Title: Forward induction and market entry with an endogenous outside option*

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Abstract.
We consider a two-player sequential game in which players first choose whether to engage in a productive (market game) or unproductive activity (contest game) and then, if both players have chosen to enter the market, they compete in prices. Both economic activities are linked because the rents in the contest game are a fraction of the market profits. Subgame perfection predicts competitive pricing and a *battle-of-the-sexes* reduced-form game with two asymmetric Nash equilibrium, where only one firm enters. Our experimental results reject the prediction based on backward induction but are easily explained by forward induction arguments. The payoffs from the rent-seeking activity (outside option) influence pricing behaviour and prices do not converge to marginal costs. When the size of the rent seeking activities is large, firms coordinate better on economic activities and, in the event of market competition, prices converge to full collusion.

JEL classification numbers: C91, D43, L13

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1. Introduction

Strategic interactions in which players attempt to avoid congestion are ubiquitous. Sometimes, these coordination games take place at the micro level, such as when we must determine a route to go from one place to another, and have local consequences. In others, they have larger repercussions and occur at the market level, for example, when firms decide in which market to operate.

Economists have studied these participation games from both a theoretical (Anderson and Engers, 2007) and experimental (Rapoport et al., 1998) point of view. Typically, payoffs from the participation game decrease with the number of entrants and the payoff from staying out is fixed and exogenous. A prominent example in Industrial Organization is *market entry games*, where a set of firms must decide whether to enter a market or stay out (Erev and Rapoport, 1998, Erev et al., 2010). Another prominent example is *contest entry games*, where a number of firms decide individually whether to seek for rents (Appelbaum and Katz, 1986, Morgan et al., 2010).

In this paper, we use the framework of participation games to analyse firm choices regarding which economic activity to pursue. In particular, we are interested in the dilemma between productive activities (e.g., producing and selling a product) and unproductive activities (e.g., seeking for rents). We find particularly appealing that these two activities are typically linked in real life, as rent seekers lobby governments for rents that come from taxes levied on productive activities.

Once this linkage is realized, a balance between productive and unproductive activities emerges in society. If no one seeks for rents, the lack of competition in the rent-seeking market could potentially make rent-seeking a profitable activity. On the other side, if all economic agents seek for rents, there is no production in the economy and no rents to seek, and the lack of competition in productive activities potentially make production into a profitable activity. Understanding this balance is the purpose of this paper as it may entail large economic inefficiencies. Throughout history, there are many examples of countries where an excess of extractive activities has become detrimental for economic development. The prototypical case is Argentina, which since the Second World War has stagnated into an extractive economy (see Acemoglu and Robinson, 2012).

In this paper, productive activity takes the form of price competition with fixed demand and zero marginal cost, and the rents to be sought are an exogenous fraction of the profits from price competition. We restrict the analysis to the two-player case,[1] which naturally leads to a *Battle-of-the-Sexes* reduced-form game, with two asymmetric pure strategy Nash equilibria with positive payoffs, where one firm enters and the other stays out and seeks for rents. Any other action profile is characterized by zero payoffs: two producers gain zero because price competition drives prices down to marginal costs and two seekers get nothing because there are no rents to be sought.

We ran two experimental treatments, where the treatment variable, the size of the rents to be sought, takes two values: in one treatment, it was a low fraction (30% of the market profits, treatment *Low*) and in the other it was a high fraction (70% of the market profits, treatment *High*). From a theoretical point of view, the reduced-form games in the two treatments have the same equilibrium payoffs. In the treatment *Low*, the firm entering the market got a payoff of 70 while the firm staying out got 30. In the treatment *High*, roles are reversed: the firm entering the market got 30 while the seeker got 70. Hence, players need to coordinate on choosing different actions in equilibrium and one player made more than the other, but switching their relative positions across treatments.

The sequential nature of the strategic interaction between firms -first they choose activities and then, if both have entered the market, price competition takes place-, opens the door for behavioural effects, as features of the first stage may influence behaviour in the second stage. Subgame perfection does not allow this channel because it reasons backwards, but the forward induction argument does, and it predicts different behaviour across treatments. This is because the decision to enter implicitly sends a signal about future behaviour: subjects who enter will never post a price that yields a profit lower than the payoff they could have obtained by staying out, which is the payoff associated with rent-seeking activities. Because our treatment variable is precisely the rent-seeking payoffs, forward induction predicts higher prices in the treatment *High* compared to the treatment *Low*.

This behavioural effect across treatments does not only influence pricing behaviour but also influences entry decisions. In the *Low* treatment, there is room in the market game for profits larger than the payoff from the outside option, which is 30. This implies that large entry rates are predicted in this treatment. In the *High* treatment, however, the highest potential profits in the market game, those from full collusion, 50, are smaller

[1] In a companion paper, Morales et al (2022), we analyse the balance between productive and unproductive activities in a three-firm experiment.

than the payoff associated to the outside option, 70. As a consequence, entry rates in the treatment *High* will not be as high as in the *Low* treatment.

Our experimental results are nicely explained by forward induction arguments. We have fixed pairs of firms playing 30 rounds of the sequential game. In the treatment *Low*, we observe dramatic levels of miscoordination, firms enter the market game almost all rounds and post a median price of 60. This posted price yields a payoff from entering of 30, the same as the payoff from the rent-seeking choice. In the treatment *High*, entry rates are much lower and conditional on both entering, firms progressively learn to reach full collusion.

The success of forward-looking arguments in explaining choices in our experimental setting expands the applicability of this type of argument beyond the simpler entry games previously analysed in the experimental literature. In the 1990s, there was an interest in finding mechanisms that would enhance player coordination in pure coordination games. One such mechanism was the existence of an outside option. Cooper et al (1993) analysed a standard *Battle-of-the-Sexes* game where one player was given an outside option. They found that the existence of the outside option moved play into the direction predicted by forward induction (it mostly selects the equilibrium where the player who was offered the outside option received a payoff higher than the payoff associated with the outside option). Similar results were found when the outside option is made available to all players of the game, as in Cachon and Camerer (1996) or Broseta et al (2003), where players were given a costly option to opt in to play a game; a median effort game and a public good game, respectively. They found that the cost to opt in -an entry fee in Cachon and Camerer (1996) and an auction in Broseta et al (2003)- was effective in shrinking the number of equilibria which players ended up playing.

Previous papers on market entry games -where the payoff from the outside option is fixed- had found *magical* and instant coordination of players at the aggregate level (Erev and Rapoport, 1998; Camerer, 2003, chapter 3). This is also the case in the literature of congestion games (see Rosenthal, 1973, for a theoretical study and Selten et al., 2007, for an experimental investigation). Congestion games are related to our paper because the payoffs from the two choices (i.e. routes) are endogenous, as they depend on the number of subjects choosing each of them.

In our experiment, we did not find such coordination between experimental players in the treatment *Low*, because entry rates are nearly 100%. However, we did observe this coordination in the treatment *High*, where firms produced the equilibrium outcome -only one firm entering- 43% of the rounds, which was very close to the expected 50% entry rate if players perfectly coordinated in one (or both) of the pure equilibria. At the aggregate level, coordination is easier to obtain when the size of rents was large enough. Despite these different dynamics across treatments, we did find that earnings were equalized between activities in both treatments and players learned to avoid a competitive clash. They extracted a large fraction of the maximum payoffs, around 80%.

The remainder of the paper is organized as follows: Section 2 outlines the experimental design, procedures, and hypotheses; Section 3 presents the experimental results; and Section 4 discusses and concludes.

2. Experimental design, procedures and hypotheses

2.1 The game

Consider the following general game: N firms play a sequential game. In the first stage, they simultaneous and unilaterally decide whether to enter a market or to stay out. Once entry decisions are taken, there is a second stage where first, those who have entered the market play a Bertrand price competition (with fixed demand and constant marginal costs) and then, those who have stayed out play a rent seeking game, where the size of the rents is a fraction $t \in [0,1]$ of the market profits.

When the number of firms is two, the game simplifies in the sense that there will never be rent seeking competition: if both decide to seek, there is no production in the game and, consequently, no rents to seek. In this paper, we focus on this case, so that the second stage is only played when both firms decide to enter the market (see also the extensive-form tree in Appendix C).

We first solve this game using standard backward induction arguments. Subgames are parametrized by the number of entrants in market competition. If no player enters, both players get zero profits because there are no market profits and therefore no rent to seek. If one player enters, she behaves as a monopolist and receives a fraction $(1 - t)$ of the monopolist profits π^M, and the firm staying out is the only seeker and spend no resources to seek and therefore gets a payoff $t\pi^M$. Finally, if both players enter the market, they have to decide their prices in the [0,100] interval; in this case the Bertrand Nash equilibrium prediction implies that both players get zero.

Once the subgames have been solved, we take a step back and consider the market entry stage. Table 1 displays the reduced form of the game, as seen from the market entry stage, assuming Nash behaviour in the price competition subgame.

Table 1. The reduced form of the game

	Enter	Stay out
Enter	Price competition 0 , 0	$(1-t)\pi^M, t\pi^M$
Stay out	$t\pi^M, (1-t)\pi^M$	0 , 0

The reduced game has the features of an asymmetric coordination game (battle-of-the-sexes) with two asymmetric pure-strategy Nash equilibria, in which one player enters the market and the other stays out. There is also a symmetric mixed-strategy equilibrium, in which a player enters with probability $(1-t)$.[2]

2.2 Experimental design and procedures

In the experiment, we assume unitary demand and zero marginal cost, setting the price interval to $[0, 100]$, resulting in monopoly profits of $\pi^M = 100$. We consider two treatments, corresponding to the following two values of the parameter t: *Low* ($t = 0.30$) and *High*, ($t = 0.70$). Table 2 displays the reduced form games for each treatment.

Table 2. Reduced form games by treatment

	Enter	Stay out
Enter	Price competition	70 , 30
Stay out	30 , 70	0 , 0

Treatment Low

	Enter	Stay out
Enter	Price competition	30 , 70
Stay out	70 , 30	0 , 0

Treatment High

An interesting feature of the experimental design is that equilibrium payoffs are identical across treatments: one player gets 70 and the other player gets 30. In the *Low* treatment,

[2] In the mixed-strategy equilibrium, a duopoly in the market happens with probability $(1-t)^2$, a monopoly happens with probability $2t(1-t)$ and no production occurs with probability t^2.

the player who enters gets 70 (and the player who stays out gets 30); while in the *High* treatment, it is the player staying out who gets 70 while the one entering gets 30.

The game was repeated 30 times under a partners-matching design. At the end of each round, experimental subjects were informed about the actions and payoffs of all players in their group. See Table 3 for details.

Table 3. Experimental design

	Treatment	
	High ($t = 0.7$)	Low ($t = 0.3$)
Subjects	20	20
Sessions	2	2
Rounds	30	30
Matching	Fixed	Fixed
Feedback Information	Individual decisions and profits of group members	Individual decisions and profits of group members
# Independent observations	10	10

The experimental sessions were conducted in the Laboratory for Research in Experimental Economics LINEEX at the University of Valencia. Forty students were recruited using a standard electronic recruitment procedure. Four sessions -two for each treatment- were conducted using Z-tree (Fischbacher, 2007) and subjects received an average payoff of 10.78€ for an experiment that lasted less than one hour. Subjects received a set of instructions with a neutral framing, without mentioning rent seeking or production, which were read aloud. Experimental instructions, translated from the Spanish, are available in the Appendix.

2.3. Experimental hypotheses

Our null hypothesis is based on the backward induction arguments presented in subsection 2.1, Table 1. As equilibrium payoffs are identical across treatments, one should expect no differences across treatments.

H0. *In both treatments, (i) competitive pressure drives posted prices down to marginal costs and (ii) players coordinate on an asymmetric Nash equilibrium, where one player entering and the other staying out.*

The sequential nature of the game lends itself to forward induction arguments. Because pricing competition occurs after players have chosen to either compete or seek, the payoff that an entering firm could have obtained by staying out may affect their pricing decisions. This is because, as the forward induction argument continues, a firm will not choose a price that guarantees a lower payoff than what they could have earned by staying out.

A number of experimental studies report results that are (partially) favourable to forward induction. They are conducted in the context of games with multiple equilibria, with the emphasis being on whether the existence of the outside option shrinks the set of *plausible* equilibria, thus facilitating coordination among players. Some papers give the outside option exclusively to one player. This is the case of Cooper et al (1993), that studied a standard Battle of the Sexes game with two asymmetric pure strategy Nash equilibria, with payoffs (200, 600) and (600, 200), and where one player was given an intermediate outside payoff, 300. They found that the existence of the outside option moved play into the direction predicted by forward induction (it mostly selects the equilibrium where the player who is offered the outside option gets the payoff 600), although the outside option was still played 20% of the times.

Other papers consider situations where all players have the outside option. Cachon and Camerer (1996) analyse the median effort game studied by Van Huyck et al (1991, 1993) –coordination games with multiple Pareto ranked symmetric equilibria- when players who opt in to play the game must pay a fee. The value of the fee is set to an intermediate value so that forward induction *selects* those equilibria with payoffs larger than the value of the entry fee. The conclusion is that forward induction has some predictive power, although it is not as strong as other selection principles (loss avoidance, for example). Finally, Broseta et al (2003) report evidence favourable to forward induction in a situation where players first compete for the right to play a public goods game with full provision points. The public goods game with full provision point is again a coordination game with two symmetric Pareto ranked equilibria. They find that auctioning off the right to play the public goods game has an impact on the performance in the public goods game, as the efficient full provision Nash equilibrium is observed in almost all experimental sessions.

Our paper shares several features with this literature; like Cooper et al (1993), it considers a battle-of-the-sexes game with two asymmetric Nash equilibria, although it offers the outside option to all players, as in Cachon and Camerer (1996) and Broseta et al (2003).

Following these experimental results, we expect our experimental subjects to behave in a way compatible with forward-looking arguments. As the payoff associated with staying out of market competition is our treatment variable, forward induction arguments predict differences in posted prices across treatments and, eventually, in market entry rates.

Under forward-looking arguments, players attach meanings to deviations from equilibrium strategies. How a subgame is reached conveys information about intended play in the subgame. Consider the pricing subgame where both players have entered. This outcome is off any equilibrium path. From the point of view of any player, the opponent has deviated from her equilibrium strategy, i.e. staying out. A player attaches a meaning to her opponent's deviation under the assumption that her opponent is maximising her expected payoff. If the opponent had followed the equilibrium strategy, she had obtained a payoff of $100t$. Hence, the reasoning continues, if the opponent has entered, she must strive for a larger payoff. Notice that this reasoning effectively rules out the opponent choosing prices in the range $[0, 100t]$ and therefore prices in the range $[0, 100t]$ will never be chosen in the pricing subgame.

Hypothesis 1. *Competitive pressure drives posted prices down, but the payoff of the outside option acts as a floor, keeping prices away from marginal costs. Consequently, posted prices will increase with the size of the rents to be sought.*

As in our experiment both players are given the outside option, we can extend the logic of forward looking a little bit to find a symmetric forward-looking equilibrium price p^F. As competitive pressures will drive prices down and when both choose the same price they share the profits, the symmetric forward-looking equilibrium price p^F must be such that $\frac{p^F}{2} = 100t$. Hence, the equilibrium price p^F in the treatment *Low* is 60. In the treatment *High*, where the payoff from staying out a payoff of 70, the prediction is full collusive price 100.

Hypothesis 2. *In the treatment High, firms fully collude by posting a price of 100, while in the treatment Low posted prices converge to 60.*

In the treatment *High*, the profits from full collusion, 50, are smaller than the payoff associated to the outside option, 70. This makes the choice of entering into the market less appealing in this treatment than in the treatment *Low*, where there are potential profits from entering above the payoff from the outside option, which is 30.

Hypothesis 3. *Market entry decreases with the size of rents.*

High individual entry rates lead to poor coordination on any asymmetric pure strategy equilibrium, as the most likely outcome is that both firms enter the market. This yields our last hypothesis.

Hypothesis 4. *There is better coordination on asymmetric pure strategy equilibrium in the treatment High compared to the treatment Low.*

3. Experimental results

In this section, we first present some summary statistics at the aggregate level, then analyse individual data and finally study the welfare implications.

Table 4. Descriptive statistics by treatment: entry rates, prices and number of entrants

Treatment	Posted prices		Market prices		Individual entry rate	Number of entrants		
	Avg	Median	Avg	Median		None	One	Two
Low (t = 0.3)	62.23 (33.8)	60	56.24 (34.0)	50	0.94	0 % -	11.7 % (0.321)	88.3 % (0.322)
High (t = 0.7)	81.12 (30.3)	100	76.46 (33.0)	100	0.60	18.7 % (.390)	43.3 % (0.496)	38 % (0.486)

St deviations in brackets

Table 4 evidences the lack of explanatory power of the backward induction arguments, rejecting the null hypothesis. Average posted and market prices are well above marginal costs; the percentage of prices below 10 is 2.5% and 8% in treatments *High* and *Low*, respectively. We also find that miscoordination (either both firms entering or both firms staying out) is the most prevalent outcome; miscoordination rates are 88.3% in the treatment *Low* and 56.7% in the treatment *High*.[3] Miscoordination rates are significantly different from 50% in the treatment *Low* (Wilcoxon signed-rank test of equality of miscoordination to 0.5 by groups, z = 2.823, p = 0.0048) but not in the treatment *High* (Wilcoxon signed-ranked test, z = 0.715. p= 0.4747).[4]

Result 1. *Backward induction arguments do not provide a satisfactory explanation for the experimental results.*

Interestingly, table 4 shows differences across treatments in line with predictions from forward-looking arguments. Although prices above competitive levels are typically observed in the experimental literature on Bertrand duopolies (see Dufwenberg and Gneezy, 2010, Fatas et al., 2014 and Dijkstra, 2015), we do observe price levels close to predictions of forward induction arguments, 60 for the treatment *Low* and 100 for the treatment *High*. (For treatment *Low*, the Wilcoxon test for equality to a price of 60 gives $z = -0.102, p = 0.919$. For treatment *High*, the comparisons with a price of 99 gives $z = -1.842, p = 0.066$).

Figure 1 displays the evolution of market prices by treatment using five-period moving averages (solid line for treatment *High* and dashed line for treatment *Low*). It also includes two horizontal lines at prices 60 (dashed line) and 100 (solid line). Appendix B displays the evolution of market and posted prices. We observe a flat pattern for treatment *Low* around 60 while there is an increasing tendency over time towards full collusion prices (100) in treatment *High*, in line with Hypotheses 1 and 2.

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[3] We do not obtain *sorting* as predicted by some learning models (see Duffy and Hopkins, 2004) nor do we obtain *alternation* (Erev et al., 2010) although there is some non-significant evidence of this phenomenon in the treatment *High*.

[4] We compare the entry rate to 50% because in a battle-of-the-sexes game, there are two asymmetric Nash equilibria. Assuming Nash predictions, miscoordination may originate from both players choosing different equilibria. If they randomise between both pure strategy equilibria, the level of miscoordination would be 50%. There is an additional symmetric mixed-strategy equilibrium in which players choose enter with probability $(1-t)^2$, and miscoordination occurs with probability $1-2t(1-t)$. In both treatments, miscoordination would occur in equilibrium with probability 58%.

Figure 1. Evolution of average market prices over rounds by treatment (5 period moving average)

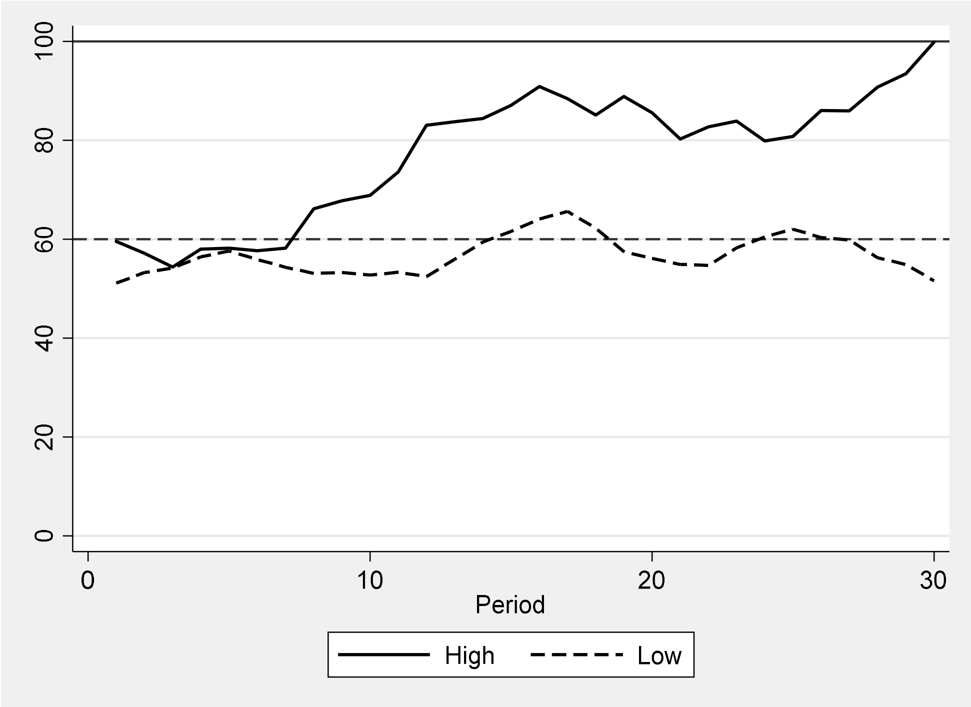


Table 5 contains panel-data estimations of market prices. Due to the different time trend across treatments, we use the variable period, a dummy variable for the High treatment, and the interaction between them as explanatory variables. The interaction effect is always positive and statistically significant, at the 1% level when all periods are considered but only marginally significant for the second half of the experiment. This implies that, once the time trend (variable *period*) is controlled for, there is positive treatment effect associated with the size of the rents to seek.[5]

Result 2. *Market prices are above competitive levels and have an increasing trend when rents are high. Their values are close to the values derived from forward-looking arguments.*

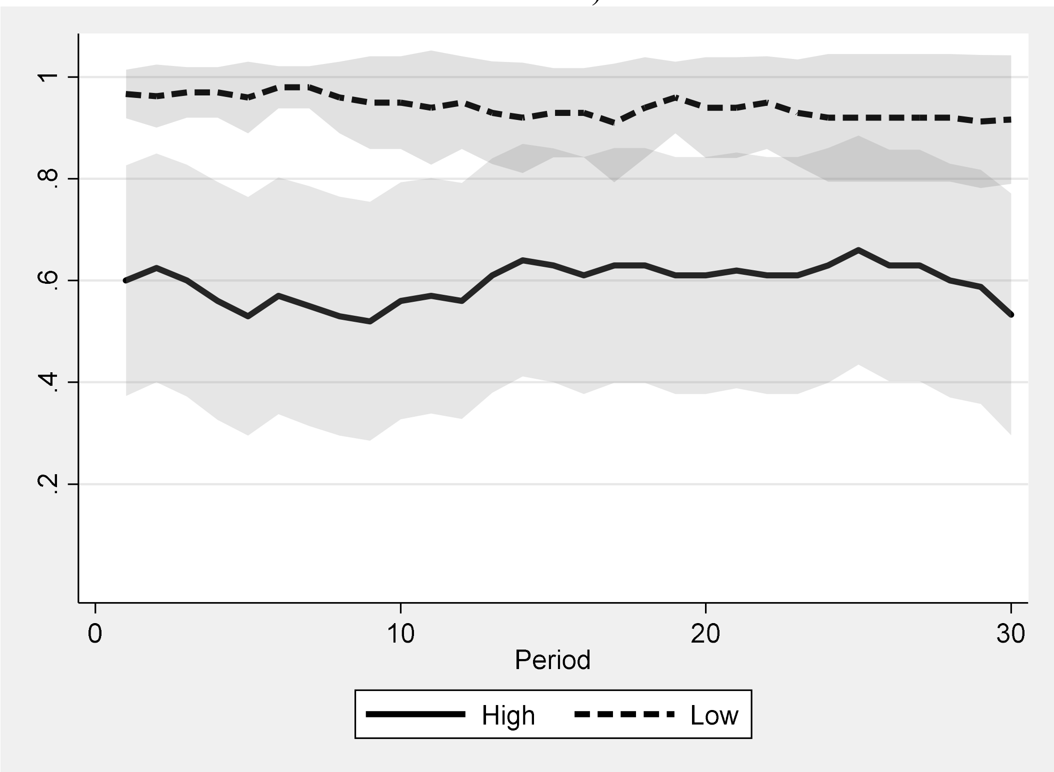
[5] The dummy variable *High* is statistically significant in none of the four models analysed. The reason is that, in the treatment High, only in 50% of the rounds we observe both firms entering the market and engaging in price competition, so we have far fewer observations of prices in the treatment *High* than in the treatment *Low*, where all firms enter the market to compete in prices. For example, in the second half of the experiment, there are two groups where firms never compete in prices (in the treatment *High*), so the number of groups for the second half of the experiment is 18.

Table 5. Estimation of treatment effects in market prices.

	All rounds		Second half	
VARIABLES	(1)	(2)	(3)	(4)
Period	0.219**	-0.0301	-0.839***	-1.070***
	(0.105)	(0.120)	(0.207)	(0.242)
High	1.834	-11.77	9.035	-10.06
	(13.83)	(13.36)	(17.16)	(19.53)
High x Period		0.962***		0.857*
		(0.235)		(0.466)
Constant	49.97***	53.72***	73.18***	78.44***
	(9.771)	(9.184)	(12.32)	(12.27)
Observations	379	379	187	187
Number of groups	20	20	18	18

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 2. Evolution of individual market entry rates by treatment (5 periods smoothing and 95 % confidence intervals in shaded areas)

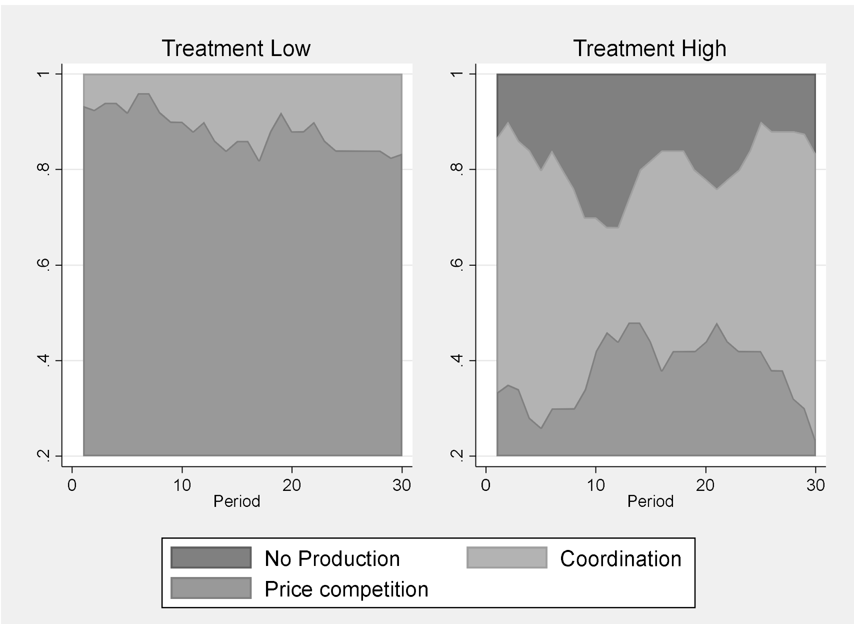


The different pricing dynamics observed across treatments help to explain the differences in entry rates. In the treatment *Low*, firms keep entering all periods (the average entry rate is 94%) hoping to get profits larger than the outside payoff of 30. Meanwhile, in the treatment *High*, firms enter into market competition less frequently (the average entry rate is 60%). These differences are statistically different (MW test for the equality of entry proportions at the group level across treatments: z=2.93, p=0.0034), confirming Hypothesis 3. The evolution of the entry rates is quite stable over time, as shown in Figure 2. This figure includes the average entry rate per treatment (solid line for the treatment *High* and dashed line for treatment *Low*) along with the corresponding confidence intervals.

Result 3. *Market entry decreases with the size of the rents, as predicted by forward-looking arguments*

Figure 3 displays the evolution of outcomes in the market (number of entrants) as a result of players' entry decisions over time by treatment. In the *Low* treatment, with an individual entry rate close to one, it is very unlikely that firms coordinate on any asymmetric Nash equilibrium; nine out of ten times, both firms enter. For the *High* treatment, there is better coordination on asymmetric pure strategy equilibria, because individual entry rates are much lower. As a result, coordination happens almost 50% of the time (43% of the time), very close to the 50% entry rate if players perfectly coordinate to play the pure asymmetric equilibria where only one player enter the market.

Figure 3. Distribution of market outcomes over rounds by treatment (5 period smoothing)



Result 4. *Experimental subjects learn to coordinate in the treatment High, but not in the treatment Low, supporting Hypothesis 4.*

We next focus on profit analysis. Table 6 displays the average profits by treatment, and then disaggregate them conditionally on the entry choice.

Table 6. Average profits by treatment

	Individual profits		
Treatment	Average	From Entering	From Staying out
Low	30.67	30.71	30.00
High	36.19	35.24	37.60

Column 2 shows that subjects earn significantly more in the treatment *High* than in the treatment *Low* (MW test, $z = 3.565$, $p = 0.0004$).

Result 5. *Better coordination increases profits, as subjects in High treatment earns on average more than subjects in Low treatment.*

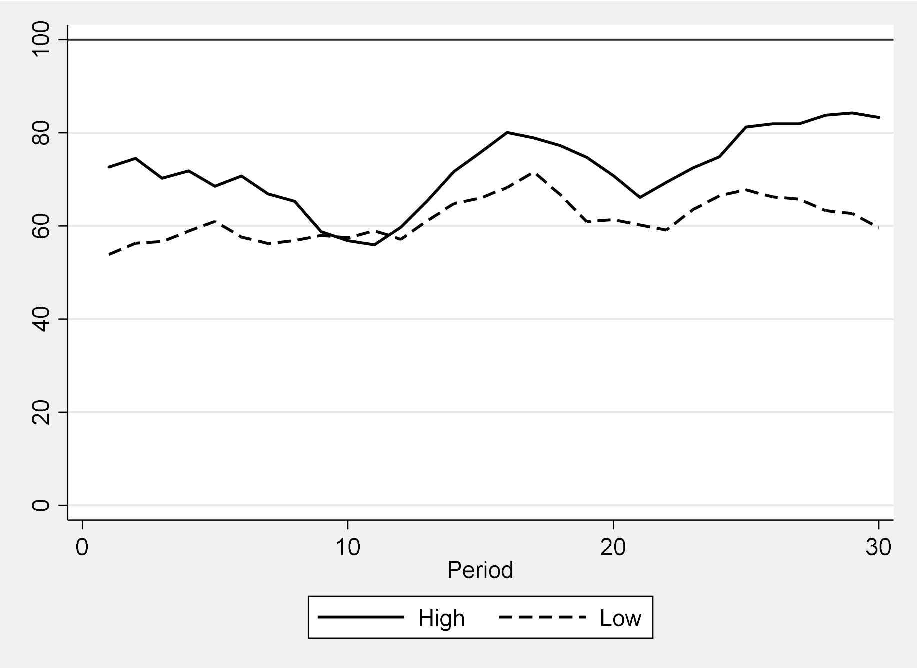
The last two columns of Table 6 show that profits are equalized across economic activities in both treatments. We test whether the average profits from entering equal the value of the average profit when not entering. We cannot reject the null hypothesis that payoffs are equalized across first stage choices (Wilcoxon signed-rank test for the treatment *Low* is $z = -1.240$, $p = 0.2149$ and $z = 0.929$, $p = 0.3528$ for the treatment *High*).

Result 6. *Competition between activities disciplines firms: there is earnings equalization between economic activities in each treatment.*

In the literature on market entry, equalization between payoffs from entering and the fixed payoff from the outside option is a common finding (see the survey on market entry games in Camerer, 2003). However, in the rent seeking literature, Morgan et al (2010) did not find such payoff equalisation. Later on, Morgan et al (2016) found the equalisation in some treatments.

We finally analyse how competition between firms fared in terms of capturing economic surplus. Figure 4 displays the evolution of the surplus captured by firms (in the experiment it is simply the sum of the earnings because there are no costs) over time. Notice that the level of 100 is the surplus captured if firms perfectly coordinated on a pure strategy equilibrium, where one firm enters and the other does not.

Figure 4. Evolution of the surplus captured by firms over rounds by treatment (5 period smoothing)



In both treatments, firms manage to capture surplus quite well, especially in the second half of the experiment, where the average levels of surplus are 64.48% and 77.80% for the *Low* and *High* treatments, respectively. For the *Low* treatment, surplus is mostly captured through collusive prices in the price competition setting, while in the *High* treatment, it is the joint action of better coordination and almost perfect collusion in the pricing game when miscoordination occurs.

4. Conclusions

In this paper, we have analysed the dilemma on which economic activity to pursue: productive activities (producing and selling a product) versus unproductive activities (seeking for rents). In the real world, this dilemma has strong implications because rent seekers lobby governments for rents that come from taxes levied on productive activities, resulting in increased inefficiency.

We analyse this dilemma experimentally, considering two firms and two different tax levels, one low and one high. For both tax levels, pure Nash equilibrium predicts coordination among firms: one will act as a producer (price competition) and the other will seek (contest competition). This equilibrium allocation resembles a *symbiotic* relationship that allows firms to avoid fierce competition.

Contrary to backward induction arguments, we observe that the tax rate has an influence on the level of competition between firms in the market game. When taxes are low, both firms choose market competition and market prices stabilize around intermediate prices. When taxes are high, firms coordinate better on economic activities and, in the event of market competition, prices converge to full collusion.

This influence is naturally explained by forward looking arguments, as in other experiments with sequential games (Cooper et al., 1993). An undesirable result is that firms in both settings learn to avoid a competitive clash and manage quite well to develop a variety of *coopetitive* strategies: they are able to extract a large proportion of the economic surplus of the economic system, above 60% in both treatments and increasing in rents size.

Those results raise a new question, which was not addressed in our experiment, about how societies determine the size of rents through the (unproductive) taxation rate and which dynamics generate virtuous cycles of low taxation and low inefficiencies and which ones have the opposite effects. This is a topic for future research.

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APPENDIX A. Translated instructions for Treatment *Low.*

The experiment will last for 30 rounds. Each round is independent (meaning that the results in a given round do not influence potential results in posterior rounds). At the beginning of the experiment you will be randomly matched with another participant; you will be part of a two-participant group. This matching will not change over the duration of the experiment. No participant will ever know the identity of the participant with whom he/she has been matched.

In each round you will have to make one or two decisions depending on your and your partner's decisions. Your first decision is whether to enter or not a market. You will make this decision without knowing the decision of your partner.

- If one of the members of your pair chooses to enter and the other does not, then the payoff for the member who entered is 70 whereas the payoff for the other person is 30.
- In no one enters, then the payoff for each one is 0.
- If both enter, then there is a second decision to be made: each one of you will have to choose a number between 0 and 100. Again, you will make this decision without knowing the decision of your partner.
    - If one of the numbers is lower than the other one, then the member of the pair who chose the lower number receives a payoff equal to that number, and the other member gets nothing.
    - If both numbers are equal, then each member of the pair receives half the chosen number.

At the end of each round you will be informed about your payoff and your partner's choices and payoffs. A table with information of previous rounds will also be available.

At the end of the experiment the sum of your payoffs over the 30 rounds will be given to you privately using a conversion rate of 100 ECU= 1 €.

APPENDIX B. FURTHER FIGURES.

Figure B. 1. Evolution of individual market entry rates by treatment (non-smoothed version)

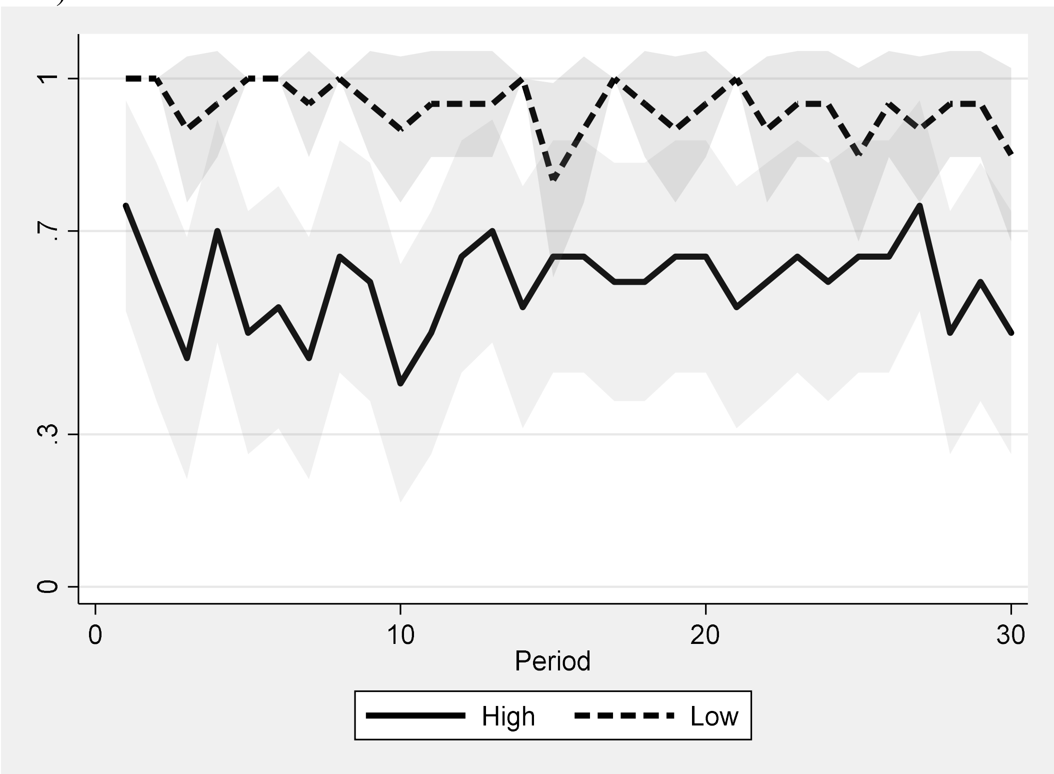


Figure B. 2. Distribution of market outcomes over rounds by treatment

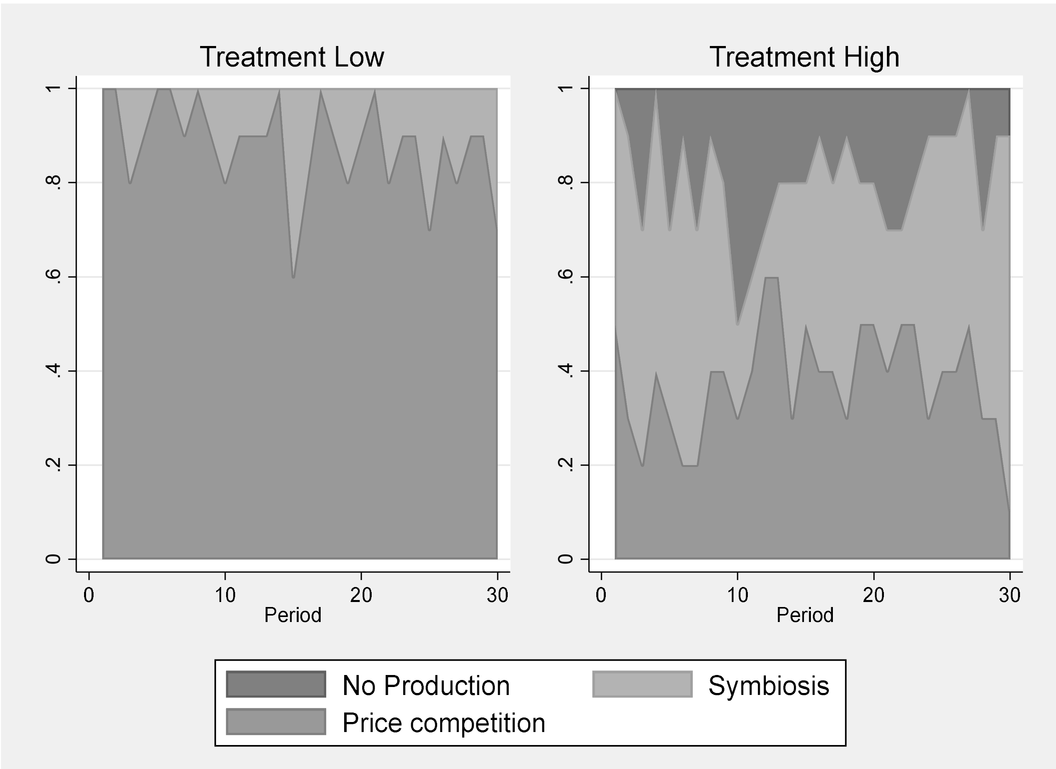


Figure B. 3. Evolution of average market prices over rounds by treatment

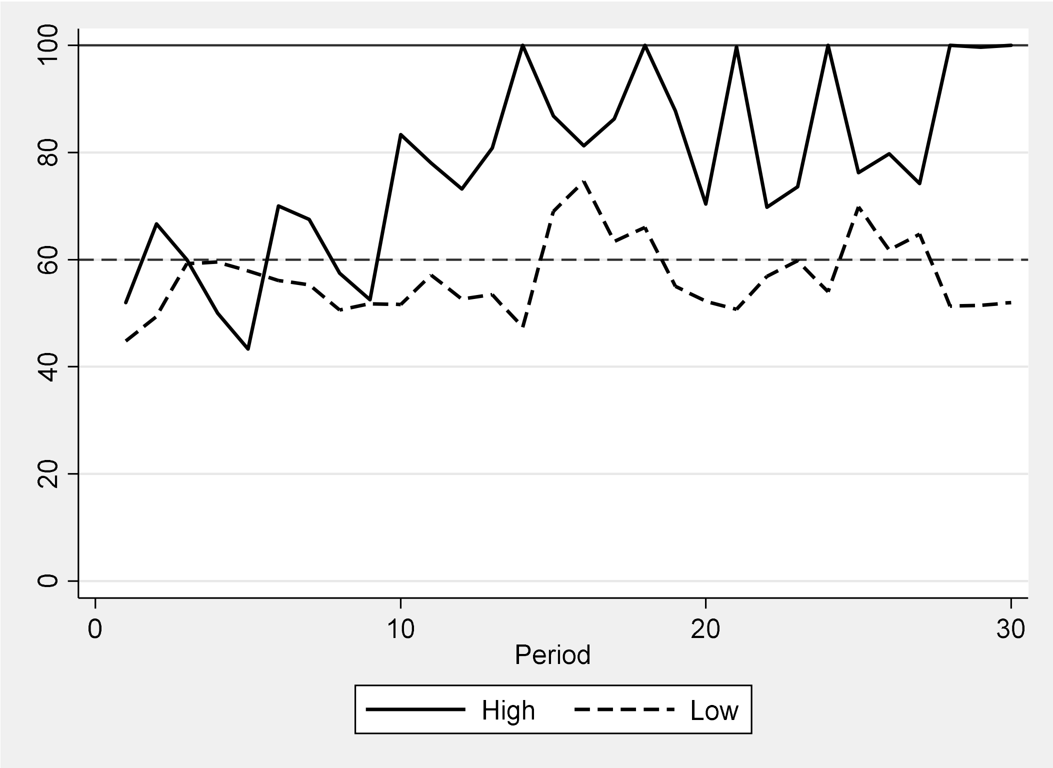


Figure B. 4. Evolution of the surplus captured by firms over rounds by treatment

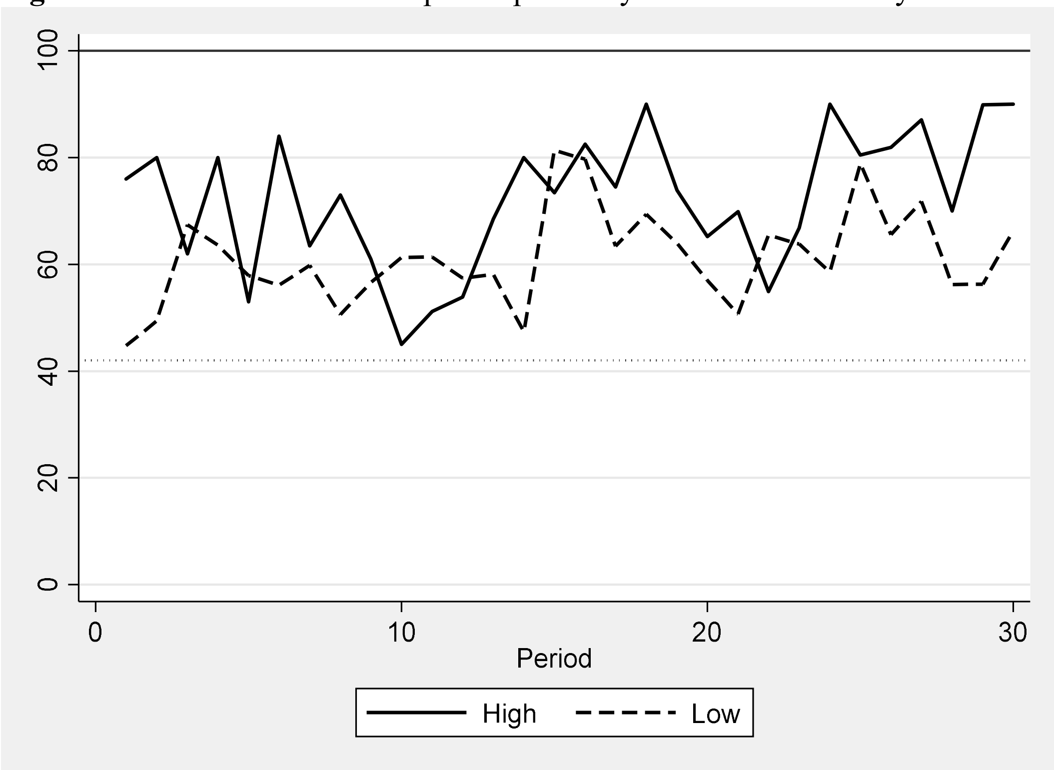
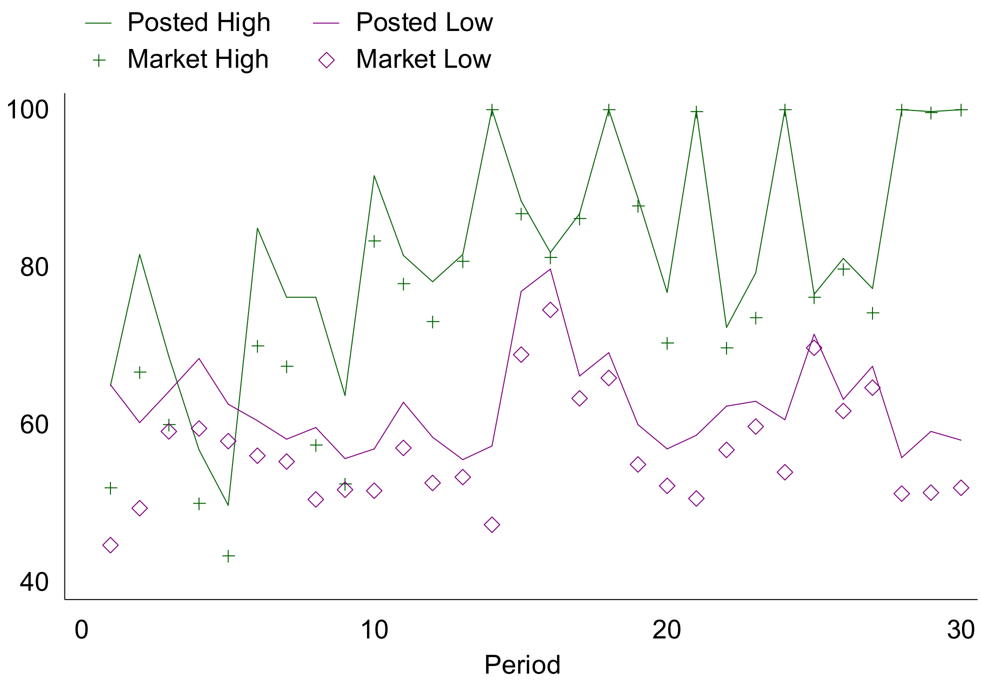


Figure B.5. Evolution of market and posted prices over rounds by treatment



APPENDIX C. Extensive form Game