100	na	100	na

Note: The table illustrates subjects' payoff dependent on their role (insider/outsider) and the total sum of insiders/outsiders. It also depicts how the combination of chat and the modified mechanism works. Payoffs are presented in *Taler* which is a synonym for *ECU* (Experimental Currency Unit). The payoffs were rounded to integers, and we always assume the subjects to play their best-responses.

In **stage zero** of SECC and MECC firms of one market were given the possibility to chat in a window for a total of 60 seconds. After that the window automatically closed and stage one started immediately.[8]

In **stage one** all subjects in a market simultaneously had to state whether they wanted to join a cartel.[9] Subjects simply had to click on a "yes-" or "no-" button. If a participant stated in stage one that she was willing to form a cartel she became a *possible insider*. Participants who stated in stage one that they did not want to form a cartel became *ultimate outsiders*.

In **stage two** everybody was informed of the total number of possible insiders and ultimate outsiders. Note that both types of subjects (possible insiders as well as ultimate outsiders) were given information on the total number of participants willing to establish a cartel. In stage two, only possible insiders were allowed to decide whether they definitely wanted to form a cartel. Beforehand, they were asked if they ultimately wanted to stick to the cartel. The possible payoff of being a cartel member was presented to them as well as the possible payoff of being an outsider. Additional information about the resulting payoffs of the ultimate outsiders was also given. Once again, possible insiders either had to click the "yes-" or "no"- button to state whether they ultimately wanted to join the cartel. If one of these subjects clicked the "no-" button, the agreement was rejected and no cartel was established. The cartel agreement became binding if and only if *all* possible insiders in stage two selected the "yes-" button to confirm that they ultimately wanted to join the cartel.[10] Otherwise they became direct competitors and received the Cournot Nash equilibrium profits of a standard four-firm Cournot market. Ultimate outsiders did

[8]Stage zero lasted for 90 seconds in the first period as subjects first had to find out how to use the chat option. Afterwards the time was reduced to 60 seconds. Firms remained anonymous during the chat and were given neutral names like "firm 1-4" which did not change.

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

[10]Note, if unanimity had not been required the firms would have again faced a coordination problem within the cartel in stage two. Hence, for the sake of operability we implemented unanimity.

not have to make any choice in stage two and were only informed of the amount of possible insiders.

In **stage three** the subjects' payoffs were determined. Every subject was informed of whether a cartel had been formed or not. Additionally, they obtained information about their own payoffs and those of the other participants which resulted from the occurrence or non-occurrence of the cartel. Figure 1 gives an overview of the mechanism's stages.

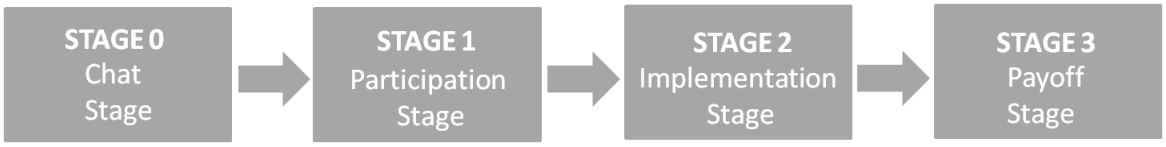

Figure 1: Cartel-formation stages

We used a fixed matching protocol where every group interacted for 10 rounds, i.e., the three-stage game was repeated for 10 periods.[11] We ran two sessions of our SEC treatment with a total of seven matching groups. Additionally, two sessions of MEC with seven matching groups were conducted. We carried out one session of SECC (with three matching groups) and one session of MECC (with four matching groups). The experiment was conducted at the *DICE Lab* of the University of Duesseldorf in February and April 2011. In total, 84 subjects from the University of Duesseldorf from various fields took part in the experiment. The profits achieved by the participants were converted at an exchange rate of 1 Taler = 0.02€. On average they earned 16.96€. The experiments were programed in z-Tree (Fischbacher, 2007) and our subjects were recruited with the online recruitment system ORSEE (Greiner, 2004) .

3 Theoretical predicitions and hypotheses

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 $P(Q_i) = 50 - \sum_{i=1}^{4} Q_i$. Firms face marginal cost of production $c = 10$. In the case of oligopolistic Cournot competition the profits of the firms correspond to:

$$\Pi = \left(\frac{40}{4+1}\right)^2 = 64. \tag{1}$$

If m firms decide to form a cartel the insiders' profits correspond to

$$\Pi(m) = \frac{(40)^2}{(4-m+2)^2 m}. \tag{2}$$

[11] We opt for fixed matching as this replicates a real market with recurrent interaction.

whereas the outsiders' profits are given by:[12]

$$\Pi(m) = \frac{(40)^2}{(4-m+2)^2}. \tag{3}$$

A complete overview of the standard Cournot payoffs depending on the cartel outcomes is provided in the following table:

TABLE 3 Standard Cournot Payoffs

Composition		**Firms' Payoffs**	
# insider(s)	# outsider(s)	insider(s)	outsider(s)
0	4	na	64
1	3	64	64
2	2	50	100
3	1	59	178
4	0	100	na

Note: The table illustrates firms' standard Cournot payoffs dependent on different cartel compositions

The cartel-stability conditions outlined in d'Aspremont et al. (1983) state that all cartel members must prefer to be inside the cartel (internal stability) while outside firms must always prefer to be outside the cartel (external stability) in equilibrium. Absent of our mechanism we never observe a stable cartel as the "internal stability" criteria given by

$$\frac{(40)^2}{(4-m+2)^2} < \frac{(40)^2}{(4-m+2)^2 m}. \tag{4}$$

holds for no value $m > 1$.

Our mechanism copes with the cartel stability issues that may jeopardize the formation of a stable cartel. As the third stage binds the cartel members to the joint maximizing strategy, possible cartel insiders at the second stage decide to form the cartel if and only if the cartel payoffs exceed the competition payoffs without a cartel. Therefore the internal-stability criteria in our mechanism corresponds to

$$\frac{(40)^2}{(4-m+2)^2 m} > 64. \tag{5}$$

Hence, internal cartel stability is guaranteed if and only if $m = 4$.

In the first stage firms decide to be either a possible insider or an ultimate outsider. As the $m = 4$ firms cartel is the only stable cartel, free-riding on the cartel always fails. There is no second stage equilibrium with outside firms, so that the $m = 4$ cartel is also

[12]Note that this strategy induces the outside firm to be very aggressive, as every outside firm will have exactly the same market share as the cartel.

externally stable. Hence all firms announce their willingness to join the cartel in the first stage, where a cartel with $m = 4$ firms is a subgame-perfect equilibrium. Proposition 1 states our result:

Proposition 1: *With standard Cournot payoffs, the cartel with $m = 4$ members is a strict subgame perfect Nash equilibrium.*

We now turn to the analysis of the case with the modified payoffs for a three-firm cartel. The payoffs are outlined in the following table:

TABLE 4 Modified Cournot Payoffs

Composition		**Firms' Payoffs**	
# insider(s)	# outsider(s)	insider(s)	outsider(s)
0	4	na	64
1	3	64	64
2	2	50	100
3	1	**70**	178
4	0	100	na

Note: The table illustrates firms' modified Cournot payoffs dependent on different cartel compositions

This modification of firms' payoffs changes the outcome of the game as follows: given our mechanism, the potential cartel members implement the cartel at the second stage if the following condition is satisfied:

$$\frac{(40)^2}{(4-m+2)^2 m} > 64 \tag{6}$$

Now, this not only holds for $m = 4$ but also for $m = 3$ as the insiders' payoffs correspond to 70.[13]

At the first stage, a firm may increase its payoffs from 100 to 178 if it becomes an ultimate outsider. The cartel with $m = 3$ is internally stable, as no firm will revoke its decision to participate in the cartel with three firms. It is externally stable, as the outside firm would reduce its payoffs if it announced its willingness to join the cartel at the first stage instead. This is not the case for the all-inclusive cartel with four firms, as one firm would be better off by becoming an ultimate outsider at the first stage. We thus formulate the following proposition:

Proposition 2: *In the case of modified Cournot payoffs we obtain four strict subgame-perfect equilibria yielding stable cartels each with $m = 3$ cartel members and every firm as the only outsider in each of the equilibra.*

[13]Note that the $m = 3$ cartel is also externally stable, i.e., no outside firm will rather be inside the cartel than outside the cartel as $178 > 100$.

We also obtain a symmetric Nash equilibrium in mixed strategies where firms opt for the possible insider position with a probability of $p = \frac{3}{16}$ as the decision is simultaneous at the first stage. Given this result the emergence of a three-firm cartel is observed with a probability of $p = 0.214$, while a four-firm cartel emerges with a probability of $p = 0.0012$. However, it suffices for our purposes to focus on a partial cartel encompassing three firms. Note that our theoretical predictions are outlined for a static framework although our experimental treatments are repeated for 10 rounds. As we do not obtain multiple equilibria, we do not expect the finite repetition of the game to yield diverging results. Nonetheless, our result section includes a learning section in order to infer whether the finite repetition of the game may influence the obtained results.

3.2 Hypotheses

Given the theoretical predictions in the previous subsection we derive our hypotheses. Propositions 1 and 2, predict that the mechanism should yield cartels. Following Proposition 1 which states that the four-firm cartel is the only cartel, we expect the all-inclusive cartel to be the most frequent cartel composition in SECC. In line with our theoretical predictions there should be no difference between the communication and the no-communication case. Thus most cartels in SEC should also be all-inclusive cartels. This concludes Hypotheses 1a and 1b.

Hypothesis 1
(a) In SECC, most cartels will be all-inclusive cartels.
(b) In SEC, most cartels will be all-inclusive cartels.

In the case of modified Cournot payoffs, proposition 2 emphasizes that only the cartel composition with $m = 3$ cartel members and one outside firm is stable. Thus, we expect that in MECC most cartels will be partial three-firm cartels. Following the theoretical predictions, this should be the same in MEC. We can therefore establish Hypotheses 2a and 2b.

Hypothesis 2
(a) Most cartels in MECC will be partial three-firm cartels.
(b) Most cartels in MEC will be partial three-firm cartels.

Our research question focuses on the formation of partial cartels. Consequently we analyze how payoff asymmetries in the case of partial cartels influence the decision to form the collusive agreement. Proposition 2 suggests that possible inside firms accept partial cartelization with three cartel members and one outside firm. This yields Hypothesis 3.

Hypothesis 3

Possible cartel members should accept partial cartelization with one outsider at the second stage of the mechanism.

4 Results

In the following paragraphs the hypotheses are tested. The analysis starts with a summary statistic reporting Stage-3 outcomes. Subsequently, the analysis focuses on attempted cartels, afterwards we present our main results focusing on established cartel compositions and firms' willingness to accept. The data contains one MECC group which decided to play a taking-turns strategy[14] coordinating the formation of a three-firm cartel which encompassed the outside firm in its collusive agreement. As this decision constitutes a collusive agreement the group is also treated as a four-firm cartel.[15]

Table 5 gives an overview of the average frequency of established cartel compositions in all periods of the four treatments.

TABLE 5 Frequency of Stage-3 Outcomes

	no cartel	2-firm cartels	3-firm cartels	4-firm cartels	**total cartels**
SECC	0.033	-	-	0.967	**0.967**
SEC	0.743	-	0.014	0.243	**0.257**
MECC	0.175	-	-	0.825	**0.825**
MEC	0.800	0.014	0.114	0.071	**0.200**

Note: The table gives an overview of Stage-3 outcomes in the different treatments. Here, the MECC group which played the taking-turns strategy between periods 4-7 is counted as a 4-firm cartel. The table furthermore includes the frequency of total established cartels.

Our results suggest that most cartels are established in SECC (97%) and MECC (83%), whereas there are 26% cartels in SEC and 20% cartels in MEC. The table furthermore emphasizes that cartels are most often all-inclusive. This is true for SECC, MECC and SEC. The only exception is the MEC treatment where firms seem to have faced a coordination problem.

4.1 Stage-1 Results: Attempted Cartels

Table 6 presents the fraction of total attempted full and partial cartels. It also consolidates the cases where only three firms (one ultimate outsider) and two firms (two ultimate

[14] Similar taking-turns strategies have been observed in Fonseca and Normann (2012).

[15] The chat protocol revealed that this group played the taking-turns strategy between periods 4 and 7. Hence, the four-firm data comprises this group's choices of periods 4-7. Note that when firms play this taking-turns strategy their joint profits are 388, while coordination to the all-inclusive cartel yields joint profits of 400.

outsiders) attempted to form the cartel.

TABLE 6 Fraction of Attempted Full and Partial Cartels

	total (attem.) full cartels	one-sided p-value	**total (attem.) partial cartels**	one ultimate outsider	two ultimate outsiders
SECC	**0.967**	$>^{*}$ 0.051	**0.033**	0.033	-
SEC	**0.357**	$\approx$ 0.223	**0.557**	0.443	0.114
MECC	**0.825**	$>^{**}$ 0.029	**0.175**	0.150	0.250
MEC	**0.086**	$<^{***}$ 0.009	**0.571**	0.257	0.314

Note: One-sided Wilcoxon matched-pairs tests were used to test for significant differences. In this table ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Tests were applied at the match-group level. We had four match groups in SECC and three match groups in MECC and seven match groups in SEC and MEC. Here, total attempted full cartels depict the rates of attempted cartels where all firms were part of the possible cartel agreement. The case where one group in the MECC treatment was playing the taking-turns strategy between periods 4-7 is also included in this category. Note, we also count this case as an attempt to a full cartel agreement since this corresponds to a collusive strategy including all four firms. The table only accounts for the cases where at least two firms opted to form a cartel at stage 1.

It turns out that in SECC significantly more full-firm cartels (96.7%) than partial cartels (3%) are attempted. Focusing on the no-communication case (SEC) no significant difference can be found between the fraction of attempted full and partial cartels.

In MECC we obtain a significantly higher rate of attempted full cartels (82.5%) than partial cartels (17.5%). In MEC the opposite is true: significantly more firms attempt the formation of partial cartels (57.1%) than full cartels (8.6%). This may be a fist indication that the communication possibility persuades the firms to coordinate to the all-inclusive cartel in the modified treatment. By contrast, absent of the chat opportunity firms in MEC try to coordinate to the partial cartel.

4.2 Stage-2 Results: Established Cartel Compositions

In order to test Hypotheses 1 and 2 we analyze which cartel compositions most often occurred in all of our treatments. Table 7 presents our main results regarding cartel coordination, i.e., it gives a comparison of established full and partial cartels. The table summarizes the fractions of established four-firm, three-firm, and two-firm cartels.

First, we observe that our mechanism facilitates the formation of cartels in all of the four treatments. A closer look at the benchmark treatments reveals that in SECC only stable four-firm cartels emerge. This confirms Hypothesis 1a.

TABLE 7 Fraction of Full and Partial Cartels (provided a cartel was established)

	total full cartels	one-sided p-value	**total partial cartels**	3-firm cartels	2-firm cartels
SECC	**1.000**	-	-	-	-
SEC	**0.944**	$>$ ** 0.034	**0.056**	0.056	-
MECC	**1.000**	-	-	-	-
MEC	**0.357**	$\approx$ 0.159	**0.642**	0.571	0.071

Note: One-sided Wilcoxon matched-pairs tests were used to test for significant differences. In this table ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Tests were applied at the match-group level. We had four match groups in SECC and three match groups in MECC and seven match groups in SEC and MEC. Here, total full cartels depict the rates of established cartels where all firms were part of the cartel. The case where one group in the MECC treatment was playing the taking-turns strategy between periods 4-7 is also included in this category. Note, we also count this case as an attempt to a full cartel agreement since this corresponds to a collusive strategy including all four firms. The table also controls for established partial cartels focusing on the cases were only three (3-firm cartels) and two firms (2-firm cartels) were part of the cartel. The table only accounts for the cases where at least two firms opted to form a cartel at stage 1.

The same is true in the absence of the communication option where significantly more full cartels than partial cartels are formed. That is, the lion's share of SEC cartels (94.4%) is composed of stable all-inclusive cartels. Thus we also accept Hypothesis 1b.

Result 1

In line with predictions, literally all cartels formed are all-inclusive cartels in SECC. In SEC significantly more four-firm cartels than partial cartels are established.

Focusing on the treatments with modified Cournot payoffs, it turns out that 100% of cartels in MECC are composed of four firms. In contrast to our theoretical predictions, firms do not form partial three-firm cartels. Instead they always coordinate the formation of all-inclusive cartels. We thus have to reject Hypothesis 2a. In the modified treatment without chat (MEC) there are more partial cartels (64.2%) than full cartels (35.7%). To infer whether the stable three-firm cartel is the most frequent cartel composition we have to compare the fraction of three-firm cartels with the fraction of two- and four-firm cartels. It turns out that we neither observe significantly more three-firm cartels (57.1%) than two-firm cartels (7.1%) (one-sided Wilcoxon matched-pairs test, $p - value = 0.121$) nor do we observe significantly more three-firm cartels than four-firm cartels (35.7%) (one-sided Wilcoxon matched-pairs test, $p - value = 0.191$). We therefore have to reject Hypothesis 2b.

Result 2

In MECC no partial cartels are established. Likewise, there is no statistical evidence that the partial cartel is the most frequent cartel in MEC.

4.3 Stage-2 Results: Acceptance of Cartel Compositions

This subsection tests Hypothesis 3 and therefore infers how potential payoff asymmetries within a stable three-firm cartel influence its formation. There is a discrepancy between the results obtained in subsection 4.1 and 4.2 as not all stable partial cartels attempted in the MEC treatment are established afterwards. In this regard this subsection analyzes whether firms form the three-firm cartel at the second stage in MECC and MEC. Table 8 therefore illustrates the inside firms' willingness to accept different potential cartel compositions at the second stage.

TABLE 8 Rate of Accepted Cartel Composition

	4 Insider 0 Outsider			3 Insiders 1 Outsider		
	accept	p-value	reject	accept	p-value	reject
SECC	1.000	-	-	-	-	1.000
SEC	0.680	$\approx$ 0.140	0.320	0.032	$<***$ 0.006	0.968
MECC	1.000	-	-	-	-	1.000
MEC	0.833	$>*$	0.167	0.444	$\approx$ 0.269	0.556

Note: One-sided Wilcoxon matched-pairs tests were used to test for treatment effects. In this table ***, **, and * indicate significance at the 1%, 5%, and 10% levels. Tests were applied at the match-group level. We had four match groups in SECC and three match groups in MECC and seven match groups in SEC and MEC. The number of "Insiders" is the amount of participants who were willing to potentially form a cartel at the first stage of the mechanism. The number of "Outsiders" is the amount of participants who were not willing to form a cartel at the first stage. The table only includes the cases where at least two firms opted to form a cartel at stage 1.

It can be seen that in SECC and MECC the four-firm cartel is always accepted. In SEC most all-inclusive cartels are formed. This is also true for MEC where significant more four-firms are accepted.

Focusing on partial cartel compositions with one outsider it turns out that in SECC and SEC all cases are rejected. There is only one exception in SEC where the three-firm cartel composition is accepted.[16] Strikingly, all partial cartel compositions with three-

[16]Note that this does not constitute a rational behavior, as firms in the three-firm cartel only earn 59 Taler in contrast to the Cournot-competition case where each firm yields 64 Taler.

firms are rejected in MECC. Similarly, in MEC most potential cartel constellations with three inside firms and one outside firm are not formed (56%). Although there is no significant difference between rejected and accepted three-firm cartels in MEC, the frequent rejections of partial cartels in MECC and MEC stand in contrast to our theoretical predictions which suggest that all three-firm cartels should be accepted.

A possible explanation might be given by fairness models like Fehr and Schmidt (1999) which suggests that every inside firm dislikes payoff asymmetries where one outside firm would get 178 Taler, while the insiders get 70 Taler each. Contrary to Hypothesis 3 we find that partial three-firm cartels are only accepted in 44% of the MEC cases and never in MECC. Thus our results contribute to Armstrong and Huck (2010) who summarize the behavioral economics literature in the IO context. Furthermore our findings are in line with Huck et al. (2001) and Huck et al. (2007).[17] Therefore we have to reject Hypothesis 3.

Result 3

Firms do not implement any partial three-firm cartel in MECC. Furthermore most of the three-firm cartels are rejected in MEC.

4.4 Stage-1: Learning Behavior

In this section we briefly analyze whether firms in our four treatments are prone to learning behavior when focusing on stage-1 decisions. Our results reveal that in SECC and MECC solely all-inclusive cartels emerge. At the second stage it turns out that firms in all treatments frequently refrain from implementing partial cartels with three insiders. By contrast all four-firm cartels in SECC and MECC are accepted, which contradicts our theoretical predictions for the MECC case.

We therefore analyze whether firms strategically reject the formation of three-firm cartels in order to incentivize outsiders to attempt all-inclusive cartels in subsequent periods. Hence, this section infers whether the fraction of attempted all-inclusive cartels changes over time. Figure 1 depicts the development of the fraction of attempted full cartels.

In MECC we observe a weak learning effect at the beginning: firms quickly anticipate to attempt the four-firm cartel after period 3. However, there is no significant difference when comparing the average attempted all-inclusive cartels in periods 1-5 (3.8) to periods 6-10 (3.8)(one-sided Wilcoxon matched-pairs test, $p-value = 0.353$). The main reason is

[17] Huck et al. (2001) observe in an experimental Stackelberg setting that Stackelberg followers sanction Stackelberg leaders by increasing their quantities. Similarly Huck et al. (2007) show in a merger experiment based on Salant et al. (1983), that merged firms prevent free-riding behavior of non-merging outside firms.

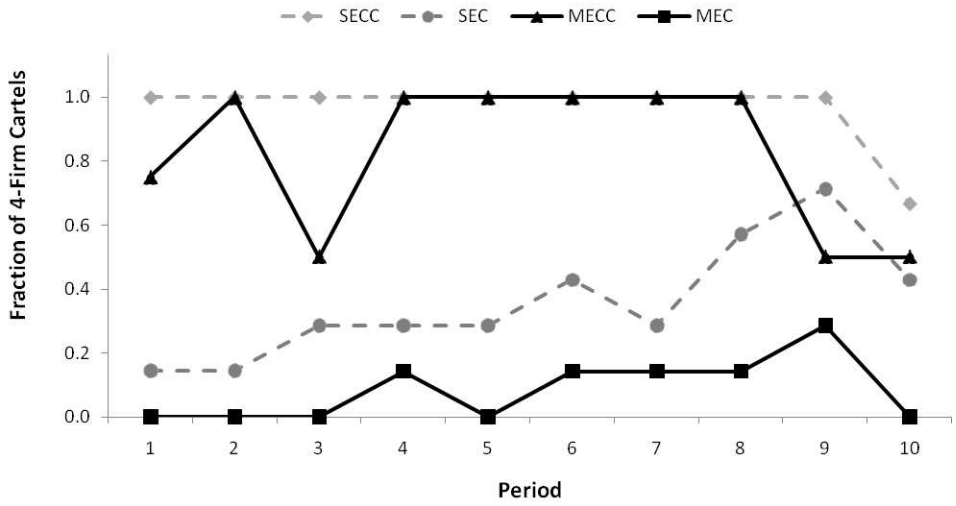

Figure 2: Development of the Fraction of Attempted Full Cartels

that firms in MECC are prone to an end-game effect which starts in period 8. By contrast in MEC no learning can be found, i.e., on average 2.06 four-firm cartels are attempted between periods 1-5 compared to 2.03 in periods 6-10 (one-sided Wilcoxon matched-pairs test, $p - value = 0.316$).

The figure illustrates that there is no learning behavior in the SECC treatment at all. The only exception is the last period where an end-game effect can be observed. By contrast in SEC it turns out that firms learn over time and anticipate that they have to attempt the all-inclusive cartel. That is, there is a significant increase of the average fraction of attempted four-firm cartels (2.71) in periods 1-5 compared to periods 6-10 (3.3)(one-sided Wilcoxon matched-pairs test, $p - value = 0.037$).

The section emphasizes that nearly all firms in SECC and MECC from the beginning attempt to establish the four-firm cartel, whereas in MEC and SEC only few firms attempt it. To account for the substantial differences in the chat treatments we therefore analyze the effects of communication in the subsequent section.

5 Analysis of the Chat Protocols

As opposed to Proposition 2 our main results revealed no significant difference between the fraction of established three-firm and four-firm cartels in MEC. Strikingly, this was further emphasized when adding a chat option, i.e., no partial cartel emerged at all in MECC. To account for these differences we analyze the chat protocols to infer whether firms discuss stage-1 and stage-2 behavior. We analyze the frequency of messages sent by firms over time. Furthermore the chat protocols are evaluated in order to infer the underlying motivations in the cartel-formation process.

In this regard we first follow an approach similar to Andersson and Wengström (2007). The authors account for the number of messages sent and the percentage of "collusive

agreements" in the markets. A collusive agreement is defined as any case where subjects in their setting proposed a price by sending a message which was not rejected by other subjects. In our setting we account for a "cheap-talk agreement" whenever firms proposed an agreement on the cartel and this was not rejected by other firms.[18] Table 9 depicts the average messages sent and the percentage of cheap-talk agreements. The table provides evidence that in both treatments most messages are sent in the first period. On average subjects send more messages in MECC (14) than in SECC (9). In both treatments there is a strong decrease of messages sent after the first period. Strikingly, this decrease is pronounced in SECC (33%) in contrast to MECC (15%).

Table 9 Average Messages Sent and Fraction of Entered Contracts

	period										
	1	2	3	4	5	6	7	8	9	10	avg.
avg. Messages sent											
SECC	18	12	11	8	10	9	11	6	6	9	9
MECC	20	17	13	16	10	14	14	13	11	14	14
cheap-talk agreements (in %)											
SECC	100	67	33	33	0	33	0	33	33	33	29
MECC	100	100	100	75	50	50	75	50	75	100	75

Note: The table depicts average messages sent and the percentage of cheap-talk agreements. Following Andersson and Wengström (2007), we define a cheap-talk agreement in a market whenever at least one subject proposed reaching a market agreement by sending a message and this was not rejected by any of the other subjects

Focusing on cheap-talk agreements it can be observed that in both treatments the implementation of the market agreement is discussed in period 1 of all markets. Starting with period 2 there is a sharp decrease of cheap-talk agreements in SECC, whereas it remains constantly high in MECC. This emphasizes that the incentives of the modified-payoff structure seem to trigger more discussions on cartel-formation strategies among firms than in SECC. To shed more light on these strategies we infer the contents of representative chat protocols. In this regard we follow Kimbrough et al. (2008) and Fonseca and Normann (2012) who have shown that quoting chat protocols of experiments may be very helpful for further revealing promising information about subjects' strategies.

We now give a representative first period example, emphasizing how firms in Market 1 of SECC decided to reach a collusive agreement:

[18] As opposed to Andersson and Wengström (2007) the agreement to form a cartel in a chat does not constitute a collusive agreement per se. In our framework chat is merely cheap talk as a cartel can only be implemented by the three-stage mechanism.

Market 1, period 1: SECC

```
firm 2:  does everybody take part ?!
firm 1:  yes, sure
firm 3:  absolutely
firm 4:  I recommend, that everybody always takes part.  This will guarantee that everybody
earns 20€ ...
firm 4:  yeah
firm 3:  :)
firm 2:  yes
```

These type of conversations took place in all three SECC markets and in all four MECC markets of period 1. It demonstrates that subjects in both treatments immediately made use of the chat option at the beginning. The chat protocols reveal that subjects in SECC quickly started to talk about subjects which had no relation to the experiment.[19] This suggests that the high cooperation rates in SECC periods arise as a result of the early discussion of formation strategies. Another example for the discussion of coordination issues is given by the chat protocols of market 2 and 3 in SECC:

Market 3, period 4: SECC

```
firm 2:  if somebody would get 178, all other participants would be worse off
firm 4:  everything would be more complicated, but after 2 rounds you would have more than
200
firm 4:  178+59
firm 1:  however, the best thing for all is that everybody takes part
firm 3:  yes!
```

Focusing on the modified treatment it turns out that there are 100% of cheap-talk agreements until period 3. In MECC there are high incentives to become the only outsider. This may explain the high amount of cheap-talk agreements compelling all the firms to cooperate. There is also evidence that firms in MECC use the chat to rebuke other firms for not taking part in the market agreement. This is illustrated by the next example:

Market 2, period 4: MECC

```
firm 1:  What's that?  Who did that?
..
firm 2:  nobody did it...
firm 1:  if somebody clicks no, then everybody will click no.  This in turn leads to the
smallest payoff for all of us
firm 2:  this is bad for everybody
firm 3:  yes, you cannot avoid it.  That's the bad thing..
firm 1:  everybody would be worse off.  Thus, we now should all take part
```

As already outlined in the previous sections, one of our MECC group (market 3) used the chat opportunity to agree to a taking-turns strategy starting from period 4. We therefore present the chat protocol of this group to demonstrate how these firms coordinated:

[19] They talked about their field of study and sports, for instance.

Market 3, period 4: MECC

```
firm 2:  all of us should uniquely not take part
firm 2:  then everybody would get 178 once
firm 2:  who wants to be the first to do that?
..
firm 1:  I will not take part!
firm 2:  firm 1!
firm 3:  yes, you!
firm 4:  ok firm 1, go ahead!
```

In period 8 they realized that this behavior did not help to increase their joint payoff. Thus, the firms immediately quit playing this strategy:

Market 3, period 8: MECC

```
firm 1:  the idea was stupid
firm 2:  which idea?
firm 1:  with this idea everybody earned on average less than 100 Taler
firm 1:  this turns out when you get 3 times 70 and once 178
firm 4:  true
firm 2:  ok, I see your point.  Then it was stupid.
firms 3:  yes!
```

The analysis of the chat data shows that the communication opportunity yields similar results as in Andersson and Wengström's (2007) high cost treatment.[20] Although chat is costless in our experiment, it turns out that the combination of chat with the three-stage mechanism is an efficient instrument to reach collusive agreements. In MECC where a high frequency of non-decreasing cheap-talk agreements can be found, it turns out that chat was an important instrument to sustain cooperation over time. This may explain why solely all-inclusive cartels emerged in contrast to MEC where most cartels were established as three-firm cartels.

Result 4 *In both treatments firms in all markets immediately propose the market agreement. In MECC firms permanently use cheap-talk agreements to stabilize long-term cooperation over time, whereas in SECC there is a sharp decrease of this behavior right after the first period.*

6 Discussion

Our paper is among the first experiments to analyze the coordination challenge faced in the formation of a partial cartel. The results show that payoff asymmetries in partial cartels between insiders and free-riding outsiders may disrupt its formation process. That is, potential cartel members prefer to revoke the decision to form the cartel if outsiders excessively profit at its expense. As the outside firm's refusal to participate in the cartel

[20] Andersson and Wengström (2007) outline in their Bertrand-oligopoly experiment, that chat is most effective when the cost of activating are high.

ultimately *does imply a renunciation* for itself, the latter ends up being a "rebel without a clue." Hence, our findings suggest that relative profits matter in the formation of a partial cartel. We therefore find confirmation for Armstrong and Huck (2010).

Although the paper points out that firms face a particular coordination challenge in the formation of a partial cartel, it does not question the emergence of partial cartels. It rather provides insight on the payoff structures that may preclude the formation of partial cartels. Put differently, our framework models the outsider as an aggressive maverick which takes over a significant market share after the emergence of the partial cartel. However, most of the partial cartels that have emerged in recent decades faced competition from outside firms operating at the fringe of the market (therefore also labeled as fringe firms). The respective fringe firms initially behaved non-aggressively and had a limited disruptive effect on the formation of a cartel. This behavior not only guaranteed the profitability of the cartel for the insiders, but also mitigated the disruptive effect of excessive payoff asymmetries we outlined here. Non-aggressive market behavior by competing fringe firms may therefore be a necessary condition for the emergence of a partial cartel.

So far this approach has abstracted from the analysis of antitrust policies, as our suggested research question necessitates a positive approach of the coordination challenge. The normative approach analyzing the efficiency of antitrust policies has to include cartel defection, which limits the applicability of our framework in this context. However, our experimental approach is not only limited to analyzing the impact of payoff asymmetries in the coordination process of a partial cartel. It may also infer coordination challenges resulting from antitrust policies. Discriminatory leniency policies, for instance, which preclude fine reductions for cartel ringleaders may generate payoff-asymmetries within a cartel. Thus firms may be disincentivize to taking a leading role in the formation of a cartel. A coordination challenge in the formation of cartels may therefore arise and may thus necessitate more theoretical and experimental evidence in this area.

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Appendix I. – Experimental Instructions of the MECC Treatment

(Not Intendend for Publication)

Experimental Instructions

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

1 Taler = 2 Cent

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 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 of 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 **10 rounds.** In these rounds, you are taking up the role of a company, which is active on a market with three other companies, so that there are in total four companies in the market. The constitution of the market 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 exists of exactly the same companies. 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 companies are also unable to gain any personal information about you. Hence, the entire experiment is completely anonymous.

Detailed Information on the Experiment

The experiment consists of **10 rounds** in total. All rounds are identical and are divided into **three parts (phases).**

In each round each company faces the following situation: In the **first phase** of a round, all companies within a market can communicate with each other via a chat window. Afterwards, each company announces whether it wishes to take part in the market agreement. In the **second phase**, the companies have to decide whether this agreement is binding. In the **third phase**, the decisions of a company are realized and the respective profits are determined according to their decisions in phase 1 and 2.

We will now explain to you, how your earnings in each round, depend on the decisions, which are implemented in the third phase. For simplification, we will call the earnings gained in the third phase **"round earnings".** Your earnings will – independently of your decision to form a market agreement or not – depend on the number of colluding participants and non- colluding participants. A more specific explanation in terms of how your "**round earnings"** are composed in each case can be found in the table below.

The table illustrates all possible outcomes of colluding participants and non- colluding participants.

It depicts which earnings can be obtained, conditional on the different constellations of participating and non-participating firms.

Possible Constellations and Respective Earnings

Participants of the Markt Agreement	Nonparticipants of the Market Agreement	Participants Payoff (EVERY participant obtains the respective payoff under the assumption that the agreement is implemented)	Nonparticipants Payoff (EVERY nonparticipant obtains the respective payoff under the assumption that the agreement is implemented)
0	4	There are no participants	64 Taler
1	3	64 Taler	64 Taler
2	2	50 Taler	100 Taler
3	1	70 Taler	178 Taler
4	0	100 Taler	There are no nonparticipants

Example 1:

Assume you are taking part in the market agreement. So does company 1. Hence there are two participants. Furthermore, there are 4-2=2 non- participants. This event is shown by row 3 in table 1. Assuming this market agreement is happening at the end of phase 2, there will be a payoff of 50 Taler for you. The other participant will **also** earn 50 Taler. The non- participants will earn 100 Taler **each**.

Example 2:

Assume **you do not take part** in the market agreement and 2 other companies also decide not to take part in it. Hence there are 3 non- participants. Furthermore, there is 4-3=1 participant. This constellation is depicted in row 2. Assuming this market agreement is implemented at the end of phase 2, there will be a payoff of 64 Taler for you. All other non- participants will **also** earn 64 Taler each. The only participant will also earn 64 Taler.

We will now explain to you the decisions, you have to make in the various phases.

Phase 1

In the first phase, you have to announce whether you intend **to take part in a market agreement or not.**

In the experiment, you will do that by using a computer screen and a mouse.

In the **first round**, a chat window will pop- up for **90 seconds** in phase 1. From the **second** to the **10th round**, this chat window will only pop- up for 60 seconds in each **first phase.** You are able to communicate with the three other companies in your market via this chat window. You only need to type in the text you want to communicate in the bottom bar. Your own text as well as the text of the other companies will appear in the window above the bottom bar. After 90 seconds, this chat window will disappear automatically in round 1 (this will be the case in round 2-10 after 60 seconds). After the chat window has closed automatically, you are not able to communicate anymore in this round and you make your decision by using the mouse in the decision window. You hit the “yes” button if you want to and the “no” button if you do not want to participate in the market-agreement. When you have made your decision you only need to click on the “ok” button. As soon as every participant has made his or her decision, the next phase will start. Apart from the decision window, there are three more windows. The windows always show the same information in each phase. You will find the “information window” in the top- left corner. You can get information about the round and the phase, in which you are at the moment. Your total earnings are shown below that.

The big window at the bottom of your screen is the “history- window”. If there is a “-1”, it means that there is no information yet available about your phase. At the end of each round all information is available, so that there will not be a “-1” in this array. Further information about this window is provided at the end of the instructions.

Phase 2

In this phase, you will find out how many firms are intending to participate in a market agreement, which would be binding in phase 3, if implemented. There are two possibilities in phase 2:

First case: In the first phase you announced your willingness to participate in the market agreement.

Hence, you would now need to decide if you really want to commit to it in phase 3. This works out as follows:

The total number of potential participants of the market agreement is presented to you. Furthermore you will find information, on how many companies are definitely not taking part in it. Additionally, you are provided with information about the earnings, which you and the other participants would get if the market agreement would be implemented. You can also see how much the non-participants would earn. Finally you would get information about the earnings of all companies if a market agreement is not implemented. You now need to decide if you still want to take part in a market agreement.

Only if all of the companies that announced their willingness to form a market agreement in phase 1 confirm in phase 2 again that they are going to form a market agreement, this commitment becomes binding.

If even **one** of these companies that announced in phase 1 to form a market agreement, now rejects the formation of a market agreement, the commitment is not binding anymore and there will not be a market agreement.

If the commitment becomes binding, then all companies that have announced and confirmed to form a market agreement, are bound to the agreement in phase 3. Hence these companies automatically commit to the market agreement in phase 3 and are hence participants of the agreement.

If the agreement is non- binding, the companies that have announced to commit in phase 1, will automatically behave as a non- participants of the market agreement in phase 3.

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

Second case: You announced in the first phase that you do not intend to form a market agreement.

When you announced in phase 1 that you do not intend to form a market agreement, there is no decision to be made in phase 2. You will only be given information about how many companies intend to commit. Furthermore you find out how many companies are definitely not participating in the market agreement. In that case, you simply need to click on the button “read”.

Note: Only the companies that have announced in phase 1 to form a market agreement may decide in phase 2, if their commitment is binding.

Phase 3

In this phase you will find out if the market- agreement becomes binding, as well as the total number of companies that decided to finally commit to the market agreement. Please note that these two possible events can occur:

Case 1: The commitments are binding and the market agreement takes place

When the commitments are binding and if you are amongst those players that decided to commit, the computer will assess you as a participant. This assessment has direct consequences on your payment. However if you are among the companies that decided not to participate, the computer will assess you as a non-collusion participant. This assessment has also direct consequences on your payoff. As soon as the computer finished the classification of participants and non-participants, a screen appears that indicates your earnings and the one of the other companies. Do not forget to press “read” after reading it.

Case 2: The commitments are not binding

If the commitment is not binding, then all companies are assessed as non- participant. This assessment has direct consequences on your payoff. The screen tells you that there is no collusion. Furthermore the earnings of all non- participants appear. Do not forget to press "read" after reading it. At the end of phase 3 a new round begins. The same procedure takes place starting at phase 1.

Example: Assume you are company A and decide to commit in phase 1. Additionally company B and C decide to commit as well. Company D decides not to commit. If the market- agreement is binding after phase 2, you receive a payoff of 70 Taler – so does B and C (4th row in the table). D receives 178 Taler. However if B, C or you decide to make the agreement non- binding in phase 2, the entire market- agreement is **non- binding**. After determining the payoffs in phase 3, B, C and you receive 64 Taler, the payoff of D decreases from 178 to 64 (table).

After the end of each round, the history window will be refreshed. Your decisions and the one of the other companies is documented as follows:

Round	= Round
Potential Participant	= Your announcement in Phase 1, to be willing to participate in the market agreement
Total number of potential participants	= total number of potential participants, who announced their willingness to participate in the market agreement in Phase 1.
Decision	= Your final decision to form the market agreement in Phase 2.
Binding (Yes/No)	= Information regarding the implementation of a market agreement
Number of participants	= Exact number of firms participating in the market agreement
Number of nonparticipants	= Exact number of firms not participating in the market agreement
Earnings participant/ nonparticipants	= Your earnings resulting from participation/ non-participation in the market agreement
Payoff of the current round	= Your payoff in the current round

Please answer the following questions to double check your understanding of the instructions.

Check-up questionnaire

We kindly ask you 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 member with the letters “A”, “B”, “C” and “D”. If there are any questions, please raise your hand.

Check-up questions 1/2

a) Assume you are company A and you announce in phase 1 that you will not participate in a market- agreement. Additionally the companies B,C and D announce to form a market agreement.
   - Which companies may decide in phase 2 if they compulsory form a market agreement?
   - Assume the collusion (market- agreement) takes place, what are the earnings in phase 3?
   - Assume the collusion does not take place, what are the earnings in phase 3?

b) Only one participant (which **announced his willingness to form a market agreement in phase 1**) commits to the market- agreement in phase 2.
   - Does the collusion take place? (Yes/No)?

c) Assume now that phase 3 begins and the computer assesses the participants and non-participants of a possible collusion.
   - Who is finally assessed as a non- participant?
   - Who is finally assessed as a participant?
   - What are the earnings in phase 3?

Check-up question 2/2

a) Assume you are company A and you announce in phase 1 to wish to form a market agreement. Additionally, company B,C and D announce that they also intend to form a market agreement.
   - Which companies may decide in phase 2 if the agreement becomes binding?
   - Assume the market agreement is implemented, what are the earning in phase 3?
   - Assume the market agreement does not take place, what are the earning in phase 3?

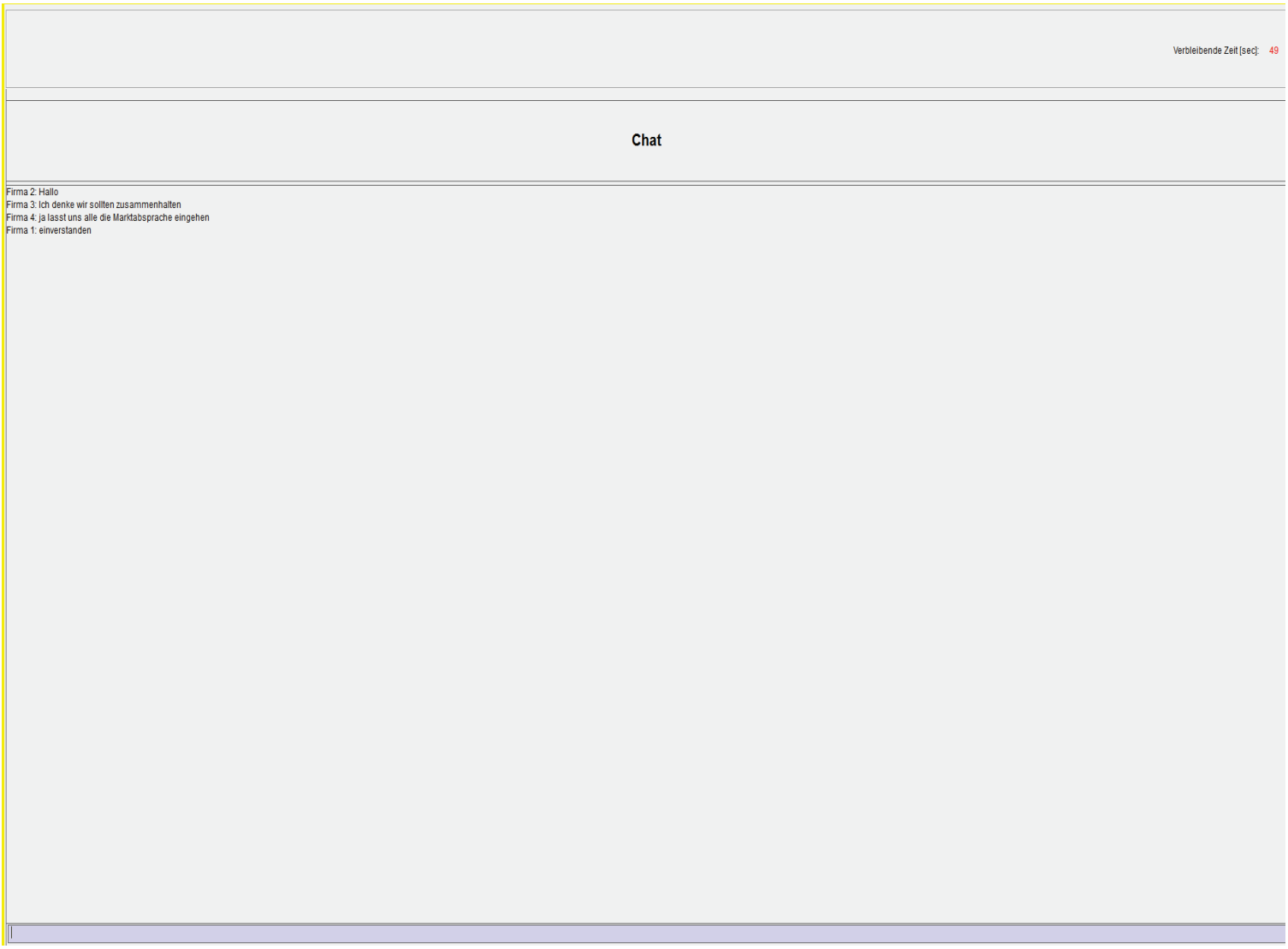
b) All participants of the market agreement (which **announced their willingness to form a market agreement in phase 1** (all companies in this case)) commit to the market agreement in phase 2.
   - Does the collusion take place? (Yes/No)?

c) Assume now that phase 3 begins and the computer assesses the participants and non-participants of a possible collusion.
   - Who is finally assessed as a non- participant?
   - Who is finally assessed as a participant?
   - What are the earnings in phase 3?

Appendix II. – Screenshots of the MECC-Treatment

(Not Intendend for Publication)

The chat stage



English translation:

Firm 2: “Hi”;
Firm 3:”I think we should cooperate”;
Firm 4:”Ok, let’s accept the market agreement”;
Firm 1: “Okay”

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