WORKING PAPER SERIES

The Divergent Effects of Long-Term and Short-Term Entry Investments on Home Market Cartels

Daniel Cracau/Abdolkarim Sadrieh

Working Paper No. 3/2014

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

FACULTY OF ECONOMICS AND MANAGEMENT

Impressum (§ 5 TMG)

Herausgeber:

Otto-von-Guericke-Universität Magdeburg
Fakultät für Wirtschaftswissenschaft
Der Dekan

Verantwortlich für diese Ausgabe:

Daniel Cracau and Abdolkarim Sadrieh
Otto-von-Guericke-Universität Magdeburg
Fakultät für Wirtschaftswissenschaft
Postfach 4120
39016 Magdeburg
Germany

http://www.fww.ovgu.de/femm

Bezug über den Herausgeber

ISSN 1615-4274

The Divergent Effects of Long-Term and Short-Term Entry Investments on Home Market Cartels

Daniel Cracau* and Abdolkarim Sadrieh†

Abstract

Positive effects of multimarket activities on cooperation between firms are widely acknowledged. We study these effects in a setting with home market asymmetries as is typical for global competition. In our multimarket duopoly experiment each firm has a home market but may also enter the other firm's market. Without entry barriers, we observe a high level of mutual forbearance with firms serving their home markets exclusively. With short-term entry barriers, the competition rates decrease significantly, as expected. Surprisingly, with long-term entry barriers, firms exhibit higher levels of competition, entering each other's market more often. We conjecture that in the latter case, bearing the cost of entry is perceived as a signal for the intention to compete and has an adverse effect on cooperation.

Keywords: Market Entry Barriers; Mutual Forbearance; Prisoner's Dilemma; Experimental Economics
JEL: D4; L1

1 Introduction

The potentially positive effect of multimarket activities on the cooperation between firms has been widely acknowledged in the economic literature, especially since Edwards (1955) coined the term "mutual forbearance." The intuition of mutual forbearance is that firms in general act less aggressively

*University of Magdeburg, Faculty of Economics and Management, Universitaetsplatz 2, 39106 Magdeburg, Germany, cracau@ovgu.de

†University of Magdeburg, Faculty of Economics and Management, Universitaetsplatz 2, 39106 Magdeburg, Germany, sadrieh@ovgu.de

towards each other when they compete in more than one market, because they have more opportunities to gain from cooperation and more options to punish non-cooperative behavior. The question that has not been sufficiently answered yet concerns the specific features that enhance or impair the emergence of mutual forbearance in multimarket oligopolies. One of the key features that have been conjectured to strengthen inter-market cooperation are barriers to entry (van Witteloostuijn and van Wegberg, 1992). According to Baumol and Willig (1981, p. 408): "An entry barrier is anything that requires an expenditure by a new entrant into an industry, but that imposes no equivalent cost upon an incumbent." In particular for multimarket firms with geographically distinct home markets, entry barriers are thought to keep the competition out, stabilizing the coexistence of parallel home market monopolies (Stigler, 1971). Barriers to entry seem particularly interesting from a policy point of view, because they are generally easy to implement by requiring entrants to acquire costly technical or legal certifications of their products, their production lines, or their services. Such entry barriers are often based on security and moral arguments, making them politically much more feasible than outright entry license fees.

While classical economic reasoning suggests that entry barriers will facilitate the emergence of mutual forbearance (van Witteloostuijn and van Wegberg, 1992), there is also reason to believe that entry barriers may actually impair inter-market cooperation. To understand why, note first that the worst possible outcome for any firm is to have a competing firm in the own home market. Hence, paying to overcome the barriers for entry insures against being exposed to the aggression of any other firm without the possibility to retaliate. Note also, however, that paying for the capability to enter the other firm's home market can be interpreted as a signal of aggression that actually harms cooperation by inducing preemptive aggression followed by retaliation. Thus, firms face a dilemma that paying for an access to the other firm's home market, on the one hand, safeguards against aggression, but, on the other hand, signals their own aggressive intention. The empirical question is whether firms are willing to give up the insurance against exploitation for the sake of signalling cooperation. If they do, mutual forbearance will be achievable. But, if the firms have a strong tendency to keep all options available, including the option to enter the other firm's home market, fear of aggression may induce aggression and destroy mutual forbearance.

In this article, we apply the experimental approach to study the effect of entry barriers on mutual forbearance in multimarket settings. We focus on the degree of cooperation between two conglomerate firms with distinct home markets. The value of cooperation in multimarket settings is obviously highest for firms that would otherwise be in a cut-throat competition, e.g. a Bertrand-type price competition or a price-quantity competition. The price-quantity (PQ) games are also known as games of price competition with perishable goods and production in advance and are characterised by the absence of pure strategy equilibria. The first mixed strategy equilibrium was presented in Levitan and Shubik (1978), where a game with linear demand and positive inventory carrying cost is studied. The mixed strategy equilibrium for PQ games with non-increasing production costs was established in Gertner (1986).

In contrast to the *classical* PQ game, Kreps and Scheinkman (1983) argue that prices are more flexible in the short run than quantities. Their model therefore contains a simultaneous capacity choice before a simultaneous price competition. While the argument of Kreps and Scheinkman (1983) might be true for a number of goods, the PQ game is still applicable for markets with perishable goods that need to be produced in advance (Davis, 2013). For these markets the PQ game can be interpreted as a price competition with sufficiently large capacities. In these types of oligopolies, in which the single market equilibria lead to zero (expected) profits, moving to a multimarket setting with mutual forbearance is a desirable outcome for the firms.

In our control treatment without barriers to entry, we have two symmetric firms and two symmetric markets. Each of the two markets is a pre-assigned home market to one of the two firms. To focus on the mutual forbearance argument in a multimarket setting, we let firms simultaneously choose a price-quantity pair for each market that they are in.[1] Compared to a single market with price-quantity competition (Cracau and Franz, 2012), we find a high degree of inter-market collusion. Firms often serve their home markets exclusively and earn monopoly profits each, even though they could enter the other market without bearing any additional cost. In a second treatment, we introduce a costly short-term investment that is needed to enter the other firm's home market. Approving the above mentioned classical intuition regarding entry barriers, inter-market collusion significantly increases. In our third treatment with long-term entry investments, however, we find significantly more entry and tougher competition than in the control treatment.

[1] Experimental duopolies with Bertrand competition are known to show a high level of cooperation even in a single market setting (Dufwenberg and Gneezy, 2000).

We relate this to the fact that firms pay to obtain the option to serve both markets and thus harm mutual forbearance by signalling competition. This phenomenon is related to, but distinct from, the phenomenon observed by Offerman and Potters (2006). They show that oligopoly competitors, who have bought a license to operate in an auction, tend to behave more cooperatively in the follow-up market. They conjecture that bidding high in the license auction is a signal of a high propensity to cooperate in the oligopoly market. In our case, however, things are different, because there are two parallel markets, of which each is the home market of one of the two firms. Hence, trying to enter the other firm's market here is more likely to be seen as a signal of aggression than of cooperation.

2 Related experiments

Theoretical studies of the mutual forbearance hypothesis based on retaliation start with Bernheim and Whinston (1990).[2] They show that the existence of a second market makes collusion more likely to be sustainable, because it increases the range of discount factors that make collusive outcomes achievable. This result holds for markets differing in the number of competitors, in growth rates or in demand fluctuations. It also holds for markets with heterogeneous firms (e.g. differing in production cost) and for differentiated products. Spagnolo (1999) extends this result and shows that if firms' static objective functions are strictly concave, multimarket contact always facilitates collusion. Empirical evidence for the mutual forbearance hypothesis is available for various industries in all parts of the world, e.g. in the U.S. airline industry (Evans and Kessides, 1994), the U.S. mobile telephone industry (Parker and Röller, 1997), and the Spanish hotel industry (Fernández and Marín, 1998).

The first experimental studies of multimarket oligopolies are conducted by Feinberg and Sherman (1985, 1988). In their first paper, they study Cournot duopolies with 2 independent, identical markets. In the second paper, they study Bertrand duopolies with 3 markets. In both studies, settings in which the same competitors are in all markets are compared to settings in which

[2]Kantarelis and Veendorp (1988) study "live and let live" firm objectives and also find that multimarket contacts can facilitate collusion. However, they base their result on the increased total demand in a situation with multiple markets rather than on firms' retaliation considerations.

different competitors are in different markets. They find that quantities are lower and prices and profits are higher in the settings with multimarket contact than in the settings with various competitors.
A second set of multimarket experiments is conducted by Phillips and Mason (1992, 1996, 2001). Phillips and Mason (1992) study two asymmetric Cournot duopolies to test the hypothesis of Bernheim and Whinston (1990). Using a similar procedure as Feinberg and Sherman (1985), they find that joining two markets through multimarket contact of conglomerate firms leads to a convergence of the degree of collusion in the two markets. They conclude that the mutual forbearance hypothesis of Bernheim and Whinston (1990) is supported in that multimarket contact facilitates collusion in markets where cooperation is relatively difficult to reach, but reduces collusion in markets where it is relatively easy. Phillips and Mason (2001) replicate these results for horizontally connected markets, i.e. for a market with only one multimarket firm and two single-market competitors. Phillips and Mason (1996) use a similar experimental design to examine the impact of market regulation in one market on the outcome of the other market. Based on a theoretical model, they conjecture that a mildly restrictive price cap in one market leads to more collusion in the other market, but a completely restrictive price cap leads to more competition. Their experimental results fully confirm both conjectures.
Cason and Davis (1995) study the effect of non-binding price communication on collusion in a setting with three firms and three posted offer markets. Each firm has a cost advantage in one of the three markets exclusively. Cason and Davis (1995) show that communication is effectively used - especially by experienced subjects - to coordinate the supply across the markets, leading to collusive outcomes. Güth et al. (2010) study the mutual forbearance hypothesis in Cournot markets with substitutes and complementary products. They find little evidence for more cooperation in conglomerates than between single-market firms.
In our experiment, we link a multimarket oligopoly with a market entry game and a price-quantity (PQ) competition. The majority of experiments on market entry focuses on the coordination in simultaneous move games with many potential entrants and a single market (Rapoport, 1995; Camerer and Lovallo, 1999; Zwick and Rapoport, 2002; and Duffy and Hopkins, 2005). In contrast, our experiment deals only with two potential entrants who simultaneously can choose to enter multiple markets.
The PQ competition that we study in this experiment has been previously

studied by Cracau and Franz (2012). They examine only the case of single-market duopolies and find low levels of cooperation as predicted in the unique mixed strategy equilibrium. Having adapted their experimental design with a linear demand function and a quasi-continuous strategy space, we can use their data on the single markets as a benchmark for our multimarket PQ duopoly.[3]

3 A simple model of a multimarket oligopoly

We assume two symmetric firms $i = 1, 2$ and two symmetric but separate markets $k = 1, 2$. The game consists of two stages. In the first stage, firms simultaneously make their entry decisions $e_{ik} \in [0; 1]$ where $e_{ik} = 1$ represents firm i's decision to enter market k.
In the second stage, both firms simultaneously choose prices p_{ik} and quantities q_{ik} for each market they have entered.[4] We denote linear market demand by $D_k(p_{ik}) = a - p_{ik}$. Firms produce identical goods. We denote linear production cost by $C(q_{ik}) = \sum_{k=1}^{2} cq_{ik}$ with $c < a$.
If a firm i is a monopolist in market k, it maximizes its profit $\pi_{ik}^M = (p_{ik} - c)q_{ik}$. For our symmetric setting with linear demand and linear production cost, monopoly profit simplifies to $\pi^M = (a - c)^2/4$. If two firms compete in the same market, they maximize expected profits and set prices and quantities according to the mixed strategy equilibrium derived in Gertner (1986).[5] For our symmetric setting with linear demand and linear production cost, the expected duopoly profit is $E\left[\pi^D\right] = 0$.
Using the results above and assuming that each firm i is always present in its own home market $k = i$, the entry game can be summarized in a $2x2$ normal form presentation, where each firm decides either to enter the other firm's home market ("Fight") or not ("Collusion"). Table 1 presents this normal form.
Assuming risk neutrality, we can easily show that the simplified game in Table 1 has no dominant strategy equilibrium, since $E\left[\pi^D\right] = 0$. Mutual *collusion* is the payoff dominant and risk minimizing equilibrium.[6] Note

[3]Other experiments using a price-quantity competition include Brandts and Guillen (2007) and Davis (2013).

[4]We assume $p_{ik} = q_{ik} = 0$ for a market k where firm i has not entered.

[5]See Cracau and Franz (2011) for a detailed explanation of the mixed strategy equilibrium.

[6]Note that the mutual *collusion* equilibrium is not risk dominant in the sense of

Table 1: Normal form of the simplified entry game

	Collusion	Fight
Collusion	π^M ; π^M	$\mathbb{E}\left[\pi^D\right]$; $\pi^M + \mathbb{E}\left[\pi^D\right]$
Fight	$\pi^M + \mathbb{E}\left[\pi^D\right]$; $\mathbb{E}\left[\pi^D\right]$	$2\mathbb{E}\left[\pi^D\right]$; $2\mathbb{E}\left[\pi^D\right]$

however that all other strategy combinations are weak Nash equilibria as well.

In the game with entry barriers, each firm i must bear a fixed entry cost $F > 0$ to enter the other firm's market $k \neq i$. If we consider the simplified form of this game, it is obvious that the payoffs from *Fight* decrease as F increases but the payoffs from *Collusion* are not affected by F. Hence, mutual *collusion* is the unique equilibrium in in the simplified game with $F > 0$.

Comparing the derived theoretical results of our multimarket oligopolies with and without market entry barriers, we conjecture that collusion should be the predominant outcome in both settings. If differences between the two games exist, however, our results suggest that collusive behavior is observed more frequently with entry barriers than without.

4 Experimental Design

Our experimental study consists of three treatments. In the treatment *B0*, we implement the two-market duopoly game without entry barriers. In the treatments *B1* and *B5*, we introduce a costly entry barrier for the second market. Table 2 summarizes the treatments.

The experimental software was programmed with z-Tree (Fischbacher, 2007). Subjects were recruited using the software ORSEE (Greiner, 2004) and they all had their major in economics or management. At the beginning of a session, subjects were randomly assigned to a cubicle in the laboratory. Instructions were handed out and read aloud. Questions were answered individually. All treatments consisted of two parts A and B. Part A of the experiment was identical across treatments. In the five rounds of part A, each subject took the role of a firm that faced a linear demand $D(p) = 100 - p$ in a monopoly

Harsanyi and Selten (1988), but minimizes payoff variance by avoiding mixed strategy equilibria that arise in the other cells of the simplified game.

Table 2: Overview of treatment parameters

Treatment	*B0*	*B1*	*B5*
Game rounds	20	20	20
Entry payment F	0	100	500
No. of stages with entry payment	–	20	4
No. of rounds covered by a single entry payment	–	1	5
Independent observations	30	27	25

home market. First, firms decided whether to enter their home market or not. Staying out of the market yielded zero profit. After entering the home market, the firm chose a price p in the range of $[0; 100]$ and a production quantity q in the range of $[0; 100]$. Both price and quantity could be chosen in 0.001 increments.[7] Subjects' quantity decisions were limited $q \leq D(p)$, i.e. to the maximum demand at the chosen price. Moreover, firms faced linear production cost $C(q) = 10q$. We expect firms to choose price-quantity pairs that maximize their net profits, i.e. $\max_{p,q} \pi = (p - 10)q$. After each round in part A, subjects were given a summary of the round outcomes.

The firms' initial budgets in part B consisted of their total part A profits.[8] Firms played 20 rounds of the multimarket game in fixed pairs that were put together from two randomly drawn monopolies.[9] In *B0*, at the beginning of each round, firms made their two entry decisions. The information on the entry decisions was then reported to both subjects. Afterward, each firm chose a price-quantity pair for each market it had entered. A what-if calculator was provided that enabled the subjects to calculate profits for any combination of firms' decisions.

Firms' profits were calculated on the basis of a homogeneous Bertrand competition with efficient rationing.[10] With this rationing scheme, the firm with the low price first sells its quantity q_L at its price p_L and the firm with the high price $p_H > p_L$ serves residual demand $D^{res}(p_H, q_L) = 100 - q_L - p_H$ if

[7] The increments were small enough to allow the implementation of the mixed strategy equilibrium as derived in Cracau and Franz (2011).

[8] This procedure avoids the *house money effect* (Thaler and Johnson, 1990).

[9] For statistical purposes, average values over all rounds of each fixed pair is considered as an independent observation.

[10] Remember, that the price and the quantity of firms that did not enter were set to zero. Hence, in a market with only one entrant, profits were calculated as in a monopoly.

positive at that price up to its quantity q_H.[11] At the end of each round in the part B, we presented a summary with prices, quantities and profits of both firms for both markets to each subject.
In *B1*, we implemented an additional stage in all rounds. In this "entry payment stage," firms decided whether to bear the cost of entry $F = 100$ to acquire the option to enter the other firm's market in the upcoming round. Firms did not need to make an entry payment for their home market. After the entry payment stage, before firms made their entry decisions, firms were informed which firm made an entry payment. The rest of the game was identical to the game in *B0*.
Finally in *B5*, we implemented an entry payment stage only in the rounds 1, 6, 11, and 16. In each of these stages, firms decided whether to bear the cost of entry $F = 500$ to acquire the option to enter the other firm's market in the next 5 rounds. The rest of the game was identical to the game in *B1*.
After the experiment, subjects were privately paid their total profits from both parts.[12] Profits were converted into Euro at an exchange rate 2000 : 1. On average, subject's earned 13.75 Euro ($\approx$ 17.85 USD) in an 80-minute session.

5 Results

We use the results of part A with firms in a monopoly setting to check whether subjects understand the game and the incentives in the game. We find that 150 out of the 164 subjects achieve monopoly profits towards the end of part A, with the remaining subjects coming close to it. Overall, subjects earn about 91% of the monopoly profits in the first part of the experiment. Because this is in line with the high percentage of optimal choices in the earlier reported monopoly settings (Potters et al., 2004), we conclude that all subjects understood the game and were comfortable with the experimental procedure.

[11]For a more detailed description of the profit calculation and the rationing scheme, see Cracau and Franz (2012).

[12]In *B5*, one subject had a negative total profit from both parts and was paid zero at the end of the experiment.

5.1 Mutual forbearance hypothesis

Table 3 summarizes the average observed prices, average production as well as average profit per market and firm in the multimarkets of our *B0*, *B1*, and *B5* treatment and compares them to monopoly and equilibrium benchmarks (in terms of expected values) and to single markets (as studied by Cracau and Franz (2012), *CF*).[13]

Table 3: Summary of experimental outcomes.

	Monopoly markets				Duopoly markets			
	Freq.	p_{ik}	q_{ik}	π_{ik}	Freq.	p_{ik}	q_{ik}	π_{ik}
B0	38.92%	54.12	45.59	1990.39	60.67%	27.86	61.40	164.60
B1	51.30%	53.86	46.00	1981.83	48.43%	25.37	67.97	78.49
B5	33.10%	53.65	45.69	1955.06	66.50%	25.56	62.84	109.48
Eq.	–	55	45	2025	–	33.03	66.97	0
CF	0%	–	–	–	100%	33.21	54.16	317.84

Adding profits from both markets, average firm profit per round is highest in *B1* (1092.63) and second-highest in *B0* (973.79). This difference is however not significant (MWU-test, $p = 0.4919$). The profit in *B5* (792.73) is significantly smaller than in *B1* (MWU-test, $p = 0.0803$) but not significantly smaller than in *B0* (MWU-test, $p = 0.3525$). Most importantly, compared to the single market experiment (317.84), profit in *B5* is significantly higher (MWU, $p = 0.0409$).

Result 1. *The mutual forbearance hypothesis is supported by the fact that in all multimarket treatments (B0, B1, B5) average profits are significantly higher than the profit in the single market (CF).*

Considering only the duopoly markets in our three treatments, we see that profits are highest in *B0*, second-highest in *B5*, and lowest in *B1*. Neither the difference in duopoly profits between *B0* and *B5* is significant (MWU-test, $p = 0.3703$), nor the difference between *B5* and *B1* is significant (MWU-test, $p = 0.5755$). The difference between *B0* and *B1*, however, is significant (MWU-test, $p = 0.0880$). Further, we find that average duopoly prices in

[13]The experimental design in Cracau and Franz (2012) is similar to ours in demand and cost functions as well as in the number of periods. For derivation of the equilibrium reference values, see Appendix A.

the multimarket treatments are below those of the single market treatment, and correspondingly average profits are (significantly) lower (MWU-test, *B0* vs. single market $p = 0.2353$, *B1* vs. single market $p = 0.0376$, *B5* vs. single market $p = 0.1164$).[14] Hence, we can conclude that the positive effect of multimarkets on profits is evidently due to mutual forbearance, i.e. where the two firms coordinate on exclusively serving their home monopolies each, and not due to intra-market collusion, i.e. where both firms are active in both markets, setting collusive prices and quantities.

5.2 Market structures

Table 4 displays an overview of the distribution of market structures observed in the experiment. The two digits in the first column represent the number of firms in a specific market structure, hence *2 - 0* means that in one market there are two firms and in the second market there is no firm. We see that about 98% of the observations in both treatments yield one of three main market constellations, *1 - 1*, *2 - 1*, and *2 - 2*. For the rest of the analysis, we refer to a *1 - 1* market structure with each firm exclusively serving one market as "Cartel" and a *2 - 2* market structure with both firms competing in both markets as "Fight." We refer to a *2 - 1* market structures with one firm cooperating and one firm fighting as "Mixed." More than 50% of all observations in *B0* are Fights, 17% are Mixed, and 29.5% are Cartels.[15]
In *B1*, the distribution of market outcomes is visibly different. We see about 42% of the observations yielding Cartels, nearly 40% yielding Fights, and about 17% are Mixed. Finally in *B5*, we find about half of the markets yielding Fights, 31% yielding Mixed market structures and 16% yielding Cartels.
Figure 1 shows the distribution of market structures over time. In *B0* (upper left panel), we observe a substantially increasing number of Cartels (Spearman Rank correlation coefficient $\rho_s = 0.9881$, $p < 0.000001$), a more or less

[14]Note, however, that the duopoly profits in all multimarket treatments are nevertheless (significantly) higher than predicted zero profits in the mixed strategy equilibrium (MWU-test, *B0* vs. equilibrium $p = 0.0004$, *B1* vs. equilibrium $p = 0.1985$, *B5* vs. equilibrium $p = 0.0653$). In simpler settings with single markets and pure quantity or pure price competition, duopoly profits have also been observed to be higher than in equilibrium (Huck et al., 2004; Dufwenberg and Gneezy, 2000).

[15]In particular, in 14 out of 18 observations in *B0* where the market outcome was collusive, firms entered their home market. In the other four observations, each firm exclusively entered the other firm's market.

Table 4: Overall Distribution of market structures.

market structure	*B0*	*B1*	*B5*
0-0	0.00%	0.00%	0.00%
1-0	0.17%	0.19%	0.20%
1-1 (Cartel)	29.50%	42.22%	16.20%
1-1 (Two-Market Monopoly)	0.83%	0.56%	1.20%
2-0	0.67%	0.37%	0.60%
2-1 (Mixed)	17.00%	16.85%	31.20%
2-2 (Fight)	51.83%	39.81%	50.60%

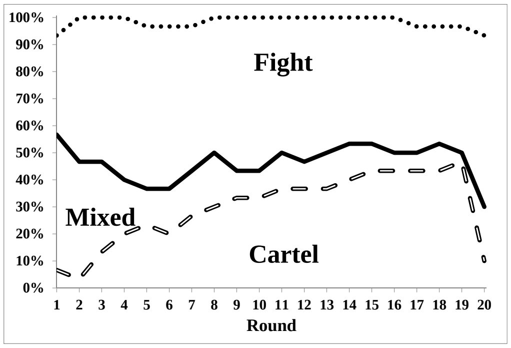
stable number of Fights, and a diminishing frequency of Mixed structures.[16] In *B1* (upper right panel), we observe a similar increase in the number of Cartels (Spearman Rank correlation coefficient $\rho_s = 0.8803$, $p < 0.000001$) at an even higher absolute rate, a diminishing frequency of Mixed structures, and a decline in Fights. In contrast, the lower panel shows that the distribution of market structures in *B5* is almost stable over time in. Comparing treatments, we find significantly more Cartels in *B0* (29%) and *B1* (42%) than in *B5* (16%) (MWU, *B0* vs. *B5* $p = 0.0825$, *B1* vs. *B5* $p = 0.0021$). The difference between *B0* and*B1* is only weekly significant (MWU, $p = 0.1379$).

In Table 5, we present the market structure transition matrices for *B0*, *B1*, and *B5*.[17] The strong diagonals in the matrices indicate inertia with duopolies generally remaining in a specific market structure over a long time. The only exception are the cases of Mixed structures in *B0* and *B1*. These market outcomes frequently precede Fight structures. Transition from Mixed to Fight structures is much lower in *B5* than in *B0* and *B1* due to the fact that some competitors remain locked out of the market until the next round, in which entry payments can be made. Note that Cartel structures are highly stable through all treatmemts. However, it seems that occassionally one of the two firms in *B5* defects by making the entry payment after a series of Cartel interactions. This seems to explain why we observe many more Mixed structures in *B5* (31%) than in *B0* and *B1* (both 16%).

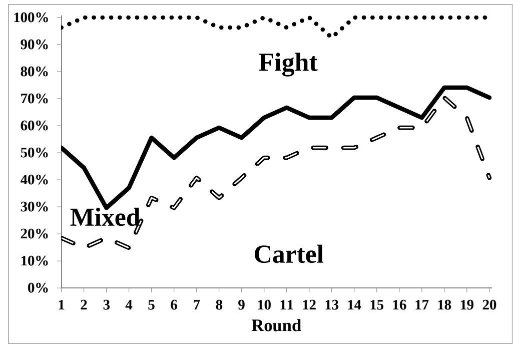
Result 2. *The proportion of Cartel structures increases over time in B0 and B1, whereas it is significantly lower and remains low in B5. The proportion*

[16]The drop of Collusion in round 20 is presumably due to an end game effect, which is persistent in the experimental literature (Argenton and Müller, 2012).

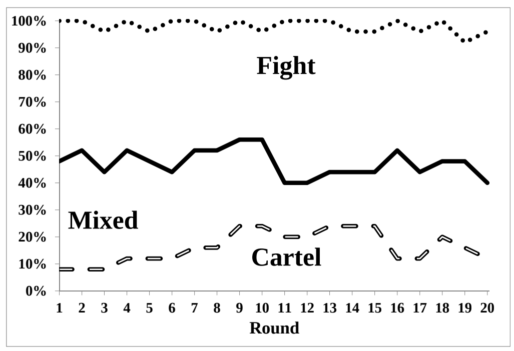
[17]We excluded all rounds that did not have any of the three predominant market structures (15 in *B0*, 11 in *B1*, and 19 in *B5*).



(a) *B0*



(b) *B1*



(c) *B5*

Figure 1: Average distribution of three selected market structures over time

of Fight structures is similar in B0 and B5 and remains relatively stable over time. In B1, the proportion of Fight structures significantly decreases over time.

Overall, the relative frequency of firms bearing the cost of entry in *B1* is about 53%. As shown in Figure 2, the frequency increases in the first three rounds, but then signifiacntly decreases until the last but one round. In contrast, the relative frequency of firms bearing the cost of entry in *B5* is significantly higher at about 77% (Chi^2-test, $p < 0.0001$). This percentage rises from 74% in the first two entry payment stages to 80% in the third and fourth stage of the experiment.

Table 5: Market structure transition matrices

(a) *B0*

from	to fight (*2-2*)	to mixed (*2-1*)	to cartel (*1-1*)	Total
Fight (*2-2*)	0.87	0.12	0.01	0.52
Mixed (*2-1*)	0.40	0.45	0.15	0.17
Cartel (*1-1*)	0.03	0.06	0.91	0.31
Total	0.53	0.16	0.31	1.00

(b) *B1*

from	to fight (*2-2*)	to mixed (*2-1*)	to cartel (*1-1*)	Total
Fight (*2-2*)	0.77	0.17	0.06	0.41
Mixed (*2-1*)	0.49	0.39	0.12	0.16
Cartel (*1-1*)	0.01	0.07	0.92	0.43
Total	0.40	0.16	0.44	1.00

(c) *B5*

from	to fight (*2-2*)	to mixed (*2-1*)	to cartel (*1-1*)	Total
Fight (*2-2*)	0.92	0.08	0.00	0.51
Mixed (*2-1*)	0.15	0.79	0.06	0.32
Cartel (*1-1*)	0.00	0.11	0.89	0.17
Total	0.52	0.31	0.17	1.00

6 Individual behavior

We study individual behavior using a regression analysis to examine how a firm's decision to cooperate depends on its own decision and its competitor's decision to cooperate in the preceding round. We estimate a firm's binary choice to cooperate using two binary explanatory variables $COOP_i^{t-1}$ for $i = 1$ (own decision) and $i = 2$ (competitor's decision), which are equal to 1 if player i entered only one of the two markets in round $t-1$ and 0 else. We further use binary explanatory variables $BARRIER_i^t$ for $i = 1$ (own decision) and $i = 2$ (competitor's decision), which are equal to 1 if player i made the entry payment in round t and 0 else.

Table 6 shows the results of our random-effects (RE) logit regressions for all treatments.[18] It is no surprise that we find a strong positive effect of

[18]To reduce noise, we excluded all rounds where the market structure did not correspond to one of the predominant ones (32 in *B0*, 24 in *B1*, and 38 in *B5*).

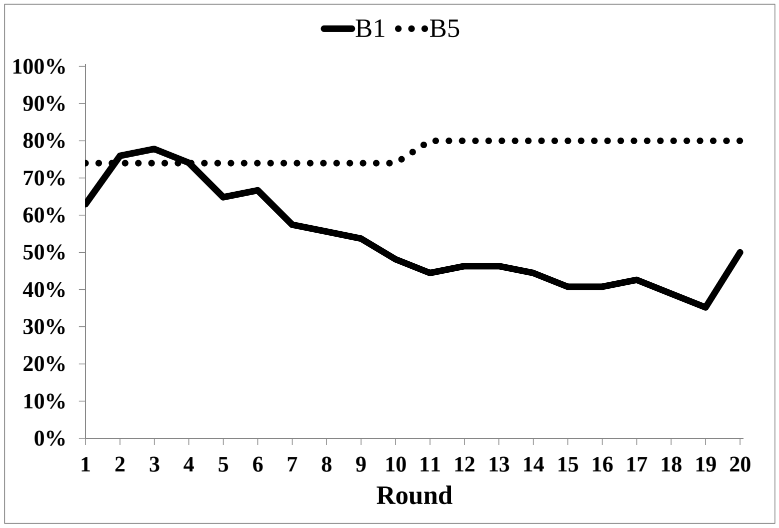


Figure 2: Average frequency of entry payment made over time.

the own cooperation in the previous period on continued cooperation in all treatments. Given the strong experimental evidence on reciprocal behavior (Fehr and Gächter, 2000; Charness and Rabin, 2002), it is also no surprise that we find a strong positive coefficient of the other firm's previous cooperation in *B0* and *B1*. The somewhat surprising finding is that the observed reciprocity in *B5* is much smaller. It seems that once firms need to commit to a long-term entry investment, they less condition their entry decision on the other firm's behavior. When we integrate the decision of the other firm to make the entry payment, we find differences between our treatment with entry barriers. In *B1*, we find a strongly significantly negative effect. This hints on firms responding with cooperation towards the other firm signalling not to compete outside its home market. In contrast in *B5*, we find no such effect.

Result 3. *In B0 and B1, firms strongly reciprocate to cooperative choices with cooperation, whereas in B5 reciprocity is much lower.*

7 Discussion and conclusion

The mutual forbearance hypothesis claims that firms are able to establish cooperation, if they interact in multiple markets. In the setting we study,

Table 6: RE logit regressions with cooperation as dependent variable.

	B0	*B1*		*B5*	
Constant	-2.87^{***}	-2.02^{***}	-0.76^{**}	-3.22^{***}	-3.72^{***}
$COOP_1^{t-1}$	2.62^{***}	2.30^{***}	1.97^{***}	4.88^{***}	4.90^{***}
$COOP_2^{t-1}$	2.70^{***}	1.97^{***}	1.47^{***}	0.91^{***}	1.24^{***}
$BARRIER_2^t$	–	–	-1.47^{***}	–	0.50
Wald χ^2	383.25^{***}	224.09^{***}	237.24^{***}	353.44^{***}	351.72^{***}
N	1108	1002	1002	912	912

*** significance at 1%, ** at 5%, * at 10% level.

mutual forbearance is conjectured to be facilitated, because firms can easily coordinate on serving only their own home market. We find that firms indeed collude by exclusively serving their home market instead of being active in both markets when they do not face barriers to entry. With costly short-term entry barriers, collusion even increases. However, when each firm has to make a costly long-term investment to enter the other firm's market, cooperation breaks down. On first sight this seems surprising because the long-term barrier to entry effectively increases entry, instead of supporting mutual forbearance.

Table 7: Normal form of the simplified entry game in *B0* (ex-post realized total profits per round)

	Firm enters 1 market	Firm enters 2 markets
Firm enters 1 market	2011.65 ; 2011.56	202.53 ; 2200.26
Firm enters 2 markets	2200.26 ; 202.53	307.39 ; 307.39

Table 7 shows the average profits for all four outcomes of the multimarket game in our treatment without entry barriers. Evidently, cooperating firms will refrain from entering both markets but, individually, each firm has a clear incentive to deviate from cooperation. It turns out that the empirical game faced by the firms in *B0* is a prisoner's dilemma. This also holds for the other two treatments. Tables 8 and 9 display the corresponding observed average values for the treatments with entry barriers. The size, the distribution, and the relationship between the empirical profits in all treatments

Table 8: Normal form of the simplified entry game in*B1* (ex-post realized total profits per round, without cost of entry)

	Firm enters 1 market	Firm enters 2 markets (needs entry payment)
Firm enters 1 market	2000.96 ; 2000.96	−98.82 ; 2053.47
Firm enters 2 markets (needs entry payment)	2053.47 ; −98.82	181.59 ; 181.59

Table 9: Normal form of the simplified entry game in*B5* (ex-post realized total profits per round, without cost of entry)

	Firm enters 1 market	Firm enters 2 markets (needs entry payment)
Firm enters 1 market	1981.94 ; 1981.94	41.33 ; 2270.46
Firm enters 2 markets (needs entry payment)	2270.46 ; 41.33	171.25 ; 171.25

are very similar.[19] Nevertheless, we observe significantly more entry into the other firm's market in the treatment with entry barriers than without. We conjecture that bearing the cost for the long-term investment to enter the other firm's market is interpreted as a signal for non-cooperative intentions.[20] It thus seems that in multimarket settings, long-term barriers to entry may have a surprising adverse effect on mutual forbearance, harming industry profits, but increasing consumer rent.

While our results provide insights into the effect of entry barriers in symmetric multimarket oligopolies, some open questions remain. Both uncertainty and asymmetry in our multimarket setting provide a link for future research.

[19]Note that we consider the gross profits in our treatments with entry barriers because the cost of entry is sunk at the time of the entry.

[20]Furthermore, the sunk cost fallacy might drive competition once entry cost are paid (Thaler, 1980). Rosenbaum and Lamort (1992) indeed find empirical evidence for lower exit rates in markets with sunk capital costs. Offerman and Potters (2006) and Buchheit and Feltovich (2011) find mixed evidence for higher degrees of competition in experimental markets with sunk cost.

Acknowledgements

We thank Armin Schmutzler and the audience at the OLIGO 2013 Workshop in Budapest for helpful comments and suggestions.

References

Argenton, C., Müller, W., 2012. Collusion in experimental bertrand duopolies with convex costs: The role of cost asymmetry. International Journal of Industrial Organization 30 (6), 508 – 517.

Baumol, W. J., Willig, R. D., 1981. Fixed costs, sunk costs, entry barriers, and sustainability of monopoly. The Quarterly Journal of Economics 96 (3), 405–31.

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

Brandts, J., Guillen, P., 2007. Collusion and fights in an experiment with price-setting firms and advance production. Journal of Industrial Economics 55 (3), 453–473.

Buchheit, S., Feltovich, N., 2011. Experimental evidence of a sunk-cost paradox: study of pricing behavior in bertrand-edgeworth duopoly. International Economic Review 52 (2), 317–347.

Camerer, C., Lovallo, D., 1999. Overconfidence and excess entry: An experimental approach. American Economic Review 89 (1), 306–318.

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

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

Cracau, D., Franz, B., 2011. Mixed-strategies in pq-duopolies. In: Chan, F., Marinova, D. and Anderssen, R.S. (eds) MODSIM2011, 19th International Congress on Modelling and Simulation. Modelling and Simulation Society of Australia and New Zealand, December 2011, pp. 1414-1420. ISBN: 978-0-9872143-1-7. www.mssanz.org.au/modsim2011/D4/cracau.pdf.

Cracau, D., Franz, B., 2012. An experimental study of mixed strategy equilibria in simultaneous price-quantity games. FEMM Working Papers 12017, Otto-von-Guericke University Magdeburg, Faculty of Economics and Management.

Davis, D. D., 2013. Advance production, inventories and market power: An experimental investigation. Economic Inquiry 51 (1), 941–958.

Duffy, J., Hopkins, E., 2005. Learning, information, and sorting in market entry games: theory and evidence. Games and Economic Behavior 51 (1), 31–62.

Dufwenberg, M., Gneezy, U., 2000. Price competition and market concentration: an experimental study. International Journal of Industrial Organization 18 (1), 7–22.

Edwards, C. D., 1955. Conglomerate bigness as a source of power. In: Business Concentration and Price Policy. National Bureau of Economic Research, Inc, pp. 329–358.

Evans, W. N., Kessides, I. N., 1994. Living by the "golden rule": Multimarket contact in the u.s. airline industry. The Quarterly Journal of Economics 109 (2), 341–66.

Fehr, E., Gächter, S., 2000. Fairness and retaliation: The economics of reciprocity. Journal of Economic Perspectives 14 (3), 159–181.

Feinberg, R., Sherman, R., 1985. An experimental investigation of mutual forbearance by conglomerate firms. In: Industry Structure and Performance. J. Schwalbach (ed.), Berlin: Sigma Rainer Bohn Verlag, pp. 139–166.

Feinberg, R. M., Sherman, R., 1988. Mutual forbearance under experimental conditions. Southern Economic Journal 54 (4), 985–993.

Fernández, N., Marín, P. L., 1998. Market power and multimarket contact: Some evidence from the spanish hotel industry. Journal of Industrial Economics 46 (3), 301–15.

Fischbacher, U., 2007. z-tree: Zurich toolbox for ready-made economic experiments. Experimental Economics 10 (2), 171–178.

Gertner, R., 1986. Essays in theoretical industrial organization. Ph.D. thesis, Princeton University.

Greiner, B., 2004. The online recruitment system orsee 2.0 - a guide for the organization of experiments in economics. Working Paper Series in Economics 10, University of Cologne, Department of Economics.

Güth, W., Häger, K., Kirchkamp, O., Schwalbach, J., 2010. Testing forbearance experimentally: Duopolistic competition of conglomerate firms. Jena economic research papers 2010,043.

Harsanyi, J. C., Selten, R., 1988. A General Theory of Equilibrium Selection in Games. Vol. 1 of MIT Press Books. The MIT Press.

Huck, S., Normann, H.-T., Oechssler, J., 2004. Two are few and four are many: Number effects in experimental oligopolies. Journal of Economic Behavior & Organization 53 (4), 435–446.

Kantarelis, D., Veendorp, E. C. H., 1988. Live and let live type behavior in a multi-market setting with demand fluctuations. Journal of Economic Behavior & Organization 10 (2), 235–244.

Kreps, D. M., Scheinkman, J. A., 1983. Quantity precommitment and bertrand competition yield cournot outcomes. Bell Journal of Economics 14 (2), 326–337.

Levitan, R. E., Shubik, M., 1978. Duopoly with price and quantity as strategic variables. International Journal of Game Theory 7 (1), 1–11.

Offerman, T., Potters, J., 2006. Does auctioning of entry licences induce collusion? an experimental study. Review of Economic Studies 73 (3), 769–791.

Parker, P. M., Röller, L.-H., 1997. Collusive conduct in duopolies: Multimarket contact and cross-ownership in the mobile telephone industry. RAND Journal of Economics 28 (2), 304–322.

Phillips, O. R., Mason, C. F., 1992. Mutual forbearance in experimental conglomerate markets. RAND Journal of Economics 23 (3), 395–414.

Phillips, O. R., Mason, C. F., 1996. Market regulation and multimarket rivalry. RAND Journal of Economics 27 (3), 596–617.

Phillips, O. R., Mason, C. F., 2001. Collusion in horizontally connected markets: Multimarket producers as conduits for learning. Advances in Strategic Management 18, 205–227.

Potters, J., Rockenbach, B., Sadrieh, A., van Damme, E., 2004. Collusion under yardstick competition: an experimental study. International Journal of Industrial Organization 22 (7), 1017–1038.

Rapoport, A., 1995. Individual strategies in a market entry game. Group Decision and Negotiation 4 (2), 117–133.

Rosenbaum, D. I., Lamort, F., 1992. Entry, barriers, exit, and sunk costs: An analysis. Applied Economics 24 (3), 297–304.

Spagnolo, G., 1999. On interdependent supergames: Multimarket contact, concavity, and collusion. Journal of Economic Theory 89 (1), 127–139.

Stigler, G. J., 1971. The theory of economic regulation. Bell Journal of Economics 2 (1), 3–21.

Thaler, R., 1980. Toward a positive theory of consumer choice. Journal of Economic Behavior & Organization 1 (1), 39–60.

Thaler, R. H., Johnson, E. J., 1990. Gambling with the House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice. Management Science 36 (6), 643–660.

van Witteloostuijn, A., van Wegberg, M., 1992. Multimarket competition: Theory and evidence. Journal of Economic Behavior & Organization 18 (2), 273–282.

Zwick, R., Rapoport, A., 2002. Tacit coordination in a decentralized market entry game with fixed capacity. Experimental Economics 5 (3), 253–272.

A Equilibrium reference values of the single market price-quantity game

As shown in Cracau and Franz (2012), the mixed strategy equilibrium derived in Gertner (1986) has the property that all strategies with positive probabilities are situated on the line $q_{ik} = D(p_{ik})$, i.e. each firm always produces exactly the market demand corresponding to the chosen price. For the demand and cost function used in our experiment, $D(p_{ik}) = 100 - p_{ik}$ and $C(q_{ik}) = 10q_{ik}$, the probability distribution for the prices thereby fully describes the mixed strategy equilibrium and is given through the distribution function

$$F(p) = \begin{cases} 0\,, & \text{for } p < 10\,, \\ 1 - c/p\,, & \text{for } 10 \leq p < 100\,, \\ 1\,, & \text{for } p \geq 100\,. \end{cases}$$

The probability density function is then given by

$$f(p) = \begin{cases} 10/p^2 & \text{, for } p \in [10, 100)\,, \\ 0 & \text{, else} \end{cases}$$

Expected values for a single market can then be calculated as

$$\begin{aligned} \mathbb{E}[p_{ik}] &= 33.03\,, \\ \mathbb{E}[q_{ik}] &= 66.97\,, \\ \mathbb{E}[\pi_{ik}] &= 0\,. \end{aligned}$$

Otto von Guericke University Magdeburg
Faculty of Economics and Management
P.O. Box 4120 | 39016 Magdeburg | Germany

Tel.: +49 (0) 3 91 / 67-1 85 84
Fax: +49 (0) 3 91 / 67-1 21 20

www.fww.ovgu.de/femm

ISSN 1615-4274