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Spillovers from legal cooperation to non-competitive prices

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Abstract

Antitrust laws prohibit private firms to coordinate their market behavior, yet many types of interfirm cooperation are legal. Using laboratory experiments, we study spillovers from legal cooperation in one market to non-competitive prices in a different market. Our theoretical framework predicts that such cooperation spillovers are most likely to occur for intermediate levels of competition. Our experimental findings support this theoretical prediction. In addition, our experimental results show that repeated interaction and communication about prices in a market are not necessary to achieve non-competitive prices in that market, as long as subjects can form binding agreements in a different market. Results from additional treatments suggest that commitment and multimarket contact are necessary for cooperation spillovers to emerge.

Keywords: Cartel; Communication; Cooperation spillovers; Antitrust; Experiment

JEL Codes: C9; D43; L13; L41

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1 Introduction

Antitrust policy in the United States and elsewhere prohibits private firms to coordinate their market behavior. Nevertheless, many types of interfirm cooperation are viewed as legitimate. Firms that form an export cartel are immune from prosecution under U.S. antitrust laws, provided there are no anti-competitive effects in the U.S. market.[1] Such export cartels can be registered with the federal government, and the U.S. Department of Commerce even suggests that "[t]wo or more joint venture partners might agree to establish uniform minimum export prices for particular goods in order to avoid price rivalry with each other."[2] Book price regulations, allowing publishers and booksellers to fix prices in the hope that non-price competition increases, exist in many countries (Canoy et al., 2006). In 2022, in the context of Russia's military aggression against Ukraine, the European Competition Network (ECN) softened the enforcement of anti-cartel law, particularly allowing firms to cooperate with one another to mitigate the effects of severe disruptions caused by the aggression.[3]

Therein lies the rub. Since 1776, when Adam Smith famously wrote in *The Wealth of Nations* that "People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices," communication among firms has been regarded as a central feature of cooperation. The much-less-often quoted conclusion of Adam Smith's remark is, "But though the law cannot hinder people of the same trade from sometimes assembling together, it ought to do nothing to facilitate such assemblies; much less to render them necessary." A relaxed approach to interfirm cooperation makes it possible for firms to assemble legally, with consequences for market performance that may be unintended and undesirable (Shapiro and Willig, 1990).

Can we expect firms to legally cooperate in one market without anti-competitive ramifications for their conduct in markets in which they are expected to compete? This is the question to which this paper is directed. Using laboratory experiments, we study whether allowing firms to coordinate their prices in one market affects their prices in an unrelated market. Each subject sequentially plays two homogeneous goods Bertrand market games against the same opponents. We vary whether subjects can jointly agree on a binding price in the first market as well as the competitiveness of the markets. We use a structured approach to price communication which has been shown to raise prices and allows us to limit

[1]The 1918 Webb-Pomerene Act forms the basis of the U.S. exemption. Similar exemptions exist in many other countries (Dick, 1992).

[2]Quote taken from the export trading company affairs website, at https://legacy.trade.gov/mas/ian/etca/tg_ian_002154.asp. A list of registered trade associations is available at https://legacy.trade.gov/mas/ian/etca/tg_ian_002147.asp.

[3]The ECN is a network of the 27 competition authorities within the European Union and the DG Competition of the European Commission. For more details about the ECN's measures, see https://competition-policy.ec.europa.eu/system/files/2022-03/202203_joint-statement_ecn_ukraine-war.pdf.

the scope of communication to one market (Hinloopen and Soetevent, 2008).

Using experiments allows us to sidestep two main challenges observational data pose. First, as explicit cooperation is illegal, it is typically not observed. Available cartel data suffer from sample selection problems as they consist of cartels discovered by antitrust authorities, cartels that cartel members disclosed, or legal forms of interfirm cooperation. Second, the ability to cooperate is not varied exogenously in the field. In the lab, we can exogenously alter whether price communication is possible and we can restrict communication to pertain only to specific markets or strategic variables. This setup is arguably much harder to implement in the field, where structuring communication between firms and observing pricing and marginal costs is challenging. Moreover, a laboratory experiment offers a controlled environment suitable for the theory-testing nature of our research questions (List, 2020).

We define cooperation spillovers as a situation where binding agreements allow firms to coordinate on the joint-profit maximum in the first market where this was not possible absent such agreements, and this cooperation spills over in the sense that the market price in the second market is higher when binding agreements are available in the first market than when they are not. Our theoretical framework spells out conditions such that the most profitable subgame-perfect Nash equilibrium is characterized by cooperation spillovers. Following Charness and Rabin (2002), we posit that firms potentially have reciprocal preferences. Their general specification is of a oligopolist's objective function that includes the standard specification of own-profit maximization as the special case in which the weight given to rivals' payoffs is zero. We study a one-shot game where firms interact once in both markets, and an infinitely repeated version of the stage game. We find that cooperation spillovers can occur in the one-shot game if firms have sufficiently strong social preferences, and show that the parameter space where this happens is decreasing in the number of firms. If firms have standard preferences, no cooperation spillovers will occur in the one-shot game. These results carry over to the infinitely repeated game, unless firms have sufficiently high discount rates so that the joint-profit maximum is part of a subgame-perfect Nash equilibrium in the absence of price agreements.

Our theoretical framework predicts that cooperation spillovers will occur if the number of firms is not so high that the competitive outcome will always result in the second market, and if the scope for coordinating on the joint-profit maximum is limited absent binding agreements. The scope for cooperation spillovers, therefore, is highest in the one-shot duopoly game. In our experimental design we compare a treatment where subjects can make binding price agreements in the first market to one where they cannot. Utilizing a between-subject design, we make this comparison in a one-shot duopoly game, a one-shot triopoly game, and a repeated duopoly game – for a total of six treatments.

We find significant spillovers from legal cooperation in the first market to non-competitive prices in the second market in the one-shot duopoly games. Allowing subjects to coordinate their prices in the first market significantly and consistently increases the prices they submit in the second market. The share of non-competitive market prices in the second market increases from 40 percent in the baseline treatment to 63 percent when binding price agreements are possible in the first market, and the degree of total surplus that the subjects jointly capture in the second market more than doubles. This is striking, as the experimental literature pinpoints repeated interaction and communication (on prices in the second market) as two crucial ingredients for the emergence of prices above the competitive price in oligopoly experiments – see Potters and Suetens (2013) for a survey. We elicit the social preferences of subjects, and find that the observed cooperation spillovers are absent for subjects with (close to) standard preferences and strong for subjects with at least moderately social preferences, in line with our theoretical framework of reciprocal preferences.

Cooperation spillovers are not observed in the aggregate results of the one-shot triopoly or repeated duopoly games. While the ability to form binding agreements does allow subjects to coordinate on the joint-profit maximum, pricing in the second market is unchanged. However, when focusing on subjects with sufficiently strong social preferences, cooperation spillovers also occur in the one-shot triopoly game. While a similar pattern is observed in the repeated duopoly game, price effects in the second market are not significantly different from zero. Overall, the data support the theoretical predictions.

In additional treatments, we study two variations of the one-shot duopoly game to identify necessary conditions for cooperation spillovers to emerge and to find further support for our theoretical framework. First, we allow subjects to form non-binding agreements in the first market – as before, by proposing prices. As our restricted price communication protocol is known to not facilitate coordination on the joint-profit maximum if agreements are cheap talk, this treatment eliminates the behavior that subjects are hypothesized to reciprocate to in our theoretical framework. Second, we implement a stranger's design whereby subjects can make binding price agreements in the first market but face a different rival in the second market. In this case, the subject that might be the beneficiary of reciprocal behavior is no longer the rival in the second market. While prices still increase in the first market compared to the no-communication benchmark in both treatments, market prices in the second market are not significantly higher when agreements are available in the first. Spillovers from legal cooperation to non-competitive prices thus require multimarket contact and binding price agreements – in line with our theoretical framework of conditional cooperation.

The main contribution of our paper is showing that allowing firms to cooperate on one dimension may have the unintended anti-competitive effects on the dimensions in which they are still expected to compete. In particular, our results highlight that such risk is relevant when the firms' managers have reciprocal preferences and in a 'Goldilocks zone' of the right amount of competition where there is neither too much nor too little of it. Policy proposals to allow firm coordination on a particular domain should, therefore, be evaluated based on the assumption that this coordination may spill over to other domains. The second contribution of this paper is showing that, to increase prices above the one-shot Nash equilibrium price in a market, neither communication about behavior in this market nor repeated interaction is necessary. All that is required is that the firms can legally cooperate with each other in a different market.

Consequently, we contribute to the literature on multimarket contact as a source of cooperation. The literature has focused on conditions under which multimarket contact fosters cooperation in a repeated game setting, starting with the seminal work by Bernheim and Whinston (1990).[4] Laferrière et al. (2024) let subjects play two repeated prisoner's dilemma games and find that multimarket contact does not increase cooperation rates on average. However, subjects do link their strategies as they tend to either defect in both markets or cooperate in both markets, making cooperation in both markets more likely and cooperation in a single market less likely. In earlier work, Phillips and Mason (1992) find that multimarket contact increases (decreases) the scope for collusion in the market that is less (more) prone to it in experimental Cournot duopolies.[5] We show that the ability to legally coordinate behavior in one market can increase prices in a different market in the absence of repeated interaction. Moreover, our results suggest that competitive effects of multimarket contact in experimental games might depend on the number of firms.[6]

Our results also relate to a very large body of work on cooperation in indefinitely repeated social dilemma games, most of which focuses on prisoner's dilemmas. Embrey et al. (2018) and Mengel (2018) survey this literature and identify the parameters of the stage game, as well as the number of periods, as key factors in generating cooperation in this setting (e.g., Charness et al. (2016)). We show allowing subjects to first coordinate their behavior in a Bertrand game can increase cooperativeness in a second Bertrand game, where such cooperation could otherwise not be sustained. While reciprocity – closely aligned to our theoretical framework – has been argued to increase cooperation in finitely repeated social dilemma games, such reciprocity appears mostly strategic as it disappears in the final periods of the game (e.g., Reuben and Suetens (2012)).[7] However, in our experiment, prices above the competitive equilibrium routinely emerge in the second market even though subjects are rematched after setting them, suggesting that non-strategic reciprocity also lead to conditional cooperation in one-shot and finitely repeated social dilemma games.[8]

[4]Evidence supporting such mutual forbearance has been uncovered in many industries, including airlines (Evans and Kessides, 1994; Ciliberto and Williams, 2014), mobile phones (Parker and Röller, 1997), and healthcare (Lin and McCarthy, 2022).

[5]Relatedly, Phillips and Mason (1996) study a repeated game duopoly experiment and find that when a binding price cap is enforced in one market, prices increase in a different market.

[6]In a three-market, posted offer, environment, Cason and Davis (1995) find that nonbinding price communication prior to posting of final binding offers can increase market prices. Freitag et al. (2021) observe increased market prices following a free chat in a multimarket Cournot experiment. We allow for both binding and non-binding price communication, and restrict the price communication to a single market. This allows us to isolate the effect of price communication in one market on behavior in the other market.

[7]See Cooper and Kagel (2016) for a survey of other-regarding preferences in games.

[8]There exists a related literature on how the order of play affects the outcome of different games in

A more general strand of literature shows that spillovers from explicit to tacit collusion can occur when firms repeatedly interact in the same market (Connor, 2001; De Roos, 2006; Kovacic et al., 2007). Mechanisms include long-term contracts and firms learning to coordinate on a particular equilibrium or fearing price wars upon deviating from collusive pricing (De Roos, 2006; Asker, 2010; Byrne and De Roos, 2019). In addition, firms are incentivized to uphold collusive pricing tacitly after a cartel is discovered when damages are awarded based on the difference between market prices pre- and post-explicit collusion (Harrington, 2004). In Fonseca and Normann (2012), allowing subjects in repeated experimental oligopolies to chat in early periods raises prices in later periods when no communication is permitted. Chowdhury and Crede (2020) also find spillovers from explicit to tacit collusion in a laboratory experiment and show that such spillovers disappear when subjects are rematched after the opportunity to collude explicitly is removed.[9]

Finally, spillovers from legal research joint ventures (RJVs) to product market collusion are known to exist (Duso et al., 2014; Sovinsky, 2022). RJVs can affect the incentive compatibility constraint of a stable cartel in the output market (e.g., Martin (1996)). In a laboratory experiment where subjects first choose R&D investments and then play a pricing game, Suetens (2008) confirms that prices are significantly closer to the optimal collusive price when subjects form binding agreements in the first stage. Relatedly, Normann et al. (2015) find spillovers from legal input buyer groups to tacit collusion in experimental markets, but only if the buyer group can exclude firms and hence punish firms that deviated from an earlier collusive agreement.

The remainder of this paper proceeds as follows. In Section 2, the theoretical framework that provides our hypotheses is introduced. Section 3 outlines the experimental design and procedures. Section 4 gives the main result, while Section 5 discusses additional treatments. Section 6 concludes.

2 Theoretical framework

This section introduces a theoretical model of cooperation spillovers, first in a one shot setting and then in a repeated game. Our aims are twofold: the model should capture the essence of examples mentioned in the introduction – such as export cartels – where firms are in multimarket contact and can coordinate their behavior in one market but not in a

laboratory experiments. See Cason et al. (2012) for an application to coordination games, and sources cited therein for the broader literature.

[9]In Cooper and Kühn (2014), subjects sequentially play a discrete Bertrand game and a coordination game. The payoff tables are carefully selected to mimic an infinitely repeated version of the Bertrand game. The focus is on how communication helps players coordinate on contingent play necessary for collusive equilibria. However, compared to the no-communication baseline, a treatment with communication in only the Bertrand game does not facilitate coordination on the Pareto optimal equilibrium of the coordination game.

different market, and the model should be sufficiently simple to implement in a laboratory experiment. While the model has many potential equilibria, we are interested in those where legal cooperation in the first market can spill over to (tacit) coordination in another market. The model and experiment are framed in terms of competing firms, but the insights apply more generally to cooperation in (infinitely-repeated) games.

Consider n firms, labeled $i = 1, 2, ..., n$, that sequentially play two simultaneous-move, homogeneous-goods, discrete Bertrand games, first in Market A and then in Market B. We study both a 'baseline game,' in which the firms cannot make binding price agreements in Market A, and a 'communication game,' in which the firms can make binding agreements in Market A. The timing of the baseline game is as follows. First, firms simultaneously set a price in Market A. When both firms have set a price, Market A clears, and the selected prices become common knowledge. Second, the firms simultaneously select prices in Market B. When prices have been set, the market clears, and firms learn about the prices set.

In Market A, firms select a price from the set $\{102, 103, \ldots, 110\}$. There is unit demand, and the marginal cost of production is $c^A = 100$.[10] Consumers buy from the firm(s) with the lowest price. Therefore, the market price p^A is the lowest of the n prices set by the firms: $p^A = \min\{p_1^A, p_2^A, ..., p_n^A\}$, where p_i^A denotes the price set by firm i in Market A. If k firms charge the lowest price p^A, each of these firms supplies a fraction $1/k$ of total demand. The profit of firm i in Market A is $(i, j = 1, ..., n)$

$$\pi_i^A = \begin{cases} p_i^A - 100 & \text{if } p_i^A < p_j^A \text{ for all } j \neq i, \\ \frac{p_i^A - 100}{k} & \text{if } p_i^A \leq p_j^A \text{ for all } j, \text{ where } k = \#\{j = 1, ..., n : p_j^A = p_i^A\}, \\ 0 & \text{if } p_i^A > p_j^A \text{ for some } j \neq i. \end{cases} \tag{1}$$

In Market B, the set of possible prices is $\{52, 53, \ldots, 70\}$.[11] There is unit demand, and the marginal cost of production is $c^B = 50$. The market price p^B is the lowest of the n prices submitted: $p^B = \min\{p_1^B, p_2^B, ..., p_n^B\}$, where p_i^B denotes the price set by firm i in Market B. If k firms charge the lowest price p^B, each of these firms supplies a fraction $1/k$ of total demand. The profit of firm i in Market B is $(i, j = 1, ..., n)$

$$\pi_i^B = \begin{cases} p_i^B - 50 & \text{if } p_i^B < p_j^B \text{ for all } j \neq i, \\ \frac{p_i^B - 50}{k} & \text{if } p_i^B \leq p_j^B \text{ for all } j, \text{ where } k = \#\{j = 1, ..., n : p_j^B = p_i^B\}, \\ 0 & \text{if } p_i^B > p_j^B \text{ for some } j \neq i. \end{cases} \tag{2}$$

The communication game differs from the baseline game in that the firms can form a

[10] A gap between the lowest possible price and the marginal cost of production is commonly used in homogeneous goods Bertrand games to ensure that players are not required to play weakly dominated strategies in Nash equilibrium (e.g., Dufwenberg and Gneezy (2000); Hinloopen and Soetevent (2008)).

[11] The price range in Market B differs from that in Market A so that the joint-profit-maximizing price in Market A does not become a focal point for Market B.

binding price agreement in Market A. Forming a price agreement is assumed to be costless.[12] The communication protocol is adapted from Hinloopen and Soetevent (2008).[13] Price agreements are binding and symmetric ($p_1^A = p_2^A = ... = p_n^A = p^A$) and result from, at most, $R \geq 1$ rounds of structured communication between the n firms. Let $\{\underline{p}^0, \ldots, \bar{p}^0\} = \{102, \ldots, 110\}$. In rounds $r = 1, \ldots, R-1$ of price communication, firms simultaneously select a minimum and maximum price from the price range $\{\underline{p}^{r-1}, \ldots, \bar{p}^{r-1}\}$. If the overlap of the n selected price ranges is a single price, an agreement has been reached, and that price is automatically implemented as the market price in Market A. If the overlap of the n selected price ranges is a price range, denote this new price range by $\{\underline{p}^r, \ldots, \bar{p}^r\}$ and firms proceed to the $r+1^{th}$ round of price communication. If the price ranges do not overlap, then $\{\underline{p}^r, \ldots, \bar{p}^r\} = \{\underline{p}^{r-1}, \ldots, \bar{p}^{r-1}\}$ and firms proceed to the $r+1^{th}$ round of price communication. In the final round R, if reached, firms select a minimum and maximum price from the price range $\{\underline{p}^{R-1}, \ldots, \bar{p}^{R-1}\}$. As before, if the overlap between the n price ranges is a single price, that price is implemented as the market price in Market A. However, if the n price ranges do not overlap or the overlap is an interval, the lowest price in the final price interval is implemented as the market price in Market A: $p_i^A = \underline{p}^R \, \forall i$. By equation (1), firm i's profit in Market A is $\pi_i^A = (p_i^A - 100)/n$. After the interaction in Market A, the communication game proceeds with the firms deciding on prices in Market B, as in the baseline game.

We build our analysis of spillover effects on the assumption that each firm i's utility is given by

$$U_i(\pi_1, \pi_2, ..., \pi_n) = \pi_i - \alpha \frac{\sum_{j \neq i} \max\{\pi_j - \pi_i, 0\}}{n-1} - \beta \frac{\sum_{j \neq i} \max\{\pi_i - \pi_j, 0\}}{n-1} + \gamma \frac{\sum_{j \neq i} m_j(\pi_i - \pi_j)}{n-1}, \tag{3}$$

$i = 1, ..., n$, where π_k denotes firm k's profits, $k = 1, ..., n$; $m_j = 1$ if j has 'misbehaved', and $m_j = 0$ otherwise. This utility structure is proposed by Charness and Rabin (2002), who, in turn, generalize the Fehr and Schmidt (1999) model of inequity aversion by including the final term on the right-hand side to incorporate reciprocal preferences. The parameters α and β measure the extent to which a firm cares about earning less, respectively, more than the other firms, and γ measures reciprocal preferences. We restrict our analysis to $\alpha, \beta, \gamma \geq 0$. Notice that this utility structure embeds the standard model where firms' shareholders only care about profit, as then $\alpha = \beta = \gamma = 0$. Firms acting in accordance with reciprocal preferences have been observed in the field (Podolny and Scott Morton, 1999). More generally, social preferences have been widely documented in laboratory experiments and have been increasingly attributed to firms since the rise of socially responsible shareholders (Riedl and Smeets, 2017).[14]

[12] Our results are robust to allowing a cost of the agreement, c, as long as c is strictly below the per-firm profit increase due to the agreement. Costs c can, for instance, be interpreted as the costs of writing and enforcing a contract.

[13] Similar communication protocols are used in Bigoni et al. (2012) and Bigoni et al. (2015), among others.

[14] For instance, Kolstad (2013) reports empirical evidence consistent with reference-dependent preferences

The communication protocol in the communication game allows all prices in the set $\{102, \ldots, 110\}$ to be part of a subgame-perfect Nash equilibrium. Clearly, all agreements such that $p^A \neq 110$ are strictly Pareto inefficient, as all firms could be made strictly better off by agreeing to $p^A = 110$. To focus on Pareto efficient Nash equilibria, we assume that in the final round of the communication game, firms select a Nash equilibrium such that the highest possible market price emerges: $p^A = 110$.[15]

We speak of cooperation spillovers when (i) the firms coordinate on $p^A = 110$ in Market A when they can make binding agreements, (ii) the firms fail to coordinate efficiently in Market A when they cannot make binding agreements, i.e., at least one firms chooses a price below 110, and (iii) the equilibrium price in Market B is higher when the firms can make binding agreements in Market A than when they cannot. Let us define $\bar{p}^B_{base}$ $[\bar{p}^B_{com}]$ as the highest price feasible in Market B as part of a symmetric subgame-perfect equilibrium for the baseline [communication] game. We assume that firm j misbehaves if and only if firm j chooses a price strictly lower than the highest possible price in Market A, i.e., $p^A_j < 110$. We establish the following result[16]

Proposition 1. *The highest feasible market price in Market B is weakly higher in the communication game than in the baseline game: $\bar{p}^B_{base} \leq \bar{p}^B_{com}$.*

To find parameters for which cooperation spillovers occur if players coordinate on the highest possible prices, i.e., for which $\bar{p}^B_{base} < \bar{p}^B_{com}$, several conditions must be checked. First, β should be sufficiently large so that when firms can make binding agreements in Market A, they have an incentive to charge $\bar{p}^B_{com} \geq c^B + 3$ rather than another price if all other firms do so as well (as the lowest possible price in Market B is $c^B + 2$). The best deviation from charging $\bar{p}^B_{com}$ is to $\bar{p}^B_{com} - 1$, resulting in the equilibrium condition

$$\frac{\bar{p}^B_{com} - c^B}{n} \geq (1-\beta)(\bar{p}^B_{com} - 1 - c^B) \Leftrightarrow \beta \geq 1 - \frac{\bar{p}^B_{com} - c^B}{n(\bar{p}^B_{com} - c^B - 1)}. \tag{4}$$

Similarly, in the case that firms cannot make binding agreements in Market A, provided that all misbehaved by setting a price below 110, $\bar{p}^B_{base}$ is an equilibrium price in Market B:

$$\frac{\bar{p}^B_{base} - c^B}{n} \geq (1-\beta+\gamma)(\bar{p}^B_{base} - 1 - c^B) \Leftrightarrow \beta - \gamma \geq 1 - \frac{\bar{p}^B_{base} - c^B}{n(\bar{p}^B_{base} - c^B - 1)}. \tag{5}$$

A third condition is that firms prefer to misbehave in Market A when they cannot make binding agreements, i.e., deviate from choosing the equilibrium price of 110 they set when

in the healthcare industry, and Broccardo et al. (2022) theoretically study optimal firm behavior in the presence of (potentially) socially responsible investors.

[15] As, without restrictions, all prices can be part of a subgame-perfect Nash equilibrium in the communication game, our lab experiment is also informative on equilibrium selection. Because we are primarily interested in prices in Market B, and, as it turns out, because subjects nearly always select the Pareto optimal outcome in the communication game, we do not focus on equilibrium selection in this paper.

[16] All proofs are in Appendix A.

they can make binding agreements. Such equilibria have the property that

$$\frac{110-c^A}{n}+\frac{\bar{p}^B_{com}-c^B}{n}<(1-\beta)(109-c^A)+\frac{\bar{p}^B_{base}-c^B}{n}\Leftrightarrow \tag{6}$$

$$\beta<1-\frac{\bar{p}^B_{com}-\bar{p}^B_{base}+110-c^A}{(109-c^A)n}=1-\frac{\bar{p}^B_{com}-\bar{p}^B_{base}+10}{9n}. \tag{7}$$

The left-hand side of the first inequality expresses a firm's utility if all firms pick $p^A_j=110$, rendering $\bar{p}^B_{com}$ as the highest feasible equilibrium price in Market B. The right-hand side of the first inequality represents a firm's utility when it is the only one deviating to the price 109, rendering $\bar{p}^B_{base}$ the highest feasible equilibrium price in Market B.

A fourth condition is that γ is sufficiently large so that $\bar{p}^B_{com}$ is not an equilibrium price when the firms cannot make binding agreements in Market A:

$$\frac{\bar{p}^B_{com}-c^B}{n}<(1-\beta+\gamma)(\bar{p}^B_{com}-1-c^B)\Leftrightarrow\gamma>\beta-1+\frac{\bar{p}^B_{com}-c^B}{n(\bar{p}^B_{com}-c^B-1)}. \tag{8}$$

Notice that none of these conditions depends on α, which measures how much a firm cares about being behind the other firms in payoffs. The conditions are α-independent because (i) in all equilibrium outcomes that we consider, the firms' payoffs are the same, and (ii) the only relevant deviations from the equilibrium outcome do not result in an outcome in which the deviating firm is behind.

Systematically checking the possible values for $\bar{p}^B_{com}$ and $\bar{p}^B_{base}$ yields the following overview of possible combinations of the parameters β and γ for which $\bar{p}^B_{base}>\bar{p}^B_{com}$

Proposition 2. *The highest feasible market price in Market B is strictly higher in the communication game than in the baseline game only if*

(i) $\beta\in\left[1-\frac{3}{2n},1-\frac{11}{9n}\right)$ *and* $\gamma\in\left(\beta+\frac{3}{2n}-1,\beta+\frac{2}{n}-1\right]$, *in which case* $\bar{p}^B_{com}-c^B=3$ *and* $\bar{p}^B_{base}-c^B=2$, *or*

(ii) $\beta\in\left[1-\frac{4}{3n},1-\frac{11}{9n}\right)$ *and* $\gamma\in\left(\beta+\frac{4}{3n}-1,\beta+\frac{3}{2n}-1\right]$, *in which case* $\bar{p}^B_{com}-c^B=4$ *and* $\bar{p}^B_{base}-c^B=3$, *or*

(iii) $\beta\in\left[1-\frac{5}{4n},1-\frac{11}{9n}\right)$ *and* $\gamma\in\left(\beta+\frac{5}{4n}-1,\beta+\frac{4}{3n}-1\right]$, *in which case* $\bar{p}^B_{com}-c^B=5$ *and* $\bar{p}^B_{base}-c^B=4$.

Proposition 2 gives parameter values for which cooperation spillovers occur if firms coordinate on the most profitable subgame-perfect equilibrium.[17] Such spillovers require β and γ to be positive but not too high. A sufficiently high β ensures that subjects can set prices

[17]Of course, cooperation spillovers could also occur if $\bar{p}^B_{base}=\bar{p}^B_{com}$, but are then not consistent with subjects coordinating on the most profitable subgame-perfect equilibrium in both the baseline and communication games.

above 52 in Market B in equilibrium, as incentives to defect from such a price decrease in β. A sufficiently high γ ensures that subjects will, nonetheless, want to defect from $\bar{p}^B_{com}$ in the baseline game, where coordination on 110 in Market A is not achieved. Both β and γ cannot be too high for $\bar{p}^B_{base} > \bar{p}^B_{com}$ to occur, as then defection in Market B is either never profitable or setting a price of 52 is optimal, in both the baseline and communication games.

As a measure for the likelihood of cooperation spillovers, we take the size of the range of β's and γ's for which the highest feasible market price in Market B is strictly higher in the communication game than in the baseline game. Notice that the size of the range of β's and γ's for which $\bar{p}^B_{base} > \bar{p}^B_{com}$ is decreasing in n. This is because, while the four conditions underlying Proposition 4 do not all become more difficult to satisfy as n increases, ultimately an increase in n reduces the parameter space for which $\bar{p}^B_{base} > \bar{p}^B_{com}$ as it becomes more attractive for firms to undercut their rivals so that the range of feasible prices in Market B tends to 52. Therefore, we conclude that cooperation spillovers are more likely to occur when fewer firms are in the market, so they are most likely to occur if $n = 2$.

Under the standard assumption that $\alpha = \beta = \gamma = 0$, the forces that allow for cooperation spillovers in our one-shot game are absent so that such spillovers do not occur. In that case, the baseline game has a unique subgame-perfect Nash equilibrium outcome, which is given by $(p^A_1, p^A_2, ..., p^A_n; p^B_1, p^B_2, ..., p^B_2) = (102, 102, ..., 102; 52, 52, ..., 52)$. The profit-maximizing subgame-perfect Nash equilibrium outcome of the communication game is given by $(p^A_1, p^A_2, ..., p^A_n; p^B_1, p^B_2, ..., p^B_2) = (110, 110, ..., 110; 52, 52, ..., 52)$. The following proposition summarizes the result in terms of the highest feasible equilibrium prices in Market B.

Proposition 3. *The highest feasible market price in Market B is equal in the baseline and communication games if firms have standard preferences: if* $\alpha = \beta = \gamma = 0$, $\bar{p}^B_{base} = \bar{p}^B_{com} = 52$.

Proposition 3 states that if firms care only about their profit, the equilibrium price in Market B equals the lowest possible price both with and without communication in Market A, despite the firms perfectly cooperating in Market A in the communication game and all firms choosing the lowest possible price in Market A in the baseline game. This would, for instance, correspond to a market where firms' shareholders have no reciprocal preferences.

Until now, we have considered a one-shot game where firms interact only once in both markets. Repeated interaction, however, underpins the theory of (tacit) collusion and characterizes many market interactions, including uncovered cartel cases such as the methylglucamine, vitamin A500 USP, and beta-carotene cartels (Marshall and Marx, 2012). Therefore, we consider cooperation spillovers in the following indefinitely repeated game. The n firms interact repeatedly with one another, first in Market A and then in Market B. After each period, another period is played with probability $\delta \in [0, 1)$ and ends with probability $1 - \delta$.

We assume that both firms play the following grim-trigger strategy: Choose (or propose) the joint-payoff maximizing price in Market A of the first period and in every subsequent

Market And period unless any firm did not always choose (or propose) the joint-payoff maximizing price previously, in which case the lowest possible prices in markets A and B are set forever. For both the baseline and communication games, all firms playing the above grim-trigger strategy constitutes a subgame-perfect equilibrium with sufficiently high continuation probability δ.

We will now analyze for which values of δ the grim-trigger strategy constitutes an equilibrium. To do so, we first establish a firm's optimal deviation strategy. For both the baseline game and the communication game, the following strategy is the most attractive deviation to the above grim-trigger strategy, where text in **bold** [*italics*] refers to the **baseline game** [*communication game*] played in Market A:

- In period 1, **choose** [*propose only*] price 110 in Market A [*in all rounds of the communication protocol*], i.e., the highest price in the set $\{102, 103, ..., 110\}$;
- In period 1, choose price 69 in Market B, i.e., the second-highest price in the set $\{52, 53, ..., 70\}$;
- In periods 2,3,..., **choose** [*propose only*] price 102 in Market A [*in all rounds of the communication protocol*], i.e., the lowest price in the set $\{102, 103, ..., 110\}$;
- In periods 2,3,..., choose price 52 in Market B, i.e., the lowest price in the set $\{52, 53, ..., 70\}$.

In other words, the optimal deviation to the above grim-trigger strategy is for a firm to deviate in the first period in Market B by undercutting the price chosen in the grim-trigger strategy. As of period 2, the lowest possible prices in markets A and B are chosen. It is always more profitable to deviate in Market B than in Market A. When deviating in Market A, a firm will earn $109 - 100 = 9$ in Market A and $(52 - 50)/n = 2/n$ in Market B for a total of $9 + 2/n$, while when only deviating in Market B, it will earn $(110 - 100)/n = 10/n$ in Market A and $69 - 50 = 19$ in Market B for a total of $19 + 10/n > 9 + 2/n$.

Proposition 4. *Suppose that the firms indefinitely repeat the sequential play of markets A and B with continuation probability δ. If $\delta \geq \frac{19n(1-\beta)-20}{19n(1-\beta)+6}$, a subgame-perfect equilibrium exists in which in all periods, the firms charge prices* $(p_1^A, p_2^A, ..., p_n^A; p_1^B, p_2^B, ..., p_n^B) = (110, 110, ..., 110; 70, 70, ..., 70)$ *in both the baseline game and the communication game.*

A corollary to the above proposition is that cooperation spillovers do not emerge if repeated interaction allows the firms to perfectly cooperate in both markets A and B regardless of their ability to make binding price agreements in Market A. The intuition is straightforward: if firms with a sufficiently high discount rate can perfectly cooperate in both markets regardless of the presence of communication in Market A, there is no scope for cooperation spillovers to increase prices in Market B. However, while cooperation spillovers occur for all discount rates under the conditions of Proposition 2 in the one-shot game, they occur for only a subset of the discount rates in the repeated game.

Comparing the results for the baseline and communication games suggests that cooperation spillovers are most likely – in the sense of the largest set of parameter values – to occur if firms do not interact repeatedly and if the number of firms in the market is low. Our hypotheses are based on the thought experiment of many separate n-firm markets, where firms' parameter values are i.i.d. draws from some joint distribution. Depending on whether the parameter values satisfy the requirements of Propositions 2 and 4, cooperation spillovers do or do not occur in equilibrium in each separate market. Averaging these spillovers over all n-firm markets generates an average spillover to market prices in Market B that depends on n and on whether players interact repeatedly or not. The standard-model predictions in Proposition 3 provide a set of alternative hypotheses, namely that cooperation spillovers will never occur.

Hypothesis 1. In the case of one-shot interaction, if firms can form binding price agreements in Market A, cooperation spillovers occur: the market price in Market B is higher than if firms cannot form binding agreements in Market A.

Hypothesis 2. In the case of one-shot interaction, cooperation spillovers from Market A to Market B are less likely to occur the higher the number of firms active in both markets.

Hypothesis 3. Cooperation spillovers from Market A to Market B are less likely to occur in the case of repeated interaction than in the case of one-shot interaction.

Before discussing our design in detail, we note that in our one-shot treatments, we rematch subjects after each period in such a way that they will never face the same subject(s) two periods in a row but might face the same subject(s) several times throughout the experiment. While this is a standard way to implement one-shot games in the laboratory, in principle, subjects play an indefinitely repeated game with strangers rather than a one-shot game. This setting is representative of many interactions in the field, (procurement) auctions being just one example. In Appendix B, we study the equilibrium properties of this indefinitely repeated game by tailoring the framework developed by Camera and Casari (2009) to the specifics of our setting. This exercise aims to determine whether the predictions stated in Hypotheses 1–3 change when allowing for tacit collusion based on a grim-trigger strategy. Indeed, the supergames implied by the rematching protocol allow for tacit collusion in markets A and B at the highest prices in the sets. If such collusion is realized, Hypotheses 1–3 will not hold because subgame-perfect equilibria exist in which the highest possible price is chosen in Market B regardless of the firms being able to form binding agreements in Market A. However, as we will show, the market prices in the absence of binding agreements and the presence of cooperation spillovers suggest that subjects view our rematching treatments as playing a series of one-shot games – or at least coordinate on the one-shot Nash equilibrium.

3 Experimental design and procedures

To test our hypotheses, we conducted a laboratory experiment. As our theory points to the one-shot duopoly game as the most favorable to cooperation spillovers, this is the starting point of our experimental implementation. We then investigate variations with three-firm markets or repeated interaction and introduce additional treatments to determine whether reciprocal preferences are the likely mechanism behind our findings. Overall, this implies a 2x3+2 experimental design. In the 2x3 part of the design, we vary the game played (the baseline game vs. the communication game) and the market's competitiveness (two firms with rematching, three firms with rematching, two firms with fixed matching). Two treatment conditions – `BASE` for the baseline game and `COM` for the communication game – are used to model the game played. The rules of both games are discussed in Section 2, and Figure 1 shows the timeline of the experiment for both treatment conditions. In Section 5, we discuss the two additional treatments that find support for reciprocal preferences driving our results.

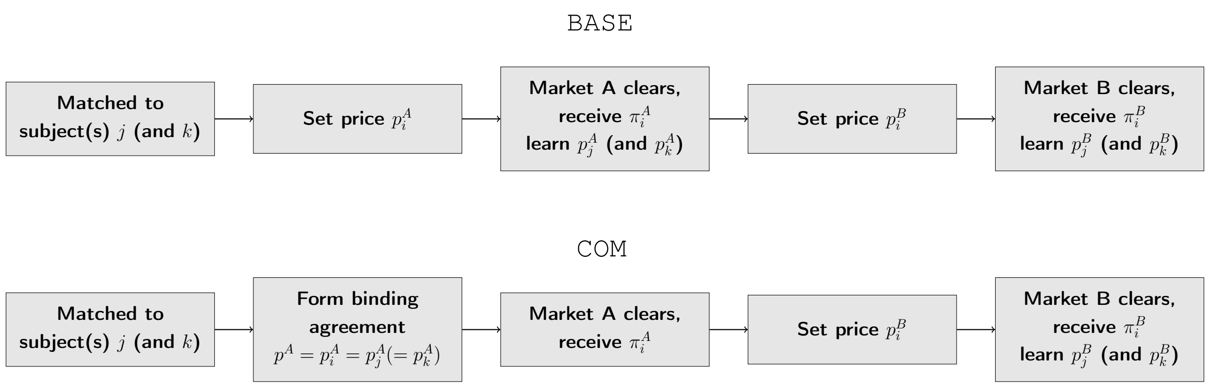


Figure 1: Timeline of subject i in the `BASE` and `COM` conditions.

In both `BASE` and `COM`, at the start of a period, subjects are matched into groups. In `BASE`, the subjects in a group first simultaneously select a price in Market A from the set $\{102, 103, \ldots, 110\}$. They are then informed about all prices chosen in their Market And their own profit, determined according to (1). The subjects in a group subsequently move on to Market B, where they again simultaneously submit their price, chosen from the set $\{52, 53, \ldots, 70\}$. Every period ends with the subjects in a group being informed about both prices and their own profit in Market B, computed as (2).

`COM` only differs from `BASE` in that in `COM`, subjects can form a binding price agreement in Market A using the communication protocol discussed in Section 2. In the experiment, we set $R = 5$. If, after five attempts, subjects have not agreed on a single price, the lowest price in the last agreed-upon range is automatically set for all subjects in a group.[18] Restricting communication to proposing price ranges ensures that subjects do not bring the outside world into the lab. More importantly, we can ensure that subjects do not explicitly communicate about the price in Market B, which aligns with our theoretical framework and ensures a conservative test of cooperation spillovers. To limit the possibility that subjects implicitly communicate about prices in Market B through their price proposals in Market A, the choice sets in markets A and B differ and do not overlap. This also makes it less likely that prices set in Market A will serve as focal prices in Market B.

Regarding competitiveness, we vary the number of firms and whether or not the same subjects interact with one another in all periods. In the `RE2` and `FIX2` conditions, each group consists of two subjects. In `RE2`, the subjects are rematched between periods, while in `FIX2`, the matching remains fixed throughout the experiment. In `RE3`, groups consist of three subjects who are rematched between periods.

Table 1: Experimental treatments

	`RE2BASE`	`RE2COM`	`RE3BASE`	`RE3COM`	`FIX2BASE`	`FIX2COM`	`RE2STRANGE`	`RE2CHEAP`
# firms	2	2	3	3	2	2	2	2
Communication	No	Yes	No	Yes	No	Yes	Yes	Yes
Binding agreements	No	Yes	No	Yes	No	Yes	Yes	No
Rematching	Yes	Yes	Yes	Yes	No	No	Yes	Yes
Multimarket contact	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
# subjects	68	68	108	108	48	48	64	68
# games	1,262	1,250	1,404	1,260	840	960	1,174	1,250
Observations	2,524	2,500	4,212	3,780	1,680	1,920	2,348	2,500

Notes: Treatment variation, count of subjects, games played, and observations, by treatment; 'Games' refers to a single repetition of the stage game in the `FIX2` treatments; Games and observations per subject can differ across treatment as the number of periods varies across sessions due to the random stopping rule; Communication = structured price communication available in Market A; Binding agreement = outcome of price communication in Market A is enforced; Rematching = Subjects are randomly rematched after each period; Multimarket contact = set of subjects in markets A and B is identical.

The computerized experiment was conducted at the Center for Research in Experimental Economics and political Decision making (CREED) of the University of Amsterdam. Students were recruited by public announcement. In total, 580 subjects participated in one of 42 sessions covering our eight treatments. We employed a between-subject design; each subject

[18]Subjects did not reach a price agreement in only 71 games (1.2% of all games where price agreements could be made).

participated in only one treatment. At the start of each session, matching groups of 4 [9] subjects were randomly formed in the two-firm [three-firm] treatments. These groups did not change during the sessions, and communication between subjects (other than through their price selection and price communication) was not possible. In the treatments with re-matching, in each period, subjects were randomly rematched within their matching group.[19] All sessions consisted of at least 35 periods. From period 35 onward, each next period was the final period with 20% probability.[20]

The experiment concluded with a circle test to obtain a measure for subjects' social preferences (Sonnemans et al., 2006). Subjects were asked to select one point on a circle with a radius of 15 euros. Each point on the circle represents an allocation of money between a sender, subject i, and a randomly selected receiver, subject j ($i \neq j$). The amount of money e_i in euro cents that subject i allocates to herself, and the amount of money e_j that subject i allocates to the receiver, subject j, satisfy $e_i^2 + e_j^2 = 1500^2$. Appendix C contains a more detailed description of the circle test and its implementation, including how a subject's β in equation (3) can be deduced from the subject's decision in the circle test.

Table 1 lists the number of subjects, games, and observations across treatments. All prices, costs, and circle tests in the experiment were denominated in euros. One period was randomly selected for payment after the experiment ended. Every subject had a 10 percent probability of being selected to determine the payment for the circle test for themselves and a randomly drawn other subject in the session. In addition, subjects received a show-up fee of 7 euros. Average earnings in the market game were 12.05 euros per subject, while sessions took 50-70 minutes to complete. Before the experiment, subjects had to correctly answer several test questions to ensure their understanding of the experiment. The instructions and test questions of `RE2COM` are in Appendix D.

4 Experimental results

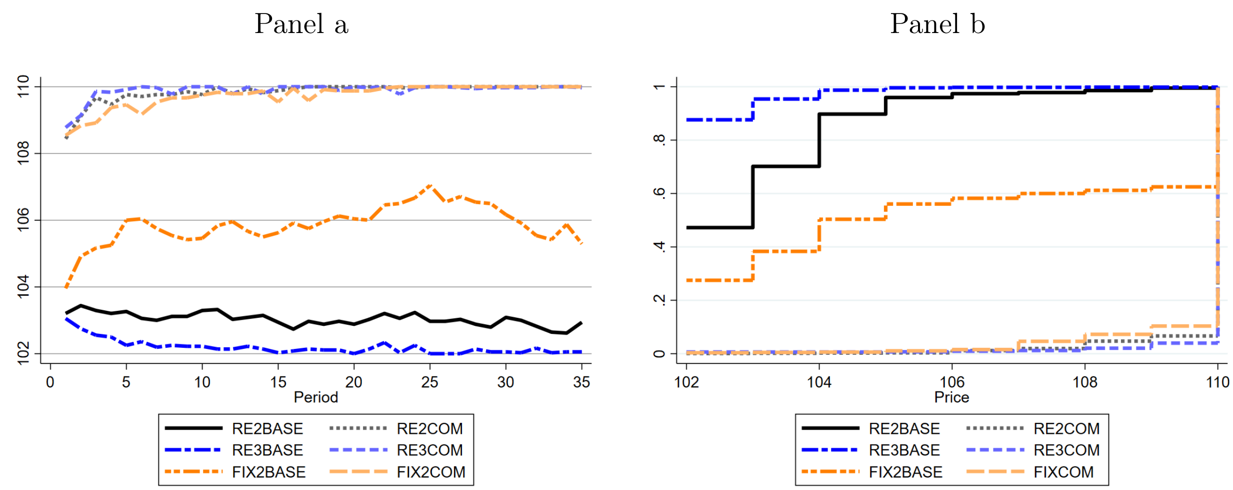
In this section, we discuss our experimental results, where the focus is always on comparing a `BASE` treatment to a `COM` treatment, holding fixed the number of firms and whether subjects are rematched after each period. Ultimately, the goal is to identify whether and under which

[19] Subjects were rematched in such a way that they would not face the same subject in two consecutive periods. Subjects were informed about this conditional rematching. Although tacit collusion is quite unlikely to be observed in groups with four or more subjects (see Huck et al. (2004) and Fonseca and Normann (2012)), we introduced this conditional rematching to eliminate any tendency towards tacit collusion due to repeated play. Indeed, the results from the `BASE` treatments with rematching, discussed below, confirm that tacit collusion was absent in both markets.

[20] This commonly used procedure softens potential end-game effects relative to a deterministic stopping rule (e.g., Holt (1985); Hinloopen et al. (2020)).

circumstances cooperation spillovers occur.[21]

Figure 2: Average market price over time (panel a) and the cumulative distribution function of market prices (panel b), Market A.



4.1 Market A

Panel a of Figure 2 shows the average market price over time in Market A, and Table 2 displays our aggregate results on pricing in Market A. In RE2BASE and RE3BASE, the market price lies just above the one-shot Nash equilibrium price with standard preferences of 102, a finding that resembles earlier results for similar experiments (e.g., Dufwenberg and Gneezy (2000); Jiménez-Jiménez and Rodero-Cosano (2023)). As expected, repeated interaction increases prices, as market prices in FIX2BASE hover around 106 after the first five periods. If subjects can form binding agreements in Market A – in all three COM treatments – the market price quickly converges to the joint-profit maximizing price of 110.

Panel b of Figure 2 shows that the cumulative distribution functions of market prices in the three COM treatments first-order stochastically dominates the cumulative distribution functions of the concomitant BASE treatments. Indeed, the average market price in RE2COM (109.85), RE3COM (109.89), and FIX2COM (109.74), are significantly higher than market prices in the no-communication counterparts RE2BASE (103.04), RE3BASE (102.19),

[21]Unless stated otherwise, regressions are used for comparisons between treatments – see Appendix E for more details. Standard errors are clustered at the matching group level to take into account the possible dependency of decisions within a matching group. These regression results are robust to using an average of all observations within a matching group as a single observation. The equality of distributions is tested using a two-sample Kolmogorov-Smirnov test, using a matchingroup average as a single observation. Results are based on the first 35 periods, although they are robust to using the full unbalanced panel.

and `FIX2BASE` (105.86).[22] These results complement the well-documented effect of non-binding communication in repeated interaction, where prices increase compared to a no-communication benchmark, but subjects do not necessarily coordinate upon the joint-profit maximizing price (Fonseca and Normann, 2012).

Table 2: Prices and measures of non-competitive prices across treatments, Market A

	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
`RE2BASE`	103.04 (1.37)	103.96 (2.28)	0.53 (0.50)	0.13 (0.17)	0.01 (0.07)
	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$
`RE2COM`	109.85 (0.68)	109.85 (0.68)	1.00 (0.03)	0.98 (0.08)	0.93 (0.25)
`RE3BASE`	102.19 (0.64)	103.48 (2.57)	0.12 (0.33)	0.02 (0.08)	0.00 (0.04)
	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$
`RE3COM`	109.89 (0.73)	109.89 (0.73)	0.99 (0.08)	0.99 (0.09)	0.96 (0.20)
`FIX2BASE`	105.86 (3.48)	106.40 (3.36)	0.73 (0.45)	0.48 (0.43)	0.38 (0.48)
	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$
`FIX2COM`	109.74 (0.93)	109.74 (0.93)	1.00 (0.06)	0.97 (0.12)	0.90 (0.30)

Notes: Submitted price = price set by subject; Market price = lowest submitted price in the duopoly or triopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds 102; Degree of profitability = $\frac{p^A-102}{110-102}$; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; Standard deviation in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Next, we consider two measures of non-competitive prices (see, e.g., Hinloopen et al. (2020)): 1) the fraction of market prices above the one-shot Nash equilibrium price that results if firms only care about profit ($\alpha = \beta = \gamma = 0$), and 2) the normalized difference between the market price and that equilibrium price, which we refer to as the 'degree of profitability' and, for Market A, is given by

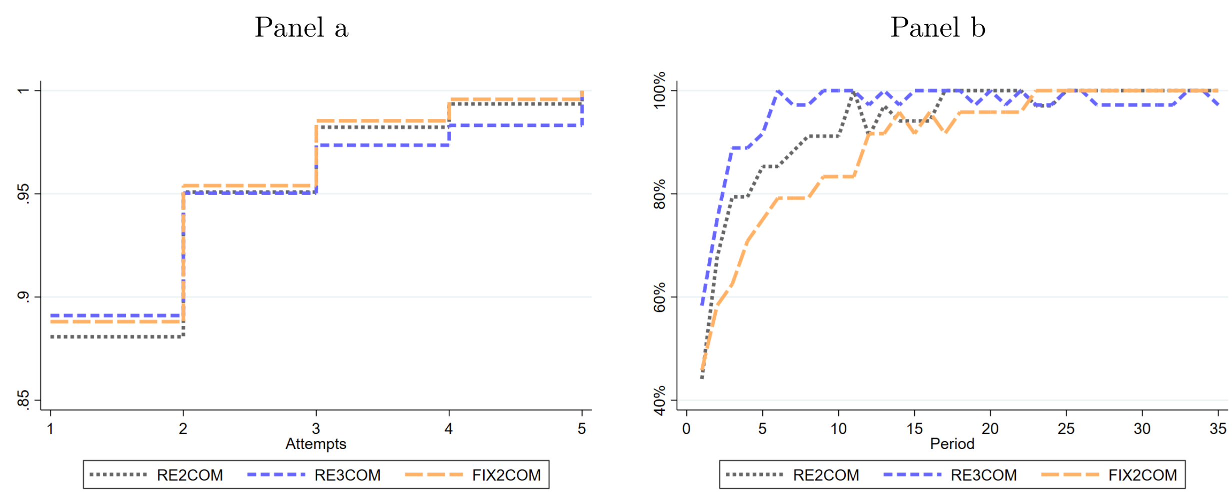
$$\frac{p^A - 102}{110 - 102}. \tag{9}$$

Without price communication, the fraction of markets with non-competitive prices increases when market competitiveness decreases: In `RE3BASE`, 12.38 percent of all games result in a price above 102, compared to 52.77 percent in `RE2BASE` and 72.5 percent in `FIX2BASE`. These differences across rematching protocol and the number of players disappear when subjects can make binding agreements in Market A. Then, between 99.37 percent

[22]For each of the COM treatments, both the average market price and the cumulative distribution function differ significantly for those for the corresponding BASE treatments at p=0.000.

(in RE3BASE) and 99.92 percent (in RE2BASE) of market prices exceed 102. As a result, while the degree of profitability ranges from about 2 percent in RE3BASE to about 50 percent in FIX2BASE, close to a 100 percent of the total surplus is extracted by the subjects in all three COM treatments.[23]

Figure 3: Cumulative distribution of communication attempts (panel a) and fraction of games over time where subjects coordinate on the joint-profit maximizing price $p^A = 110$ (panel b) in Market A



According to the assumptions made in our theoretical analysis, a requirement for the existence of cooperation spillovers is that subjects set $p^A = 110$ when binding agreements are available and $p^A < 110$ when these are unavailable. Indeed, communication allows subjects to successfully coordinate on market price 110 in all three COM treatments: the percentage of all market-periods where $p^A = 110$ ranges from 89.64 (753 out of 840 games) in FIX2COM to 96.03 (1210 out of 1260 games) in RE3COM. Figure 3 plots the cumulative distribution function of the number of communication attempts required to reach a price agreement (panel a) and the share of markets where subjects agree to set the highest price (panel b). While an agreement is reached after a single attempt in close to 90 percent of all market-periods in all three COM treatments, this percentage rises to between 92.47 in FIX2COM and 93.39 in RE2COM after the first five periods. Moreover, after the first five periods between 94.17 (in FIX2COM) and 98.61 (in RE3COM) percent of all agreements are to set $p^A = 110$. Hence, subjects quickly learn to almost perfectly coordinate on the joint-profit maximum within a single communication attempt in all three COM treatments.

When binding agreements are unavailable – in RE2BASE and RE3BASE – a market price of 110 occurs in less than 1 percent of all games. Therefore, there is substantial scope for

[23] P-values for comparisons between the fraction of markets with a market price above 102 [*degree of profitability*] in the BASE and COM treatments, are given by 0.000 [*0.000*] for RE2, 0.000 [*0.000*] for RE3, and 0.000 [*0.000*] for FIX2.

cooperation spillovers in our rematching treatments, as at least one of the firms 'misbehaves' – sets a price below 110 – in essentially every market when subjects are rematched, but subjects very rarely misbehave when binding agreements are available. In FIX2BASE, 37.5 percent of all market-periods have a market price of 110. While repeated interaction increases market prices, therefore, those prices still fall short of the joint-profit maximum most of the time. We conclude the scope for cooperation spillovers exists in all treatments but seems more moderate when subjects are not rematched than when they are, in the sense that the share of market-periods that satisfy the first two requirements for them to emerge is lowest in the FIX2 treatments.[24]

> **Result 1: Binding price communication facilitates coordination on the joint-profit maximum in Market A.** When binding price agreements are permitted in Market A, the market price in Market A converges to the joint-profit-maximizing price of 110. Absent the ability to communicate about prices, prices are significantly lower in all treatments and, if subjects are rematched, close to the one-shot Nash equilibrium that results if subjects care only about their profit.

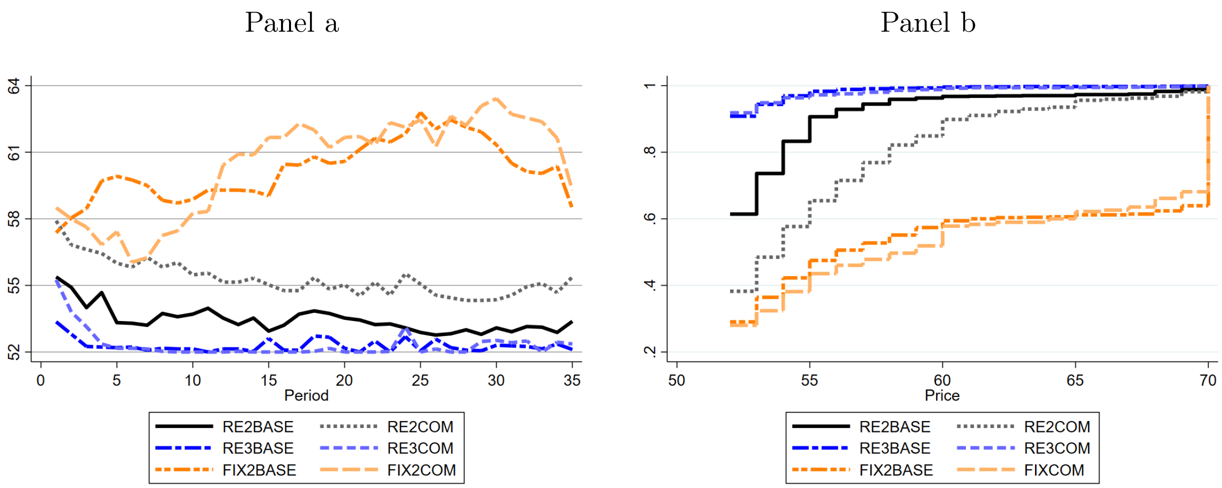
4.2 Market B

For Market B, we start by discussing the results of the RE2 treatments, as our theoretical analysis predicts this to be the setting most conducive to cooperation spillovers. Panel a of Figure 4 shows the average market price over time in Market B, and Table 3 provides our aggregate results on pricing in Market B. As in Market A, in RE2BASE the price settles just above the one-shot Nash equilibrium price if firms maximize profit. That is, the well-documented result that subjects play the one-shot Nash equilibrium price in a Duwfenberg-Gneezy type of game also holds if subjects interact consecutively in two unrelated markets.

More importantly, however, is that market prices in RE2COM are consistently above market prices in RE2BASE. Therefore, Figure 1 provides evidence of sustained cooperation spillovers. In particular, in RE2COM, the average market price of 55.30 is significantly higher than the average market price of 53.45 in RE2BASE ($p = 0.030$). Cooperation spillovers to submitted prices are even larger, as subjects submit a price of 57.04 in RE2COM, which is significantly higher than the price of 54.33 that is submitted in RE2BASE ($p = 0.011$). Overall, then, we find evidence of cooperation spillovers as prices in Market A are close to

[24] Given that $n = 2$ in FIX2BASE, we can use the implied values of β discussed in Appendix C to determine a numerical value for the critical discount rate in Proposition 4. Given that this critical discount rate is always below 0.4 in our data, and subjects are rematched with probability one in the periods of FIX2BASE used in our analysis, we might expect that all permissible prices in Market A can be part of a subgame-perfect equilibrium. In line with existing experimental studies that rely on a similar Bertrand set-up, we find that subjects do not manage to perfectly coordinate on the joint-profit-maximizing price (e.g., Hinloopen and Soetevent (2008); Chowdhury and Crede (2020)).

Figure 4: Average market price over time (panel a) and cumulative distribution function of market prices (panel b), Market B



102 in RE2BASE, close to 110 in RE2COM, and in Market B (market) prices are consistently and significantly higher in RE2COM than in RE2BASE.

Table 3: Prices and measures of non-competitive prices across treatments, Market B

	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
RE2BASE	53.45 (3.18)	54.33 (4.10)	0.40 (0.49)	0.08 (0.18)	0.09 (0.29)
	$\wedge^{**}$	$\wedge^{**}$	$\wedge^{**}$	$\wedge^{**}$	$\wedge$
RE2COM	55.30 (4.25)	57.04 (5.89)	0.63 (0.48)	0.18 (0.24)	0.13 (0.34)
RE3BASE	52.28 (1.32)	53.81 (4.58)	0.10 (0.30)	0.02 (0.07)	0.00 (0.00)
	$\wedge$	$\wedge$	$\vee$	$\wedge$	$=$
RE3COM	52.32 (1.63)	54.82 (5.71)	0.08 (0.27)	0.02 (0.09)	0.00 (0.00)
FIX2BASE	60.18 (8.04)	61.19 (7.87)	0.71 (0.45)	0.45 (0.45)	0.42 (0.49)
	$\wedge$	$\wedge$	$\wedge$	$\wedge$	$\wedge$
FIX2COM	60.45 (7.75)	61.80 (7.71)	0.73 (0.45)	0.47 (0.43)	0.37 (0.48)

Notes: Submitted price = price set by subject; Market price = lowest submitted price in the duopoly or triopoly; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds 52; Degree of profitability $= \frac{p^B - 52}{70 - 52}$; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard deviation in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

As a consequence of the observed cooperation spillovers, the fraction of games where the market price exceeds 52 increases from 40.34 percent in RE2BASE to 62.77 percent of all games in RE2COM ($p = 0.046$). In addition, allowing binding agreements in Market A more than doubles the share of total surplus that subjects capture in Market B as the degree of profitability in RE2COM of 18.35 percent is significantly higher than the 8.08 percent in RE2BASE ($p = 0.030$). The incidence of coordination on prices above 52 also increases, albeit not significantly so, from 9.41 percent to 13.36 percent (p=0.170). In sum, allowing subjects to coordinate their prices in Market A increases the incidence of non-competitive market prices in Market B by 55.60 percent and the degree of profitability by 127.10 percent.

Next, we turn to the RE3 treatments, where the necessary conditions for cooperation spillovers were realized in Market A, but where our theoretical framework suggests the scope for cooperation spillovers is more modest than in RE2. Figure 4 shows that market prices in RE3BASE and RE3COM almost immediately converge very close to 52 and remain at that level throughout the experiment. Unsurprisingly, then, the distribution functions of market prices in both treatments are near-identical. Market prices in RE3BASE (52.28) and RE3COM (52.32) do not significantly differ either (p=0.768). While subjects do submit higher prices in Market B when binding agreements are permitted in Market A than when they are not – 54.82 versus 53.81, respectively – this difference is not statistically significant (p=0.149). Therefore, we conclude that our aggregate results do not provide evidence of cooperation spillovers in RE3.

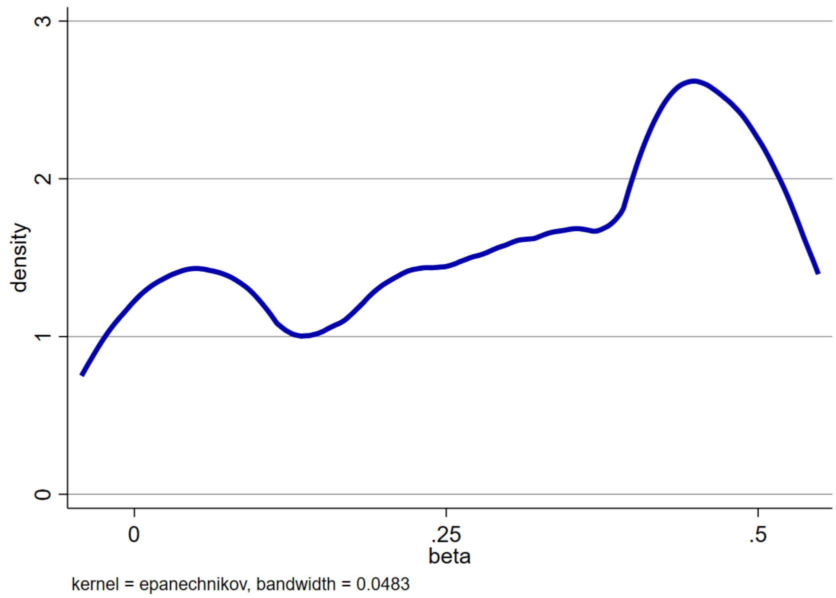
Finally, we investigate the FIX2 treatments. Here, theory suggests that repeated interaction might allow subjects to coordinate on the highest price in both markets, regardless of the possibility of communicating in Market A. However, the set of equilibria from the RE2 games are also equilibria of the repeated game, so there might be scope for cooperation spillovers if subjects either select equilibria that are not payoff maximizing or do not interpret the FIX2 treatments as repeated games. In line with this notion, we showed that prices are close to 110 in Market A of FIX2COM, but significantly lower in FIX2BASE.

Figure 4 shows that market prices in FIX2BASE and FIX2COM fluctuate around 61 after an initial increase and that the ranking of market prices in the two treatments changes several times throughout the experiment. In line with this, market prices and submitted prices in FIX2BASE (60.18 and 61.19, respectively) are slightly lower than in FIX2COM (60.45 and 61.80, respectively), but not significantly so (p=0.882 and p=0.724, respectively). None of our other measures differ significantly across the two treatments either, and it is noteworthy that the degree of profitability is close to 50 percent in all markets – A and B – characterized by repeated action but without binding price agreements. We, therefore, conclude that our aggregate results in the FIX2 treatments are likely the result of repeated interaction and are not in line with the existence of cooperation spillovers.

Our results in Market B, therefore, align with our three hypotheses. We conclude:

Result 2: Aggregate cooperation spillovers are only observed in one-shot duopoly games. With binding price agreements in Market A, the market price in

Figure 5: Kernel density of social preferences



Market B increases significantly compared to such agreements being absent, but only in duopolies that interact only once in both markets. While weak cooperation spillovers also exist if either repeated interaction or an additional player is introduced to this setting, these cooperation spillovers are not statistically significant.

That persistent and sizeable cooperation spillovers emerge in a market where price communication is impossible, and firms interact only once, is striking as the experimental literature pinpoints repeated interaction and communication as important drivers of non-competitive prices. Dufwenberg and Gneezy (2000) consider a discrete Bertrand experiment very similar to the markets in our experiment and find that market prices are only somewhat above the static Nash prediction when subjects are rematched each period. In a similar setting, Fonseca and Normann (2012) show that introducing repeated interaction increases prices, but only for duopolies, echoing the "two are few four are many" result of Huck et al. (2004). However, allowing subjects to communicate drastically increases prices, even in the already non-competitive duopoly case.

What, then, can explain our results? Our theoretical framework provides an explanation grounded in reciprocal preferences in line with the work of Fehr and Schmidt (1999) and Charness and Rabin (2002). If subjects value more than their profit alone, Proposition 2 provides conditions under which the highest feasible equilibrium price in `FIX2COM` is higher than in `FIX2BASE`. In particular, parameter β in utility function (3) must be sufficiently (but not too) high – β being a parameter that measures the degree to which a subject dislikes obtaining more profit than her rival. Similarly, the parameter γ – capturing a dislike for rivals that 'misbehave' by not setting the highest price in Market A – should be sufficiently high. If both conditions hold, cooperation spillovers occur in the most profitable subgame-perfect Nash equilibrium.

The remainder of this paper is concerned with building further evidence that reciprocal preferences are the likely explanation for our results. Guided by theory, we start by relating cooperation spillovers to a subject's β. The value of a subject's β can be deduced from their choices in a circle test – an incentivized social preference test conducted after the market game ended and not announced before that moment (Sonnemans et al., 2006). Appendix C details this test – where subjects select an allocation of money between themselves and another subject – the elicitation of β, and the results. Before analyzing the relation between cooperation spillovers and β, we briefly highlight two potential issues: whether the circle test reflects stable social preferences rather than some outcome of the market game, and whether these preferences are randomized over treatments. In Appendix C, we show that circle test choices are unrelated to a variety of outcomes of the market game, which indicates that the circle test measures a fixed characteristic of an individual, as intended. Appendix C also reports evidence suggesting that our results are unlikely to be the result of failing to randomize social preferences across treatments.

Table 4: Summary statistics of social preferences

	p(5)	p(25)	p(50)	p(75)	p(95)
Social preferences (β)	0.01	0.16	0.34	0.48	0.50

Notes: Kernel density and summary statistics of β, which measures social preferences as given in equation (3), rounded to two decimal points. p(5), p(25), p(50), p(75) and p(95) refer to the 5th, 25th, 50th, 75th and 95th percentile of the distribution, respectively. Based on the 348 subjects in the six main treatments for which $\beta > 0$.

Figure 5 plots the distribution of β over all six treatments, and Table 4 gives selected percentile of this distribution. The distribution is bimodal, with peaks occurring close to 0 and 0.5. Note that β can only be elicited if a subject allocates at least as much money to herself as to her partner in the circle test. Failure to do so does not imply that a subject has standard preferences or preferences different from utility function (3), but that β is not identified from (3). Therefore, it is not the case that subjects without an elicited β have standard preferences while subjects with an elicited β have preferences in line with equation (3). Instead, values of β close to zero correspond to standard preferences, while larger values of βs indicate social preferences in line with utility function (3).

Table 5 displays estimated treatment effects on submitted prices of `COM` compared to

Table 5: Cooperation spillovers, by degree to which subjects exhibit social preferences

	Treatment		
Sample	RE2	RE3	FIX2
Full sample	2.71 (1.009)**	1.01 (0.675)	0.61 (1.720)
	$n = 4,760$	$n = 7,560$	$n = 3,360$
All $\beta > 0$	2.40 (1.075)**	1.13 (0.676)	-0.29 (1.903)
	$n = 3,885$	$n = 5,635$	$n = 2,660$
Top three quartiles of $\beta > 0$	3.11 (1.184)**	1.58 (0.742)**	1.20 (2.082)
	$n = 3,115$	$n = 4,165$	$n = 1,855$
First quartile of $\beta > 0$	-0.58 (0.798)	-0.33 (1.022)	-4.20 (2.929)
	$n = 770$	$n = 1,470$	$n = 805$
Second quartile of $\beta > 0$	3.49 (1.377)**	0.48 (0.629)	3.60 (3.311)
	$n = 1,330$	$n = 1,120$	$n = 595$
Third quartile of $\beta > 0$	2.60 (1.475)*	2.17 (1.096)*	2.88 (3.085)
	$n = 945$	$n = 1,610$	$n = 525$
Fourth quartile of $\beta > 0$	3.57 (1.643)**	1.38 (1.098)	0.41 (2.489)
	$n = 840$	$n = 1,435$	$n = 735$

Notes: Table 5 reports the estimated coefficient of an indicator for a COM treatment from a regression of the submitted price in market B on this indicator, an indicator for the first 5 periods, and a constant; The comparison is always between a BASE and a COM treatment, holding fixed the number of players and the rematching protocol; Treatment effects are broken down by β, which measures social preferences as given in equation (3); Moments based on the single distribution of β covering all six treatments; n = number of observations; Standard errors, clustered at the matching group level, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

BASE, broken down by β. The first row reproduces the treatment effects underlying Table 3, only identifying significant cooperation spillovers in RE2. In the subsample for which $\beta > 0$, we find qualitatively similar results. Recall that subjects with a low β are those most consistent with standard preferences. Estimating treatment effects for the top 3 quartiles of the β distribution, we find larger treatment effects compared to the full sample in all cases – 3.11 in RE2, 1.58 in RE3, and 1.20 in FIX2. Interestingly, significant cooperation spillovers are now also observed for the triopoly treatments (p=0.044). These results suggest that cooperation spillovers are stronger for subjects with stronger social preferences than for those who have (close to) standard preferences, and that the same forces that are present in RE2 also contribute to cooperation spillovers in the other treatments.

Proposition 2 suggests that cooperation spillovers might be concave in β in RE2 and RE3, and this could also be the case in FIX2 if subjects play the one-shot Nash equilibrium in the repeated game. To test this prediction, we generate treatment effects of COM on submitted prices separately for each quartile of β. Table 5 shows that estimated treatment effects are negative and insignificant for the first quartile of β – regardless of rematching protocol or number of players. That is, cooperation spillovers do not occur for the group of subjects that most resemble standard preferences ($\beta \approx 0$). For RE3 and FIX2, for all other quartiles of β, estimated treatment effects are positive, and point estimates are concave in β – as predicted by theory. However, treatment effects are not significantly different from zero except that of the third quartile in RE3. In RE2, treatment effects are positive, large, and significantly different from zero in the three top quartiles of β. For RE2, estimate treatment effects are not concave in β, but seem to vary non-monotonically with β. Even though our hypotheses are based on the highest feasible price in Market B, the theoretical predictions quite closely match our empirical results. We conclude:

> **Result 3: Cooperation spillovers only occur if social preferences are sufficiently strong.** We find that social preferences need to be sufficiently strong for cooperation spillovers to emerge – β needs to be sufficiently large. Moreover, when such preferences are strong enough, cooperation spillovers also occur in the triopoly treatments. Qualitatively, the results from our treatments with fixed matching are similar, although cooperation spillovers are not statistically significant in that case.

5 Cooperation spillovers: Necessary conditions

In this section, we report results from two additional treatments that aim to explore further the mechanisms underpinning our main findings on cooperation spillovers. In the previous section, we showed that these spillovers relate to β as expected. In addition, our theory points to γ in equation (3) being a relevant parameter for cooperation spillovers to emerge. Recall that γ measures a player's dislike for her rivals 'misbehaving' – i.e., a dislike for her rivals not setting a sufficiently high price in Market A. In particular, our propositions build on the assumption that a subject 'rewards' her rivals for setting a high price in Market A. The two additional treatments adjust the setting from RE2COM in such a way that subjects still form agreements on prices but that the forces that we hypothesize to cause cooperation spillovers are weakened or removed if subjects act in accordance with utility function (3).

The two additional treatments test the necessity of multimarket contact and binding price agreements for the spillover to occur. In RE2CHEAP, we relax the assumption that the price agreement in Market A is binding. The same communication protocol was used as in RE2COM. However, after completing the communication phase, subjects still had to submit a price. This could be any price from the initial set $\{102, 103, \ldots, 110\}$, independent of the price agreed upon in the communication phase.[25] Because, for this communication protocol, cheap talk is known to be too weak a communication mechanism for firms to coordinate consistently on the monopoly price (Hinloopen and Soetevent, 2008), subjects that act in accordance with utility function (3) are likely always to perceive their rivals as having misbehaved in Market A. As a result, even though subjects always face the same rivals in markets A and B, the highest feasible Market B equilibrium price in RE2CHEAP and RE2BASE likely coincides. Therefore, we do not expect cooperation spillovers to emerge in RE2CHEAP.

In RE2STRANGE, we relax the assumption of multimarket contact: in each period, subjects face a different rival in markets A and B. After each period, subjects were randomly rematched for Market A so they would not face the same subject in Market A in two consecutive periods. Within a period, subjects were rematched to face a different subject in Market A than in Market B. As the rival that potentially misbehaves in Market A is different from the rival that a subject encounters in Market B, the final term in utility function (3) drops out if subjects only wish to retaliate to the rival(s) that they see misbehaving. Therefore, we expect that cooperation spillovers will be substantially weaker in RE2STRANGE than in RE2COM.[26]

5.1 Non-binding price communication

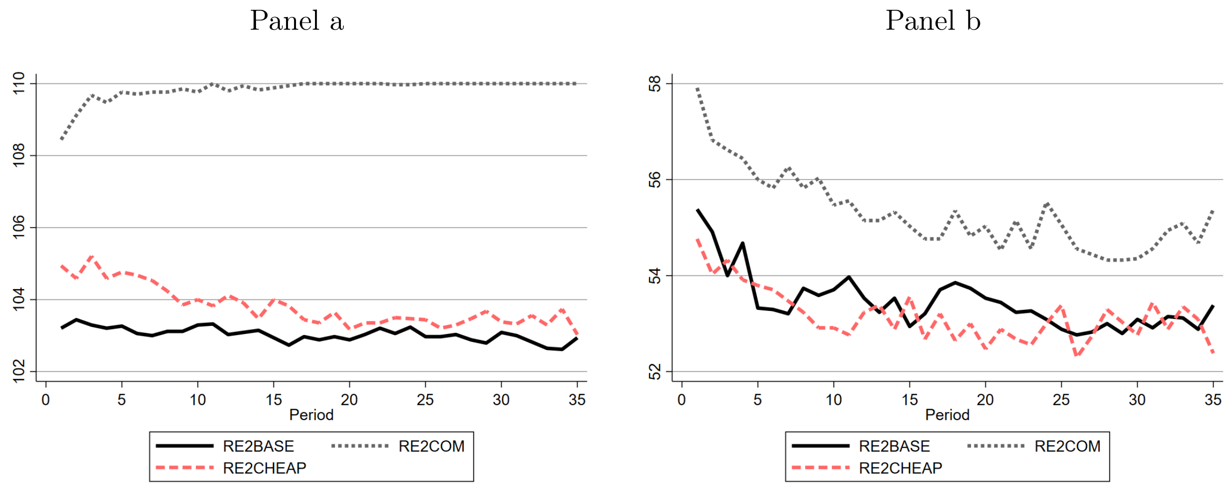
Panel a of Figure 6 shows the average market price over time in Market A in RE2CHEAP, RE2BASE and RE2COM. The statistical tests comparing behavior across these treatments are in Table 6. There are two observations to be made. First, non-binding communication increases the market price, even though subjects interact only once. That is, the market price of 103.81 in RE2CHEAP is significantly higher than the market price of 103.04 in RE2BASE ($p = 0.023$), although the difference is small economically. Relatedly, allowing subjects to make non-binding price agreements significantly increases the degree of profitability and the incidence of 110 emerging as market price ($p = 0.023$ and p=0.055, respectively). On average, the magnitude of the price increase is in line with that observed in Hinloopen and Soetevent (2008), although it decreases over time, suggesting that market prices in RE2BASE and RE2CHEAP might have converged if the experiment had lasted longer.

Second, although the market price increases significantly if subjects can make non-binding price agreements, the increase is relatively small compared to the market price in RE2COM.

[25] If no agreement was reached after five attempts, subjects were informed that no agreement had been reached and that, therefore, the lowest price from the final price set constituted the (non-binding) agreement.

[26] All other aspects of the additional treatments are identical to those in RE2COM, descriptive statistics of the treatments are in Table 1, and further details on the overall procedures and earnings are at the end of Section 3.

Figure 6: Average market price over time in Market A (panel a) and Market B (panel b), for RE2BASE, RE2COM and RE2CHEAP.



This is due to the non-binding nature of the price agreement, as subjects do consistently form agreements. Subjects successfully form an agreement in 96.72 percent of all cases. These agreements always stipulate a price above 102, and in 68.20 percent of them, a price of 110. However, in only 45 games (3.91 percent of all agreements), subjects stick to the (non-binding) agreement. Moreover, 110 emerges as a market price in only 3.11 percent of all games. Hence, our theoretical framework would predict that market prices in B do not differ between RE2BASE and RE2CHEAP, as subjects consistently 'misbehave' in Market A by not setting a price of 110.

The average market prices over time in Market B in RE2CHEAP, RE2BASE and RE2COM are shown in panel b of Figure 6, see also Table 6. The market price of 53.16 in RE2CHEAP does not differ significantly from 53.45, the market price in RE2BASE ($p = 0.463$). That is, in RE2CHEAP, there is no spillover from legal cooperation in Market A to the market price in Market B. Also, in Market B, the fraction of prices above the one-shot Nash equilibrium price and the degree of profitability are not affected significantly if subjects are allowed to make non-binding price agreements in Market A. We thus observe:

> **Result 4: Cooperation spillovers do not occur if price agreements in Market A are not binding.** With non-binding price agreements in Market A, the market price in Market A increases compared to the situation without agreements, but only slightly. This price increase does not spill over to Market B, as Market And submitted prices do not differ depending on whether non-binding agreements are available in Market A.

Table 6: Prices and measures of non-competitive prices, across treatments

	Market A				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
RE2BASE	103.04 (1.37)	103.96 (2.28)	0.53 (0.50)	0.13 (0.17)	0.01 (0.07)
	$\wedge^{**}$	$\wedge$	$\wedge$	$\wedge^{**}$	$\wedge^{*}$
RE2CHEAP	103.81 (1.92)	104.56 (2.50)	0.67 (0.47)	0.23 (0.24)	0.03 (0.17)
	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$
RE2COM	109.85 (0.68)	109.85 (0.68)	1.00 (0.03)	0.98 (0.08)	0.93 (0.25)
	Market B				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
RE2BASE	53.45 (3.18)	54.33 (4.10)	0.40 (0.49)	0.08 (0.18)	0.09 (0.29)
	$\vee$	$\vee$	$\vee$	$\vee$	$\wedge$
RE2CHEAP	53.16 (2.55)	54.16 (4.03)	0.37 (0.48)	0.06 (0.14)	0.11 (0.31)
	$\wedge^{**}$	$\wedge^{***}$	$\wedge^{**}$	$\wedge^{**}$	$\wedge$
RE2COM	55.30 (4.25)	57.04 (5.89)	0.63 (0.48)	0.18 (0.24)	0.13 (0.34)

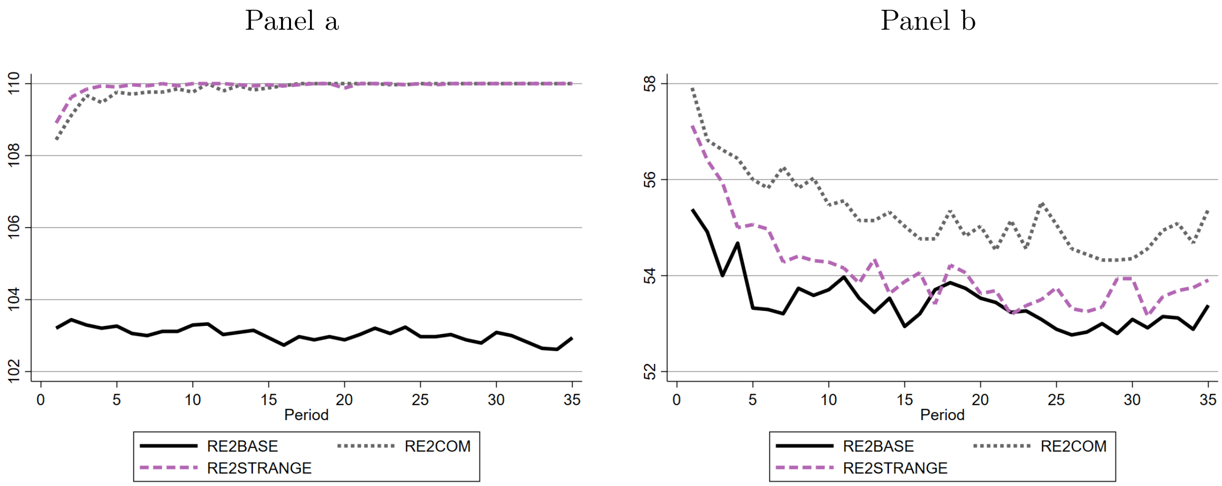
Notes: Submitted price = price set by subjects; Market price = lowest submitted price in every duopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds the static Nash equilibrium price of 102; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds the static Nash equilibrium price of 52; Degree of profitability = $\frac{p^A - 102}{110 - 102}$ in Market A and $\frac{p^B - 52}{70 - 52}$ in Market B; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard deviation in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

5.2 No multimarket contact

The development of prices over time in RE2BASE, RE2COM and RE2STRANGE are shown in Figure 7 with concomitant comparisons in Table 7. Panel a clearly shows that pricing behavior in Market A is not affected by subjects facing the same opponent in Market B or not, when subjects are allowed to make binding price agreements. Indeed, the average market price of 109.93 in RE2STRANGE does not differ significantly from 109.85, the average market price in of RE2COM ($p = 0.127$). At the same time, it is significantly higher than the average market price of 103.04 in RE2BASE ($p = 0.000$). The first two conditions for cooperation spillovers to emerge – that subjects set a price of 110 when agreements are available and misbehave when they are not – hold without multimarket contact.

Quite a different picture emerges for Market B. The spillover from legal cooperation in Market A to prices in Market B largely disappears if subjects face a different opponent in

Figure 7: Average market price over time in Market A (panel a) and Market B (panel b), for RE2BASE, RE2COM and RE2STRANGE.



Market B than in Market A, in line with subjects only retaliating to subjects that actually misbehaved in Market A: the average market price of 54.12 in RE2STRANGE does not differ significantly from 53.45, the average market price in RE2BASE ($p = 0.194$). While the difference between submitted prices in RE2STRANGE (55.50) and RE2BASE (54.33) is weakly significant (p=0.089), this result disappears if the first five periods are dropped from the analysis. However, while (market) prices in RE2STRANGE are lower than in RE2SCOM, these differences are not significant either. A possible explanation is that our rematching-to-strangers implementation of one-shot games creates a weaker type of multimarket contact across periods in RE2STRANGE that slightly inflates prices in Market B. In terms of significance, however, we observe:

> **Result 5: Absent multimarket contact, binding communication in Market A does not increase the price in Market B.** With binding price agreements in Market A, the market price in Market A increases. In most cases, subjects coordinate upon the joint-profit-maximizing price. This price increase does not spill over to market prices in Market B if subjects face a different opponent in Market A than in Market B.

5.3 Discussion

In sum, the strong price spillovers reported in Section 4 disappear when price agreements are non-binding and when subjects face a different rival in each market. This is in line with our theoretical framework where cooperation spillovers can occur due to conditional cooperation: if a subject sets a sufficiently high price in Market A, her rival is potentially willing to set a higher price in Market B. Our additional treatments maintained price communication, but

Table 7: Prices and measures of non-competitive prices, across treatments

	Market A				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
RE2BASE	103.04 (1.37)	103.96 (2.28)	0.53 (0.50)	0.13 (0.17)	0.01 (0.07)
	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$	$\wedge^{***}$
RE2STRANGE	109.93 (0.39)	109.93 (0.39)	1.00 (0.00)	0.99 (0.05)	0.96 (0.19)
	$\vee$	$\vee$	$\vee$	$\vee$	$\vee$
RE2COM	109.85 (0.68)	109.85 (0.68)	1.00 (0.03)	0.98 (0.08)	0.93 (0.25)
	Market B				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
RE2BASE	53.45 (3.18)	54.33 (4.10)	0.40 (0.49)	0.08 (0.18)	0.09 (0.29)
	$\wedge$	$\wedge^{*}$	$\wedge^{*}$	$\wedge$	$\wedge$
RE2STRANGE	54.12 (2.66)	55.50 (4.44)	0.59 (0.49)	0.12 (0.15)	0.14 (0.34)
	$\wedge$	$\wedge$	$\wedge$	$\wedge$	$\vee$
RE2COM	55.30 (4.25)	57.04 (5.89)	0.63 (0.48)	0.18 (0.24)	0.13 (0.34)

Notes: Submitted price = price set by subjects; Market price = lowest submitted price in every duopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds the static Nash equilibrium price of 102; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds the static Nash equilibrium price of 52; Degree of profitability = $\frac{p^A-102}{110-102}$ in Market A and $\frac{p^B-52}{70-52}$ in Market B; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard deviation in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

altered the setting compared to RE2COM by either removing multimarket competition so that a subject can not respond to a rival that set a high price in Market A, or by making agreements non-binding, so that the incidence of high prices in Market A drastically drops and there is no reason to set a higher price in Market B.[27]

Our results also suggest that a number of alternative explanations for our results are unlikely. In particular, explanations based on the act of communicating on prices seem improbably. Such explanations include that price coordination in Market A could create a social norm among all subjects facilitating higher prices in Market B, the agreement in Market A creating a focal point in Market B, or the subjects learning how to coordinate

[27]Conditional cooperation is observed in a broader experimental literature. For instance, subjects contribute voluntarily to a public good if they know that others have done so (Keser and Van Winden, 2000). Moreover, in one-shot sequential prisoner's dilemma games, second movers play more cooperatively if first-movers have also done so (Schneider and Shields, 2022).

in Market A and subsequently utilizing this information in Market B. These explanations suggest that price coordination on 70 in Market B should be much more pronounced than we observe, and cooperation spillovers would likely also emerge in the RE2STRANGE treatment. Moreover, it is not clear why treatment effects would depend on β in such explanations.

Explanations for cooperation spillovers based on the subjects interpreting the RE2 treatments as some type of repeated game also seem at odds with the data. If subjects see the game as a repeated game with strangers, the results seem at odds with the theory of experimental supergames put forward in Appendix B. It could also be argued that subjects see the subsequent interaction in markets A and B as a repeated game of two periods, be it that markets A and B are not identical. It is well-documented, however, that prices converge to the static Nash equilibrium price in settings where the number of consecutive interactions is (very) limited and known in advance (Fonseca and Normann, 2012; Embrey et al., 2018). Furthermore, in both interpretations of a repeated game, it is unclear why the results should depend on the elicited social preferences of the subjects. Lastly, in our repeated game treatments, no cooperation spillovers emerge.

A final alternative explanation is that price communication reduces strategic uncertainty among players. Maybe the prices that a subject's rivals set in Market A shapes her beliefs about the prices that those rivals will set in Market B.[28] However, given that coordinating on the monopoly price of 110 in Market A constitutes a one-shot Nash equilibrium in RE2COM, it is unclear that much can be learned from this behavior. In fact, prices in Market A appear to contain more information in the BASE than in the COM treatments. Moreover, strategic uncertainty does not explain why subjects need to exhibit social preferences to a sufficient degree for cooperation spillovers to emerge.

Overall, these potential alternative explanations do not rule out conditional cooperation caused by reciprocal preferences of subjects in the sense of Fehr and Schmidt (1999) and Charness and Rabin (2002) as a plausible explanation for our results.

6 Conclusion

The prohibition of the coordination of market behavior by private firms is a staple of antitrust policy around the world. However, many types of interfirm cooperation are permitted. This raises the question whether the legal assembly of firms might lead to cooperation spillovers to markets where firms are expected to compete. We have addressed this question experimentally in laboratory markets. To develop hypotheses regarding the occurrence of cooperation spillovers, we have built a theoretical framework in which firms sequentially play two homogeneous goods Bertrand games. The firms potentially have reciprocal preferences in the sense of Charness and Rabin (2002). We have derived conditions under which the most

[28]Such beliefs could be elicited, for instance by using the approach of Aoyagi et al. (2024).

profitable subgame-perfect Nash equilibrium is characterized by cooperation spillovers. We particularly find cross-market spillovers to be most likely to occur in a 'Goldilocks zone' of the right amount of competition where there is neither too much nor too little of it. We test this prediction in laboratory markets in which we vary both the level of competition and whether subjects can form (potentially binding) price agreements in the first market. In line with our theoretical predictions, we find that for an intermediate level of competition, allowing binding price agreements in the first market significantly increases submitted prices, market prices, and the occurrence of non-competitive prices in the second market. We also find support for our theory at the micro level in that cross-market spillovers particularly take place among experimental participants with sufficiently strong social preferences.

Results from additional treatments suggest commitment to the price agreements and multimarket contact are necessary to generate cooperation spillovers. The additional treatments put our main result in perspective. Sizeable spillovers from legal cooperation to non-competitive prices exist, but enforceable contracts and multimarket contact must support the cooperation. Enforceable contracts arise mainly when cooperation is legal and encouraged by government institutions. Examples of such legal cooperation are export cartels, book-price regulation, and the ECN recently allowing firms to cooperate in the context of Russia's military aggression against Ukraine. Our results caution against such arrangements and stress that firms should not be expected to cooperate on one dimension without this having anti-competitive effects on the dimensions in which they are still expected to compete.

Our findings, therefore, echo Adam Smith's concern that the law ought not to facilitate assemblies of competitors. In practice, legal cooperation exists more broadly than just on prices like in our setting. For instance, joint ventures to exploit oil fields are the rule, not the exception, in the crude oil industry. Research and development joint ventures, which have for example been prominent in the semiconductor industry, also face special rules in U.S. and E.U. antitrust.[29] In the fight against climate change, European competition authorities are pushing to relax antitrust treatment of interfirm cooperation on sustainability, while expecting firms to still compete on prices (Schinkel and Treuren, 2021). The recent report by Mario Draghi (2024), former president of the European Central Bank, includes several proposals to modernize the E.U.'s competition policy to safeguard European competitiveness in the future. One such proposal is that "cross-industry coordination and data sharing to accelerate the integration of AI into European industry [...] should be [...] safeguarded from antitrust enforcement by competition authorities." Laboratory studies by Suetens (2008) and Normann et al. (2015) suggest that firms being allowed to coordinate their market behavior on dimensions other than the price may also have the unintended consequence of softening

[29]Under the National Cooperative Research and Production Act of 1993. See, generally, Federal Trade Commission and U.S. Department of Justice, *Antitrust Guidelines for Collaborations Among Competitors*, April 2000. For the E.U., see *Commission Regulation (E.U.) No 1217/2010* on the exemption of R&D agreements, to be updated and extended July 2023.

competition between them in other markets.

An open question is the extent to which the experimental results are informative about markets in practice. Arguably, our experiment provides a conservative test of our hypotheses regarding cooperation spillovers in that our experimental design rules out many factors that could facilitate price spillovers in the field, such as unrestricted communication. Our experimental findings suggest that the answer to the question of external validity is rooted in the extent to which the managers responsible for the involved firms' pricing strategy exhibit reciprocal preferences, and the extent to which our rematching-to-strangers protocol captures firm interactions in the field.[30]

Regarding reciprocal preferences, some empirical evidence is available. For instance, Podolny and Scott Morton (1999) observe that high social status entrants are significantly less likely to be preyed upon than the low social status entrants in the merchant shipping industry. Another example is provided by Fershtman and Spiegel (2024) who report excessive price cuts for bread by industrial bakeries in Israel when competing bakeries entered their "home turf", followed by hundreds of phone conversations by the bakeries' executives (wire-tapped by the Israel Competition Authority) in an attempt to stop the excessive competition. Our rematching-to-strangers protocol captures interactions in the field where firms interact repeatedly, but not always with the same rivals and often without having full knowledge of the identity of the other firms. Repeated (procurement) auctions provide a good example of such a setting. Overall, then, our results suggest caution is warranted when allowing firms to cooperate, and point to conditions under which cooperation spillovers are particularly likely to emerge.

References

Aoyagi, M., Fréchette, G. R., and Yuksel, S. (2024). Beliefs in repeated games: An experiment. *American Economic Review*, 114:3944–3975.

Asker, J. (2010). Leniency and post-cartel market conduct: Preliminary evidence from parcel tanker shipping. *International Journal of Industrial Organization*, 28:407–414.

Bernheim, B. D. and Whinston, M. D. (1990). Multimarket contact and collusive behavior. *RAND Journal of Economics*, 21:1–26.

Bigoni, M., Fridolfsson, S.-O., Le Coq, C., and Spagnolo, G. (2012). Fines, leniency, and rewards in antitrust. *RAND Journal of Economics*, 43:368–390.

[30]Regarding the comparability of experimental subject populations and to professionals, Fréchette (2016) surveys the literature and concludes that students and professionals are qualitatively similar in terms of behavior in the lab.

Bigoni, M., Fridolfsson, S.-O., Le Coq, C., and Spagnolo, G. (2015). Trust, leniency, and deterrence. *Journal of Law, Economics, and Organization*, 31:663–689.

Broccardo, E., Hart, O., and Zingales, L. (2022). Exit versus voice. *Journal of Political Economy*, 130(12):3101–3145.

Byrne, D. P. and De Roos, N. (2019). Learning to coordinate: A study in retail gasoline. *American Economic Review*, 109:591–619.

Camera, G. and Casari, M. (2009). Cooperation among strangers under the shadow of the future. *American Economic Review*, 99:979–1005.

Canoy, M., van Ours, J., and van der Ploeg, F. (2006). The economics of books. In Ginsburg, V. A. and Throsby, D., editors, *Handbook of the Economics of Art and Culture, Volume 1*. Elsevier.

Cason, T. N. and Davis, D. D. (1995). Price communications in a multimarket context: An experimental investigation. *Review of Industrial Organization*, 10:769–787.

Cason, T. N., Savikhin, A. C., and Sheremeta, R. M. (2012). Behavioral spillovers in coordination games. *European Economic Review*, 56:233–245.

Charness, G. and Rabin, M. (2002). Understanding social preferences with simple tests. *Quarterly Journal of Economics*, 117(3):817–869.

Charness, G., Rigotti, L., and Rustichini, A. (2016). Social surplus determines cooperation rates in the one-shot prisoner's dilemma. *Games and Economic Behavior*, 100:113–124.

Chowdhury, S. M. and Crede, C. J. (2020). Post-cartel tacit collusion: Determinants, consequences, and prevention. *International Journal of Industrial Organization*, 70:102590.

Ciliberto, F. and Williams, J. W. (2014). Does multimarket contact facilitate tacit collusion? Inference on conduct parameters in the airline industry. *RAND Journal of Economics*, 45:764–791.

Connor, J. M. (2001). "Our customers are our enemies": The lysine cartel of 1992–1995. *Review of Industrial Organization*, 18:5–21.

Cooper, D. J. and Kagel, J. H. (2016). Other-regarding preferences. In Kagel, J. and Roth, A., editors, *Handbook of Experimental Economics, Volume 2*. Princeton University Press.

Cooper, D. J. and Kühn, K.-U. (2014). Communication, renegotiation, and the scope for collusion. *American Economic Journal: Microeconomics*, 6:247–78.

De Roos, N. (2006). Examining models of collusion: The market for lysine. *International Journal of Industrial Organization*, 24:1083–1107.

Dick, A. R. (1992). Are export cartels efficiency-enhancing or monopoly promoting? Evidence from the Webb-Pomerene experience. *Research in Law and Economics*, 15:89–127.

Draghi, M. (2024). *EU competitiveness: Looking ahead.* European Commission.

Dufwenberg, M. and Gneezy, U. (2000). Price competition and market concentration: An experimental study. *International Journal of Industrial Organization*, 18:7–22.

Duso, T., Röller, L.-H., and Seldeslachts, J. (2014). Collusion through joint R&D: An empirical assessment. *Review of Economics and Statistics*, 96:349–370.

Embrey, M., Fréchette, G. R., and Yuksel, S. (2018). Cooperation in the finitely repeated prisoner's dilemma. *Quarterly Journal of Economics*, 133:509–551.

Evans, W. N. and Kessides, I. N. (1994). Living by the "golden rule": Multimarket contact in the US airline industry. *Quarterly Journal of Economics*, 109:341–366.

Fehr, E. and Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *Quarterly Journal of Economics*, 114:817–868.

Fershtman, C. and Spiegel, Y. (2024). Price fixing or fixing competition? Bread in Israel. In Harrington, J. and Schinkel, M., editors, *Cartels Diagnosed*. Cambridge University Press.

Fonseca, M. A. and Normann, H.-T. (2012). Explicit vs. tacit collusion—The impact of communication in oligopoly experiments. *European Economic Review*, 56:1759–1772.

Freitag, A., Roux, C., and Thöni, C. (2021). Communication and market sharing: An experiment on the exchange of soft and hard information. *International Economic Review*, 62:175–198.

Fréchette, G. R. (2016). Experimental economics across subject populations. In Kagel, J. and Roth, A., editors, *Handbook of Experimental Economics, Volume 2*. Princeton University Press.

Harrington, J. E. (2004). Post-cartel pricing during litigation. *Journal of Industrial Economics*, 52:517–533.

Hinloopen, J., Onderstal, S., and Treuren, L. (2020). Cartel stability in experimental first-price sealed-bid and English auctions. *International Journal of Industrial Organization*, 71:102642.

Hinloopen, J. and Soetevent, A. R. (2008). Laboratory evidence on the effectiveness of corporate leniency programs. *RAND Journal of Economics*, 39:607–616.

Holt, C. A. (1985). An experimental test of the consistent-conjectures hypothesis. *American Economic Review*, 75:314–325.

Huck, S., Normann, H.-T., and Oechssler, J. (2004). Two are few and four are many: Number effects in experimental oligopolies. *Journal of Economic Behavior & Organization*, 53:435–446.

Jiménez-Jiménez, F. and Rodero-Cosano, J. (2023). Conditioning competitive behaviour in experimental Bertrand markets through contextual frames. *Journal of Behavioral and Experimental Economics*, 103:101987.

Keser, C. and Van Winden, F. (2000). Conditional cooperation and voluntary contributions to public goods. *Scandanavian Journal of Economics*, 102:23–39.

Kolstad, J. T. (2013). Information and quality when motivation is intrinsic: Evidence from surgeon report cards. *American Economic Review*, 103:2875–2910.

Kovacic, W., Marshall, R., Marx, L., and Raiff, M. (2007). Lessons for competition policy from the vitamins cartel. In Ghosal, V. and Stennek, J., editors, *The Political Economy of Antitrust*. Elsevier.

Laferrière, V., Montez, J., Roux, C., and Thöni, C. (2024). Multigame contact: A double-edged sword for cooperation. *American Economic Journal: Microeconomics*, 16:39–61.

Lin, H. and McCarthy, I. M. (2022). Multimarket contact in health insurance: Evidence from Medicare Advantage. *forthcoming in Journal of Industrial Economics*.

List, J. A. (2020). Non est disputandum de generalizability? A glimpse into the external validity trial (no. w27535) National Bureau of Economic Research.

Marshall, R. C. and Marx, L. M. (2012). *The Economics of Collusion: Cartels and Bidding Rings*. MIT Press.

Martin, S. (1996). R&D joint ventures and tacit product market collusion. *European Journal of Political Economy*, 11:733–741.

Mengel, F. (2018). Risk and temptation: A meta-study on prisoner's dilemma games. *Economic Journal*, 128(616):3182–3209.

Normann, H.-T., Rösch, J., and Schultz, L. M. (2015). Do buyer groups facilitate collusion? *Journal of Economic Behavior & Organization*, 109:72–84.

Parker, P. M. and Röller, L.-H. (1997). Collusive conduct in duopolies: Multimarket contact and cross-ownership in the mobile telephone industry. *RAND Journal of Economics*, 28:304–322.

Phillips, O. R. and Mason, C. F. (1992). Mutual forbearance in experimental conglomerate markets. *RAND Journal of Economics*, 23:395–414.

Phillips, O. R. and Mason, C. F. (1996). Market regulation and multimarket rivalry. *RAND Journal of Economics*, 27:596–617.

Podolny, J. M. and Scott Morton, F. M. (1999). Social status, entry and predation: The case of British shipping cartels 1879–1929. *Journal of Industrial Economics*, 47:41–67.

Potters, J. and Suetens, S. (2013). Oligopoly experiments in the current millennium. *Journal of Economic Surveys*, 27:439–460.

Reuben, E. and Suetens, S. (2012). Revisiting strategic versus non-strategic cooperation. *Experimental Economics*, 15:24–43.

Riedl, A. and Smeets, P. (2017). Why do investors hold socially responsible mutual funds? *Journal of Finance*, 72:2505–2550.

Schinkel, M. P. and Treuren, L. (2021). Green antitrust: Friendly fire in the fight against climate change. In Holmes, S., Middelschulte, D., and Snoep, M., editors, *Competition Law, Climate Change & Environmental Sustainability*. Concurrences.

Schneider, M. and Shields, T. (2022). Motives for cooperation in the one-shot prisoner's dilemma. *Journal of Behavioral Finance*, 23:438–456.

Shapiro, C. and Willig, R. D. (1990). On the antitrust treatment of production joint ventures. *Journal of Economic Perspectives*, 4:113–130.

Sonnemans, J., Van Dijk, F., and Van Winden, F. (2006). On the dynamics of social ties structures in groups. *Journal of Economic Psychology*, 27:187–204.

Sovinsky, M. (2022). Do research joint ventures serve a collusive function? *Journal of the European Economic Association*, 20:430–475.

Suetens, S. (2008). Does R&D cooperation facilitate price collusion? An experiment. *Journal of Economic Behavior & Organization*, 66:822–836.

Appendices

A Proofs of propositions

Proof of Proposition 1 We solve the games using backward induction, starting with Market B. Consider a candidate equilibrium in which both firms choose price p^B in Market B. Given the firms' utility structure, the most attractive deviation from p^B is to a price $p^B - 1$. If $p^B = c^B + 2$, such deviation does not exist as $p^B - c^B \geq 2$ by construction, so $p^B = c^B + 2$ constitutes an equilibrium of the market-B subgame as upward deviations from p^B are never profitable. $p^B > c^B + 2$ is part of an equilibrium if and only if

$$\left(1 - \beta + \frac{\sum_{j \neq i} m_j \gamma}{n-1}\right)(p^B - 1 - c^B) \leq \frac{p^B - c^B}{n} \Leftrightarrow$$
$$\left(1 - \frac{1}{n} - \beta + \frac{\sum_{j \neq i} m_j \gamma}{n-1}\right)(p^B - c^B) \leq 1 - \beta + \frac{\sum_{j \neq i} m_j \gamma}{n-1}.$$

Observe that if $\gamma > 0$, the highest possible price is at least as high when none of the firms misbehaved than when at least one firm misbehaved. Turning to Market A, we start by observing that in the communication game, both firms pricing at the highest possible price (i.e., at $p^A = 110$) is always part of an equilibrium strategy. As a result, in the communication game, the highest possible equilibrium price in Market B is given by

$$\bar{p}^B_{com} = \max \left\{ p^B \in \{52, 53, ..., 70\} | \left(1 - \frac{1}{n} - \beta\right)(p^B - c^B) \leq 1 - \beta \right\}.$$

Now, consider the case that the firms do not have the opportunity for binding communication in Market A. Then,

$$\bar{p}^B_{base} = \max \left\{ p^B \in \{52, 53, ..., 70\} | \left(1 - \frac{1}{n} - \beta + \frac{\sum_{j \neq i} m_j \gamma}{n-1}\right)(p^B - c^B) \leq 1 - \beta + \frac{\sum_{j \neq i} m_j \gamma}{n-1} \right\}.$$

As $p^B - c^B \geq 2$, it follows that $\bar{p}^B_{base} \leq \bar{p}^B_{com}$. ■

Proof of Proposition 2 Follows directly from in equalities (4)–(8), the restriction $\bar{p}^B_{base}, \bar{p}^B_{com} \in \{52, 53, ..., 70\}$, and the condition $\bar{p}^B_{base} > \bar{p}^B_{com}$. ■

Proof of Proposition 3 We start by establishing that the baseline game has a unique subgame-perfect Nash equilibrium outcome, which is given by $(p^A_1, p^A_2, ..., p^A_n; p^B_1, p^B_2, ..., p^B_2) = (102, 102, ..., 102; 52, 52, ..., 52)$. The proof proceeds by backward induction. The unique Nash equilibrium of the Market B subgame is $(p^B_1, p^B_2, ..., p^B_n) = (52, ..., 52)$. Consider a firm $j = 1, ..., n$. If all firms $i \neq j$ set $p^B_i = 52$, the best response of firm j is to set $p^B_j = 52$ as this results in payoffs $\pi^B_j = \frac{52-50}{n} = 2/n$, while any other choice by firm j leads to profit of

0 as then $p_j^B > p_i^B$. To establish uniqueness, notice that for any $p_{-j}^B \equiv \min_{i \neq j} p_j^B \neq 52$, the best response of firm j is to set $p_j^A = p_{-j}^A - 1$. For the Market A subgame, it is analogously established that $(p_1^A, p_2^A, ..., p_2^A) = (102, 102, ..., 102)$ is the unique Nash equilibrium outcome in Market A.

Turning to the communication game, analogously to the baseline game, the unique equilibrium of the Market B subgame is $(p_1^B, p_2^B, ..., p_n^B) = (52, ..., 52)$. Because the one-shot equilibrium price is Market B equals 52 in both the baseline game and the communication game, it follows that $\bar{p}_{base}^B = \bar{p}_{com}^B = 52$. ∎

Proof of Proposition 4 The expected value of the stream of profits when all firms play the grim-trigger strategy equals:

$$V^C = \sum_{t=1}^{\infty} \left(\frac{110 - 100}{n} + \frac{70 - 50}{n} \right) \delta^{t-1} = \frac{30}{n} \frac{1}{1 - \delta}.$$

The expected value of the stream of profits when deviating are given by:

$$\begin{aligned} V^D &= \left(\frac{110 - 100}{n} + (69 - 50)(1 - \beta) \right) + \sum_{t=2}^{\infty} \left(\frac{102 - 100}{n} + \frac{52 - 50}{n} \right) \delta^{t-1} \\ &= \frac{10}{n} + 19(1 - \beta) + \frac{4}{n} \frac{\delta}{1 - \delta}. \end{aligned}$$

It follows that

$$V^C \geq V^D \Longleftrightarrow \delta \geq \frac{19n(1 - \beta) - 20}{19n(1 - \beta) + 6}.$$

∎

B Theoretical results for the experimental supergame among strangers with an indefinite horizon

In our rematching treatments, subjects are rematched after each period in such a way that they will never face the same subject(s) two periods in a row, but might face the same subject(s) several times throughout the course of the experiment. While this is a standard way to implement one-shot games in the laboratory, in principle, subjects play an indefinitely repeated rather than a one-shot game. Therefore, in this appendix, we study the equilibrium properties of this indefinitely repeated game by tailoring the framework developed by Camera and Casari (2009) to the specifics of our setting, i.e., allowing for more than two strategies in the stage game, and using a matching protocol in which subjects do not interact in two subsequent periods with one another. The aim of this exercise is to determine whether the predictions stated in Hypotheses 1–3 change when allowing for tacit collusion based on a grim-trigger strategy.

Consider the following indefinitely repeated game. Four risk-neutral firms, labeled $i = 1, 2, 3, 4$, interact for an indefinite number of periods. At the beginning of each period, the set of four firms is randomly split in two subsets of two firms, i.e., every firm $i \in \{1, 2, 3, 4\}$ is randomly matched with another firm $j \in \{1, 2, 3, 4\} \setminus \{i\}$. Next, the two firms in each subset interact repeatedly with one another, first in Market A and then in Market B. After each period, the game continues with probability $\delta \in [0, 1)$ and ends with probability $1 - \delta$. If the game continues after a period, in the next period, the firms are randomly rematched to one of the two firms they have not interacted with in the current period.

We assume that firms play the following community-wide grim-trigger strategy: Choose (or propose only) the joint-payoff maximizing price at every opportunity until at some point, the other firm in the current matching chooses another price (or price range). After having ever observed another firm not choosing (only) the joint-payoff maximizing price, choose (only) the lowest possible prices in markets A and B. For both the baseline game and the communication game, both described in section 2, all four firms playing the above grim-trigger strategy constitutes a subgame-perfect equilibrium with sufficiently high continuation probability δ.

We will now turn to analyzing for what δ the grim-trigger strategy constitutes an equilibrium. To do so, we first establish a firm's optimal deviation strategy. For both the baseline game and the communication game, the following strategy is the most attractive deviation to the above grim-trigger strategy, where text in **bold** [*italics*] refers to the **baseline game** [*communication game*]:

- In periods 1 and 2, **choose** [*propose only*] price 110 in Market A [*in all rounds of the communication protocol*], i.e., the highest price in the set $\{102, 103, ..., 110\}$;

- In periods 1 and 2, choose price 69 in Market B, i.e., the second-highest price in the set $\{52, 52, ..., 70\}$;

- In periods 3,4,..., **choose** [*propose only*] price 102 in Market A [*in all rounds of the communication protocol*], i.e., the lowest price in the set $\{102, 103, ..., 110\}$;

- In periods 3,4,..., choose price 52 in Market B, i.e., the lowest price in the set $\{52, 52, ..., 70\}$.

In other words, the deviation strategy is for a firm to deviate in the first two periods, and only to do so in Market B (and not in Market A), by undercutting the price chosen in the grim-trigger strategy with one unit. As of period 3, the lowest possible prices in markets A and B are chosen. Observe that the rematching protocol allows a firm to benefit from deviating in both periods 1 and 2 because in period 2, it will always compete against another firm than in period 1, which ensures that the competitor in period 2 has not yet noticed the deviation. Starting in period 3, the rematching protocol will match the deviating firm to an opponent choosing the lowest possible prices in markets A and B, to which the firm's best response is choosing the lowest price as well. Notice also that in both the baseline game and the communication game, it is better to deviate in Market B than in Market A. In the first and the second periods, when deviating in Market A, a firm will earn at most $109 - 100 = 9$ in Market A and $(52 - 50)/2 = 1$ in Market B for a total of at most 10, while, when only deviating in Market B, it will earn $(110 - 100)/2 = 5$ in Market A and $69 - 50 = 19$ in Market B for a total of 24.

The expected value of the stream of profits when all firms play the grim-trigger strategy equals:

$$V^C = \sum_{t=1}^{\infty} \left(\frac{110 - 100}{2} + \frac{70 - 50}{2} \right) \delta^{t-1} = \frac{15}{1 - \delta}.$$

The expected value of the stream of profits when deviating are given by:

$$\begin{aligned} V^D &= \left(\frac{110 - 100}{2} + (69 - 50)(1 - \beta) \right) (1 + \delta) + \sum_{t=3}^{\infty} \left(\frac{102 - 100}{2} + \frac{52 - 50}{2} \right) \delta^{t-1} \\ &= (24 - 19\beta)(1 + \delta) + \frac{2\delta^2}{1 - \delta}. \end{aligned}$$

It follows that

$$V^C \geq V^D \Leftrightarrow \delta^2(22 - 19\beta) \geq 9 - 19\beta.$$

Denoting the critical discount factor corresponding to treatment T by $\underline{\delta}^T$, we have

$$\underline{\delta}^{RE2BASE} \leq \sqrt{\frac{9}{22}} \approx 0.640. \tag{10}$$

Analogously, for 3-firm markets, it follows that

$$V^C = \frac{10}{1 - \delta} \geq V^D = \left(\frac{10}{3} + 19(1 - \beta) \right) (1 + \delta) + \frac{4}{3} \frac{\delta^2}{1 - \delta} \Leftrightarrow \delta^2(63 - 57\beta) \geq 37 - 57\beta.$$

$$\Leftrightarrow \underline{\delta}^{RE3BASE} \leq \sqrt{\frac{37}{63}} \approx 0.766$$

In the RE2STRANGE treatment, deviation is less attractive than in the RE2BASE treatment. The reason is that the other firm's punishment strategy starts kicking in in the next period rather than one period later: After deviating in Market B in one period, in the next period, the firm is either matched with the same firm in Market A (with probability 1/3), or (with probability 2/3) with a firm in Market B for whom the community-wide punishment strategy has been ignited. In the next period, optimally, the deviating firm charges price 109 in Market A and price 69 in Market B. As a result,

$$V^C = \frac{15}{1 - \delta} \geq V^D = 24 - 19\beta + \frac{1}{3}(-2\alpha + 19(1 - \beta))\delta + \frac{2}{3}(9(1 - \beta) - 2\alpha)\delta + 2\frac{\delta^2}{1 - \delta}$$

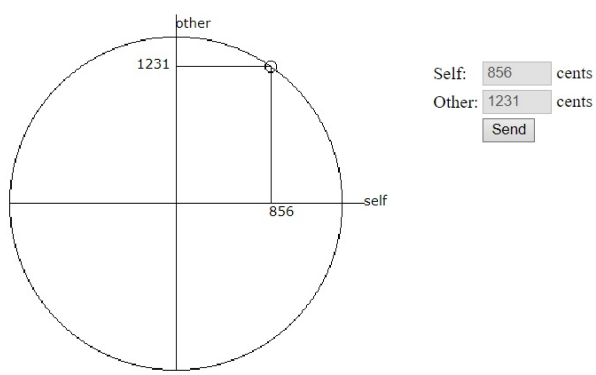
$$\Leftrightarrow \underline{\delta}^{RE2STRANGE} \leq \frac{\sqrt{4573} - 35}{62} \approx 0.526.$$

In all cases, the actual continuation probabilities (100 per cent in the first 35 periods and 80 per cent in later periods) are greater than the threshold values, implying that Hypotheses 1–3 will not hold true because subgame-perfect equilibria exist in which the highest possible price is chosen in Market B regardless of the firms being able to form binding agreements in Market A.

C Circle test

Our theoretical framework posits a utility function consistent with reciprocal preferences that nests standard preferences where firms care only about profit (Fehr and Schmidt, 1999; Charness and Rabin, 2002). In particular, we focus on eliciting parameter β in utility function (3), as it is of central interest to our propositions. In this appendix, we introduce our method for measuring β, detail the implementation and results, provide evidence suggesting that test results are not caused by the outcome of the market game, and find that social preferences are reasonably well balanced across treatments. Based on the results in this appendix, in the main text, we take the elicited preference parameter as a characteristic of an individual subject and investigate the heterogeneity of cooperation spillovers with respect to the degree to which subjects exhibit social preferences.

Figure C1: Circle test



We use a circle test to estimate a subject's β in equation (3). The test measures whether subjects have preferences over the payoff of other subjects relative to their own payoff – see Sonnemans et al. (2006) for more details. Figure C1 shows the circle test that was implemented in our experiments. Appendix D contains the instructions. Subjects were asked to select one point on a circle with a radius of 15 euros. Each point on the circle represents an allocation of money between the subject making the decision, subject i, and another subject, subject j ($i \neq j$). The amount of money in euro cents that subject i allocates to herself, e_i, and the amount of money that subject i allocates to subject j, e_j, satisfy $e_i^2 + e_j^2 = 1500^2$. Subjects could practice selecting points on the circle before progressing to the screen where the actual decision needed to be made. The circle test was presented to the subjects without any point selected or payoff combinations displayed. In each session, the circle test of one subject was randomly selected for payment. Subjects were not informed of each other's choices other than through payments.

For a given subject i, any choice in the circle test that satisfies $e_i \geq e_j > 0$ is consistent with a parameter $\beta > 0$ in equation (3) – which is the case for 457 out of 580 subjects (78.79 percent). This is not to say that other subjects do not have social preferences, but once $e_i < e_j$, for instance, it is no longer possible to recover β from utility function (3) as this parameter only becomes active if a subject's profit exceeds that of her partner. Notice that $e_i^2 + e_j^2 = 1500^2$ implies $e_j = \sqrt{1500^2 - e_i^2}$. If equation (3) represents her utility function, and conditional on $e_i \geq e_j > 0$, subject i chooses e_i to maximize $e_i - \beta(e_i - e_j) = e_i - \beta(e_i - \sqrt{1500^2 - e_i^2})$. The first-order condition of the maximization problem is given by

$$1 - \beta - \beta \frac{e_i}{\sqrt{1500^2 - e_i^2}} = 0 \iff 1 - \beta - \beta \frac{e_i}{e_j} = 0 \Rightarrow \beta = \frac{1}{1 + \frac{e_i}{e_j}}.$$

Table C1: Circle test allocations and implied β, averages by treatment

treatment	implied β	self (e_i)	other (e_j)	subjects
RE2BASE	0.28	1354	493	68
RE2BIND	0.31	1292	575	68
RE3BASE	0.24	1351	407	108
RE3BIND	0.36	1266	637	108
FIX2BASE	0.28	1358	410	48
FIX2BIND	0.29	1289	604	48
RE2STRANGE	0.32	1305	578	64
RE2CHEAP	0.32	1306	578	68

Notes: "self" refers to the amount of money a subject allocates to herself, "other" to the amount of money allocated to an anonymous other subject. Treatment averages in cents, rounded to cents. Implied β calculated for subjects for which $e_i \geq e_j > 0$.

Table C1 shows the average values of e_i and e_j by treatment, as well as the average implied β for subjects that have social preferences $0 < \beta < 1$. Selected amounts in the circle test are very similar across treatments, with the average amount allocated to oneself between 12.92 euro and 13.54 euro and the average amount allocated to the other between 4.93 euro and 5.78 euro.

We did not want the circle test to influence subjects' behavior, so subjects received instructions for the test after completing all periods of the experiment and were unaware

Table C2: Regressions relating circle test choices to market outcomes

	Dependent variable			
	self (e_i)			
Total earnings	-0.08			
	(0.068)			
Mean earnings		-2.84		
		(2.561)		
Median earnings			-3.02	
			(2.336)	
S.d. of earnings				0.18
				(5.642)
Constant	1329	1328	1328	1313
	(15.248)***	(15.508)***	(13.984)***	(14.539)***
R^2	0.00	0.00	0.00	0.00
Observations	580	580	580	580

Notes: Table C2 reports regression output relating circle test choices to market outcomes; Total (Mean) [Median] earnings = A subject's total (mean) [median] earnings in the market game; S.d. of earnings = Standard deviation of earnings across all periods of the market game; Standard errors, clustered at the matching group level, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

they would participate in a circle test when playing the Bertrand games. Therefore, test results could be influenced by the subjects' earlier experience. To mitigate this concern, we matched subjects in pairs that had not encountered each other during the Bertrand games and informed the subjects of this matching procedure. In addition, Table C2 contains regression-based evidence that circle test choices are unrelated to market outcomes. The main concern is that subjects who did not earn much in the market game will allocate more money to themselves in the circle test. As one period is randomly selected for payment and subjects do not know which period when filling out the circle test, subjects do not know with certainty what their earnings will be. Therefore, we relate a subject's circle test choice to various earnings outcomes: total, average, or median earnings, as well as the standard deviation of total earnings across periods. Table C2 shows that point estimates are very small and not significantly different from zero for all earnings measures. These results suggest that the circle test measures a fixed characteristic of an individual, as intended.

Table C3: Treatment effects of price communication on subjects' choices in the circle test

	Dependent variable: self (e_i)		
	RE2	RE3	FIX2
$\mathbb{I}^{RE2COM}$	-62.76		
	(35.086)*		
$\mathbb{I}^{RE3COM}$		-85.11	
		(26.734)***	
$\mathbb{I}^{FIX2COM}$			-69.63
			(49.848)
Constant	1,354	1,351	1,358
	(16.756)	(18.964)	(32.422)
R^2	0.03	0.04	0.03
Observations	136	216	96

Notes: Table C3 reports regression output relating how much money a subject allocates to herself in the circle test – e_i – to an indicator for a COM treatment; The comparison in always between a BASE and a COM treatment, holding fixed the number of players and the rematching protocol; Standard errors, clustered at the matching group level, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

To test whether the average β is comparable across treatments, we run a series of pairwise comparisons to estimate the 'treatment effects' of COM compared to BASE on β. Table C2 provides the results. Point estimates of treatment effects are small – roughly five percent of the average – in all treatments, not significantly different from 0 in FIX2 (p=0.169), and only significant at the 10 percent level in RE2 (p=0.083). We conclude that moderate randomization failure exists but is unlikely to explain our aggregate results. In line with this, the treatment effects and standard errors of the regressions underlying Tables 2 and 3 are virtually unchanged when including β as a control variable in the regressions. Given these results, the significant differences in market prices across treatments, the similarity of the circle test allocations across treatments, and the sample size, we believe our results are not driven by randomization failure.

D Instructions

The instructions were computerized. Subjects could read through html pages at their own pace. All questions needed to be answered correctly for the subject to progress to the experiment. The instructions for the circle test were only made available after the experiment had been completed by all subjects. For brevity, we include only the instructions for `RE2COM`. The instructions for the other treatments are available from the authors upon request.

Introduction

Welcome to this experiment. Please read the following instructions carefully. Pen and paper are on your table, you can use these during the experiment. We ask that you do not communicate with other people during the experiment. Please refrain from verbally reacting to events that occur during the experiment. The use of mobile phones is not allowed. If you have any questions, or need assistance of any kind, please notify the experimenter by raising your hand. Please comply with these rules, otherwise you will be asked to leave and you will not be paid.

Your earnings will depend on your decisions, and the decisions of other participants: your rivals. You will be paid in cash, privately, at the end of the experiment.

Outline of the experiment

This experiment consists of 35 periods with certainty, after which the experiment will end each period with a probability of 20 percent. Each period you are matched with one other subject: your rival. You will never play against the same rival twice in a row. You will never learn with whom you are matched

During the experiment, you can earn points. At the end of the experiment, one period will be randomly selected for payment. Your earnings will depend on the profit you earned in that period. Prices and profits in the experiment are in euros. In addition, you always receive the show-up fee of 7 euros.

Each period you compete sequentially in two markets: Market A and Market B. First, you communicate with your rival about the price in Market A. When you have reached an agreement about the price, this price will determine your earnings in Market A. Next, both you and your rival select a price for Market B. Once these two prices are selected, you learn your rival's price, and your profit in Market B. You play against the same rival in Market A and Market B. Each period you are randomly matched with a new rival. The markets and the communication protocol are described in detail on the next page.

The history of this experiment consists of a list of the prices that you and your rivals have set in all previous periods, with the concomitant profits. The complete history can be accessed through an on-screen button whenever you set a price.

The markets

In Market A, you and your rival discuss prices in a structured manner. Both you and your rival select a range of acceptable integer prices from 102-110. You do this by selecting your lowest acceptable price, and your highest acceptable price. If the range of acceptable prices you and your rival select overlaps, this overlap becomes the new range of prices and you again select a minimum and maximum price. If the range of acceptable prices you and your rival select does not overlap, you again select a minimum and maximum price from 102-110. You can suggest a single price by entering the same price as the minimum and maximum price. If the overlap is a single price, this price is automatically set in Market A. If you do not reach an agreement about the price in Market A after 5 attempts, the lowest price of the last price range is the price for Market A. Your profit in Market A that period is (price-100)/2.

Example 1: You select 104 as the lowest acceptable price, and 108 as the highest acceptable price. Your rival selects 106 as the lowest price, and 109 as the highest price. In the next attempt you can propose prices from the range 106-108.

Example 2: You select 105 as the lowest acceptable price, and 109 as the highest acceptable price. Your rival selects 108 as both the lowest and highest acceptable price. The overlap is the unique price 108, which is automatically set, giving you profit of (108-100)/2=4.

Example 3: You select 105 as the lowest acceptable price, and 109 as the highest acceptable price. Your rival selects 106 as the lowest acceptable price, and 108 as the highest acceptable price. The new range of acceptable price is 106-108, and the process repeats but you are unable to narrow the range down further in the remaining attempts. Price 106 is automatically set. Your profit is (106-100)/2=3.

In Market B, both you and your rival select an integer price in the range 52-70. When both you and your rival have selected a price, you receive information about your rival's price, and about your own profit. Your profits in Market B are calculated as follows:

Your price $<$ Rival price: your profit $=$ your price $-$ 50

Your price = Rival price: your profit = (your price – 50) / 2

Your price > Rival price: your profit = 0

Example 4: Both you and your rival set a price equal to 64. Your profit is (64-50)/2=7.

Example 5: You set a price equal to 58, and your rival sets a price equal to 53. Your profit is 0, and your rival's profit is 3.

Question 1

In total, how many different subjects will you play against in this experiment?
- One subject.
- Two subjects.
- More than two subjects.

Question 2

Your profit for a single period is given by:
- Your profit in Market A.
- Your profit in Market B.
- The sum of your profits in markets A and B.

Question 3

The price you set in Market B can be equal to the price you agreed upon in Market A. True/False

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Question 4

The agreement in Market A affects the prices you can select in Market B. True/False

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Question 5

In Market A, you propose as lowest price 105 and as highest price 108. Your rival proposes as lowest and highest price 107. What happens?
- You proceed to the next attempt. The lowest price you can propose is 105, the highest price you can propose is 107.

- You proceed to the next attempt. The lowest price you can propose is 105, the highest price you can propose is 108.
- You agree to set price 107 in Market A. Your profit is (107-100)/2=3.5.

Question 6

In Market B, your price is 64, and the price of your rival is 66. What is your profit in Market B?

Question 7

The monetary payoff you will receive at the end of the experiment depends on the show-up fee of 7 euros, and
- Your profit in one randomly selected market, in one randomly selected period.
- Your profit in one randomly selected market, in all periods.
- Your profit in both markets, in one randomly selected period.

Question 8

In the period that was selected for payment at the end of the experiment, prices were as follows. In Market A, both you and your rival agreed on price 106. In Market B, you set price 62, and your rival set price 64. In euros, how much will you receive?

Summary

We will start the first period when everybody has finished reading the instructions. Below you find a summary.

The experiment has 35 periods with certainty, after which the experiment ends each period with 20 percent probability. Each period you are matched with one other subject: your rival. You will never play against the same rival twice in a row. All prices and profits in this experiment are in euros. At the end of the experiment one period will be randomly chosen. You will be paid your profit that period in euros, and the show-up fee of 7 euros. You will be paid privately.

Each period consists of two markets. First, you discuss prices in Market A. If you agree on a single price, that price is automatically set in Market A. If, after 5 attempts, you do not agree on a single price, the lowest price in the range you agreed upon is set. If you did not agree on any price range, price 102 is set. The set price automatically determines profit in Market A as (price-100)/2. Second, you set a price in Market B. After prices have been set in Market B, you learn about your profit in Market B and the price of your rival.

The history of all prices set by you and your rivals, and your profits, is accessible each time you need to select a price.

Final task

You now choose earnings for yourself and one other subject, the OTHER, by picking a point on the circle. The OTHER subject you choose earnings for is a subject you did not play against. You will never know the identity of the OTHER. Your choice will be paid to you and the OTHER with 10 percent chance. With 90 percent chance, no payment will be made. This money is in addition to anything you already earned with the experiment. The horizontal axis shows how much you earn: the more to the right, the more you will earn. The vertical axis shows how much the OTHER will earn: the more to the top, the more the OTHER earns. Points on the circle left of the middle mean negative earnings for you, points below the middle mean negative earnings for the OTHER. You can try different points now by clicking on the circle. When you are ready to make a choice, please proceed to the next screen.

E Regressions identifying treatment effects

In this appendix, we present the regressions underlying Tables 2, 3, 6, and 7. All regressions are of the form

$$y_i = \beta_0 + \beta_1 \mathbb{I}_i^{treat} + \beta_2 \mathbb{I}_i^{early} + \varepsilon_i, \tag{11}$$

where $\mathbb{I}_i^{treat}$ is an indicator variable that equals 1 if observation i is from treatment $treat \in$ {`RE2COM`, `RE3COM`, `FIX2COM`, `RE2CHEAP`, or `RE2STRANGE`}, $\mathbb{I}_i^{early}$ is an indicator variable that equals 1 if observation i comes from one of the first five periods of a session, and comparisons are always between two treatments. For both Market A and Market B we investigate five outcome variables. The market price is the lowest price set in a (stage) game. The submitted price is the price a subject sets herself. $p^A > 102$ and $p^B > 52$ are indicator variables that equal one whenever a price above the competitive Nash equilibrium price emerges as market price in Market A or Market B, respectively. The degree of profitability is $\frac{p^A-102}{110-102}$ in Market A, and $\frac{p^B-52}{70-52}$ in Market B. Finally, $p^A = 110$ is an indicator variable that equals one if the market price in Market A equals 110, and $p^{min} = p^{max} > 52$ is an indicator variable that equals one subjects coordinate on a price above 52 in Market B. For set prices, i indicates a subject, while for the other outcomes i indicates a (stage) game.

Standard errors are clustered at the matching group level. This conservative approach accounts for the fact that behavior might be correlated between different (stage) games and subjects in a matching group. All analyses in Sections 4 and 5 use data from the first 35 periods only, so that the rematching protocol is constant across periods and the sample is balanced. Our results are robust to a variety of alternative approaches, such as interacting the treatment and early indicators, using the full unbalanced panel, or including additional controls based on the circle test outcomes.

Table E1: Regressions comparing prices in market A of RE2BASE and RE2COM

	Dependent variable				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
$\mathbb{I}^{RE2COM}$	6.81	5.88	0.47	0.85	0.93
	(0.188)***	(0.194)***	(0.081)***	(0.024)***	(0.021)***
$\mathbb{I}^{early}$	-0.18	-0.02	0.07	-0.02	-0.13
	(0.153)	(0.194)	(0.035)*	(0.019)	(0.038)***
Constant	103.06	103.97	0.52	0.13	0.02
	(0.188)***	(0.198)***	(0.083)***	(0.023)***	(0.007)***
R^2	0.91	0.75	0.31	0.91	0.87
Observations	2,380	4,760	2,380	2,380	2,380

Notes: Table E1 reports regression output relating outcomes based on prices in market A to an indicator for RE2COM and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds 102; Degree of profitability = $\frac{p^A-102}{110-102}$; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E2: Regressions comparing prices in market A of `RE3BASE` and `RE3COM`

	Dependent variable				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
$\mathbb{I}^{RE3COM}$	7.70	6.41	0.87	0.96	0.96
	(0.054)***	(0.235)***	(0.033)***	(0.007)***	(0.010)***
$\mathbb{I}^{early}$	0.02	0.03	0.15	0.00	-0.09
	(0.147)	(0.186)	(0.053)**	(0.018)	(0.034)**
Constant	102.19	103.47	0.10	0.02	0.01
	(0.045)***	(0.247)***	(0.031)***	(0.006)***	(0.005)***
R^2	0.97	0.74	0.78	0.97	0.92
Observations	2,520	7,560	2,520	2,520	2,520

Notes: Table E2 reports regression output relating outcomes based on prices in market A to an indicator for `RE3COM` and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the triopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds 102; Degree of profitability = $\frac{p^A-102}{110-102}$; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E3: Regressions comparing prices in market A of `FIX2BASE` and `FIX2COM`

	Dependent variable				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
$\mathbb{I}^{FIX2COM}$	3.88	3.34	0.27	0.48	0.52
	(0.611)***	(0.558)***	(0.060)***	(0.076)***	(0.090)***
$\mathbb{I}^{early}$	-0.88	-0.64	0.04	-0.11	-0.27
	(0.274)***	(0.247)**	(0.036)	(0.034)***	(0.048)***
Constant	105.98	106.49	0.72	0.50	0.41
	(0.629)***	(0.572)***	(0.063)***	(0.079)***	(0.087)***
R^2	0.38	0.32	0.15	0.38	0.33
Observations	1,680	3,360	1,680	1,680	1,680

Notes: Table E3 reports regression output relating outcomes based on prices in market A to an indicator for `FIX2COM` and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds 102; Degree of profitability = $\frac{p^A-102}{110-102}$; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E4: Regressions comparing prices in market B of RE2BASE and RE2COM

	Dependent variable				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
$\mathbb{I}^{RE2COM}$	1.85	2.71	0.22	0.10	0.04
	(0.815)**	(1.009)**	(0.108)**	(0.045)**	(0.028)
$\mathbb{I}^{early}$	1.44	2.40	0.28	0.08	-0.01
	(0.392)***	(0.416)***	(0.050)***	(0.022)***	(0.021)
Constant	53.25	53.99	0.36	0.07	0.09
	(0.336)***	(0.377)***	(0.065)***	(0.019)***	(0.015)***
R^2	0.07	0.09	0.09	0.07	0.00
Observations	2,380	4,760	2,380	2,380	2,380

Notes: Table E4 reports regression output relating outcomes based on prices in market B to an indicator for RE2COM and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds 52; Degree of profitability = $\frac{p^B - 52}{70 - 52}$; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E5: Regressions comparing prices in market B of `RE3BASE` and `RE3COM`

	Dependent variable				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
$\mathbb{I}^{RE3COM}$	0.04	1.01	-0.02	0.00	-
	(0.141)	(0.675)	(0.026)	(0.008)	-
$\mathbb{I}^{early}$	0.76	0.83	0.31	0.04	-
	(0.155)***	(0.390)**	(0.048)***	(0.009)***	-
Constant	52.17	53.69	0.05	0.01	-
	(0.119)***	(0.424)***	(0.024)**	(0.007)	-
R^2	0.03	0.01	0.14	0.03	-
Observations	2,520	7,560	2,520	2,520	2,520

Notes: Table E5 reports regression output relating outcomes based on prices in market B to an indicator for `RE3COM` and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the triopoly; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds 52; Degree of profitability = $\frac{p^B-52}{70-52}$; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E6: Regressions comparing prices in market B of `FIX2BASE` and `FIX2COM`

	Dependent variable				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
$\mathbb{I}^{FIX2COM}$	0.27	0.61	0.02	0.02	-0.05
	(1.814)	(1.720)	(0.087)	(0.101)	(0.094)
$\mathbb{I}^{early}$	-2.48	-1.76	0.04	-0.14	-0.22
	(0.875)***	(0.887)*	(0.061)	(0.049)***	(0.050)***
Constant	60.53	61.44	0.70	0.47	0.45
	(1.466)***	(1.364)***	(0.065)***	(0.081)***	(0.078)***
R^2	0.01	0.01	0.00	0.01	0.03
Observations	1,680	3,360	1,680	1,680	1,680

Notes: Table E6 reports regression output relating outcomes based on prices in market B to an indicator for `FIX2COM` and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds 52; Degree of profitability = $\frac{p^B-52}{70-52}$; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E7: Regressions comparing prices in market A of `RE2BASE` and `RE2CHEAP`

	Dependent variable				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
$\mathbb{I}^{RE2CHEAP}$	0.77	0.60	0.15	0.10	0.03
	(0.324)**	(0.390)	(0.105)	(0.041)**	(0.013)*
$\mathbb{I}^{early}$	0.73	0.98	0.18	0.09	-0.01
	(0.210)***	(0.248)***	(0.050)***	(0.026)***	(0.005)
Constant	102.93	103.82	0.50	0.12	0.01
	(0.189)***	(0.199)***	(0.083)***	(0.024)***	(0.004)
R^2	0.07	0.04	0.04	0.07	0.01
Observations	2,380	4,760	2,380	2,380	2,380

Notes: Table E7 reports regression output relating outcomes based on prices in market A to an indicator for `RE2CHEAP` and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds 102; Degree of profitability = $\frac{p^A-102}{110-102}$; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E8: Regressions comparing prices in market A of `RE2COM` and `RE2CHEAP`

	Dependent variable				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
$\mathbb{I}^{RE2CHEAP}$	-6.04	-5.28	-0.32	-0.76	-0.90
	(0.274)***	(0.346)***	(0.067)***	(0.034)***	(0.025)***
$\mathbb{I}^{early}$	0.27	0.36	0.11	0.03	-0.13
	(0.245)	(0.275)	(0.042)**	(0.031)	(0.038)***
Constant	109.81	109.80	0.98	0.98	0.95
	(0.052)***	(0.055)***	(0.006)***	(0.007)***	(0.018)***
R^2	0.82	0.68	0.20	0.82	0.82
Observations	2,380	4,760	2,380	2,380	2,380

Notes: Table E8 reports regression output relating outcomes based on prices in market A to an indicator for `RE2CHEAP` and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds 102; Degree of profitability = $\frac{p^A-102}{110-102}$; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E9: Regressions comparing prices in market B of RE2BASE and RE2CHEAP

	Dependent variable				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
$\mathbb{I}^{RE2CHEAP}$	-0.29	-0.17	-0.03	-0.02	0.01
	(0.393)	(0.512)	(0.091)	(0.022)	(0.026)
$\mathbb{I}^{early}$	1.17	1.92	0.32	0.07	0.02
	(0.294)***	(0.379)***	(0.040)***	(0.016)***	(0.023)
Constant	53.29	54.06	0.36	0.07	0.09
	(0.334)***	(0.377)***	(0.065)***	(0.019)***	(0.015)***
R^2	0.02	0.03	0.06	0.02	0.00
Observations	2,380	4,760	2,380	2,380	2,380

Notes: Table E9 reports regression output relating outcomes based on prices in market B to an indicator for RE2CHEAP and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds 52; Degree of profitability = $\frac{p^B-52}{70-52}$; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E10: Regressions comparing prices in market B of RE2COM and RE2CHEAP

	Dependent variable				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
$\mathbb{I}^{RE2CHEAP}$	-2.14	-2.88	-0.26	-0.12	-0.03
	(0.786)**	(1.009)***	(0.109)**	(0.044)**	(0.033)
$\mathbb{I}^{early}$	1.43	2.47	0.31	0.08	-0.01
	(0.357)***	(0.433)***	(0.054)***	(0.020)***	(0.026)
Constant	55.10	56.69	0.58	0.17	0.14
	(0.782)***	(0.977)***	(0.093)***	(0.043)***	(0.025)***
R^2	0.10	0.10	0.11	0.10	0.00
Observations	2,380	4,760	2,380	2,380	2,380

Notes: Table E10 reports regression output relating outcomes based on prices in market B to an indicator for RE2CHEAP and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds 52; Degree of profitability = $\frac{p^B - 52}{70 - 52}$; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E11: Regressions comparing prices in market A of RE2BASE and RE2STRANGE

	Dependent variable				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
$\mathbb{I}^{RE2STRANGE}$	6.90	5.97	0.47	0.86	0.96
	(0.182)***	(0.188)***	(0.081)***	(0.023)***	(0.012)***
$\mathbb{I}^{early}$	-0.02	0.14	0.08	0.00	-0.08
	(0.128)	(0.173)	(0.036)**	(0.016)	(0.026)***
Constant	103.04	103.94	0.52	0.13	0.02
	(0.187)***	(0.198)***	(0.083)***	(0.023)***	(0.005)***
R^2	0.92	0.76	0.31	0.92	0.92
Observations	2,310	4,620	2,310	2,310	2,310

Notes: Table E11 reports regression output relating outcomes based on prices in market A to an indicator for RE2STRANGE and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds 102; Degree of profitability = $\frac{p^A-102}{110-102}$; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E12: Regressions comparing prices in market A of `RE2COM` and `RE2STRANGE`

	Dependent variable				
	Market price	Submitted price	$p^A > 102$	Degree of profitability	$p^A = 110$
$\mathbb{I}^{RE2STRANGE}$	0.09	0.09	0.00	0.01	0.03
	(0.055)	(0.056)	(0.001)	(0.007)	(0.024)
$\mathbb{I}^{early}$	-0.50	-0.50	0.00	-0.06	-0.22
	(0.102)***	(0.105)***	(0.003)	(0.013)***	(0.039)***
Constant	109.92	109.92	1.00	0.99	0.96
	(0.041)***	(0.041)***	(0.000)***	(0.005)***	(0.018)***
R^2	0.11	0.10	0.00	0.11	0.12
Observations	2,310	4,620	2,310	2,310	2,310

Notes: Table E12 reports regression output relating outcomes based on prices in market A to an indicator for `RE2STRANGE` and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^A > 102$ = dummy variable equal to 1 when the market price p^A exceeds 102; Degree of profitability = $\frac{p^A - 102}{110 - 102}$; $p^A = 110$ = dummy variable equal to 1 when the market price p^A equals 110; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E13: Regressions comparing prices in market B of RE2BASE and RE2STRANGE

	Dependent variable				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
$\mathbb{I}^{RE2STRANGE}$	0.67	1.17	0.19	0.04	0.04
	(0.505)	(0.666)*	(0.100)*	(0.028)	(0.026)
$\mathbb{I}^{early}$	1.61	2.25	0.34	0.09	0.00
	(0.323)***	(0.399)***	(0.046)***	(0.018)***	(0.020)
Constant	53.22	54.01	0.35	0.07	0.09
	(0.335)***	(0.378)***	(0.065)***	(0.019)***	(0.015)***
R^2	0.05	0.05	0.09	0.05	0.00
Observations	2,310	4,620	2,310	2,310	2,310

Notes: Table E13 reports regression output relating outcomes based on prices in market B to an indicator for RE2STRANGE and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds 52; Degree of profitability = $\frac{p^B-52}{70-52}$; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Table E14: Regressions comparing prices in market B of RE2COM and RE2STRANGE

	Dependent variable				
	Market price	Submitted price	$p^B > 52$	Degree of profitability	$p^{min} = p^{max} > 52$
$\mathbb{I}^{RE2STRANGE}$	-1.18	-1.54	-0.03	-0.07	0.00
	(0.847)	(1.096)	(0.116)	(0.047)	(0.032)
$\mathbb{I}^{early}$	1.88	2.82	0.33	0.10	-0.04
	(0.375)***	(0.440)***	(0.059)***	(0.021)***	(0.023)
Constant	55.03	56.64	0.58	0.17	0.14
	(0.783)***	(0.978)***	(0.093)***	(0.044)***	(0.025)***
R^2	0.06	0.06	0.06	0.06	0.00
Observations	2,310	4,620	2,310	2,310	2,310

Notes: Table E14 reports regression output relating outcomes based on prices in market B to an indicator for RE2STRANGE and an indicator for the first 5 periods; Submitted price = price set by subject; Market price = Lowest submitted price in the duopoly; $p^B > 52$ = dummy variable equal to 1 when the market price p^B exceeds 52; Degree of profitability = $\frac{p^B-52}{70-52}$; $p^{min} = p^{max} > 52$ = dummy variable equal to 1 when players coordinate on a price above 52; Standard errors, clustered by matching group, in brackets; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.