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ABSTRACT

Naked exclusion: Towards a behavioral approach to exclusive dealing

We report experimental results on exclusive dealing inspired by the literature on "naked exclusion." Our key findings are: First, exclusion of a more efficient entrant is a widespread phenomenon in lab markets. Second, allowing incumbents to discriminate between buyers increases exclusion rates compared to the non-discriminatory case only when payments to buyers can be offered sequentially and secretly. Third, allowing discrimination does not lead to significant decreases in costs of exclusion. Accounting for the observation that buyers are more likely to accept an exclusive deal the higher is the payment, substantially improves the fit between theoretical predictions and observed behavior.

JEL Classification: C91, L12 and L42

Keywords: coordination, entry deterrence, exclusive dealing, experiments, externalities and foreclosure

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1. Introduction

For a long time, exclusive contracts have been hotly debated in antitrust law and in academia. Since the beginning of the 20th century courts have treated firms using exclusive contracts harshly for fear such contracts could be used to exclude rivals and, thus, hamper competition.¹ Starting in the 1950s, scholars belonging to the Chicago school (see, e.g., Director and Levi, 1956; Posner, 1976; Bork, 1978) argued that such fears are not warranted since using exclusive contracts for the sole purpose of anti-competitively excluding rivals would not be in the interest of rational firms. Recently, however, this *laissez-faire* view has been challenged by various theorists who describe circumstances under which anti-competitive exclusion of rivals may indeed occur. One prominent contribution in this literature is the naked exclusion model put forward by Rasmusen, Ramseyer and Wiley (1991) and Segal and Whinston (2000*b*) [henceforth RRW-SW].²

The RRW-SW framework features an incumbent seller, a more efficient entrant and a number of buyers with independent demand. Due to economies of scale caused by, for instance, fixed entry costs the entrant needs a sufficiently high number of “free” buyers (those not bound by exclusive contracts) to enter the market profitably. An exclusive contract in this framework takes the form of a payment from the incumbent to a buyer in exchange for the buyer’s promise to buy exclusively from the incumbent. The main feature of the RRW-SW model is that, under mild assumptions, the incumbent needs to “convince” only a subset of buyers in the market to sign an exclusive contract to deter entry and can, if successful, extract monopoly profits from all buyers.

RRW-SW show that when it is impossible for the incumbent to discriminate between buyers, exclusion is not guaranteed. The reason is that the monopoly profit the incumbent would earn under exclusion is not high enough to compensate a sufficiently high number of buyers (necessary to achieve exclusion) for their forgone consumer surplus that would result from entry of the more efficient entrant. The buyers’ subgame is a symmetric coordination game with multiple equilibria and exclusion occurs if a sufficiently high number of buyers fail to coordinate on the (more efficient) rejection equilibrium. If, however, the incumbent is able to discriminate among buyers, exclusion arises with certainty. Indeed, in this case, compensating a subset of the buyers for the forgone consumer surplus that would result from buying from the more efficient entrant is possible and sufficient to obtain exclusion. If, in addition, the contract terms are private information or buyers are approached sequentially, RRW-SW show that

¹Early cases include *Standard Fashion Company v. Margrane-Houston Company* [258 U.S. 346 (1922)] and *United States v. Aluminum Co. of America* [148 F.2d 416 (1945)]. More recent cases include *Microsoft* [253 F.3d 34 (2001)], *U.S. v. Dentsply* [399 F.3d (2001)], and *Conwood v. United State Tobacco* [290 f.3d 758 (2002)].

²The term “naked” refers to the sole purpose of an exclusive deal to audaciously exclude a rival without offering any efficiency justification.

exclusion is achieved at negligible costs. The idea is that with private information, a buyer accepts “lousy” contract terms, because he believes that being offered a “lousy” contract implies that sufficiently many other buyers will accept for sure. In the case of sequential contracting, a buyer anticipates that, if he rejects a “lousy” contract, the incumbent can surely convince enough subsequent buyers to accept by making them offers they cannot refuse.

In this paper, we report the results of a systematic laboratory inquiry into the use of exclusive contracts in the RRW-SW framework. We are particularly interested in whether allowing for discrimination increases exclusion rates and decreases exclusion costs for the incumbent in the case of (private) simultaneous or sequential contracting compared to the case where discrimination is not possible. Therefore, in a first part of the experiment, incumbents cannot discriminate between buyers, while in a second part, they can.

There are only a few empirical studies analyzing the effect of exclusive contracts; most of them deal with analyzing their effect on prices and welfare in the beer industry. The results are mixed. For instance, whereas Slade (2000) finds a negative effect of exclusive contracts on consumer welfare, Sass (2005), Asker (2004), and Asker (2005) report a positive effect. The paucity of empirical studies on the effect of exclusive contracts—a fact lamented by, e.g., Whinston (2006) and Lafontaine and Slade (2008)—is perhaps not surprising as many of the details that contracts may entail and that determine market outcomes may simply not be available to the outside observer. More importantly, in the light of our results it is conceivable that relevant data on exclusive contracts will continue to be rare, because the most effective contracts enabling exclusion are those that are made secretly (and sequentially). This is a first reason why we think that data from the lab are welcome.

Evidence from the lab can contribute to the literature on exclusive dealing for other reasons as well. First, it provides guidance for equilibrium selection in cases where there is a multiplicity of equilibria. For example, in the case of non-discriminatory contract terms, both exclusionary and non-exclusionary outcomes can arise, and there are no clear predictions about how costly exclusion will be for the incumbent.³ Second, as outlined above, when the size of the payments from the incumbent to buyers is private information or buyers can be approached sequentially by the incumbent, theory makes the stark prediction that exclusion can be achieved (almost) for free. This point hinges on the assumption that in these cases, some buyers will accept any payment, also very small ones, in exchange for exclusivity. However, in the light of the empirical literature on bargaining games, in particular the ultimatum game (see Güth, 1995; Roth, 1995, for overviews), it is questionable whether this prediction has sufficient behavioral relevance.

³Also in the case of simultaneous discriminatory contracts, there is a continuum of exclusionary equilibria which imply different exclusion costs for the incumbent.

Our results confirm that anti-competitive exclusion is potentially a serious problem as it occurs in more than two thirds of all cases. We also find that allowing the incumbent to discriminate between buyers does not necessarily increase exclusion rates compared to the non-discriminatory case, given that full exclusion is not obtained in the latter case. It only does so when payments can be offered sequentially *and* secretly. Moreover, allowing the incumbent to discriminate between buyers neither leads to a decrease in costs of exclusion when contract terms are private information or in the case of sequential contracting. At first sight, these results are not in line with the theoretical predictions. The driving force behind the results is that buyers become more likely to accept an exclusive contract as the payment proposed by the incumbent increases. Since such behavior is intuitive, plausible, and a robust phenomenon in our data, we propose to modify the naked exclusion model by modeling buyers' acceptance probability with a logit response function. We show that such modification improves the correspondence between theory and behavior and generates comparative-statics predictions that are largely in line with observed behavior.

Other experimental studies of naked exclusion are Smith (2007) and Spier and Landeo (2009). Smith (2007) focuses on the case where an incumbent cannot discriminate between buyers and finds that the likelihood of exclusion increases as the incumbent needs fewer buyers to sign exclusive contracts for entry to be deterred. Spier and Landeo (2009) examine the effects of contract endogeneity and communication between buyers in non-discriminatory and discriminatory simultaneous-move games. One of their main findings is that communication increases the likelihood of exclusion when discrimination between buyers is possible, while it decreases the likelihood of exclusion (and thus increases coordination on the more efficient rejection equilibrium) when it is not possible. Our paper differs from these two studies in two main respects. First, in neither of the earlier experiments can an incumbent approach buyers sequentially, whereas, as we report above, this is the case where exclusion occurs most often. Second, and perhaps most importantly, we propose and discuss a “behavioral” version of the naked exclusion model of RRW-SW in order to bring theoretical predictions and observed outcomes closer together.⁴

Other models study exclusive dealing in a related context. Aghion and Bolton (1987), for example, show that a contract written by an incumbent firm and a customer that include exclusionary and damage penalty provisions may lead to inefficient foreclosure. The contract allows the incumbent firm and customer to extract surplus from the entrant. Bernheim and Whinston (1998) model exclusive dealing in a multi-market case. They show that exclusive contracts accepted in one market may deter entry

⁴Additionally, we allow for a fine grid of possible payments from the incumbent to a buyer in exchange for exclusivity. This is not the case in both of the earlier experimental studies. In Spier and Landeo (2009) incumbents can only offer 4 different payments, and 7 in Smith (2007).

and reduce welfare because of the fall in competition in another market. Fumagalli and Motta (2006) take into account that buyers might not be final consumers but firms that compete in a downstream consumer market. They find that downstream competition might limit the effectiveness of exclusive contracts as an anti-competitive device. An opposite result is found by Simpson and Wickelgren (2007) in a model where customers are able to breach a contract and pay expectation damages.

The remainder of the paper is organized as follows. In Section 2, we introduce the naked exclusion model. Section 3 contains the experimental design and procedures, and the hypotheses. In Section 4, we report the results. In Section 5, we discuss a behavioral approach to naked exclusion. Section 6 concludes.

2. Theory

The RRW-SW model features an incumbent seller, a more efficient entrant, and, in our implementation, two buyers who are final consumers. Due to, for instance, fixed entry costs, the entrant needs to sell to both buyers to make entry profitable. Therefore, if the incumbent can induce at least one of the two buyers to sign an exclusive contract, entry is deterred.⁵

In our parametric example, the incumbent has unit production costs of $c_I = 20$ and the entrant has unit production costs of $c_E = 0$. The two buyers have independent demand functions given by $D(p) = 50 - p$. The model has three stages. In a first stage the incumbent offers to pay $x_1, x_2 \in \{0, 1, 2, \dots\}$ to buyer 1 and 2, respectively, and the buyers either accept or reject the proposed amount. By accepting, a buyer signs a contract with the incumbent in which he promises to buy exclusively from the incumbent. In a second stage the decisions of the two buyers become publicly known and the entrant decides about entry. In a third stage, all active firms set prices and payoffs ensue.

Solving the game backwards, consider first the case where entry occurs (i.e., both buyers reject the incumbent's offer). In this case, the entrant will set a price of $p_E = c_I = 20$ (or slightly below) and thus will sell to both "free" buyers. This leaves the incumbent with zero profit and generates a consumer surplus of $CS^E = 450$ for each buyer. If entry does not occur, the incumbent has monopoly power over both buyers and monopoly pricing leads to a (gross) total profit of $\pi^m = 450$ for the incumbent and a consumer surplus of $CS^I = 112.5$ for each buyer. The net profit of the incumbent is then either $450 - x_i$ if only buyer i accepts ($i = 1, 2$), or $450 - x_1 - x_2$ if both buyers accept, and buyers earn 115

⁵RRW-SW analyze the general case with $N \geq 2$ buyers, where the entrant enters the market if and only if the number of buyers that sign exclusive contracts is smaller than N^* with $1 \leq N^* \leq N$.

decision of buyer 2

		Accept	Reject
		decision of buyer 1	Accept
	Reject	165, 165 + x_2	500, 500

Table 1: Payoff of buyers

(112.5)⁶ plus the amount of the accepted payment.

In order to avoid zero earnings for the incumbent in the case entry occurs, and thus potential frustration on the part of subjects acting in the role of an incumbent in the experiment, we add 50 to the *final* payoffs of *all* active players.⁷ Under this parameterization, the incumbent earns 50 in the case of entry and 500 minus the sum of the accepted payments in the case of exclusion. The payoff matrix of the buyers is as shown in Table 1. To illustrate, if at least one buyer accepts payment x offered by the incumbent, entry is deterred and the accepting buyer(s) earn 165 (= 115 + 50) + x . A buyer who rejects, earns 165 in the case of entry deterrence. If both buyers reject such that the more efficient entrant would enter the market, the buyers earn 500 = CS^E + 50 each. The extra consumer surplus of entry for a single buyer is thus equal to 335 = CS^E - CS^I .

If the incumbent cannot discriminate between buyers, such that $x_1 = x_2 = x$, both exclusionary and non-exclusionary equilibria exist. To ensure exclusion the incumbent would have to offer at least $x = 335$ such that both buyers are sure to accept (see Table 1). However, such an offer would lead to negative profits for the incumbent as $500 - 2 \times 335 < 0$. For offers of $x \leq 335$, the buyers play a symmetric coordination game. Hence, there are two classes of subgame-perfect equilibria: exclusion equilibria where $x \in [0, 225]$ and both buyers accept⁸ and no-exclusion equilibria where $x \in [0, 335]$ and both buyers reject. Successful exclusion is thus obtained if buyers fail to coordinate on rejecting the incumbent's payment.⁹ We refer to this game in which the incumbent makes offers simultaneously and cannot discriminate between buyers as SIMNON.¹⁰

⁶We round the consumer surplus of 112.5 up to $CS^I = 115$ in order to avoid "crooked" payoffs in the experiment.

⁷In our experiment, the entrant is simulated. See Section 3 for more details on the design.

⁸The upper bound on offers in this class of equilibria is due to the fact that for offers $x > 250$ incumbents would make losses.

⁹In the buyers' subgame, risk dominance predicts that both buyers reject if $x < 167.5$ and both buyers accept if $x > 167.5$. Buyers are indifferent for $x = 167.5$ (Harsanyi and Selten, 1988). Note also that only non-exclusionary equilibria are perfectly coalition-proof (see Segal and Whinston, 2000b).

¹⁰Note that we focus on pure strategy equilibria. However, there also exist mixed strategy equilibria in the buyers' subgame. These have the property that the probability of acceptance *decreases* with the offer in order to keep the other buyer indifferent between accepting and rejecting. As this property is clearly rejected by the data we do not consider

A different strategic game arises when the incumbent can *discriminate* between buyers by simultaneously offering them different payments in exchange for exclusivity. In this case, given that an incumbent needs to convince only one buyer to sign an exclusionary contract and his total monopoly profit is sufficiently high to do this ($500 > 335$), the entrant can be excluded with certainty (see case A of Proposition 3 in Segal and Whinston, 2000*b*) and only exclusionary equilibria exist. The costs of exclusion depend on whether the amounts offered by the incumbent are observable for both buyers. In the case of perfect observability (we call this game SIMDIS-P where the “P” stands for public), exclusion costs lie anywhere between zero and 336. Indeed, in one subgame-perfect Nash equilibrium the incumbent offers a payment of 335 or 336 to one buyer, who accepts, and zero to the other buyer, who rejects. In other subgame-perfect Nash equilibria offers to both buyers are positive and sum up to an amount smaller than or equal to 336 and both buyers accept.¹¹ In the case of secret contracts, where a buyer cannot observe the amount offered to the other buyer (we call this game SIMDIS-S where the “S” stands for secret), the incumbent obtains exclusion for free. In fact, under passive beliefs, the unique (perfect Bayesian) Nash equilibrium predicts the incumbent to offer $(x_1, x_2) = (0, 0)$ and both buyers accept.¹²

Finally, RRW-SW consider the case where the incumbent can write contracts with the buyers *sequentially*. More specifically, here the incumbent first makes an offer to one buyer (buyer 1), who decides whether to accept or reject, and then to the other buyer (buyer 2) who—after being informed about buyer 1’s decision—also decides whether to accept or reject. We refer to this game as SEQ-P, where the “P” indicates that the offer made to buyer 1 becomes (publicly) known to buyer 2. In this game exclusion again arises for sure and almost for free. Indeed, in the subgame-perfect Nash equilibrium the incumbent offers zero or one to buyer 1 who accepts and zero to buyer 2 who rejects or accepts. The reason that buyer 1 accepts a payment of zero or one is that he knows that if he

equilibria in mixed strategies.

¹¹In the buyers’ subgame, risk dominance predicts that both buyers accept if $x_1 x_2 > (335 - x_1)(x_2 - 335)$, or equivalently, $x_1 + x_2 > 335$. If $x_1 + x_2 < 335$ both buyers reject and if $x_1 + x_2 = 335$ they are indifferent (Harsanyi and Selten, 1988).

¹²Under passive beliefs, a buyer receiving an out-of equilibrium offer, believes that the other buyer received the equilibrium offer (see McAfee and Schwartz, 1994). To see that the equilibrium is unique under passive beliefs, consider an offer (x_1, x_2) which is rejected by both buyers. This cannot be an equilibrium as the seller can deviate from this by offering 335 (or 336) to one buyer and get acceptance. Next, consider as candidate equilibrium the offer (x_1, x_2) with $x_2 \in [1, 335]$. If buyer 1 accepts, this cannot be an equilibrium as buyer 2 should accept as well in this case and the seller could have saved money by setting $x_2 = 0$. If buyer 1 rejects, buyer 2 should reject as well, which cannot be an equilibrium, as we just explained. Note that this reasoning holds for any $x_1 < 335$ and in particular for $x_1 = 0$. Hence offers of 0 to both buyers and both buyers accepting is the only equilibrium outcome (see Segal and Whinston, 2000*b*). Note also that wary beliefs (see McAfee and Schwartz, 1994) deliver the same result.

would reject, the incumbent would make buyer 2 an offer he cannot refuse (≥ 335). Given that buyer 1 accepts (and hence entry is deterred), buyer 2 is offered zero. In a second version of this sequential game, buyer 2 is only informed about whether or not buyer 1 accepted his offer but not about the offer itself. We refer to this game as “SEQ-S”, where the “S” indicates that the offer to buyer 1 is a secret to buyer 2. The difference in information conditions between the two sequential games with respect to buyer 2 is inconsequential for the subgame-perfect equilibrium prediction. Hence predictions in this game are the same as in “SEQ-P.”

3. Experimental procedures and hypotheses

The experiment was run in May and October 2007 in CentERlab at Tilburg University with mainly economics, business, and law students (180 in total).¹³ Sessions took about 90 minutes and participants earned €18.81 on average.

Since we are interested in the interaction between the incumbent and the buyers, there was no entrant present in our experiments. To generate payoffs for the incumbent and the buyers, we assumed subgame-perfect behavior of the entrant with respect to both his entry and pricing decision. This leads to buyers’ (truncated) payoff table as shown in Table 1, with the only difference that a payoff of 50 was added to all entries of each cell as mentioned in the theory section. All participants in a session received the same instructions, containing the payoff tables of the incumbent and the buyers.¹⁴ The experiment consisted of two parts and subjects were informed about this. Instructions for the second part were distributed after completion of the first part. Subjects were informed that monetary earnings would depend on the cumulative earnings made throughout the experiment. In the instructions, payoffs were denoted in points and, in order to cover potential losses of participants acting in the role of an incumbent, all participants were initially endowed with 1600 points. The conversion rate of points into Euro was 400:1. In order to ensure that subjects understood the instructions, they were asked to answer a series of control questions before the experiment started. After having correctly answered the control questions, subjects were randomly assigned a role, which was fixed throughout the experiment.¹⁵

The experiment has four treatments and the conditions in the treatments only differ with respect to the *second* part. Table 2 provides an overview of the experimental conditions. In the *first* part of the

¹³We used the z-Tree toolbox to program the experiment (Fischbacher, 2007).

¹⁴The instructions for SIMNON, SIMDIS-P and SEQ-P can be found in Section A.1 of the Appendix. The instructions for the other cases are very similar and available from the authors upon request.

¹⁵In the experiment we used neutral wording and did not mention the existence of a potential entrant. An incumbent was called an A-participant and buyers were called B-participants.

Treatment	First part	Second part	Sequential	Full info	# Subjects	# Markets	# Matching groups
1	SIMNON	SIMDIS-P	no	yes	45	15	5
2	SIMNON	SIMDIS-S	no	no	45	15	5
3	SIMNON	SEQ-P	yes	yes	45	15	5
4	SIMNON	SEQ-S	yes	no	45	15	5
Total					180	60	20

Table 2: Overview of treatments and number of observations

experiment subjects played game SIMNON, i.e., the non-discriminatory version of the naked exclusion game and in the *second* part they played a discriminatory game. In the *first* part, incumbents were asked to make a (symmetric) offer to the matched buyers, after which the buyers had to decide independently and simultaneously whether to accept or reject the offer. In order to allow for learning, the same game was repeated ten times.¹⁶ After each repetition, information was provided to incumbents and buyers about acceptance decisions and own payoffs, and participants were randomly rematched within matching groups of nine subjects each (three incumbents and six buyers).

In the *second* part of the experiment, subjects played one of the four discriminatory games, i.e., either SIMDIS-P, SIMDIS-S, SEQ-P, or SEQ-S. In games SIMDIS-P and SIMDIS-S, incumbents made their offers simultaneously to both buyers, while in games SEQ-P and SEQ-S, sequentially. The discriminatory games were also repeated ten times and participants were randomly rematched within the same matching groups as in the first part. At the end of each repetition, subjects were again informed about acceptance decisions and own payoffs. Participants acting in the role of a buyer in the discriminatory games alternated between being buyer 1 and buyer 2 and were informed about this. This switching was implemented in order to avoid the possibility that an incumbent always discriminated the same buyer subject.

The RRW-SW model predicts that in SIMNON, there is a multiplicity of equilibria where either both buyers reject or both buyers accept the offer made by the incumbent. The exclusion rate can thus lie anywhere between 0 and 1. Under a discriminatory regime, however, both buyers rejecting cannot be part of a subgame perfect Nash equilibrium, implying that the exclusion rate is predicted to be equal to 1. One would thus expect the exclusion rate to increase in the discriminatory games played in part 2 compared to the non-discriminatory game played in part 1 of the experiment. This is our first hypothesis.

Hypothesis 1 *The exclusion rate increases in the discriminatory games SIMDIS-P, SIMDIS-S, SEQ-*

¹⁶In treatment 1, one matching group played the game only eight times in both parts of the experiment.

P, and SEQ-S compared to the non-discriminatory game SIMNON, as long as it is strictly below 1 in the latter game.

Similarly, with respect to the costs of exclusion for incumbents, the predictions of the RRW-SW model are clear-cut for three of the four discriminatory games (SIMDIS-S, SEQ-P and SEQ-S): they are predicted to be either 0 or 1. Compared to the non-discriminatory game, where the costs can lie anywhere above 0, one would thus expect to see a decrease in part 2 compared to part 1 in these three cases. This is our second hypothesis.

Hypothesis 2 *Exclusion costs decrease in the discriminatory games SIMDIS-S, SEQ-P, and SEQ-S compared to the non-discriminatory game SIMNON, as long as they are strictly above one in the latter game.*

4. Results

In Subsection 4.1 we provide an overview of the main experimental results. In Subsection 4.2 we give a more detailed account of the incumbents' offers and the buyers' acceptance behavior in the five games and pave the way to a behavioral approach to naked exclusion.

4.1. Main results

We test the two research hypotheses by analyzing the incremental effects on outcomes when moving from SIMNON to SIMDIS-P, SIMDIS-S, SEQ-P, or SEQ-S, respectively. Table 3 gives an overview of the observed average exclusion rates and costs in part 1 (SIMNON) and the average change in exclusion rates and costs in the different parts 2 compared to the related part 1. The exclusion rate is defined as the share of cases in which the incumbent was able to exclude the entrant from the market, that is, the share of cases in which at least one buyer accepts the incumbent's offer. The costs of exclusion are equal to the sum of the accepted amounts offered by the incumbent, given exclusion. The table also indicates the direction of the change in exclusion rates and costs predicted by theory when moving from the first-part game SIMNON to any of the second-part games. For instance, the "+" in column 2 next to SIMDIS-P means that theory predicts the exclusion rate to increase in this game in comparison to game SIMNON (conditional on the exclusion rate in SIMNON being lower than 1).

Table 3 shows that in part 1 the average exclusion rate is 0.67, which is well below 1, and average exclusion costs are equal to 247, which is well above 1. This implies that there is scope for exclusion

	Exclusion Rate		Exclusion Costs	
	Predicted	Observed	Predicted	Observed
Part 1				
SIMNON	≤ 1	0.67 (0.03)	≥ 1	247 (10.5)
Part 2 - The incremental effect of allowing discrimination				
SIMDIS-P	+	-0.05 (0.05)	?	+7 (11.2)
SIMDIS-S	+	-0.07 (0.03)	-	-28 (23.2)
SEQ-P	+	-0.03 (0.07)	-	+22 (19.5)
SEQ-S	+	+0.25 (0.07)**	-	+10 (39.0)

Notes: The numbers in the table are averages of averages by independent observation. Standard errors (in brackets) refer to variability between independent observations.

Average **exclusion rates** (standard errors) in the part-1 SIMNON games preceding part-2 game SIMDIS-P, SIMDIS-S, SEQ-P, and SEQ-S are, respectively, 0.70 (0.07), 0.65 (0.05), 0.74 (0.04), and 0.59 (0.07). None of the pairwise comparisons of exclusion rates in part-1 plays of SIMNON are statistically significant (two-tailed Mann-Whitney U tests). Average **exclusion costs** (standard errors) in the part-1 SIMNON games preceding part-2 game SIMDIS-P, SIMDIS-S, SEQ-P, and SEQ-S are, respectively, 242 (7.9), 257 (16.8), 245 (12.7), and 240 (39.3). None of the pairwise comparisons of exclusion costs in part-1 plays of SIMNON are statistically significant (two-tailed Mann-Whitney U tests).

A ** indicates whether the difference between part 1 and part 2 is significant at the 5% level according to a one-tailed Wilcoxon signed-ranks test.

Table 3: The effect of allowing discrimination on exclusion rates and costs

rates to increase and exclusion costs to decrease in parts 2. What the table shows, however, is that average exclusion rates in parts 2 do not necessarily increase. Average exclusion rates even decrease in SIMDIS-P, SIMDIS-S and SEQ-P compared to the related SIMNON, although this is not significant.¹⁷ Only when SEQ-S is played in part 2, does the average exclusion rate increase significantly by 25 percentage points compared to part 1. A consequence of this is that payoffs of incumbents in SEQ-S increase and payoffs of buyers decrease significantly (at the 10% and 5% level, respectively, in one-tailed Wilcoxon signed-ranks tests). The only case in which Hypothesis 1 is not rejected is thus the case in which offers are made sequentially *and* secretly.

With respect to exclusion costs, Table 3 shows that they increase on average in SEQ-P and SEQ-S compared to SIMNON, although this is not significant. Only in SIMDIS-S does exclusion become

¹⁷ Note that the same qualitative results hold if the analyses are based on the final five rounds of each part of the experiment when subjects have gained experience. If a less conservative procedure is used to evaluate statistical significance of differences between parts 1 and 2—i.e., regressions by treatment where a dummy is included that refers to (the discriminatory) part 2—the decrease in exclusion rate in SIMDIS-S compared to the related SIMNON is significant at the 5% level, which is in line with results presented by Spier and Landeo (2009). However, this significance disappears in the final five rounds.

cheaper on average compared to SIMNON, but the decrease is statistically not significant.¹⁸ Overall, hypothesis 2 is thus rejected.

Our main finding so far is that the exclusion rate does not increase significantly in three of the four part-2 discriminatory games vis-à-vis the part-1 non-discriminatory game. One may argue that this observation might be due to our within-subject design and that with a between-subject design it would have been more likely to observe a clear increase in exclusion rates in all discriminatory games vis-à-vis the non-discriminatory game.¹⁹ However, there is evidence that cautions against such a conclusion. First, in a pilot session where game SIMDIS-P was run without a preceding game SIMNON, the average exclusion rate was 0.71 which is of the same order of magnitude as the one we report above (0.66). Second, in contrast to our within-subject design, Spier and Landeo (2009) use a between-subject design. They find that the exclusion rate in their discriminatory treatment does not increase in comparison to their non-discriminatory game treatment.²⁰ Moreover, the result that in the part-2 game SEQ-S we do observe a significant increase in the exclusion rate compared to the part-1 game SIMNON, demonstrates that our design does allow for a differential effect of the part-2 games. Finally, although outcomes look similar in the part-2 games (except for SEQ-S), subjects do behave differently in the different part-2 games, as will become clear in subsection 4.2.

4.2. A closer look at behavior in the five games

In this subsection we take a closer look at the behavior in the individual games and highlight the most salient features of the data.

a. Simultaneous non-discriminatory game

Table 4 shows the distribution of offers made by incumbents, acceptance rates of buyers and incumbents' profits in SIMNON. The table shows that, first, about 86% of incumbents' offers are between 95 and 214 with a peak in the range 135-174. Second, the average profit of incumbents has an inverted-U shape with a maximum in the range 135-174. Third, the acceptance rate of buyers increases monotonically with the amount of the payment and is slightly above 50% in the range of offers 135-174.

Incumbents thus seem to be successful in offering those amounts that maximize their profits. A potential rationale is that incumbents choose offers in such a way that the probability that *exactly*

¹⁸Using less conservative regression results makes this decrease significant at the 5% level as long as all observations are taken into account and not just the final five rounds.

¹⁹In a within-subject design, the same subjects are observed in different experimental treatments, whereas in a between-subject design different subjects are observed in different experimental treatments.

²⁰See Result 1 in Spier and Landeo (2009) and note that our game SIMNON corresponds to their game "EN/ND/NC" while our game SIMDIS-P corresponds to their game "EN/D/NC".

	Offer made by incumbent							
	0-14	15-54	55-94	95-134	135-174	175-214	215-254	≥ 255
% of Cases	2.4	1.9	3.0	23.9	34.3	27.9	5.6	1.0
Acceptance rate (in %)	7.1	13.6	13.9	33.1	52.0	58.7	71.2	100
Mean profit incumbents	113	159	152	213	228	166	96	-350

Note: The table is based on 594 observations: 57 markets are repeated 10 times and 3 markets are repeated 8 times.

Table 4: Distribution of offers and acceptance rates and mean incumbents' profits as a function of offers in the non-discriminatory game

one buyer accepts is maximized. This probability is maximized at the point where buyers switch between rejecting and accepting, that is, where the acceptance rate switches from being below 50% to being above 50%, which happens in the range [135-174] (see also Smith, 2007).²¹ Therefore, it looks as if incumbents choose payments so as to maximize profits taking into account buyers' acceptance behavior.

Finally, that the acceptance rate of buyers increases with the amount of the payment is consistent with experimental evidence from coordination games (e.g., stag hunt). Indeed, players in such games take *ceteris paribus* less risk to coordinate on the efficient equilibrium when the "risky" payoff is lower or the payoff corresponding to the safe alternative is higher (see, e.g., Battalio, Samuelson and Huyck, 2001; Schmidt et al., 2003). Translated to the naked exclusion context, buyers take less risk to reject an offer made by the incumbent if the offer, and thus the payoff from accepting, is higher.

b. Simultaneous discriminatory games

Behavior in the simultaneous discriminatory games is summarized in Table 5, in which we show combinations of minimum offers (rows) and maximum offers (columns). A bold number in the table indicates the relative frequency with which a specific combination of offers was chosen by sellers, while the number below (in normal font) indicates the corresponding exclusion rate at this combination of offers. Consider first treatment SIMDIS-P (the upper part of Table 5) where offers are publicly known. Two observations stand out. First, in 16.7% of the cases the minimum offer is in the interval [0-14] while the maximum offer is in the interval [335-350]. This is the outcome emphasized by various authors (see, e.g., Motta, 2004; Whinston, 2006). Here, one buyer is offered an amount that is a bit larger than 335 (which makes accepting the offer a dominant strategy) and the other buyer is offered zero or very little. As predicted by the theory, an incumbent who makes such offers is successful in deterring

²¹Data from post-experimental questionnaires also point in this direction.

SIMDIS-P												
Min Offer	Max Offer											Row Total
	0–14	15–54	55–94	95–134	135–174	175–214	215–254	255–294	295–334	335–350	>350	
0–14	—	—	—	1.4	0.7	3.5	3.5	—	5.6	16.7	—	31.3
15–54	—	1.4	—	—	0.7	2.1	—	—	—	—	—	4.2
55–94	—	0	0.7	—	—	4.2	—	—	—	—	—	4.9
95–134	—	—	—	13.9	6.9	2.1	6.9	—	1.4	—	—	31.3
135–174	—	—	—	80.0	90.0	100	80.0	—	50.0	—	—	16.0
175–214	—	—	—	—	15.3	—	0.7	—	—	—	—	11.8
215–254	—	—	—	—	68.2	—	100	—	—	—	—	0.7
Col. Total	0.0	1.4	0.7	15.3	23.6	22.2	13.2	0.0	6.9	16.7	—	100.0

SIMDIS-S												
Min Offer	Max Offer											Row Total
	0–14	15–54	55–94	95–134	135–174	175–214	215–254	255–294	295–334	335–350	>350	
0–14	0.7	—	0.7	8.0	4.7	12.0	13.3	—	6.0	5.3	2.7	53.3
15–54	0	1.3	—	4.0	6.7	1.3	4.0	—	1.3	—	1.3	20.0
55–94	—	0	1.3	0.7	0.7	—	0.7	0.7	—	—	—	4.0
95–134	—	—	50.0	100	100	—	100	100	—	—	—	15.3
135–174	—	—	—	6.7	2.7	1.3	—	0.7	3.3	—	0.7	3.3
175–214	—	—	—	60.0	50.0	0	—	0	80.0	—	100	4.0
215–254	—	—	—	—	1.3	1.3	0.7	—	—	—	—	0.0
Col. Total	0.7	1.3	2.0	19.3	16.0	20.0	18.7	1.3	10.7	5.3	4.7	100.0

Note: Each cell contains the percentage of cases (in bold) and the corresponding exclusion rate. Data for SIMDIS-P are based on 144 observations in total (12 markets are repeated 10 times and 3 markets are repeated 8 times) and for SIMDIS-S on 150 observations in total (15 markets repeated 10 times).

Table 5: Distribution of offers and exclusion rates as a function of offers in simultaneous discriminatory games

entry: the observed exclusion rate is 0.88.²² Second, we see more than 40% of the cases located on the diagonal, where offers to buyers are (roughly) symmetric and where the buyers' subgame is, in fact, a coordination game. Most of these (roughly) symmetric offer combinations (29% of all cases) fall into ranges [95-134] or [135-174] and could, as long as their sum is smaller than 336, be part of a subgame-perfect Nash equilibrium. However, since the corresponding exclusion rates are well below 1, most of these cases are *not* part of a subgame perfect Nash equilibrium and average exclusion rates are, in fact, smaller than the one corresponding to offer combinations of [0-14] and [335-350]. Yet, it turns out that, on average, the incumbents' profits corresponding to these symmetric offers are higher than profits earned in the asymmetric case. Indeed, incumbents who offer extremely unequal combinations of minimum and maximum offers in the range [0-14] and [335-350], respectively, earn on average 159 while incumbents who offer (roughly) symmetric combinations that fall into the range [95-134] or [135-174] earn on average 268 or 205, respectively. Since by making roughly symmetric offers an incumbent earns not less than by making extremely unequal offers, there is thus no reason to expect incumbents' play to converge to the latter type of offers.²³

Consider next the lower part of Table 5 which shows the results in game SIMDIS-S where a buyer is not informed about the amount offered to the other buyer in the market. The distribution of offers is clearly different from the one in SIMDIS-P. First, the importance of discriminatory offer combinations [0-14] and [335-350] is reduced. Second, (roughly) symmetric offer combinations are much less common than in SIMDIS-P. The reason is that in SIMDIS-S there is a change in the distribution of minimum offers compared to SIMDIS-P while the distribution of maximum offers remains largely unchanged (except for a decrease of maximum offers in range [335-350]). That is, in SIMDIS-S the distribution of minimum offers (measured by the row totals in Table 5) has much more mass on lower offers. In fact, while offers that fall into the two lowest categories of minimum offers account for only 35.5% of the cases in treatment SIMDIS-P, they account for 73.3% of all cases in treatment SIMDIS-S.²⁴ However,

²²Spier and Landeo (2009) observe these "divide-and-conquer" offers more frequently than we do, which is, arguably, not surprising given that the action space for the incumbent is restricted to four possible payments.

²³Again, one might object that the low incidence of extremely unequal offers (offer combinations of [0-14] and [335-350]) we observe in game SIMDIS-P is an artefact of our design that has subjects first play the game in which incumbents can only make non-discriminatory offers which are symmetric by definition. However, in a pilot session in which subjects only participated in game SIMDIS-P, those extremely unequal offers occurred in only about 10.5% of the cases which is about 6 percentage points less than the corresponding share we report above.

²⁴A linear regression where the minimum offer made is regressed on a SIMDIS-S dummy indicates that the difference in offers is significant ($p < 0.001$). Another linear regression indicates that the difference in maximum offer is also significant (and lower in SIMDIS-S), but this significance disappears when one only considers the final five rounds, when subjects have experience. The regressions mentioned include random effects taking into account the nested panel structure and standard errors taking into account possible dependency within independent observations.

while behavior in SIMDIS-S is different from SIMDIS-P, and costs of exclusion are on average lower, it does not come close to what theory predicts, i.e., that exclusion should be reached with offers of zero. This is because, also here, the probability that buyers accept an offer increases with the size of one's own offer and very low offers (in the range [0-14]) are never accepted. Incumbents seem to realize this and take it into account when deciding which amounts to offer.

Finally, although this is not immediately clear from Table 5, we should mention that also in SIMDIS-P, there is a positive relation between the offered payment and the acceptance rate of buyers (more on this in Section 5.2).

c. Sequential games

Recall that we have two versions of the sequential game. While in SEQ-P the second buyer is informed about both the offer made to buyer 1 and the latter's acceptance decision, in SEQ-S buyer 2 only knows whether or not buyer 1 has accepted his offer. Table 6 gives percentages of cases and acceptance rates as a function of offers in the sequential games. The data are provided separately for buyers 1 and 2; and for buyers 2 depending on whether the corresponding buyer 1 has accepted or rejected his own offer. We will show, among other things, that acceptance decisions of buyers depend on the size of the offers, also in SEQ-P and SEQ-S.

Consider first offers made by the incumbent to buyer 1 and the acceptance behavior of the latter. Table 6 shows that the mode of offers to buyer 1 is in the range [175-214], which is far above the theoretical prediction of zero or one. A possible reason that incumbents offer such "large" amounts is that buyers 1 (almost) never accept low offers in the range [0-14]. In fact, in SEQ-P the acceptance rate in range [0-14] is 0 and in SEQ-S it is 9%. However, we observe that acceptance rates of buyers 1 are positively related to the size of the offer, for both SEQ-P and SEQ-S, and that incumbents seem to take this into account.

Note the equivalence here between behavior of buyers 1 in the naked exclusion game and responders in ultimatum game experiments. Indeed, from ultimatum game experiments we know that there is a positive relation between proposers' offers and responders' acceptance rates. Offers considered too low are rejected frequently, which results in dramatic payoff consequences for both players (see Güth, 1995; Roth, 1995, for overviews). Anticipating this, most proposers offer substantial amounts to the responder. In both sequential naked exclusion games an incumbent knows that once his offer to buyer 1 is rejected, he needs to make an offer of 335 or 336 to buyer 2 to achieve exclusion and this would make him earn "only" 164 or 165. Hence, anticipating rejections of small payments by buyer 1 that result in "low" profits, the incumbent might offer relatively high amounts to buyer 1.

SEQ-P											
Offer range	0-14	15-54	55-94	95-134	135-174	175-214	215-254	255-294	295-334	335-350	> 350
To buyer 1											
% of Cases	5.3	2.7	—	14.0	14.0	31.3	16.7	2.0	4.7	8.7	0.7
Acc. rate	0	0	—	19.0	47.6	59.6	76.0	66.6	71.4	100	100
To buyer 2 after buyer 1 accepted											
% of Cases	91.5	2.4	1.2	3.7	1.2	—	—	—	—	—	—
Acc. rate	68.0	100	100	100	100	—	—	—	—	—	—
To buyer 2 after buyer 1 rejected											
% of Cases	4.4	2.9	—	2.9	1.5	10.3	4.4	—	—	52.9	20.6
Acc. rate	0	0	—	0	0	0	0	—	—	38.9	78.6
SEQ-S											
Offer range	0-14	15-54	55-94	95-134	135-174	175-214	215-254	255-294	295-334	335-350	> 350
To buyer 1											
% of Cases	7.3	5.3	2.0	13.3	14.7	26.0	16.0	2.7	6.0	3.3	3.3
Acc. rate	9.1	12.0	33.3	35.0	63.6	69.2	87.5	100	100	100	100
To buyer 2 after buyer 1 accepted											
% of Cases	87.4	8.4	—	3.2	1.1	—	—	—	—	—	—
Acc. rate	65.0	100	—	100	100	—	—	—	—	—	—
To buyer 2 after buyer 1 rejected											
% of Cases	12.7	—	—	3.6	5.5	10.9	7.3	—	1.8	45.5	12.7
Acc. rate	0	—	—	0	0	16.7	75.0	—	0	80.0	100

Note: Data for SEQ-P and SEQ-S are based on 150 observations each (15 markets repeated 10 times).

Table 6: Distribution of offers and acceptance rates as a function of offers in sequential games

What is different between SEQ-P and SEQ-S, is that in the same range of offers acceptance rates of buyers 1 are always larger in SEQ-S than those in SEQ-P. That is, offers of the same size are more easily accepted in SEQ-S than in SEQ-P. It seems that this is not fully anticipated by incumbents: although the distribution of offers to buyer 1 in SEQ-S lies somewhat more to the left compared to SEQ-P, offers in SEQ-S are not significantly lower.²⁵

Regarding offers made to buyer 2 and acceptance behavior of the latter, the picture looks as follows. On the one hand, in cases where buyer 1 accepts his offer, around 90% of the time incumbents offer very low amounts to buyer 2 in SEQ-P and SEQ-S. This is, allowing for some noise, what one would expect from a rational, payoff-maximizing incumbent who knows that once buyer 1 accepts, exclusion is achieved and it is not necessary to make a payment to buyer 2. On the other hand, in cases where buyer 1 rejects, incumbents mostly offer very high amounts to buyers 2: around 50% of the time the offer is in the range [335-350] in both games, and in about 13% (21%) of the time in game SEQ-S (SEQ-P) the offer is even above 350. In SEQ-P, where offers to buyer 2 in the range [335-350] are accepted less than 40% of the time, it turns out that offering an amount above 350 might even be necessary to convince buyers 2 to accept. As is the case with buyer 1, buyer 2 is more likely to accept offers of the same size in SEQ-S than in SEQ-P.²⁶

The observed difference in buyers' acceptance behavior between SEQ-P and SEQ-S is potentially related to differences in buyer 1's abilities to signal his intention. In SEQ-P, by rejecting a relatively high offer, buyer 1 arguably sends a strong signal to buyer 2 saying that he takes a relatively high risk in order to indicate his intention to reach the high-payoff rejection equilibrium. In SEQ-S, buyer 1 cannot send this kind of signal since buyer 2 does not receive information about the size of the (rejected) amount. Therefore, for a given amount offered, buyers 2 accept more often in SEQ-S than in SEQ-P. Anticipating this inability to (forcefully) signal intentions, buyers 1 also accept more often in SEQ-S than in SEQ-P.

²⁵A logit regression where the acceptance decision of buyer 1 is regressed on the offer made to buyer 1 and a SEQ-S dummy indicates that the difference between SEQ-P and SEQ-S is indeed statistically significant ($p = 0.022$). A linear regression where the offer made to buyer 1 is regressed on a SEQ-S dummy only indicates that the difference in offers is not significant ($p = 0.510$). In the last five rounds, the p -value is much lower ($p = 0.106$), though, which could suggest that there is some learning on the part of incumbents. The regressions mentioned include random effects taking into account the nested panel structure. Standard errors are corrected for possible dependency within independent observations.

²⁶The difference in buyer 2's behavior between SEQ-P and SEQ-S is again statistically significant ($p = 0.038$), while the difference in incumbents' offers to buyer 2 after a rejection of buyer 1 is not ($p = 0.210$).

5. Towards a behavioral approach to naked exclusion

In the preceding section, it became clear that, in all games, the buyers' acceptance probability is positively related to the incumbents' proposed payments. Therefore, a natural way to summarize buyer behavior is to estimate the acceptance probability as a function of the proposed payments, for example by means of a logistic response function (see, e.g., Slonim and Roth, 1998, in the context of an ultimatum game). This is what we do in Subsection 5.1. The regression results confirm that, in all games, the buyers' acceptance probability depends positively and significantly on the incumbents' proposed payments.²⁷

In the light of this result, we think that any adjustment to the naked exclusion model should start with a modeling alternative that predicts the positive relationship between incumbents' offers and buyers' acceptance probability. In other words, instead of assuming subgame perfect Nash equilibrium play in the buyers' subgame, a solution concept should be employed that predicts that buyers are more likely to accept the higher is the own (and other) offer.

One solution concept that delivers this result is the quantal-response equilibrium (QRE) (see McKelvey and Palfrey, 1995; Goeree, Holt and Palfrey, 2005). The basic idea of the QRE is that players (in our case, buyers) make mistakes, but that less costly mistakes are more likely than more costly ones (in our case, buyers are more likely to accept a high offer than a low offer). As we show in Appendix A.2, QRE gives rise to a probability of acceptance that can be approximated by a logit function.

Another alternative delivering the desirable relationship between incumbents' offers and buyers' acceptance probability is risk dominance combined with players having heterogeneous risk preferences. Recall, for example, that in the buyers' subgame in SIMNON, risk dominance predicts that (both) buyers reject when the offer is low ($x < 167.5$), (both) accept when it is high ($x > 167.5$) and are indifferent when $x = 167.5$. If risk preferences are heterogeneous such that different players switch at different thresholds, one could argue that the buyer behavior observed in SIMNON is in line with risk dominance.²⁸ This is illustrated in Figure 3 in Appendix A.4 that plots the acceptance probability predicted by risk dominance and, additionally, an estimated logit function of the general form $P(\text{Accept}) = F(\alpha + \beta \text{Offer} + \epsilon)$ (see also Subsection 5.1). For buyer behavior in game SIMDIS-P, a similar argument can be made. Here, an estimated logit function that regresses a buyer's acceptance

²⁷An exception is the estimated coefficient of buyers 2 in SEQ-S, given that buyer 1 has accepted. This estimate is statistically not significant.

²⁸Heinemann, Nagel and Ockenfels (2009) show that in symmetric stag hunt games, a majority of subjects uses threshold strategies. They suggest different models, some inspired by global games, to organize this behavior.

probability on both offers can be argued to be in line with risk dominance, as defined in footnote 11, combined with heterogeneity of risk preferences.²⁹

In this paper we refrain from trying to identify which of these alternative modeling approaches best captures the behavior we observe in the buyers' subgames. Rather, we confine ourselves to suggesting these alternatives and illustrating that they give rise to probability-of-acceptance functions that can be approximated by logit functions. For our analysis below (predicting incumbents' offers to buyers), we simply work with such estimated logit functions as they most accurately summarize the behavior of buyers observed in the various games.

In Subsection 5.2, we perform the following exercise. We recompute incumbents' optimal offers and resulting market outcomes using the estimated response functions of buyers obtained in Subsection 5.1. That is, instead of assuming subgame-perfect behavior (as RRW-SW do), we use buyers' observed behavior in the subgames as an input into the incumbents' maximization problem. We show that this "behavioral" approach to the naked exclusion model organizes observed incumbent behavior and game outcomes quite well. In particular, once buyer behavior is modeled more realistically, our exercise shows that the behavioral RRW-SW model does not necessarily predict that exclusion rates should increase in discriminatory games compared to the non-discriminatory one, nor that exclusion costs should fall dramatically in SIMDIS-S, SEQ-P and SEQ-S. Before presenting the details, a number of remarks are in order.

First, as we use observed buyer behavior to predict incumbents' average offers in all games, it is perhaps not too surprising that we see a much improved fit between (new) predictions and observed behavior of incumbents. Nevertheless, the exercise shows that once actually observed buyer behavior is taken into account, observed incumbents' behavior (which often deviates substantially from the RRW-SW predictions) can be rationalized.

Second, for some cases RRW-SW predict corner solutions (exclusion rates of 1 and exclusion costs of 0 or 1), while our experimental results show that average behavior is less "extreme". Any alternative prediction, that does not coincide with RRW-SW, will therefore necessarily improve the fit between our observed data and the alternative prediction (including random behavior on the part of subjects). However, our modification of the RRW-SW model captures a clear and systematic (and intuitive) pattern in the observed buyer data and is therefore a meaningful adjustment to the original RRW-SW framework.

Third, as suggested above, we only add (e.g., QRE) perturbations or noise to the buyers' profits or

²⁹Yet another approach that gives rise to a positive relation between proposed payments and acceptance probability, is one where buyers who fail to coordinate on rejecting, suffer from an emotional cost. See Section A.3 in the Appendix for a more detailed discussion of psychological costs from miscoordination in the context of the naked exclusion model.

actions, and not to those of the incumbent. The reason is that adding perturbations to an incumbent’s profits would not add much to the analysis except for “explaining” why the incumbent makes out-of-equilibrium offers. The point is that buyers see the incumbent’s offer before they decide and hence adding “incumbent noise” does not create a strategic effect. This is different when it comes to perturbing buyers’ payoffs.

Fourth, the result that our behavioral RRW-SW model predicts that exclusion rates do not necessarily increase and exclusion costs do not necessarily decrease in discriminatory games compared to the non-discriminatory one, is not an artefact of the specific parameters estimated for the buyers’ (logit) response function. This is illustrated in Appendix A.5 where we show for SEQ-P that the qualitative predictions are robust to changes in the estimated parameters of the response function of buyers.

In all, we view this section as a step towards an intuitive but simple behavioral approach to naked exclusion. It consists of substituting standard subgame-perfect behavior of buyers by a response function predicted by e.g. QRE or “risk dominance + noise” and keeping all other features of the RRW-SW framework intact; in particular the assumption that incumbents in the first stage maximize their profits anticipating buyers’ behavior in the subgames. As we will demonstrate below, this minimal change substantially increases the correspondence between theory and aggregate observed behavior.

5.1. Buyers’ acceptance behavior

We estimate the buyers’ acceptance probability as a logit function of the offered amounts. In the cases where the amounts offered to both buyers are the same or where a buyer has no information about the offer made to the other buyer in the market, only a buyer’s own offer is included in the regression (in SIMNON, SIMDIS-S, SEQ-S and for buyer 1 in SEQ-P). In other cases, the offer made to the other buyer in the market is included as well (in SIMDIS-P and for buyer 2 in SEQ-P).

Table 7 presents the estimation results for the five games and confirms that, overall, the relation between the size of a buyer’s own offer and his acceptance probability is positive and significant. As mentioned, only in SEQ-S this is not the case for the second-moving buyer who knows that the first-moving buyer has accepted.

For SIMDIS-P, it turns out that whether buyers accept or reject does not only depend significantly on the size of their own offer, but also—albeit less strongly—on the size of the offer made to the other buyer in the market. If a buyer assumes that the higher the offer the other buyer receives, the more likely it is that the other buyer will accept his contract such that coordination on both buyers rejecting becomes less likely, the more likely a buyer will accept as well and not take the risk to reject. In SEQ-P, on the other hand, the acceptance decision of buyer 2 is not significantly related to the offer made to buyer 1. Note, however, that the negative sign of this relation, given that buyer 1 rejects, is in line

with the signaling-of-intentions story advanced above.

5.2. Incumbents' behavior and new predictions

In this subsection, we predict incumbents' average offers (and implied average market outcomes) using buyers' observed response functions as estimated in Table 7. More precisely, when deciding which amounts to offer to buyers, we assume that an incumbent maximizes his expected profit taking into account that the probability that buyers accept offers is positively related to the size of the amount in the way described in Table 7. Tables 8 and 9 compare the predictions of RRW-SW and the observed outcomes with the predictions of the modified version of the RRW-SW model.

a. Simultaneous non-discriminatory game

In SIMNON we assume that the probability that a buyer accepts an offer of size x is described by the logistic function $F(x) = \frac{1}{1+e^{-(\alpha+\beta x)}}$, with the estimates for α and β , i.e., $\hat{\alpha}$ and $\hat{\beta}$ given in Table 7. Given that a buyer's response function is described by $F(x)$, the probability that two, exactly one, or none of the buyers accept the incumbent's offer x is given by $F(x)^2$, $2F(x)(1-F(x))$, and $(1-F(x))^2$, respectively. The payoffs for the incumbent in these cases are $500 - 2x$, $500 - x$, and 50 , respectively. Hence the incumbent maximizes expected profits by choosing to offer the amount x that solves

$$\max_x \{F(x)^2(500 - 2x) + 2F(x)(1 - F(x))(500 - x) + (1 - F(x))^2(50)\}.$$

We find that the predicted size of the offer is $x = 158$ yielding a predicted exclusion rate of $1 - (1 - F(158))^2 = 0.77$. These predictions are close to what is observed in the experiment: an average offer of 154 and an exclusion rate of 0.67 (see also Tables 8 and 9).³⁰ Exclusion costs are predicted to be equal to 164, which is below the observed average cost of 246.

b. Simultaneous discriminatory games

For SIMDIS-P it turned out that whether buyers accept or reject does not only depend significantly

³⁰Recall that incumbents earn 50 , $500-x$, and $500-2x$ if, respectively, no, one, and both sellers accept their offer. Answers given in the post-experimental questionnaire suggest that incumbents might have wanted to make an offer that maximizes the probability that exactly one buyer accepts. The probability that exactly one buyer accepts is maximized if both buyers accept the offer with probability 0.5 . Using the estimated function $F(x)$ above, the solution of the equation $2F(x)(1 - F(x)) = 0.5$ yields $x = 157$, which compares nicely to the average offer of 154 observed in the data. Note also the similarity between the average observed offer and the offer ($x = 167.5$) that makes a buyer indifferent between accepting and rejecting according to the selection criterion of risk-dominance.

	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\gamma}$	N	LL
SIMNON	-5.48*** (0.60)	0.035*** (0.003)	-	1188	-649.05
SIMDIS-P	-6.32** (2.69)	0.023** (0.009)	0.014* (0.008)	288	-167.38
SIMDIS-S	-4.12*** (0.70)	0.022*** (0.004)	-	300	-127.02
SEQ-P					
buyer 1	-3.54*** (1.26)	0.020*** (0.006)	-	150	-80.55
buyer 2 (1 accepts)	-3.07 (6.06)	2.018*** (0.586)	0.015 (0.028)	82	-34.83
buyer 2 (1 rejects)	-15.06** (6.41)	0.043** (0.019)	-0.002 (0.003)	68	-30.63
SEQ-S					
buyer 1	-2.90*** (0.47)	0.022*** (0.004)	-	150	-69.90
buyer 2 (1 accepts)	0.07 (0.33)	0.547 (0.351)	-	95	-44.95
buyer 2 (1 rejects)	-6.14* (3.28)	0.023** (0.011)	-	55	-20.88

Note: The regression equation is either $P(\text{Accept})_{ijt} = F(\alpha + \beta \text{OwnOffer}_{ijt} + \nu_i + \nu_{ij} + \epsilon_{ijt})$ or $P(\text{Accept})_{ijt} = F(\alpha + \beta \text{OwnOffer}_{kjt} + \gamma \text{OtherOffer}_{ijt} + \nu_i + \nu_{ij} + \epsilon_{ijt})$ for matching group $i = 1$ to 20, buyer $j = 1$ to 6 and period $t = 1$ to 20. F is the logit function and nested random effects (ν_i and ν_{ij}) are included. For the regression of buyers 2 in SEQ-S given rejection of buyer 1, ν_{ij} was left out because of non-convergence of the ML-estimator. Standard errors (in brackets) are robust to possible dependency within matching groups. Two-tailed significance levels of 1%, 5%, and 10% are indicated by *, ** and ***, respectively.

Table 7: Estimation results for buyers' probability of acceptance

Offered Payments			
		Predicted	Observed
		RRW-SW	Modified RRW-SW
Part 1			
SIMNON	$x \geq 0$	158	154
Part 2			
SIMDIS-P	$x_1 + x_2 \leq 336$	$x_1 = x_2 = 171$	$x_1 = 208; x_2 = 89$
SIMDIS-S	$x_1 \leq 1, x_2 = 0$	$x_1 = 238; x_2 = 62$	$x_1 = 204; x_2 = 42$
SEQ-P	$x_1 \leq 1, x_2 = 0$	$x_1 = 223; x_2^a = 0; x_2^r = 378$	$x_1 = 188; x_2^a = 9; x_2^r = 301$
SEQ-S	$x_1 \leq 1, x_2 = 0$	$x_1 = 178; x_2^a = 0; x_2^r = 304$	$x_1 = 177; x_2^a = 9; x_2^r = 260$

Notes: The predictions in columns “RRW-SW” are based on the RRW-SW model and the predictions in columns “Modified RRW-SW” are based on the behavioral naked exclusion model. Observed payments are averages of offered payments averaged over independent observation. In the case of SIMDIS-P and SIMDIS-S, x_1 refers to the maximum and x_2 to the minimum offer. In the case of SEQ-P and SEQ-S, x_2^a and x_2^r refer to amounts offered to buyer 2, given that buyer 1 accepted or rejected, respectively.

Table 8: Predicted and average observed offered payments

on the size of their own offer, but also on the size of the offer made to the other buyer in the market. The probability that a buyer accepts is thus described by the function $F(x_1, x_2) = \frac{1}{1 + e^{-(\hat{\alpha} + \hat{\beta}x_1 + \hat{\gamma}x_2)}}$, where x_1 and x_2 stand for the offer made to the buyer himself and the offer made to the other buyer in the market, respectively. The parameters $\hat{\alpha}$, $\hat{\beta}$, and $\hat{\gamma}$ are given in Table 7.

An incumbent maximizes expected profits by offering (x_1, x_2) that solves

$$\max_{x_1, x_2} \left\{ \begin{array}{l} F(x_1, x_2)F(x_2, x_1)(500 - x_1 - x_2) + F(x_1, x_2)(1 - F(x_2, x_1))(500 - x_1) \\ + F(x_2, x_1)(1 - F(x_1, x_2))(500 - x_2) + (1 - F(x_1, x_2))(1 - F(x_2, x_1))(50) \end{array} \right\}.$$

The solution to this problem is that offered payments are symmetric and equal to $x_1 = x_2 = 171$. The predicted exclusion rate is 0.75, which is more in line with the observed 0.66 than the stark prediction of 1.³¹ However, observed exclusion costs (249) are higher than our prediction (171) and fall in the (wide) interval predicted by RRW-SW ([0, 336]).

In SIMDIS-S, a buyer’s acceptance decision can only depend on the own offer because the offer made to the other buyer in the market is not observed. The incumbent’s optimization problem is written as follows.

$$\max_{x_1, x_2} \left\{ \begin{array}{l} F(x_1)F(x_2)(500 - x_1 - x_2) + F(x_1)(1 - F(x_2))(500 - x_1) \\ + F(x_2)(1 - F(x_1))(500 - x_2) + (1 - F(x_1))(1 - F(x_2))(50) \end{array} \right\}$$

³¹The sum of observed average payments proposed by incumbents (208+89=297) corresponds reasonably well to the amount that makes buyers indifferent between accepting and rejecting in the buyers’ subgame ($x_1 + x_2 = 335$). It can only be a subgame-perfect Nash equilibrium, however, if both buyers accept and this is not what we observe.

	Exclusion Rate			Exclusion Costs		
	Predicted		Observed	Predicted		Observed
	RRW-SW	Modified RRW-SW		RRW-SW	Modified RRW-SW	
Part 1						
SIMNON	≤ 1	0.77	0.67	≥ 0	164	246
Part 2						
SIMDIS-P	1	0.75	0.66	≤ 336	171	249
SIMDIS-S	1	0.77	0.58	≤ 1	183	218
SEQ-P	1	0.91	0.71	≤ 1	232	265
SEQ-S	1	0.92	0.84	≤ 1	187	251

Notes: The predictions in columns “RRW-SW” are based on the RRW-SW model and the predictions in columns “Modified RRW-SW” are based on the behavioral naked exclusion model. Observed outcomes are the averages on which Table 3 is based (see Table 3 for further notes).

Table 9: Predicted and average observed exclusion rates and costs

Using the estimated parameters in Table 7, the solution to this problem turns out to be asymmetric: $x_1 = 62, x_2 = 238$. Comparing this to the average observed minimum and maximum offer—42 and 204—this is a reasonable match. The corresponding exclusion rate equals 0.77, which somewhat overestimates the observed exclusion rate of 0.58, but is less stark than the original RRW-SW prediction. Exclusion costs are again underestimated by our approach but come closer to the observed ones than the standard prediction.

c. Sequential games

For the sequential games, we again use the same approach of estimating the relevant functions that describe the probability that buyers accept. In theory, there is no coordination problem between the buyers here. However, if e.g. buyers make mistakes or there are emotional costs/benefits associated with mis/coordination, the incumbent does not know exactly which offer will make a buyer accept. This is captured by $F(\cdot)$.

In the SEQ-P case we estimate $F_1(x_1)$ which is the probability that the buyer moving first accepts the offer made to him (x_1). If he does, it is optimal for the incumbent to offer 0 to the second-moving buyer ($x_2^a = 0$). This is also close to what we observe in the data. If the offer x_1 is rejected, the incumbent offers x_2^r to the second-moving buyer. Conditional on the first offer x_1 we denote the probability that the second offer gets accepted as $F_2(x_2^r, x_1)$. Hence, the incumbent solves

$$\max_{x_1, x_2^r} \{F_1(x_1)(500 - x_1) + (1 - F_1(x_1))F_2(x_2^r, x_1)(500 - x_2^r) + (1 - F_1(x_1))(1 - F_2(x_2^r, x_1))(50)\}.$$

Using the estimates presented in Table 7 we find $x_1 = 223, x_2^a = 0, x_2^r = 378$ yielding an exclusion rate

of 0.91. These predictions are closer to the observed average offers of, respectively, 188, 9 and 301, and to the observed exclusion rate of 0.71 than the original predictions. And so are exclusion costs (232 vs. 265).

In SEQ-S, the second buyer observes whether the first offer was accepted or not, but he does not observe the size of this (accepted or rejected) offer. In this case, we estimate an acceptance probability $F_1(x_1)$ for the first buyer and, conditional on x_1 being rejected, we estimate the acceptance probability $F_1(x_2^r)$ for the second buyer. Like in SEQ-P, if the first offer is accepted, the optimal second offer is zero, which is mostly consistent with what is observed in the data ($x_2^a = 0$). The incumbent's optimization problem becomes

$$\max_{x_1, x_2^r} \{F_1(x_1)(500 - x_1) + (1 - F_1(x_1))F_2(x_2^r)(500 - x_2^r) + (1 - F_1(x_1))(1 - F_2(x_2^r))50\}.$$

Using the parameters estimated in Table 7, we find $x_1 = 178$, $x_2^a = 0$, $x_2^r = 304$ and an exclusion rate of 0.92. As in SEQ-P these predictions are closer to the observed offers of, respectively, 177, 9 and 260, and an exclusion rate of 0.84 than the very small offers and the exclusion rate predicted by the original naked exclusion model. Exclusion costs are again estimated to be much higher compared to the original prediction, and this is also what is observed.

6. Summary and concluding remarks

Recent studies on exclusive dealing show that under certain circumstances inefficient exclusion can be achieved using exclusivity clauses. In particular, absent efficiency-enhancing effects of exclusivity and in the presence of economies of scale for the entrant, RRW-SW show that an incumbent can take advantage of coordination problems between buyers in order to achieve anti-competitive exclusion. If the incumbent cannot discriminate between buyers by offering them different payments, RRW-SW show that exclusion cannot be guaranteed. They also show that in the case where discrimination between buyers is possible, exclusion is obtained with certainty and should thus be observed more frequently than in the non-discriminatory case. Moreover, if the contracted payments are private information or buyers can be approached sequentially, exclusion is not only certain, but almost costless as well, such that one should see exclusion costs fall compared to the non-discriminatory case.

In our laboratory experiment, we find that exclusion occurs in more than two thirds of the cases and is thus, potentially, a serious problem. However, exclusion rates do not necessarily increase when discrimination between buyers is possible compared to the case where it is not possible. Exclusion rates only increase when payments can be offered sequentially and secretly. Moreover, in all cases, the

costs of exclusion for incumbents are substantial and do not decrease significantly when predicted by theory.

The driving force behind these results is that there exists a positive relation between buyers' acceptance probability and the amount of the payment proposed by the incumbent, which is an intuitive and plausible finding and, arguably, recognized by competition authorities.³² Therefore, we suggest to modify the existing naked exclusion model, by modeling the buyers' acceptance decision in the subgames as an increasing function of the payment (keeping all other aspects of the RRW-SW framework intact). This function might be a logit function, which is consistent with, for example, quantal-response equilibrium. We show that such a modification increases the fit between the predictions of the RRW-SW model and the experimental observations substantially. The most important implication is that the theoretical predictions become less "extreme." In fact, exclusion is no longer obtained with certainty in discriminatory regimes, and exclusion costs are substantially above zero, close to a level observed in the case of non-discriminatory contracts. Moreover, the modified model predicts exclusion rates to be higher under sequential than under simultaneous (discriminatory) contracting with buyers, which is partly corroborated by our experimental results.

Our results might also be relevant for antitrust policy. Indeed, regulatory bodies and courts often have to judge whether an exclusive contract has an efficiency rationale.³³ This task is not straightforward, and it is conceivable that erroneous rulings are made. One would hope there exists comprehensive and decisive empirical evidence on the effects of exclusive contracts to help to avoid such misjudgments. Unfortunately, though, empirical assessments of the use of exclusive contracts are rare and there is reason to believe that it will not be easy to overcome this shortcoming in the near future. Therefore, our paper can contribute to the discussion of the controversial efficiency-enhancing versus foreclosure effect of exclusive contracts by analyzing whether the *form* in which the contract is offered to buyers affects the likelihood of exclusion. More precisely, papers by, among others, Besanko and Perry (1993) and Segal and Whinston (2000a) show how exclusivity clauses can enhance manufacturers' incentives to invest. However, these investment-enhancing effects do not depend on the form in which the exclusive contracts are offered (e.g., simultaneously or sequentially). Here, our results give insights. We find that the most effective way to achieve exclusion is to approach buyers sequentially and secretly. As we

³²Recent guidelines of the European Commission regarding the abuse of a dominant position state the following on the use of conditional rebates that incumbent firms may give to buyers, potentially in order to exclude rivals: "The higher the rebate as a percentage of the total price (...), the stronger the likely foreclosure of actual or potential competitors" (EC, 2008).

³³See, for example, Segal and Whinston's (2000a) discussion of a DoJ investigation of Ticketmaster's contracting practice, or the recent Microsoft case (see footnote 1) in which Microsoft was accused of entering exclusive deals with original equipment manufacturers of computers in an effort to exclude Microsoft's rivals.

cannot see any reason why investment protecting exclusivity clauses should be offered sequentially and secretly to buyers, an argument can be made that contracts offered in this form should be interpreted as aiming at exclusion only. For practical purposes, this would mean that once an investigation uncovers the following two circumstances, an antitrust authority should be on high alert: (i) the suspected company staggered its contracting with buyers over a certain period of time; and (ii) it took active measures to keep secret (previous) offers made (see also Whinston, 2006, p. 147f).

Our results leave several interesting questions about the use and effect of exclusive contracts unanswered. First, in this study, we have considered the use of contracts that “nakedly” aim at exclusion. However, as mentioned above, several papers (such as Besanko and Perry, 1993; Segal and Whinston, 2000*a*) show that exclusive contracts can be efficiency-enhancing by promoting investments. Hence, it would be interesting to study a framework in which contracts can have both exclusionary and efficiency-enhancing effects (see Fumagalli, Motta and Ronde, 2007). Second, the contracts studied here aim at deterring entry. In particular, it was assumed that the adversely affected agent (the entrant) is not present when the incumbent negotiates the contracts with buyers. One can also consider the situation in which a rival to the contracting upstream party is already in the market and can react (e.g., by means of counteroffers) to the negotiation process (see Spector, 2007). Third, one could study markets where buyers are not final consumers which might limit the effectiveness of exclusive contracts (see Fumagalli and Motta, 2006).

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A. Appendix

A.1. Instructions

A.1.1. Part 1: SIMNON

- Please read these instructions closely.
- Do not talk to your neighbours and remain quiet during the entire experiment.
- If you have a question, raise your hand. We will come up to you to answer it.

Introduction

- In this experiment you can earn money by interacting with other participants.
- Your earnings are measured in “Points.” The number of points that you earn depends on the decisions that you and other participants make.
- For every 400 Points you earn, you will be paid 1 Euro in cash.
- You will start the experiment with 1600 Points in your account. (This is the 4 Euro show-up fee you were promised.)
- Your total number of points at the end of the experiment will be equal to the sum of the points you have earned in each round plus the show-up fee.
- Your identity will remain anonymous to us as well as to the other participants.
- The experiment consists of two parts. Below are the instructions for the first part. You will receive the instructions for the second part after completion of the first part.

Description of the first part of the experiment

The first part of the experiment consists of 10 rounds. The events in each round are as follows:

At the beginning of each round, you will be randomly assigned to a group of 3 participants. In each group, one participant will act in role A and two participants will act in role B. Then there will be two stages:

Stage 1: The A participant can offer each of the two B participants in his group a payment of $X \geq 0$. The payment X is the same for both B participants.

Stage 2: The two B participants will be informed about X . Then both B participants simultaneously and independently have to decide whether to accept or reject this payment.

Payoffs

The payoffs of the A participant

Imagine that you are an A participant and that you offer the payment $X \geq 0$. Then your payoffs as an A participant are as follows:

	If no B accepts	If one B accepts	If the two B's accept
	50	$500 - X$	$500 - 2X$

This means:

- If none of the B participants accepts the offer, you earn 50;
- If only one B participant accepts the offer, you earn $500 - X$;
- If the two B participants accept the offer, you earn $500 - 2X$;
- Please note that as an A participant you can make losses. This is the case when only one B participant accepts and the payment X is larger than 500 or when both B participants accept and the payment X is larger than 250.

The payoffs of the B participants

Imagine that you are a B participant and imagine that you choose rows (Accept or Reject) in the table below. Then your payoffs as a B participant are as follows:

		Decision of the other B participant	
		The other B accepts	The other B rejects
		Accept	Reject
Your decision as participant B	Accept	$165 + X$	$165 + X$
	Reject	165	500

This means:

- If you choose “Accept,” you earn $165 + X$ (whether the other B participant accepts or rejects.)
- If you choose “Reject,” your payoff depends on what the other B participant chooses.
 - If the other B participant accepts, you earn 165.
 - If the other B participant rejects, you earn 500.

Role assignment and information

- The first part of the experiment consists of 10 rounds.
- Your role as either an A or a B participant will be determined at the beginning of the experiment and then remains fixed for the entire first part of the experiment.
- Your computer screen (see the top line) indicates which role you act in.
- Please remember that in every round, groups of 3 participants are randomly selected from the pool of participants in the room. We will make sure that each of the groups will always consist of one A participant and two B participants.
- At the end of each round, you will be given the following information about what happened in your own group during the round: the offer made by the A participant, the decisions of the two B participants, and your own payoff.

A.1.2. Part 2: SIMDIS-P

- The main difference with the first part is that in the second part A participants can make different offers to the B participants.
- For the exact rules of the second part of the experiment, please read the following instructions carefully.

Description of the second part of the experiment

The second part of the experiment consists of 10 rounds. The events in each round are as follows:

At the beginning of each round, you will be randomly assigned to a group of 3 participants. In each group, one participant will act in role A and two participants will act in role B. The two participants acting in role B will be called B1 and B2. Then there will be two stages:

Stage 1: The A participant can offer each of the two B participants in his group a payment. That is, the A participant can offer B1 a payment $X1 \geq 0$ and B2 a payment of $X2 \geq 0$. The two payments $X1$ and $X2$ can be the same or they can be different.

Stage 2: The two B participants will be informed about $X1$ and $X2$. Then both B participants simultaneously and independently have to decide whether to accept or to reject their own offered payment. That is, B1 decides whether to accept or to reject $X1$ and (at the same time) B2 decides whether to accept or to reject $X2$.

Payoffs

The payoffs of the A participant

Imagine that you are an A participant and that you offer the payments $X1 \geq 0$ and $X2 \geq 0$. Let the B participants be denoted by Bi where $i = 1, 2$. Then your payoffs as an A participant are as follows:

	If no B accepts	If only Bi accepts	If the two B's accept
	50	$500 - Xi$	$500 - X1 - X2$

This means:

- If none of the B participants accepts the offer, you earn 50.
- If only participant Bi ($i = 1, 2$) accepts the offer, you earn $500 - Xi$;
- If the two B participants accept the offer, you earn $500 - X1 - X2$;
- Please note that as an A participant you can make losses. This is the case when only participant Bi ($i = 1, 2$) accepts and the payment Xi is larger than 500 or when both B participants accept and the the sum of the payments $X1$ and $X2$ is larger than 500.

The payoffs of the B participants

Imagine that you are participant Bi ($i = 1, 2$) who is offered the payment Xi ($i = 1, 2$) by the A participant, and imagine that you choose rows (Accept or Reject) in the table below. Then your

payoffs as participant B_i are as follows:

		Decision of the other B participant	
		The other B accepts	The other B rejects
Your decision as participant B_i	Accept	$165 + X_i$	$165 + X_i$
	Reject	165	500

This means:

- If you choose “Accept,” you earn $165 + X_i$ (whether the other B participant accepts or rejects.)
- If you choose “Reject,” your payoff depends on what the other B participant chooses.
 - If the other B participant accepts, you earn 165.
 - If the other B participant rejects, you earn 500.

Role assignment and information

- The second part of the experiment consists of 10 rounds.
- All participants will act in the same role as in the first part. That is, an A participant will remain an A participant and a B participant will remain a B participant throughout the second part of the experiment. As a B participant you will alternate acting in role B1 and role B2 across rounds. That is, if you are B1 (or B2) in round 1, you will be B2 (or B1) in round 2. Then, in round 3 you will again be B1 (or B2) and so on.
- Your computer screen (see the top line) indicates in every round which role you act in.
- Please remember that in every round, groups of 3 participants are randomly selected from the pool of participants in the room. We will make sure that each of the groups will always consist of one A participant and two B participants.
- At the end of each round, you will be given the following information about what happened in your own group during the round: the offers made by the A participant to the two B participants, the decisions of the two B participants, and your own payoff.

A.1.3. Part 2: SEQ-P

- The main difference with the first part is that in the second part A participants can make different offers to the B participants and that decision making will be sequential.
- For the exact rules of the second part of the experiment, please read the following instructions carefully.

Description of the experiment

The experiment consists of 10 rounds. The events in each round are as follows:

At the beginning of each round, you will be randomly assigned to a group of 3 participants. In each group, one participant will act in role A and two participants will act in role B. The two participants acting in role B will be called B1 and B2. Then there will be four stages:

Stage 1: The A participant can offer the B1 participant in his group a payment. That is, the A participant can offer B1 a payment $X1 \geq 0$.

Stage 2: The B1 participant will be informed about $X1$. Then the B1 participant has to decide whether to accept or to reject the offered payment. That is, the B1 participant decides whether to accept or to reject $X1$.

Stage 3: The A participant will be informed about whether B1 has accepted or rejected the offer $X1$. Then the A participant can offer the B2 participant in his group a payment. That is, the A participant can offer B2 a payment $X2 \geq 0$.

Stage 4: The B2 participant will be informed both about $X1$ and $X2$ as well as about whether the B1 participant has accepted or rejected the payment $X1$. Then the B2 participant has to decide whether to accept or to reject the offered payment. That is, B2 decides whether to accept or to reject $X2$.

Payoffs

The payoffs of the A participant

Imagine that you are an A participant and that you offer the payments $X1 \geq 0$ and $X2 \geq 0$. Let the B participants be denoted by B_i where $i = 1, 2$. Then your payoffs as an A participant are as follows:

	If no B accepts	If only B_i accepts	If the two B's accept
	50	$500 - X_i$	$500 - X1 - X2$

This means:

- If none of the B participants accepts the offer, you earn 50.
- If only participant B_i ($i = 1, 2$) accepts the offer, you earn $500 - X_i$;
- If the two B participants accept the offer, you earn $500 - X_1 - X_2$;
- Please note that as an A participant you can make losses. This is the case when only participant B_i ($i = 1, 2$) accepts and the payment X_i is larger than 500 or when both B participants accept and the the sum of the payments X_1 and X_2 is larger than 500.

The payoffs of the B participants

Imagine that you are participant B_i ($i = 1, 2$) who is offered the payment X_i ($i = 1, 2$) by the A participant, and imagine that you choose rows (Accept or Reject) in the table below. Then your payoffs as participant B_i are as follows:

		Decision of the other B participant	
		The other B accepts	The other B rejects
Your decision as participant B_i	Accept	$165 + X_i$	$165 + X_i$
	Reject	165	500

This means:

- If you choose “Accept,” you earn $165 + X_i$ (whether the other B participant accepts or rejects.)
- If you choose “Reject,” your payoff depends on what the other B participant chooses.
 - If the other B participant accepts, you earn 165.
 - If the other B participant rejects, you earn 500.

Role assignment and information during the experiment

- The second part of the experiment consists of 10 rounds.
- All participants will act in the same role as in the first part. That is, an A participant will remain an A participant and a B participant will remain a B participant throughout the second part

of the experiment. As a B participant you will alternate acting in role B1 and role B2 across rounds. That is, if you are B1 (or B2) in round 1, you will be B2 (or B1) in round 2. Then, in round 3 you will again be B1 (or B2) and so on.

- Your computer screen (see the top line) indicates in every round which role you act in.
- Please remember that in every round, groups of 3 participants are randomly selected from the pool of participants in the room. We will make sure that each of the groups will always consist of one A participant and two B participants.
- At the end of each round, you will be given the following information about what happened in your own group during the round: the offers made by the A participant to the two B participants, the decisions of the two B participants, and your own payoff.

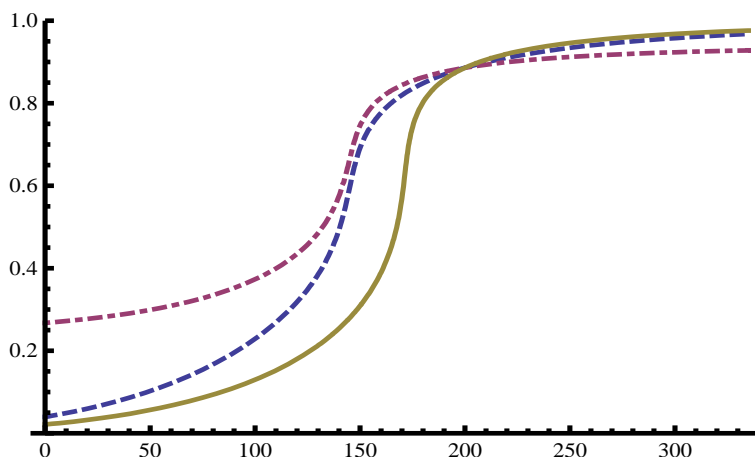


Figure 1: *Using quantal response: acceptance probability $F(x)$ for the symmetric case (solid line), $F(x, 200)$ (dashed) as a function of the offer x to the buyer himself and $F(200, x)$ as a function of the offer to the other buyer (dot-dashed).*

A.2. Quantal response equilibrium

A justification for using the logit function to describe buyer behavior (e.g., buyers' acceptance probability as a function of the offer(s) made by the incumbent) is given by a quantal response equilibrium (see McKelvey and Palfrey, 1995; Goeree, Holt and Palfrey, 2005). The idea here is that players make mistakes (or that "real" payoffs are perturbed) but are more likely to play strategies that yield higher expected payoffs. Let $\phi : \mathbb{R} \rightarrow \mathbb{R}_+$ be a strictly increasing and continuous function. Then we assume that the probability F_i that i accepts the offer x_i (while the other buyer has an offer x_j) is given by

$$F_i = \frac{\phi(165 + x_i)}{\phi(165 + x_i) + \phi(500 - 335F_j)}$$

where the probability that j accepts the offer x_j is given by

$$F_j = \frac{\phi(165 + x_j)}{\phi(165 + x_j) + \phi(500 - 335F_i)}$$

In words, the higher i 's payoff ($165 + x_i$) from accepting the incumbent's offer (compared to not accepting and getting expected pay off $(1 - F_j)500 + F_j165 = 500 - 335F_j$), the more likely i is to accept.

Figure 1 illustrates the quantal response approach for the case where $\phi(x) = x^\lambda$ with $\lambda = 3.5$. This approach suggests that the probability of acceptance can be approximated by a logit function.

The significance of modeling buyer's behavior with a non-degenerate distribution function F can be illustrated as follows. When assuming subgame-perfect buyer behavior, an optimal strategy of the incumbent is to get exclusion for sure by

offering (0, 335) in SIMDIS-P. However, for buyer behavior as described by the example considered in Figure 1, the incumbent does better by offering the same to both buyers ($x = 170$). In fact, expected profits for the incumbent equal 223 in this case which are higher than profits assuming subgame-perfect buyer behavior ($500 - 335 = 165$). Clearly, the exact optimum depends on the parameters. Hence, we use the estimated logit functions in Table 7 and then calculate the incumbent's optimal offers for this logit function.

A.3. Emotional costs of coordination failure

An alternative model based on perturbations of buyers' payoffs in a simultaneous game –that justifies using a (non-degenerate) logistic distribution for the acceptance probability as a function of the offer(s) made by the incumbent– is the following. Buyers are assumed to suffer an emotional cost when they fail to coordinate on rejecting an incumbent's offer.

To perturb the payoffs to the buyers, we make the following two changes to the framework above. First, there is a fraction $p \in [0, 1]$ of buyers who always reject the offer of the incumbent. These buyers are committed to the Pareto optimal equilibrium (Reject,Reject). Of the remaining $1 - p$ buyers who are not committed, their payoffs are given by table A1. The only change is a disutility $\alpha \geq 0$ in case the buyer rejects while the other buyer accepts. We interpret this as the disutility from disappointment (emotional cost) that the buyers did not manage to coordinate.³⁴ The disutility α has a distribution function $H(\cdot)$ with support over the nonnegative real numbers. If player 1 accepts the offer x_1 , his payoff equals

$$165 + x_1 \tag{1}$$

If instead he rejects, his expected payoff equals

$$F_2(165 - \alpha) + (1 - F_2)500 \tag{2}$$

where F_2 is the probability that player 2 accepts the offer x_2 . Let $\alpha_1^*(x_1, x_2)$ denote the type α who is indifferent between accepting the offer x_1 and rejecting it. Similar expressions can be written for player 2. Then the probability of acceptance for player j can be written as

$$F_j = (1 - p)(1 - H(\alpha_j^*(x_i, x_j)))$$

with $i \neq j$. For the symmetric case, we have $x_1 = x_2$ and $\alpha_1^*(x, x) = \alpha_2^*(x, x) = \alpha^*(x)$.

Solving these equations yields a probability of acceptance $F(x) = (1 - p)(1 - H(\alpha^*(x)))$ for the symmetric case and $F(x_1, x_2)$ for the asymmetric case. Figure 2 gives an example with a typical shape

³⁴Another way to model the buyers committed to (Reject,Reject) is to allow for $\alpha < 0$. However, this seems less intuitive.

		Buyer 1	
		Accept	Reject
Buyer 2	Accept	$165 + x_1, 165 + x_2$	$165 + x_1, 165 - \alpha$
	Reject	$165 - \alpha, 165 + x_2$	$500, 500$

Table A1: Payoffs to buyers

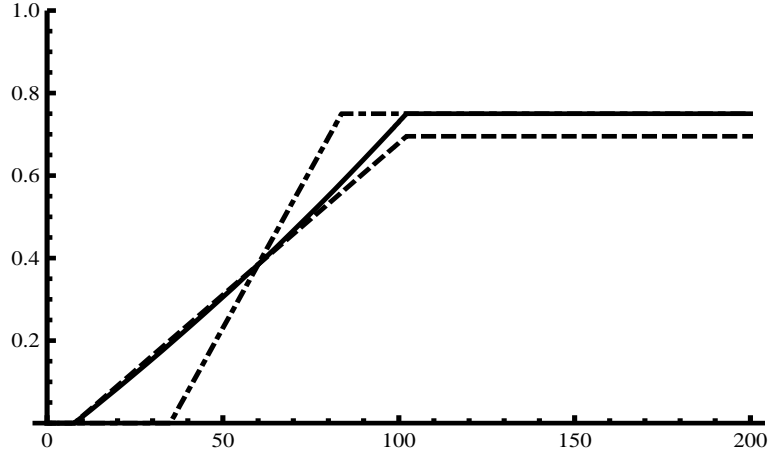


Figure 2: The acceptance probability $F(x)$ for the symmetric case (dot-dashed), $F(x, 60)$ as a function of the offer X to the buyer himself (solid) and $F(60, x)$ as a function of the offer to the other buyer (dashed). The figure was generated for the case where $H = \alpha/(\alpha + 400)$ and $p = 0.25$.

for the function F . The dot-dashed curve gives the acceptance probability for the symmetric case as a function of the offer x . For low offers x , the offer is always rejected. As offers increase, the probability of acceptance is positive and increasing in x . Very high offers are always accepted by buyers who are not committed to rejecting offers. The solid line gives the acceptance probability as a function of your own offer, while the other buyer gets an offer of 60. It has a similar shape as in the symmetric case, except that the probability of acceptance is higher (lower) for offers $x < (>)60$ as the other buyer got a better (worse) offer. The dotted line gives the probability of acceptance as a function of the other buyer's offer assuming you get an offer of 60. Again we see a similar shape of the acceptance function. Even for offers above 100, the acceptance probability is below $1 - p$. Due to the relatively low offer of 60, there are values of α that reject this offer even if the other buyer got a high offer.

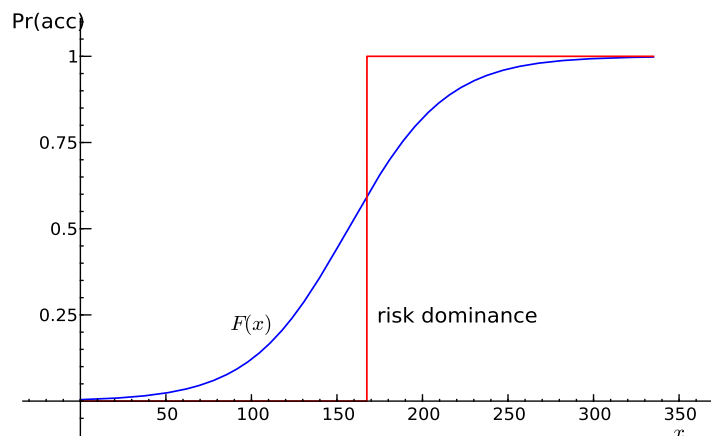


Figure 3: A buyer's acceptance probability as a function of the offer in treatment SIMNON predicted by risk-dominance and by an estimated logit function

A.4. Buyers' acceptance probability predicted by risk dominance and an estimated logit function

Figure 3 illustrates a buyer's acceptance probability as a function of the offer in treatment SIMNON predicted by risk-dominance and by an estimated logit function.

A.5. Robustness analysis of "Modified RRW-SW" predictions for SEQ-P

Since our "Modified RRW-SW" predictions differ most starkly from the subgame perfect predictions in the case of SEQ-P (see tables 8 and 9) we do the following robustness check. For buyer 1 we define a multinormal distribution with expectations (see table 7) -3.54 for $\hat{\alpha}$ and 0.02 for $\hat{\beta}$. The standard deviations and correlation for $\hat{\alpha}$ and $\hat{\beta}$ equal resp. 1.26 , 0.006 and -0.97 (which we derived from our estimation). For buyer 2 we define a multinormal distribution with expectations -15.06 for $\hat{\alpha}$, 0.04 for $\hat{\beta}$ and -0.002 for $\hat{\gamma}$. The resp. standard deviations equal 6.41 , 0.019 and 0.003 . Finally, the correlation coefficients between $\hat{\alpha}$ and $\hat{\beta}$, $\hat{\alpha}$ and $\hat{\gamma}$, $\hat{\beta}$ and $\hat{\gamma}$ equal resp. -0.9988 , 0.4663 and -0.4828 .

We simulate 10.000 draws for buyer 1's $\hat{\alpha}$ and $\hat{\beta}$ and buyer 2's $\hat{\alpha}$, $\hat{\beta}$ and $\hat{\gamma}$. For each draw we calculate the incumbent's optimal offer and derive the exclusion rate and exclusion costs. The histograms of the exclusion rate and costs are given in Figure 4. The figure shows that our prediction for SEQ-P that the exclusion rate is strictly below 1 and the exclusion cost clearly above 0 is robust.

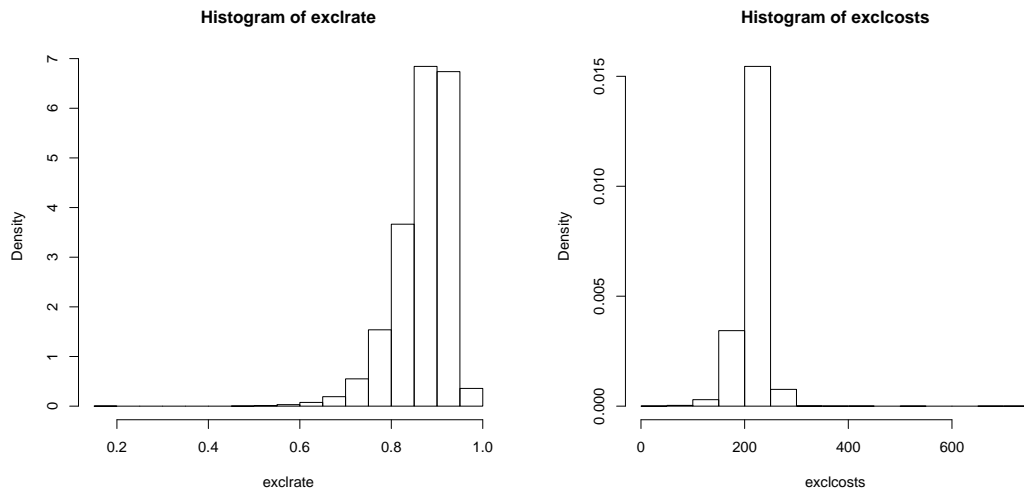


Figure 4: *Histograms of exclusion rates and exclusion costs for 10,000 draws of parameters for the buyers' acceptance probability functions in SEQ-P.*