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Abstract

We consider experimental markets of repeated homogeneous price-setting duopolies. We investigate the effect on collusion of sequential versus simultaneous price setting. We also examine the effect on collusion of changes in the size of each subject's market share in case both subjects set the same price. Our results show that sequential price setting compared with simultaneous price setting facilitates collusion, if subjects have equal market shares or if the follower has the larger market share. With sequential price setting, we find more collusion if subjects have equal market shares rather than unequal market shares. We observe more collusion if the follower has the larger market share than if the follower has the smaller market share.

JEL Classification Codes: C73, C92, L13, L41.

Keywords: Collusion, Price Leadership, Asymmetries, Experiment.

1 Introduction

In about one third of the cartel cases prosecuted by the European Commission, the market had a price leader and (several) price followers (Mouraviev and Rey, 2011). Examples include markets for fittings, professional videotape and candle wax (DG Competition, 2006, 2007, 2008). In a recent

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study, Mouraviev and Rey (2011) theoretically investigate the role of price leadership with regard to (tacit) collusion. They allow for the possibility of unequal market shares in case firms set the same price. They argue that sequential price setting, compared with simultaneous price setting, facilitates collusion by making it easier to punish deviations by the leader, which relaxes the incentive of the leader to deviate. Furthermore, they show that, with sequential price setting, collusion is facilitated if the follower's market share is higher, in case both firms set the same price. In particular, considering a repeated duopoly model with homogeneous goods and sequential price setting, Mouraviev and Rey demonstrate that collusion can be sustained for any discount factor, if the follower's market share is large enough. In contrast, with simultaneous price setting, collusion can only arise in equilibrium if the discount factor is large enough (Friedman, 1971).

Inspired by Mouraviev and Rey (2011), we consider experimental markets of repeated homogeneous price-setting duopolies. We investigate the effect on collusion of sequential versus simultaneous price setting. Further, we examine the effect on collusion of changes in the size of each subject's market share in case both subjects set the same price. In particular, we address the following two questions. First, does price leadership facilitate collusion, for a given type of market sharing? Second, with sequential price setting, does a larger market share of the follower facilitate collusion? There is one related issue which we will also examine. Mouraviev and Rey (2011) argue that market-share inequality in case firms set the same price, might facilitate collusion with sequential price setting. But we know from standard theory that with simultaneous price setting, market-share inequality hinders collusion (Ivaldi et al., 2003; Motta, 2004, pp. 164–165). We also investigate this claim in our experiment.

In our experiment we impose whether subjects set prices simultaneously or sequentially. We exogenously impose market shares in case subjects set the same price, to isolate the effect of market-share inequality. With simultaneous price setting we consider two treatments which differ in how the market is shared in case subjects set the same price. In one treatment the market is shared equally, in the other unequally. With sequential price setting we consider three treatments which differ in how the market is shared in case subjects set the same price. In one treatment the market is shared equally, in one the follower obtains the larger market share, and in one the follower obtains the smaller market share. To the best of our knowledge, we are the first to conduct an experiment on price leadership with homogeneous Bertrand competition, and our experiment is the first with unequal market sharing in case subjects set the same price.

Concerning the theory, there are two possible caveats in relation to our experiment. First, since we focus on tacit collusion, subjects might find it difficult to coordinate on the same collusive price. In the theoretical analyses of collusion by Motta (2004) and Mouraviev and Rey (2011), this coordination problem does not play a role. In practice, however, the coordination problem might be relevant, in particular in the case of simultaneous price setting. Scherer and Ross (1990, pp. 346–347) mention that one reason to introduce leadership in a market is indeed to facilitate tacit coordination on the same collusive price. This coordination problem is due to the unobservability of the competitor's price when one has to set her own price. A subject who wants to coordinate on the same price or wants to undercut her competitor, can therefore not be certain what her optimal strategy should be. Second, the larger the market share of the follower in case firms set the same price, the larger the difference between the collusive payoffs of the follower and leader. In the theoretical analysis of Mouraviev and Rey (2011), the utility of one firm does not depend on the profit of the other firm, but it might have an effect in practice. We know from the experimental literature that fairness arguments, in the sense that subjects dislike (large) payoff differences, matter (e.g. in the ultimatum game, see Roth, 1995; Camerer, 2003). In addition, Gibbons and Murphy (1990) and Albuquerque (2009) empirically show that CEOs of firms do not only care about their absolute performance, but also care about their relative performance. If such an effect is relevant in our experiment, it might imply that subjects are not willing to collude, if that would lead to too large payoff differences. Thus, an increase in payoff differences might (partially) offset the procollusive effect identified by Mouraviev and Rey.

In evaluating the results, we use three measures of collusion. We find the following with regard to our two main questions. First, we find more collusion with sequential price setting than with simultaneous price setting, if firms have equal market shares. We also find more collusion with sequential price setting than with simultaneous price setting if the follower has the larger market share. However, if the follower has the smaller market share, evidence is mixed. We argue that this can be explained in terms of the coordination problem and fairness arguments mentioned above. Second, with sequential price setting, a larger market share of the follower sometimes facilitates collusion. If we compare the case where the follower has the smaller market share with the cases where the market share of the follower is equal to or larger than the market share of the leader, we find more collusion in the latter cases. However, if we compare the case where the market shares of the follower and leader equal with the case where the follower has the larger market share, we find less collusion in the latter case.

The remainder of this paper is organized as follows. Section 2 provides an overview of the related literature. Section 3 presents the experimental design and Section 4 the theoretical predictions. Section 5 gives our results, while Section 6 concludes. Our regression model and detailed information on the experiment are provided in the Appendices.

2 Related Literature

Our experiment considers price leadership and a type of asymmetric market sharing. In this section we discuss the literature about (i) price and quantity leadership, (ii) different types of market sharing, and (iii) different types of asymmetries between firms.

Several experimental papers discuss price and quantity leadership. Hildenbrand (2010) provides an extensive overview. Kübler and Müller (2002) compare sequential price setting with simultaneous price setting in a repeated duopoly with heterogeneous products and symmetric firms. They find that sequential price setting yields more collusion than simultaneous price setting. Huck et al. (2001) conduct an experiment on quantity leadership in homogeneous duopoly markets. They observe in a repeated game higher levels of output, and thus less collusion, with sequential quantity setting than with simultaneous quantity setting. These two experiments impose one of the subjects to take the role of the leader, while the other subject acts as the follower. In our experiment we do the same. Some other experiments consider endogenous timing where each round consists of two stages and subjects are allowed to choose in which stage to set their price or quantity. For example, Datta Mago and Dechenaux (2009) investigate repeated price-setting homogeneous duopolies with capacity-constrained firms. They find more collusion when it turns out that subjects have chosen to set prices in different stages rather than in the same stage. Furthermore, this effect is stronger with asymmetric capacity constraints. Further, Fonseca et al. (2006) consider repeated homogeneous duopolies where subjects announce when to set their quantity. They find no effect on collusion between these two cases. Other related experiments are Huck et al. (2002) and Fonseca et al. (2005). In summary, we see that sequential price setting facilitates collusion, while sequential quantity setting hinders collusion. With endogenous timing, there is more collusion when it turns out that subjects have chosen to set prices in different stages rather than in the same stage, while there is no such effect for quantity setting.

Some experiments consider different types of market sharing. Puzzello (2008) investigates the effect on collusion of two different tie-breaking rules in case firms set the same price in a homogeneous duopoly with simultaneous price setting and capacity-constrained firms. She considers a *share* tie-breaking rule where the market is shared equally, and a *random* tie-breaking rule where each firm is selected with the same probability to supply the market first. The random tie-breaking rule implies unequal market sharing ex post, but ex ante payoffs do not differ between the two rules. Puzzello finds more collusion with the share tie-breaking rule than with the random tie-breaking rule. On the other hand, Davis and Wilson (2002) find no difference in collusion between these two tie-breaking rules in an auction with homogeneous goods and four capacity-constrained sellers per market. Thus, evidence on the effect on collusion of asymmetric market sharing is mixed. In our experiment we impose unequal market shares in a number of treatments. However, our firms are not capacity constrained.

A number of experiments focus on different types of asymmetries between firms. Mason et al. (1992) investigate quantity-setting duopolies with a homogeneous good. Each firm has either low or high constant marginal cost. The authors find more collusion if firms have equal marginal costs than if firms have different marginal costs. Dugar and Mitra (2009) vary the size of the marginal cost asymmetry in homogeneous Bertrand-duopolies under fixed matching of subjects and random assignment of marginal costs in every round. They find more collusion if the difference between the two possible values of marginal costs is smaller.[1] Phillips et al. (2011) examine heterogeneous quantity-setting duopolies and different marginal costs. They find more collusion if firms have equal marginal costs than if firms have

[1]This result is confirmed by Dugar and Mitra (2013) in the same experimental setup with random matching of subjects and fixed marginal costs.

different marginal costs. They find no difference in collusion if the difference between the possible values of marginal costs is smaller. Argenton and Müller (2012) investigate the effect of firms with different (convex) cost structures in price-setting duopoly markets with homogeneous goods. They find no difference in collusion if firms have the same cost structure or different ones. Finally, Fonseca and Normann (2008) analyze duopolies and triopolies with price competition and homogeneous goods. Firms have symmetric or asymmetric capacity constraints. Holding the number of firms constant, they find more collusion with equal capacity constraints. In summary, we see that asymmetric costs or asymmetric capacity constraints in general hinder collusion. In our experiment firms have no capacity constraints, no fixed costs and marginal costs are normalized to zero.

3 Experimental Design

The experiment consists of a repeated price-setting duopoly game where subjects sell a homogeneous good. Demand is inelastic and normalized to unity. Costs are normalized to zero. Every subject participates in a number of duopolies which are called matches. Each match has the same structure. During one match a subject plays with the same competitor. Every match consists of a randomly-determined number of rounds. Following Roth and Murnighan (1978), we simulate an infinitely repeated game by implementing a given continuation probability after every round.[2] With probability $\delta \in (0, 1)$, two subjects play another round with each other. With probability $1 - \delta$, the current match ends. This implies that the expected number of rounds in a match is $\frac{1}{1-\delta}$. We impose a continuation probability of $\delta = 0.70$, which is common knowledge among subjects. Each pair is therefore expected

[2] This setup is also implemented in the experiments of, amongst others, Dal Bó (2005), Blonski et al. (2011), Dal Bó and Fréchette (2011), Bigoni et al. (2012) and Cason et al. (2013).

to be matched for $3\frac{1}{3}$ rounds.[3]

We run five treatments which differ in two dimensions: subjects set prices simultaneously or sequentially in each round; and the market is shared equally or unequally in case subjects set the same price. Our treatments with simultaneous price setting consist of two stages in each round. In stage 1, subjects choose their prices simultaneously and independently. In stage 2, subjects learn the price chosen by their competitor and profits are realized. Our treatments with sequential price setting consist of three stages in each round. In stage 1, the leader chooses her price. In stage 2, the follower learns the price chosen by the leader. Subsequently, the follower chooses her own price. In stage 3, the leader learns the price chosen by its competitor and profits are realized.

In every round, subjects choose a price from the set $\{3, 4, \ldots, 12\}$. The prices 1 and 2 are excluded to ensure uniqueness of the equilibrium in the one-shot game (see also Dufwenberg and Gneezy, 2000). If a subject sets the lowest price, she[4] captures the entire market and makes profit equal to her price. If subjects set the same price, the division of the market depends on the treatment. To isolate the effect of market-share inequality and to simplify the experiment, we exogeneously impose market shares in case subjects set the same price.[5]

In SimEqual we have simultaneous price setting and each subject obtains a share of 50% of the market in case subjects set the same price. In all other treatments we have two different types of players, A and B. Half of the subjects were randomly assigned to role A and the other half to role B. Subjects kept their role throughout the session. In each match an A-player was matched with a B-player. In the other treatment with simultaneous

[3] Appendix B provides the actual number of rounds played in each match in each session.

[4] We refer to a subject as "she".

[5] This is a difference between our experimental setup and Mouraviev and Rey's (2011) theoretical model: they assume that firms can share the market as they wish in case they charge the same price.

price setting, SimUnequal, subject A obtains a share of 30% of the market while subject B obtains a share of 70%, in case both players charge the same price.[6] In the treatments with sequential price setting, subject A is the price leader while subject B is the price follower. We have three treatments with sequential price setting which differ in how the market is shared in case subjects set the same price. In Follower30 the follower obtains a share of 30% of the market while the leader obtains a share of 70%. In Follower50 each subject obtains a share of 50% of the market. In Follower70 the follower obtains a share of 70% of the market while the leader obtains a share of 30%.

Information on the reasons of implementing unequal market shares is not provided to the subjects in our experiment. However, they were presented the structure of profits and a payoff table. The treatments are summarized in Table 1.

Table 1: Treatment characteristics.

Treatment	Price setting	Market shares in case subjects set the same price		
			Subject A	Subject B
SimEqual	Simultaneous	Equal	50%	50%
SimUnequal		Unequal	30%	70%
Follower30	Sequential	Unequal	70%	30%
Follower50		Equal	50%	50%
Follower70		Unequal	30%	70%

In the treatments with sequential price setting subject A is the price leader while subject B is the follower.

Once a match ends, subjects are matched to create new duopolies. All treatments, except SimEqual, used an absolute typed stranger design, i.e.

[6]From the ultimatum game literature it is known that payoff differences matter (Roth, 1995; Camerer, 2003). In the ultimatum game, one of two subjects proposes a division of a fixed amount of money. The other subject, the responder, either accepts or rejects this proposal. If she accepts, the money is divided according to the proposal. If the responder rejects, each receives nothing. Oosterbeek et al. (2004) find in their meta analysis of the ultimatum game that the probability of acceptance increases in the percentage of money offered to the responder. Furthermore, most offers below 20% are not accepted. We presume that in our experiment the smallest share should be above 20%, but also not too close to 50%. We decided to set the smallest market share at 30%.

each A-player was matched exactly once to each B-player and vice versa. Therefore, the total number of matches in a session is $\frac{P}{2}$, where P is the number of subjects in a session. Since we had 16 or 18 subjects in each session, 8 or 9 matches were being played. In SimEqual an absolute stranger design was used. Because there is a maximum of 9 matches in the other treatments, we randomly matched each subject in SimEqual to 9 unique other subjects. Therefore, all sessions had the same expected total number of rounds.

4 Equilibrium

In this section we discuss the theoretical properties of the model behind our experiment. In Section 4.1 we discuss simultaneous price setting and in Section 4.2 sequential price setting. We present our hypotheses in Section 4.3.

4.1 Simultaneous Price Setting

First, consider the one-shot game with simultaneous price setting. In case both firms set the same price, firm $i \in \{1, 2\}$ receives a given share $\alpha_i \in (0, 1)$ of the aggregate profit, where $\alpha_1 + \alpha_2 = 1$. In the one-shot Bertrand-Nash equilibrium both firms set a price $p^N = 3$, i.e. the lowest possible price. We refer to this as the "competitive equilibrium" and "competitive price", respectively. Since we have inelastic unit demand and zero costs, the corresponding aggregate competitive profit is given by

$$\pi^N \equiv p^N = 3. \qquad (1)$$

Firm i receives a profit $\alpha_i p^N$ in the competitive equilibrium.

Next, suppose that both firms set a collusive price $p^C \in \{4, \ldots, 12\}$, which is larger than the competitive price.[7] The corresponding aggregate

[7]Note that all prices above the competitive price are collusive, but the collusive price $p^C = 12$ Pareto dominates all other collusive prices.

collusive profit is given by

$$\pi^C \equiv p^C. \tag{2}$$

Firm i receives profit $\alpha_i p^C$ if firms collude. In the one-shot game, a collusive price cannot be sustained as an equilibrium.

We now turn our attention to the (infinitely) repeated game. We assume that firms use grim trigger strategies (Friedman, 1971). Then, each firm will set a collusive price p^C in every round as long as no firm has deviated from this price. After a deviation, firms revert to the one-shot Bertrand-Nash equilibrium forever. More formally, we define $V^C(\alpha_i)$ as firm i's value in case both firms set a collusive price p^C in each round, i.e.

$$V^C(\alpha_i) \equiv \frac{\alpha_i \pi^C}{1-\delta}. \tag{3}$$

Consider a unilateral deviation, and suppose that the optimal deviation yields deviation profit π^D. Note that by deviating, the firm will supply the whole market and, therefore, receive all profit in that round. However, in future rounds firm i receives its share α_i of the aggregate competitive profit (1). Therefore, the value of a unilateral deviation for firm i is

$$V^D(\alpha_i) \equiv \pi^D + \frac{\delta}{1-\delta}\alpha_i \pi^N. \tag{4}$$

Firm i will not deviate if and only if $V^C(\alpha_i) \geq V^D(\alpha_i)$, i.e.

$$\frac{\alpha_i \pi^C}{1-\delta} \geq \pi^D + \frac{\delta}{1-\delta}\alpha_i \pi^N, \tag{5}$$

which results in the critical discount factor

$$\delta \geq \delta_{sim}(\alpha_i) \equiv \frac{\pi^D - \alpha_i \pi^C}{\pi^D - \alpha_i \pi^N}. \tag{6}$$

An equilibrium that sustains collusion exists if and only if both firms are willing to collude, i.e. if and only if $\delta \geq \max\{\delta_{sim}(\alpha_1), \delta_{sim}(\alpha_2)\}$. From (6) it follows that $\frac{\partial \delta_{sim}}{\partial \alpha_i} < 0$, and therefore collusion is sustainable with simultaneous price setting if and only if

$$\delta \geq \delta_{sim}(\min\{\alpha_1, \alpha_2\}). \tag{7}$$

Thus, the discount factor of the smallest firm is most stringent (cf. Motta, 2004, pp. 164–165), i.e. an increase in market-share inequality makes collusion less stable.

4.2 Sequential Price Setting

Next, take the model with sequential price setting. Considering the one-shot game, in case both firms set the same price, the leader obtains a given share $\alpha_L \in (0, 1)$ of the aggregate profit and the follower's share is $\alpha_F = 1 - \alpha_L$. In the one-shot Bertrand-Nash equilibrium both firms set a price $p^N = 3$. In case both firms set the competitive price, the leader receives the competitive profit $\alpha_L p^N$, and the follower the competitive profit $\alpha_F p^N$. Similarly, if firms collude on the same price $p^C \in \{4, 5, \ldots, 12\}$, the leader receives the collusive profit $\alpha_L p^C$, and the follower the collusive profit $\alpha_F p^C$. In the one-shot game, a collusive price cannot be sustained as an equilibrium since any collusive price by the leader will be undercut in the same round by the follower and, therefore, the leader will set the competitive price.

Next, we examine the (infinitely) repeated game and assume again that firms use grim trigger strategies. We find that the leader's value of colluding is

$$V^C(\alpha_L) = \frac{\alpha_L \pi^C}{1 - \delta}, \tag{8}$$

whereas the follower's value of colluding is

$$V^C(\alpha_F) = \frac{\alpha_F \pi^C}{1 - \delta}. \tag{9}$$

Consider a unilateral deviation by the leader. If the leader deviates, this is immediately noticed and punished by the follower. The follower undercuts the leader's deviation in the same round, implying that the leader will not obtain any profit in that round. Consecutively, in future rounds the leader receives its share α_L of the aggregate competitive profit. A deviation by the leader is never profitable, since

$$\frac{1}{1-\delta}\alpha_L\pi^C \geq \frac{\delta}{1-\delta}\alpha_L\pi^N. \tag{10}$$

The leader thus prefers to collude since its incentive compatibility constraint is always satisfied.

Next, consider a unilateral deviation by the follower. The follower's optimal deviation yields deviation profit π^D. Since firms use grim trigger strategies, a deviation by the follower will be followed by both firms reverting to the one-shot Bertrand-Nash equilibrium from the next round onward. Thus, in future rounds the follower receives its share α_F of aggregate competitive profit, and the value of a unilateral deviation of the follower is

$$V^D(\alpha_F) = \pi^D + \frac{\delta}{1-\delta}\alpha_F\pi^N. \tag{11}$$

With sequential price setting, an equilibrium sustaining collusion exists if and only if $V^C(\alpha_F) \geq V^D(\alpha_F)$, i.e.

$$\frac{\alpha_F\pi^C}{1-\delta} \geq \pi^D + \frac{\delta}{1-\delta}\alpha_F\pi^N, \tag{12}$$

which results in the critical discount factor

$$\delta \geq \delta_{seq}(\alpha_F) \equiv \frac{\pi^D - \alpha_F\pi^C}{\pi^D - \alpha_F\pi^N}. \tag{13}$$

From (13), it follows that $\frac{\partial\delta_{seq}}{\partial\alpha_F} < 0$. Thus, increasing the follower's market share decreases the critical discount factor (cf. Mouraviev and Rey, 2011), and hence facilitates collusion.

4.3 Hypotheses

Proceeding, we examine when, according to theory, collusion is sustainable in our experiment. Given the collusive price p^C and our discrete price set, the optimal deviation price is $p^D = p^C - 1$. For each treatment we determine for all possible collusive prices $p^C \in \{4, 5, \ldots, 12\}$ the critical discount factors

Table 2: Overview of treatments and theoretical implications for $\delta = 0.70$.

Treatment	Market shares		Critical discount factor (min)	(max)	Collusion sustainable?
SimEqual	$\alpha_1 = 0.50$	$\alpha_2 = 0.50$	$\delta_{sim}(0.50) \approx 0.526$	0.667	yes
SimUnequal	$\alpha_1 = 0.30$	$\alpha_2 = 0.70$	$\delta_{sim}(0.30) \approx 0.733$	0.857	no
Follower30	$\alpha_L = 0.70$	$\alpha_F = 0.30$	$\delta_{seq}(0.30) \approx 0.733$	0.857	no
Follower50	$\alpha_L = 0.50$	$\alpha_F = 0.50$	$\delta_{seq}(0.50) \approx 0.526$	0.667	yes
Follower70	$\alpha_L = 0.30$	$\alpha_F = 0.70$	$\delta_{seq}(0.70) \approx 0.222$	0.292	yes

Critical discount factors are calculated for all collusive prices $p^C \in \{4, 5, \ldots, 12\}$. The minimum and maximum of these values are presented in columns four and five.

derived in (6) and (13). The minimum and maximum of these critical discount factors are given in Table 2. The critical discount factors are smaller than the continuation probability $\delta = 0.70$ in SimEqual, Follower50 and Follower70. Therefore, collusion is sustainable in these treatments. In SimUnequal and Follower30 the critical discount factors are larger than the continuation probability and, therefore, collusion is not sustainable in those treatments.

These theoretical predictions are based on the implicit assumptions that subjects are fully rational, risk neutral, and able to coordinate perfectly on any (collusive) equilibrium. The model, however, is parsimonious in reality due to, e.g., risk aversion. We thus do not expect that there will *always* be collusion whenever δ is larger than the critical discount factor; neither do we expect that there will *never* be collusion whenever δ is smaller than it. Instead, we take a more pragmatic approach and focus on the tightness of the incentive compatibility constraints (see also Bigoni et al., 2012). We make the assumption that it is more difficult to sustain collusion with tighter constraints and, thereby, makes collusion less likely to occur. An incentive compatibility constraint is tighter if the difference between the values of colluding and deviating is smaller.

We first rank the treatments based on the tightest incentive compatibility constraint within each treatment. With simultaneous price setting, this is the constraint of the subject with the smallest market share. With sequential price setting, it is the constraint of the follower. The tightness of these constraints is reflected in the size of the critical discount factors in columns four and five of Table 2. The range of the critical discount factor of SimUnequal and Follower30 is identical, and highest among all treatments. The range of the critical discount factor of Follower70 is lowest among all treatments. Finally, the range of the critical discount factor of SimEqual and Follower50 is the same, and at an intermediate level among all treatments. Thus, we see that the constraints are (i) tightest in SimUnequal and Follower30, (ii) less tight in SimEqual and Follower50, and (iii) least tight in Follower70.

Proceeding, we refine our ranking of the treatments using the least restrictive incentive compatibility constraint within a treatment. With simultaneous price setting, this is the constraint of the subject with the larger market share. With sequential price setting, it is the constraint of the leader. Recall that the leader always prefers to collude and, therefore, her constraint is never binding. With simultaneous price setting, the constraint of the subject with the larger market share is binding and, therefore, tighter than the constraint of the leader with sequential price setting.

We now present hypotheses in order to answer our two main questions. To investigate whether price leadership facilitates collusion for a given type of market sharing, we have:

Hypothesis 1 (**Effect of Price Leadership**). *There is more collusion with sequential price setting than with simultaneous price setting, irrespective of the allocation of market shares in case firms set the same price.*

To examine whether, with sequential price setting, a larger market share of the follower facilitates collusion, we consider:

Hypothesis 2 (**Effect of Follower's Market Share**). *Suppose that subjects set prices sequentially. Then there is more collusion if the market share* *of the follower is larger (in case subjects set the same price).*

Ultimately, as a benchmark, we also investigate whether, with simultaneous price setting, market-share inequality hinders collusion. Therefore, we have:

Hypothesis 3 (Effect of Unequal Market Sharing). *Suppose that subjects set prices simultaneously. Then there is more collusion with market-share equality than with market-share inequality (in case subjects set the same price).*

5 Results

The experiment has been conducted at the Groningen Experimental Economics Laboratory (GrEELab) at the University of Groningen in 2012. A total of 176 subjects participated which were all students at that Faculty (98.3%) or at other faculties of that university (1.7%). Every session consisted of one treatment and lasted between 60 and 90 minutes. Every treatment was run twice. Treatments were randomly assigned to sessions, and either 16 or 18 subjects participated in a session.

The experiment was programmed in z-Tree (Fischbacher, 2007). Printed instructions were provided and read aloud.[8] Subjects first had to answer a number of questions correctly on their computer to ensure understanding of the experiment.

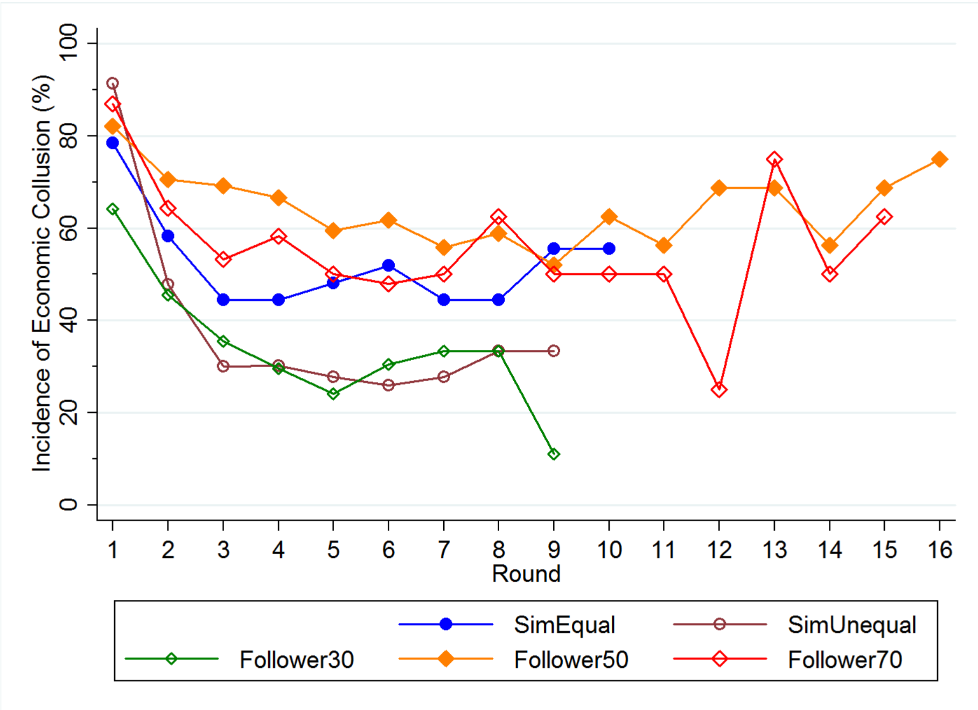
Subjects were paid their cumulative earnings in euros at a rate of €0.07 per point, including an initial endowment of 75 points. Average earnings were €11.49 and ranged from €7.30 to €24.60. Detailed information on each session, including the number of rounds played in each match, and average, minimum and maximum earnings, is provided in Appendix B.

[8]Appendix D reproduces instructions for Follower70. Instructions for other treatments are similar and available upon request.

5.1 Measures of Collusion

We measure collusion in three different ways. First, we consider the **incidence of economic collusion**, i.e. the percentage of markets where, in a given round, the actual market price exceeds the competitive price $p^N = 3$. Figure 1 shows the incidence of economic collusion over time for each treatment.[9] All treatments are highly economically collusive in the first round. In

Figure 1: Incidence of economic collusion per round (average across all active groups).



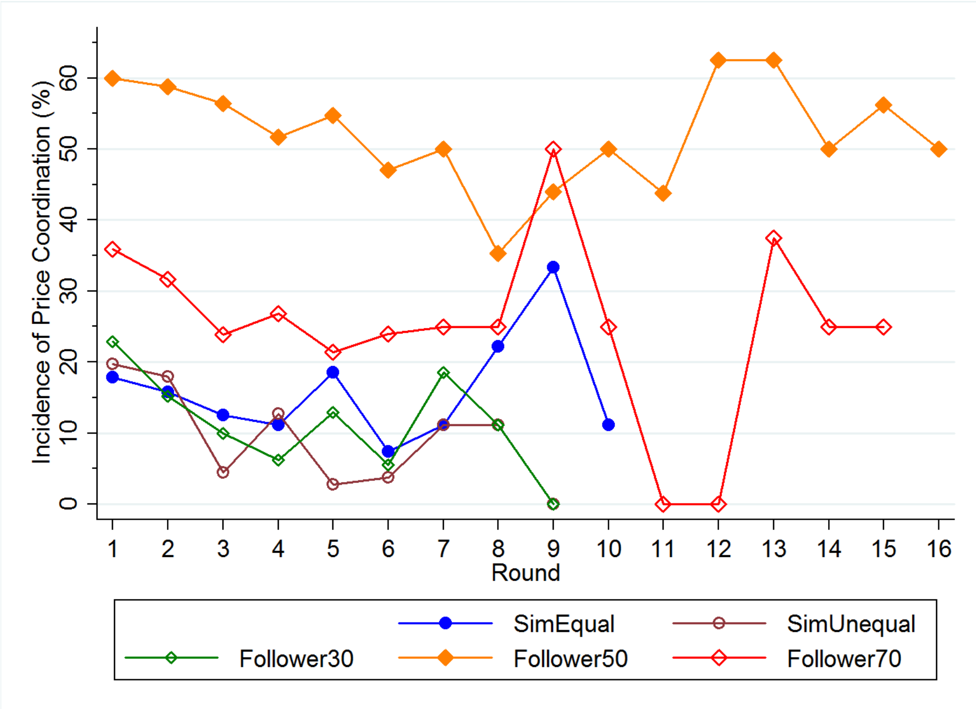
SimEqual, Follower50 and Follower70 the incidence is roughly stable over time, while there seems to be a decreasing time trend in SimUnequal and Follower30.

Second, we consider the **incidence of price coordination**. This is the percentage of markets where, in a given round, both subjects charge

[9]Averages are calculated per round over all active groups. Note that the number of active groups is not constant over rounds.

the same collusive price $p^C \in \{4, 5, \ldots, 12\}$.[10] This is a stricter measure than the incidence of economic collusion. Figure 2 shows the incidence of price coordination over time for each treatment. In most treatments

Figure 2: Incidence of price coordination per round (average across all active groups).

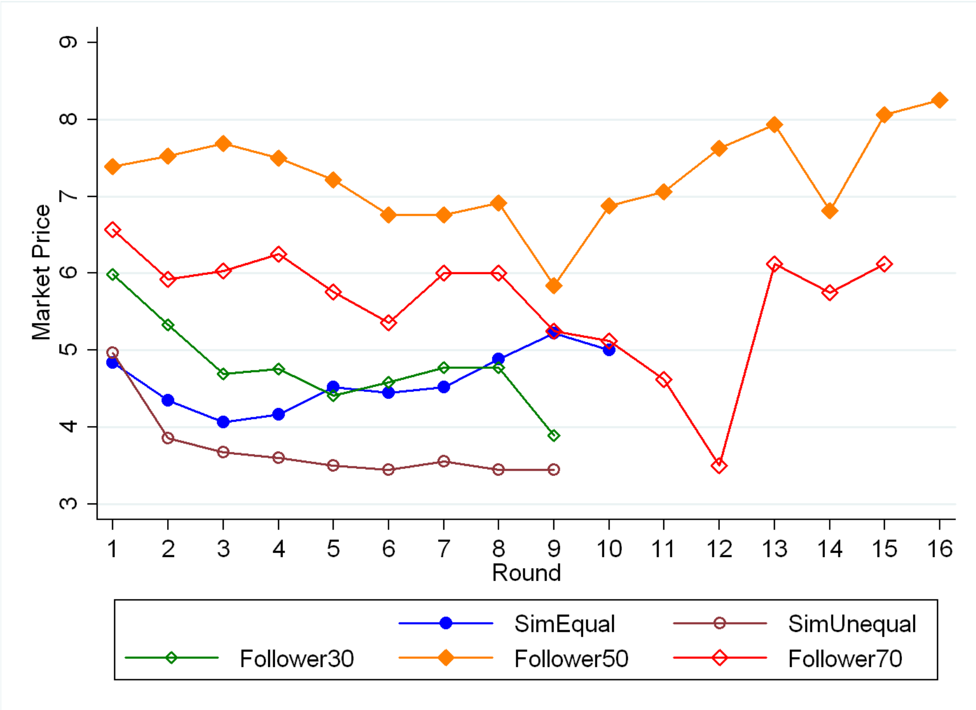


the incidence of price coordination in each round is much lower than the incidence of economic collusion, but in Follower50 they are close to each other. Hence, in that case, economic collusion is frequently accompanied by price matching.

Third, we investigate the magnitude of **market prices**. Figure 3 shows the average price path for each treatment. Market prices in the treatments

[10] There are a few markets where subjects manage to take turns in supplying the market by alternating in prices. Results remain qualitatively the same when we include price alternation in our definition of price coordination. We also obtain qualitatively similar results if we focus on coordination on the highest collusive price of 12, which is a stricter measure of price coordination.

Figure 3: Market price per round (average across all active groups).



with sequential price setting are almost always higher than in the treatments with simultaneous price setting. Again, there seems to be a decreasing time trend in SimUnequal and Follower30.

We will next discuss the results for each hypothesis.[11] Comparing the relevant treatments in a pairwise fashion, all statistical tests reported below are for the no-treatment effect versus the two-sided alternative, as outlined in Appendix A.

5.2 Effect of Price Leadership

First, we examine Hypothesis 1. We begin with the scenario where subjects have equal market shares in case they set the same price. Hypothesis 1 then

[11] We include data from all matches and all rounds. In order to examine the existence of possible learning effects in the first matches, we also considered our results if we exclude the first one or two matches. Our results remain qualitatively the same in that case.

implies more collusion in FOLLOWER50 than in SIMEQUAL. Table 3 reports on these treatments. We obtain the following result.

Table 3: Comparison of SIMEQUAL and FOLLOWER50 (across all rounds and active groups).

	SimEqual		Follower50
Economic Collusion	59.9%	≈	68.5%
Price Coordination	15.4%	$<^{***}$	54.4%
Market Price	4.52	$<^{***}$	7.32

Entries between values indicate whether the value to the left is significantly lower (<), significantly higher (>), or does not differ significantly (≈) from the value to the right. Differences between treatments are tested using regressions with clustered standard errors on group level as outlined in Appendix A. *** denotes significance at the 0.1% level.

Result 1a (Effect of Price Leadership). *There is more collusion in* FOLLOWER50 *than in* SIMEQUAL, *when measured by the incidence of price coordination or the level of market prices.*

Hence, for two out of three measures of collusion we find support for Hypothesis 1 when subjects have equal market shares (in case they set the same price). The incidence of economic collusion is also higher in FOLLOWER50 than in SIMEQUAL, but there the difference is not significant.

Next, consider the scenario where subjects have unequal market shares in case they set the same price. Hypothesis 1 then implies more collusion in both FOLLOWER30 and FOLLOWER70 than in SIMUNEQUAL. Table 4 reports on these treatments. We have the following result.

Result 1b (Effect of Price Leadership).

a. There is more collusion in FOLLOWER70 *than in* SIMUNEQUAL, *for all three measures of collusion.*

b. There is more collusion in FOLLOWER30 *than in* SIMUNEQUAL, *when measured by the level of market prices. However, there is more collusion in* SIMUNEQUAL *than in* FOLLOWER30, *when measured by the incidence of economic collusion.*

Table 4: Comparison of SimUnequal with Follower30 and Follower70 (across all rounds and active groups).

	Follower30		SimUnequal		Follower70
Economic Collusion	42.7%	$<^{*}$	52.4%	$<^{*}$	64.3%
Price Coordination	14.3%	$\approx$	13.2%	$<^{***}$	28.7%
Market Price	5.14	$>^{***}$	4.07	$<^{***}$	6.04

Entries between values indicate whether the value to the left is significantly lower ($<$), significantly higher ($>$), or does not differ significantly ($\approx$) from the value to the right. Differences between treatments are tested using regressions with clustered standard errors on group level as outlined in Appendix A. * denotes significance at the 5% level; *** at 0.1%.

Hence, when the follower has the larger market share we find strong support for Hypothesis 1. However, when the follower has the smaller market share, evidence is mixed. We find support for Hypothesis 1 using market prices as a measure of collusion, but the hypothesis is rejected using economic collusion as a measure.

A possible explanation for this mixed result is the following. We distinguish two different effects. First, consider the subject with a market share of 30% in case subjects set the same price. In Follower30, a follower who wants to undercut the leader can simply set a price that is one unit lower than the leader's price.[12] In SimUnequal, a subject who aims to undercut her competitor, cannot observe the other's price. Therefore, she will be more careful and generally set a somewhat lower price than her counterpart in Follower30. This implies an upward pressure on prices in Follower30 vis-à-vis SimUnequal.[13] It does not affect the incidence of economic collusion in either treatment, as long as subjects still set a price above 3.

[12] The leader sets a collusive price in 46.7% of the cases in Follower30. Subsequently, the follower undercuts optimally in 64.2% of these cases while the follower matches the leader's price in 30.6% of these cases.

[13] In SimUnequal 64.6% of the subjects with the smaller market share and 63.5% of the subjects with the larger market share set a collusive price. In those cases, the prices 4–7 are chosen by 84.0% of the subjects with the smaller market share and by 85.5% of the subjects with the larger market share. When a collusive price is chosen in Follower30, a price in this range is chosen by 49.8% of the leaders and by 41.8% of the followers.

Second, consider the subject with a market share of 70% in case subjects set the same price. In FOLLOWER30 it turns out that many leaders set a price equal to 3.[14] Presumably, these leaders reason that if they would set a price larger than 3, the follower would not be willing to match this price and thus accept only 30% of the corresponding collusive profit while the leader would obtain the remaining 70%. Hence, these leaders anticipate the followers to use a fairness argument in the sense that followers dislike outcomes where they receive (much) less than the leader, and instead prefer to undercut the leader's price. This fairness argument is related to the finding in the ultimatum game literature that many subjects dislike payoff differences (Roth, 1995; Camerer, 2003), and in particular dislike it when they receive less than others (Fehr and Schmidt, 1999). In SIMUNEQUAL the fairness argument is less pervasive because it is more uncertain who will supply the market. This is due to the unobservability of the competitor's price when one has to set her own price. If the subject with a market share of 70% would draw her price from the same distribution as the subject with a market share of 30%, then in expectation the subjects would share the market equally and hence fairness arguments do not play a role. This is indeed what we observe in our experiment.[15] Hence, in SIMUNEQUAL fairness is less of an issue than in FOLLOWER30. This implies a downward pressure on both prices and the incidence of economic collusion in FOLLOWER30 vis-à-vis SIMUNEQUAL.

Combining the two arguments above, we obtain an unambiguously negative effect on economic collusion in FOLLOWER30 in comparison with SIMUNEQUAL, which is confirmed by our results. However, the two arguments imply countervailing effects on the size of the market price. We find the first upward

[14]In FOLLOWER30 the leader set the minimum price in 53.3% of the cases. In SIMUNEQUAL 35.4% of the subjects with the smaller market share and 36.5% of the subjects with the larger market share set a price equal to 3.

[15]In SIMUNEQUAL, a Kolmogorov-Smirnov test for equality of distribution functions indicates that the distribution of prices chosen by the subject with the smaller market share is not significantly different from the distribution of prices chosen by the subject with the larger market share (p-value = 0.999).

effect to be dominating.

The absence of a fairness argument in SimUnequal also explains why our results support Hypothesis 1 when we compare SimUnequal with Follower70. In Follower70 the follower obtains a share of 70% of the collusive profit if she matches the leader's price. Leaders therefore anticipate that the followers are willing to match a high collusive price set by them.

5.3 Effect of Follower's Market Share

Second, we examine Hypothesis 2. It implies more collusion in Follower70 than in both Follower50 and Follower30, and more collusion in Follower50 than in Follower30. Table 5 reports on these treatments. Note

Table 5: Comparison of Follower30, Follower50 and Follower70 (across all rounds and active groups).

	Follower30		Follower50		Follower70		Follower30
Economic Collusion	42.7%	$<^{***}$	68.5%	$\approx$	64.3%	$>^{***}$	42.7%
Price Coordination	14.3%	$<^{***}$	54.4%	$>^{***}$	28.7%	$>^{***}$	14.3%
Market Price	5.14	$<^{***}$	7.32	$>^{**}$	6.04	$>^{**}$	5.14

Entries between values indicate whether the value to the left is significantly lower (<), significantly higher (>), or does not differ significantly ($\approx$) from the value to the right. Differences between treatments are tested using regressions with clustered standard errors on group level as outlined in Appendix A. ** denotes significance at the 1% level; *** at 0.1%.

that Follower30 is listed twice in this table, to facilitate all pairwise comparisons. We obtain the following result.

Result 2 (**Effect of Follower's Market Share**).

Suppose that subjects set prices sequentially.

a. *There is more collusion in both* Follower70 *and* Follower50 *than in* Follower30*, for all three measures of collusion.*

b. *There is less collusion in* Follower70 *than in* Follower50*, when measured by the incidence of price coordination or the level of market prices.*

Hence, we find that the effect on collusion of a larger market share of the follower is an inverted u-shape: we find more collusion if subjects have equal market shares rather than unequal market shares, but we observe more collusion if the follower has the larger market share than if the follower has the smaller market share. We thus find strong support for Hypothesis 2 when the follower's market share changes from 30% to 50% or from 30% to 70%. However, when the follower's market share changes from 50% to 70%, we reject Hypothesis 2 for both the incidence of price coordination and the level of market prices as measures of collusion.[16] The incidence of economic collusion is also higher in Follower50 than in Follower70, but the difference is not significant.

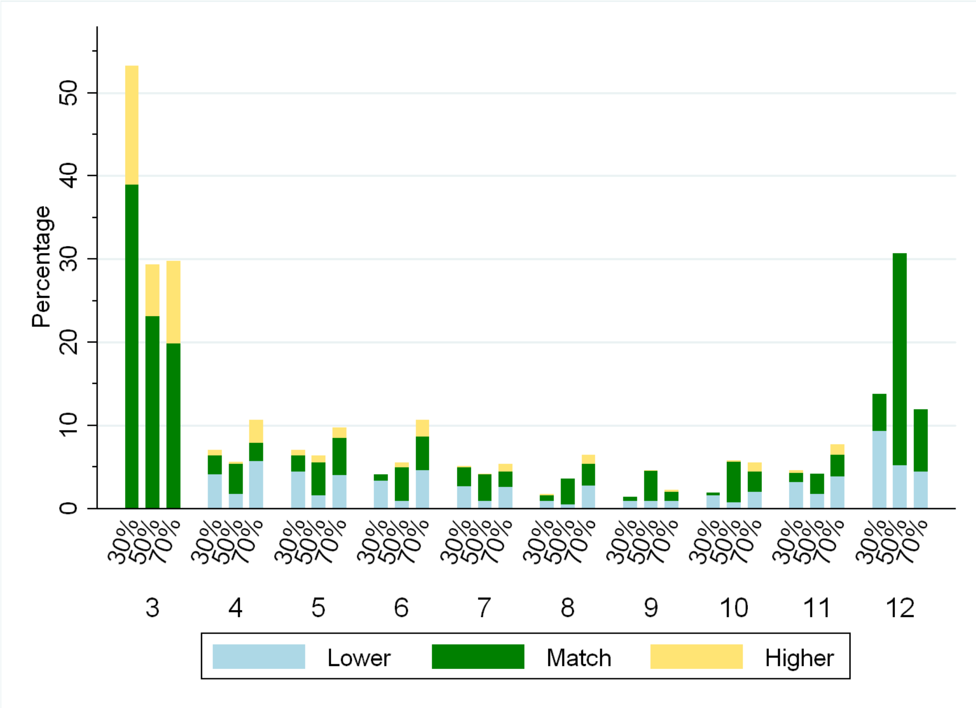
The result of Follower50 versus Follower70 can be understood as follows. Figure 4 shows the price chosen by the leader in all rounds per treatment with sequential price setting.[17] For each treatment, the size of each vertical bar shows which percentage of leaders has set the corresponding price. Within each bar we indicate, respectively, which percentage of the followers has set a higher price than the leader, has matched the leader's price, or has set a lower price than the leader. We first investigate the level of market prices. Here, a fairness argument can explain why market prices are higher in Follower50 than in Follower70. Suppose that the follower will always match the price of the leader. In Follower50, there will then be no difference in profits between follower and leader. On the other hand, in Follower70 the difference in profit received by both subjects is 40% of the chosen price. If the leader wants the absolute difference in profit not to be too large, she can empower this by charging a lower price.[18] This implies

[16]This result is, however, in accordance with Puzzello (2008) who also found more collusion if the market is shared more equally, although theory predicted no difference between equal and unequal market sharing there.

[17]Appendix C provides a complete overview of the prices chosen by the leader and the follower in each treatment.

[18]Note that the leader intentionally hurts himself by charging a lower price. From Fehr and Schmidt (1999) we know that subjects are willing to punish other subjects, even if

Figure 4: Distribution of leader's prices and follower's responses with sequential price setting (across all rounds and active groups).



a downward pressure on prices in FOLLOWER70 vis-à-vis FOLLOWER50. It appears that the leader's average price in FOLLOWER70 is lower than in FOLLOWER50 (6.37 and 7.48, respectively, $p = 0.133$).

Second, we investigate the incidence of price coordination. Consider the follower in a given round. She might consider her current profit to be too low if she would match the price of the leader. In particular, she might even be willing to sacrifice current profit by setting a higher price than the leader, thereby showing that she is interested in higher prices in future rounds. Since (future) profits are increasing in the follower's market share, we expect this effect to be stronger in FOLLOWER70 than in FOLLOWER50 which is confirmed in our experiment.[19] Furthermore, we also see that more followers

this is costly for themselves.

[19]In FOLLOWER70 20.6% of followers set a price higher than the leader's price, while in FOLLOWER50 this is done by only 8.4% of the followers (values are significantly different

undercut in Follower70 than in Follower50.[20] A possible explanation for this is the following, where we distinguish between two types of followers. Consider the type of follower in a given round, who has set a higher price than the leader in the previous round. Then, irrespective of whether the leader has increased her price in comparison to the previous round, a number of these followers undercut the leader[21] to compensate their sacrificed profits of the previous round. Next, consider another type of follower in a given round. In Follower50, the difference in follower's profit between matching and undercutting the price of the leader is 50%. In Follower70 this difference is 30% and, thus, smaller than in Follower50. Furthermore, the difference in leader's profit is smaller in Follower70 than in Follower50. This implies that, based on a fairness argument, the additional disutility of undercutting instead of matching the price of the leader is smaller in Follower70 than in Follower50. Therefore, followers might be less reluctant to undercut the price of the leader in Follower70 than in Follower50.

5.4 Effect of Unequal Market Sharing with Simultaneous Price Setting

Ultimately, we examine Hypothesis 3. It implies more collusion in SimEqual than in SimUnequal. Table 6 reports on these treatments. We obtain the following result.

Result 3 (Effect of Unequal Market Sharing). *There is more collusion in* SimEqual *than in* SimUnequal*, when measured by the level of market prices.*

at 1%).

[20]In Follower70 30.9% of the followers undercut, while in Follower50 only 14.0% of the followers do this (values are significantly different at 1%).

[21]In Follower70 7.9% (of 30.9%) of the followers undercut the leader after having set a higher price than the leader in the previous round. In Follower50 only 0.6% (of 14.0%) of the followers do this.

Table 6: Comparison of SimEqual and SimUnequal (across all rounds and active groups).

	SimEqual		SimUnequal
Economic Collusion	59.9%	$\approx$	52.4%
Price Coordination	15.4%	$\approx$	13.2%
Market Price	4.52	$>^*$	4.07

Entries between values indicate whether the value to the left is significantly lower (<), significantly higher (>), or does not differ significantly ($\approx$) from the value to the right. Differences between treatments are tested using regressions with clustered standard errors on group level as outlined in Appendix A. * denotes significance at the 5% level.

Hence, for one out of three measures of collusion we find support for Hypothesis 3. The incidence of economic collusion and the incidence of price coordination are also higher in SimEqual than in SimUnequal, but the differences are not significant.

6 Conclusion

In this paper we considered experimental markets of repeated homogeneous price-setting duopolies. We investigated the effect on collusion of sequential versus simultaneous price setting. We also examined the effect of changes in the size of each subject's market share in case both subjects set the same price. In particular, we addressed the following two questions.

First, does price leadership facilitate collusion, for a given type of market sharing? Our findings provide evidence that price leadership facilitates collusion, if subjects have equal market shares in case they set the same price. With unequal market shares, price leadership facilitates collusion only if the follower has the larger market share. Evidence is mixed if the follower has the smaller market share.

Second, with sequential price setting, does a larger market share of the follower facilitate collusion? This is partially confirmed in our experiment. If we compare the case where the follower has the smaller market share with the cases where the market share of the follower is equal to or larger than the market share of the leader, we find more collusion in the latter cases. However, if we compare the case where the market shares of the follower and leader equal with the case where the follower has the larger market share, we find less collusion in the latter case.

Our results which contradict our expectations, might be explained in terms of the coordination problem and fairness arguments. This latter effect does not only exist in the experimental laboratory, but also exists in real markets. Gibbons and Murphy (1990) and Albuquerque (2009) empirically show that CEOs of firms do not only care about their absolute performance, but also care about their relative performance.

Based on our results, we believe that antitrust authorities should scrutinize markets with price leadership, since price leadership is a possible indication of collusion. Furthermore, markets where firms share the market equally are also more susceptible of collusion. With price leadership, there is more collusion in markets where the follower has the larger market share, than if the follower has the smaller market share.

We mention some open questions which would be interesting for further research. In our experiment we impose whether a firms is the leader or the follower. We can also impose firms to take turns in being the leader, as happened in, e.g., the Australian gasoline market (Wang, 2009). In that case, the effect on collusion of an increase in the follower's market share might be different, because the fairness argument is less strong than in our current setup. Further, we are also interested whether subjects will be able to coordinate on a collusive outcome in a setting with endogenous timing, where subjects are allowed to choose in which stage to set their price. Another open question is whether price leadership facilitates collusion if subjects can communicate. We know that communication leads to more collusion in oligopolies with simultaneous price setting (Fonseca and Normann, 2012), but the effect with sequential price setting is not investigated yet. Finally, it remains to be seen what the effect is on collusion if a subject's payoff depends on her own and her competitor's profit, which would also decrease the fairness argument compared with our current setup.

Appendix

A Regression Model

A.1 Group Level

Subjects had to decide which price to charge in every round. Because subjects of a group possibly interact with each other for several rounds, there might be correlation between observations of the same group. We estimate an econometric model[22] by adopting a regression model with clustered standard errors to account for the above-mentioned correlations, following Kübler and Müller (2002) and Dal Bó (2005).

If the variable of interest is the incidence of economic collusion, then $y_{rgs} = 1$ if in round $r \in \{1, 2, \ldots, R_{gs}\}$, group $g \in \{1, 2, \ldots, G_s\}$ in session $s \in \{1, 2, \ldots, S\}$ colluded, and $y_{rgs} = 0$ otherwise. The variable y is defined similarly if we consider whether a group coordinated on the same collusive price. If we look at market prices, then y_{rgs} is the market price in round r of group g in session s. Differences between treatments are tested in a pairwise fashion. Every treatment is run twice, thus $S = 4$. Since we have 16 or 18 subjects in each session, each subject is matched with 8 or 9 other subjects. This implies that $G_s \in \{64, 81\}$ is the number of groups that played in session s. It turned out that every group played at most 16 rounds (see Table B.1), thus $R_{gs} \in \{1, 2, \ldots, 16\}$ is the number of rounds played by group g in session s.

We estimate the following regression model with clustered standard errors at the group level to test for differences in the variable y between treatments a and b:

$$y_{rgs} = \beta_0 + \beta_1 \text{treatment}_{gs} + \epsilon_{rgs}, \tag{A.1}$$

[22] Note that the session average of the variable of interest would be one independent observation. Thus, we would have two independent observations per treatment. The Mann-Whitney U test is only defined for at least 3 independent observations per treatment. Therefore, non-parametric tests cannot be used.

where β_0 and β_1 are coefficients to be estimated, ϵ_{rgs} are normally distributed errors, and treatment$_{gs}$ is a dummy that equals 1 if group g in session s participated in treatment a, and 0 otherwise.

Model (A.1) allows for possible correlations between the errors ϵ_{rgs} over rounds r for a given group g in session s. Furthermore, we assume that the errors of group g and group $g' \neq g$ in session s are not correlated, and that the errors of group g in session s and session $s' \neq s$ are not correlated. In particular, the assumptions on the errors are

$$E\left[\epsilon_{rgs}|x_{rgs}\right] = 0 \tag{A.2}$$

$$Var\left(\epsilon_{rgs}\right) = \sigma_{rr,gs} \tag{A.3}$$

$$Cov\left(\epsilon_{rgs}, \epsilon_{r'gs}\right) = \sigma_{rr',gs} \qquad \text{if } r \neq r' \tag{A.4}$$

$$Cov\left(\epsilon_{rgs}, \epsilon_{rg's}\right) = 0 \qquad \text{if } g \neq g' \tag{A.5}$$

$$Cov\left(\epsilon_{rgs}, \epsilon_{rgs'}\right) = 0 \qquad \text{if } s \neq s' \tag{A.6}$$

The corresponding formula for the robust covariance matrix (Cameron et al., 2011) in the linear regression model is given by

$$\widehat{\text{Var}}\left(\hat{\beta}\right) = \frac{N-1}{N-k}\left(\frac{G}{G-1}\right)(X'X)^{-1}\left(\sum_{s=1}^{S}\sum_{g=1}^{G_s} u'_{gs}u_{gs}\right)(X'X)^{-1}, \tag{A.7}$$

where $N = \sum_{s=1}^{S}\sum_{g=1}^{G_s} R_{gs}$ is the total number of observations, $k = 2$ the number of regressors, $G = \sum_{s=1}^{S} G_s$ the total number of groups, X the $(N \times 2)$-matrix of regressors, $u_{gs} = \sum_{r=1}^{R_{gs}} \epsilon_{rgs}x_{rgs}$, $\epsilon_{rgs} = y_{rgs} - x'_{rgs}\hat{\beta}$, $x_{rgs} = [1, \text{treatment}_{rgs}]$ the (2×1)-vector of independent variables for the observation in round r of group g in session s, and $\hat{\beta} = \left[\hat{\beta}_0, \hat{\beta}_1\right]$ the (2×1)-vector of coefficient estimates.

We estimate (A.1) using logit regression when looking at the incidence of economic collusion and the incidence of price coordination. We use linear regression when looking at market prices. All statistical tests reported in Section 5 are for the relevant no-treatment effect versus the two-sided alternative using z-tests with logit regression or t-tests with linear regression.

A.2 Individual Level

We also report on a few results on the individual level. At the level of the follower we are interested in the percentage of followers which set a lower/higher price than the leader. At the level of the leader we are interested in how often the leader sets a certain price, and the average price set. Differences between treatments are tested in a pairwise fashion as in (A.1), but the errors are clustered at the individual level instead of the group level.

B Session Details

Table B.1 provides detailed information on each session. We performed a binomial goodness-of-fit test to test the hypothesis that the continuation probability was binomially distributed with a 70% probability of continuation. The hypothesis was not rejected (rejection probability of 30.8%).

Table B.1: Number of rounds played during each match, and average, minimum and maximum earnings, for all sessions.

Treatment	Match										Earnings		
	1	2	3	4	5	6	7	8	9	Total	Average	Min	Max
SimEqual	4	7	1	1	3	3	3	1	1	24	€8.65	€8.00	€9.40
SimEqual	3	2	7	1	2	10	2	2	1	30	€10.44	€9.15	€13.10
SimUnequal	1	4	4	3	4	3	1	6	3	29	€9.47	€7.45	€11.30
SimUnequal	1	5	9	1	2	1	2	7	2	30	€9.47	€7.65	€11.40
Follower30	5	6	4	1	1	1	1	2	1	22	€9.24	€7.55	€11.65
Follower30	1	7	4	4	3	7	5	9	1	41	€12.64	€10.10	€18.10
Follower50	16	2	3	15	1	3	5	2	-	47	€17.73	€11.70	€24.60
Follower50	1	9	2	8	1	3	4	3	4	35	€13.88	€10.15	€16.95
Follower70	6	5	4	3	1	2	1	1	1	24	€10.68	€7.30	€14.95
Follower70	4	6	15	4	5	3	1	3	-	41	€13.58	€9.00	€20.65

There were 18 participants in each session. A dash '-' in match 9 indicates that the corresponding session had only 16 participants.

C Distribution of Prices per Treatment

Tables C.1 up to C.5 provide information per treatment on the distribution of prices chosen by every subject across all rounds and active groups.

Table C.1: Distribution (%) of prices chosen in SimEqual across all rounds and active groups (N=486).

Subject 1	Subject 2										Total
	3	4	5	6	7	8	9	10	11	12	
3	16.1	8.8	6.0	2.5	3.5	1.4	0.8	0.4	0.4	0.2	29.0
4		3.1	6.0	3.7	1.0	1.4	0.6	0.2	0.0	1.2	11.9
5			4.3	7.4	4.1	1.2	0.0	0.0	0.2	2.1	19.1
6				4.3	3.9	0.8	0.8	0.8	0.2	1.4	14.8
7					1.0	0.8	1.4	0.6	0.0	1.9	10.5
8						0.2	0.4	0.2	0.0	1.2	5.1
9							0.0	0.0	0.0	0.6	1.4
10								0.0	0.0	0.0	1.2
11									0.2	0.0	0.6
12										2.3	6.2
Total	16.1	11.9	16.3	17.9	13.6	6.0	4.1	2.3	1.0	10.9	100.0

Table C.2: Distribution (%) of prices chosen in SimUnequal across all rounds and active groups (N=531).

Subject 30%	Subject 70%										Total
	3	4	5	6	7	8	9	10	11	12	
3	24.3	5.5	2.1	1.7	0.6	0.2	0.0	0.0	0.2	0.9	35.4
4	5.3	5.5	4.1	2.3	1.5	0.2	0.4	0.2	0.4	0.4	20.2
5	1.7	1.7	3.8	3.0	2.3	0.0	0.4	0.4	0.2	0.4	13.8
6	1.1	2.1	3.2	2.8	1.9	0.8	0.2	0.2	0.2	0.4	12.8
7	1.5	1.1	1.3	1.1	0.6	0.6	0.6	0.6	0.0	0.2	7.5
8	0.8	0.4	0.6	0.9	0.6	0.4	0.0	0.0	0.0	0.2	3.8
9	0.4	0.0	0.4	0.2	0.2	0.0	0.0	0.0	0.0	0.2	1.3
10	0.2	0.2	0.6	0.6	0.2	0.0	0.0	0.0	0.0	0.2	1.9
11	0.2	0.2	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.1
12	1.1	0.2	0.4	0.0	0.0	0.2	0.0	0.2	0.0	0.2	2.3
Total	36.5	16.8	16.8	13.0	7.7	2.3	1.5	1.5	0.9	3.0	100.0

Table C.3: Distribution (%) of prices chosen in Follower30 across all rounds and active groups (N=567).

Leader	Follower										Total
	3	4	5	6	7	8	9	10	11	12	
3	39.0	3.5	0.4	0.2	0.7	0.9	0.5	0.7	0.2	7.2	53.3
4	4.1	2.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	7.1
5	0.0	4.4	1.9	0.2	0.2	0.0	0.0	0.0	0.0	0.4	7.1
6	0.0	0.0	3.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	4.1
7	0.0	0.0	0.0	2.7	2.3	0.0	0.0	0.0	0.0	0.2	5.1
8	0.0	0.0	0.0	0.0	0.9	0.7	0.2	0.0	0.0	0.0	1.8
9	0.0	0.0	0.0	0.0	0.0	0.9	0.5	0.0	0.0	0.0	1.4
10	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.4	0.0	0.0	1.9
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	1.1	0.4	4.6
12	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	9.0	4.4	13.8
Total	43.0	10.2	5.8	3.7	4.1	2.7	2.8	4.4	10.2	13.1	100.0

Table C.4: Distribution (%) of prices chosen in FOLLOWER50 across all rounds and active groups (N=691).

Leader	Follower										Total
	3	4	5	6	7	8	9	10	11	12	
3	23.2	1.5	0.3	0.0	0.0	0.0	0.1	0.4	0.0	3.9	29.4
4	1.7	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	5.6
5	0.3	1.3	3.9	0.1	0.1	0.1	0.0	0.1	0.0	0.3	6.4
6	0.0	0.0	0.9	4.1	0.0	0.0	0.0	0.0	0.0	0.6	5.5
7	0.0	0.0	0.0	0.9	3.2	0.0	0.0	0.0	0.0	0.1	4.2
8	0.0	0.0	0.0	0.0	0.4	3.2	0.0	0.0	0.0	0.0	3.6
9	0.0	0.0	0.0	0.0	0.0	0.9	3.6	0.1	0.0	0.0	4.6
10	0.0	0.0	0.0	0.0	0.0	0.0	0.7	4.9	0.1	0.0	5.8
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	2.5	0.0	4.2
12	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	4.9	25.5	30.7
Total	25.3	6.4	5.1	5.1	3.8	4.2	4.5	7.5	7.5	30.7	100.0

Table C.5: Distribution (%) of prices chosen in FOLLOWER70 across all rounds and active groups (N=544).

Leader	Follower										Total
	3	4	5	6	7	8	9	10	11	12	
3	19.9	2.2	0.6	0.2	0.4	0.6	0.4	0.7	1.3	3.7	29.8
4	5.7	2.2	1.1	0.0	0.0	0.0	0.0	0.4	0.4	0.9	10.7
5	0.0	4.0	4.4	0.4	0.2	0.0	0.0	0.0	0.0	0.7	9.7
6	0.0	0.0	4.6	4.0	0.7	0.2	0.0	0.0	0.0	1.1	10.7
7	0.0	0.0	0.2	2.4	1.8	0.4	0.0	0.0	0.4	0.2	5.3
8	0.2	0.0	0.0	0.2	2.4	2.6	0.4	0.0	0.4	0.4	6.4
9	0.0	0.0	0.0	0.0	0.0	0.9	1.1	0.0	0.0	0.2	2.2
10	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.4	1.1	0.0	5.5
11	0.0	0.0	0.0	0.0	0.0	0.0	0.2	3.7	2.6	1.3	7.7
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	4.2	7.5	12.0
Total	25.7	8.5	10.9	7.2	5.5	4.6	4.0	7.4	10.3	16.0	100.0

D Instructions Follower70

Market decision making

You are going to participate in an experiment on market decision making.

We will first read the instructions aloud. Then you will have time to read them on your own. The instructions are identical for all participants. After reading, there is the possibility to ask questions individually. Please refrain from talking during the entire experiment.

The experiment consists of separate games. Each game has the same structure. You will play each game with a different person. You play at most once with the same person during the entire experiment. During one game you will play with the same player. Together, you and that other person form a group. You will never learn who the other player is.

Before the experiment starts, we randomly determine whether you are an A-player or a B-player. During the entire experiment you will keep this role. An A-player will always play with a B-player, and vice versa.

In this experiment you can earn points. The number of points you earn depends on the decisions made by you and those made by the other player in your group. At the beginning of the experiment, you receive 75 points in your account. At the end of each game, the points that you earned in that game will be added to your account. At the end of the experiment the number of points in your account will be converted to euros, at a rate of €0.07 per point.

The experiment is expected to last for approximately 75 minutes.

Rules of a Game
During a game you play with the same person. A game consists of several rounds. The number of rounds is random. After every round a number from 1, 2, 3, up to and including 100 is drawn by a computer. If the number is smaller than or equal to 70, a new round starts. If, however, it is higher than 70, the game ends. Thus, there is a probability of 70% that a new round of a game will be played and a probability of 30% that the game ends. If a

game ends a new game starts. A new game will be played with a different person. Hence, in each game you meet a new person.

Rules in a Round
Each round of a game consists of four steps. These steps are the same every round.

Step 1: pricing decision A-player
The A-player chooses one of the following prices:

$$3, 4, 5, 6, 7, 8, 9, 10, 11, 12.$$

Step 2: pricing decision B-player
After the A-player has chosen his price, the B-player learns the price chosen by the A-player in step 1. Next, the B-player chooses one of the following prices:

$$3, 4, 5, 6, 7, 8, 9, 10, 11, 12.$$

You and the other player receive the following number of points:

- If your price is lower than the price chosen by the other player, you receive a number of points equal to your price. The other player receives 0 points.
- If your price is the same as the price chosen by the other player, the A-player receives a number of points equal to 30% of his price. The B-player receives a number of points equal to 70% of his price.
- If your price is higher than the price chosen by the other player, you receive 0 points. The other player receives a number of points equal to his price.

The number of points you receive can be found in Table 1. This table is added to the instructions. Table 1 reads as follows. The possible prices of the A-player are indicated next to the rows. The possible prices of the B-player are indicated above the columns. In the cell at which row and column intersect, the number of points the A-player receives is up to the left and the number of points the B-player receives is down to the right.

Examples

- Suppose that the A-player chooses a price of 6, and the B-player chooses a price of 8. In Table 1 you move down until you reach the row which has 6 on the left of it. Then, you move to the column with 8 above it. You see that the A-player receives 6 points, while the B-player receives 0 points.
- Suppose that the A-player chooses a price of 9, and the B-player chooses a price of 9. In Table 1 you move down until you reach the row which has 9 on the left of it. Then, you move to the column with 9 above it. You see that the A-player receives 2.7 points, while the B-player receives 6.3 points.
- Suppose that the A-player chooses a price of 11, and the B-player chooses a price of 7. In Table 1 you move down until you reach the row which has 11 on the left of it. Then, you move to the column with 7 above it. You see that the A-player receives 0 points, while the B-player receives 7 points.

Please make sure you understand Table 1 and also make sure that it is in line with the instructions above.

Step 3: summary of round
After the B-player has chosen his price, the A-player learns the price chosen by the B-player in step 2. The number of points you have received will also be displayed. Throughout the experiment, there will also be a box on your screen where you can observe the prices chosen by you and the other player in previous rounds during a game.

Step 4: continuation outcome
The drawn number is displayed. Remember that if the number is smaller than or equal to 70, a new round of a game starts. If, however, it is higher than 70, the game ends.

End of experiment
After the last game has been played, the experiment ends. You receive a message on your screen that no further game will take place. At the end of the experiment, the total number of points in your account will be converted at a rate of €0.07 per point. Before being paid in private, you have to hand in the instructions.

After the experiment, please do not discuss the content of the experiment with anyone, including people who did not participate.

Please refrain from talking throughout the experiment.

THANK YOU VERY MUCH FOR PARTICIPATING AND GOOD LUCK!

Table 1

	Price chosen by B-player									
Price chosen by A-player	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
3	0.9 2.1	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0	3 0
4	0 3	1.2 2.8	4 0	4 0	4 0	4 0	4 0	4 0	4 0	4 0
5	0 3	0 4	1.5 3.5	5 0	5 0	5 0	5 0	5 0	5 0	5 0
6	0 3	0 4	0 5	1.8 4.2	6 0	6 0	6 0	6 0	6 0	6 0
7	0 3	0 4	0 5	0 6	2.1 4.9	7 0	7 0	7 0	7 0	7 0
8	0 3	0 4	0 5	0 6	0 7	2.4 5.6	8 0	8 0	8 0	8 0
9	0 3	0 4	0 5	0 6	0 7	0 8	2.7 6.3	9 0	9 0	9 0
10	0 3	0 4	0 5	0 6	0 7	0 8	0 9	3 7	10 0	10 0
11	0 3	0 4	0 5	0 6	0 7	0 8	0 9	0 10	3.3 7.7	11 0
12	0 3	0 4	0 5	0 6	0 7	0 8	0 9	0 10	0 11	3.6 8.4

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