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# Naked Exclusion: An Experimental Study of Contracts with Externalities\*

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## Abstract

This paper reports the results of an experiment designed to assess the ability of an incumbent seller to profitably foreclose a market with exclusive contracts. We use the strategic environment described by Rasmusen, Ramseyer, and Wiley (1991) and Segal and Whinston (2000) where entry is unprofitable when sufficiently many downstream buyers sign exclusive contracts with the incumbent. When discrimination is impossible, the game resembles a stag-hunt (coordination) game in which the buyers' payoffs are endogenously chosen by the incumbent seller. Exclusion occurs when the buyers fail to coordinate on their preferred equilibrium. Two-way non-binding pre-play communication among the buyers lowers the power of exclusive contracts and induces more generous contract terms from the seller. When discrimination and communication are possible, the exclusion rate rises. *Divide-and-conquer* strategies are observed more frequently when buyers can communicate with each other. Exclusion rates are significantly higher when the buyers' payoffs are endogenously chosen rather than exogenously given. Finally, secret offers are shown to decrease the incumbent's power to profitably exclude.

KEYWORDS: Bargaining with Externalities; Contracting with Externalities; Experiments; Exclusive Dealing; Antitrust; Discrimination; Endogenous Payoffs; Communication; Coordination Games; Equilibrium Selection

JEL Categories: K21, K41, C72, C90, L12, L40

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# 1 Introduction

In the mid-1990s, Anheuser-Busch Inc., the largest beer company in the United States with 46% of domestic beer shipments and 70% of industry's operating profit, came under antitrust scrutiny for its business practices. In an apparent response to the successful inroads made by fledgling beer manufacturers such as Sierra Nevada and Samuel Adams, Anheuser-Busch tightened its controls over its network of beer distributors. Using "100% share of mind" contracts – a phrase reportedly coined by Chairman August Busch III himself – Anheuser-Busch rewarded distributor exclusivity with cash payments and perks such as low-interest loans and truck-painting allowances. These contracts, together with Anheuser-Busch's corporate diversification into the specialty beer segment with labels such as Red Wolf and Black & Tan Porter, made it unattractive for distributors to carry competitor's brands. In 1998, *The Wall Street Journal* reported that "growth for domestic microbrews – including brands such as Samuel Adams and Sierra Nevada – hit a brick wall" and "analysts [were] predict[ing] the demise of many small brewers."<sup>1</sup>

Exclusive dealing contracts have been subject of lively academic debate for many years. In the 1970s, scholars identified with the Chicago School argued emphatically that exclusive dealing contracts could not be profitably employed by incumbents to exclude more efficient rivals (Bork, 1978). In their view, exclusive dealing arrangements would be adopted only when they served legitimate business goals, such as preventing free riding and protecting relationship-specific investments.<sup>2</sup> In recent years, however, scholars have used the tools of game theory and information economics to show that exclusive contracts may be adopted for purely anticompetitive reasons. Rasmusen, Ramseyer and Wiley (1991), for example, argued that incumbent firms can profitably exclude rival firms by exploiting externalities among downstream buyers.<sup>3</sup> This line of research, dubbed "Naked Exclusion," has been refined by Segal and Whinston (2000), extended by Fumagalli and Motta (2006) and Simpson and Wickelgren (2007, 2001), among others.<sup>4</sup> It has also been highlighted in

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<sup>1</sup>"Amid Probe, Anheuser Conquers Turf," *The Wall Street Journal*, March 9, 1998. The probe by the Department of Justice was later abandoned.

<sup>2</sup>The crux of this argument is fairly intuitive and can be easily described. An incumbent seller would want to discourage the entry of competitors in order to protect market share and profit margins. Buyers, on the other hand, would prefer to facilitate entry since entry would lead to lower prices. The Chicago School scholars argued that the amount of money that the incumbent would need to pay to rope the reluctant buyers into exclusive deals – namely their increased consumer surplus from entry – would swamp the incumbent's future gain from exclusion (the monopoly rents). See Kaplow (1985) for a comprehensive discussion of this literature.

<sup>3</sup>Kaplow (1985) critiqued the Chicago School using a similar logic.

<sup>4</sup>Innes and Sexton (1994) explore the power of exclusive contracts when buyers can form coalitions with the entrant.

the more general theoretical literature on contracting with externalities (Segal, 1999, 2003).<sup>5</sup> Our paper contributes to this literature by exploring these issues in a laboratory setting.

Specifically, Rasmusen, Ramseyer and Wiley (1991) and Segal and Whinston (2000) argued that an incumbent monopolist can use exclusive contracts (modeled as transfers from the incumbent to a buyer in exchange for the buyer's promise not to buy from any other seller) to deter efficient entry when there are economies of scale in production. Entry becomes unprofitable when sufficiently many buyers have agreed to exclusive deals, since the entrant cannot achieve minimum efficient scale. Intuitively, the decision of a single buyer to sign an exclusive contract reduces the likelihood of entry and therefore imposes a negative externality on the other buyers. Segal and Whinston (2000) showed that, when the incumbent seller cannot discriminate and must make the same offer to all buyers, both "exclusion equilibria" (where entry is prevented) and "entry equilibria" can exist. Importantly, the market is foreclosed only when the buyers fail to coordinate on their preferred equilibrium. In contrast, when the incumbent monopolist can discriminate and offer better deals to some buyers than to others, exclusion can be achieved without relying upon coordination failures. Through *divide-and-conquer* strategies, the incumbent can effectively exploit the negative externalities among the buyers and foreclose the market.

Experimental work on contracting with externalities is interesting and important for many reasons. First, the framework described in Rasmusen, Ramseyer and Wiley (1991) and Segal and Whinston (2000) involves coordination games with endogenous payoffs – the buyers' payoffs in the acceptance subgame are designed by the incumbent seller. To the best of our knowledge, ours is the first experimental study of coordination games with complete information and payoffs endogenously determined by the previous move of a strategic player.<sup>6</sup> Second, Segal and Whinston (2000) point out that the ability of the incumbent seller to discriminate among buyers by offering different contracts enhances the seller's ability to exclude rivals. No experimental test has been conducted to assess this theoretical prediction. Third, the experimental literature on coordination games explores the importance that non-binding pre-play communication has on equilibrium selection (see, for instance, Cooper et al. 1992). However, the effect of communication on the incumbent

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<sup>5</sup>Another branch has focused on contracts with stipulated damages for breach of contract. Aghion and Bolton (1987) and Spier and Whinston (1995) argued that such contracts are not designed to discourage entry per se but are rather designed to extract economic value from the entrant by influencing the entrant's future pricing behavior.

<sup>6</sup>Dopuch et al. (1997) conduct an experimental study to assess the effects of different legal regimes, including joint-and-several liability, on the frequency and amounts of settlements. They do not restrict the players' demands. As a consequence, their study does not provide a comprehensive analysis of the coordination games with endogenous payoffs. See Charness, et al. (2007) for an experimental study of prisoners' dilemma with endogenous transfers made in the first period by the *same* players who move in the second period.

sellers' exclusive offers (and hence, on the power of exclusionary contracts) has not been previously explored (theoretically or empirically).<sup>7</sup>

Our experimental design encompasses two offer treatments, no discrimination (where the incumbent is constrained to make equal offers) and discrimination (where the incumbent's offers can be different). We also consider two communication treatments, no communication between the buyers and two-way buyer-buyer communication where the buyers state their intentions before deciding whether to accept or reject the exclusive deals. Finally, we consider two buyer-payoff treatments, endogenous and exogenous. For the endogenous-payoff treatment, an actual subject (representing the seller) chooses the transfer payments. For the exogenous-payoff treatment, we take these very same offers and administer them to a separate set of subjects in an exogenous fashion (through a computer-seller). A combination of these treatments generates eight experimental conditions. The subjects, a pool of undergraduate and graduate students from Northwestern University, were paid according to their performance.

Our experimental results confirm that communication among the buyers significantly reduces the likelihood of exclusion. This effect is particularly strong when the incumbent seller is constrained not to discriminate and must make the same offers to the buyers. Communication also significantly affects the offers chosen by sellers, inducing more generous offers when the seller cannot discriminate and inducing *divide-and-conquer* offers when the seller can discriminate. Discrimination raises the likelihood of exclusion, when the buyers can communicate with each other. Finally, we find that the buyers are more likely to accept exclusive deals when these deals are endogenously designed by another subject in the laboratory rather than exogenously generated. This effect is particularly strong when the buyers can communicate with each other. Our findings underscore the importance of combining experimental and behavioral observation with theoretical modeling.

Although our paper is motivated by exclusive dealing and market foreclosure, we believe that our findings and insights might apply to other contexts as well. Contracts with externalities are prevalent in environments such as corporate takeovers, licensing, mergers, and debt bailouts (Segal, 1999, 2003). Moreover, these issues arise in a variety of bargaining situations including joint and several liability (Kornhauser and Revesz, 1994), class action litigation (Che and Spier, forthcoming),

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<sup>7</sup>In recent work conducted independently of ours, Smith (2007) studies the effect of the number of buyers in the market and the percentage of buyers required to exclude. Her study differs from ours in many important respects. First, Smith does not allow for discrimination and therefore cannot assess the effectiveness of Segal and Whinston's (2001) *divide-and-conquer* offers. Second, her study does not explore the effects of endogeneity on buyers' payoffs. Third, she does not consider the effects of private offers. Her experimental design is also very different from ours.

and plea bargaining with criminal defendants (Bar-Gill and Ben-Shahar, 2007). Although the theoretical literature has been very active, there are surprisingly few empirical tests of these models. This may be due to the scarcity of data; in the real world, negotiations are typically conducted in private and are not easily observed by researchers.<sup>8</sup> Conducting experiments to assess the predictions from these theoretical models is a valuable alternative to traditional empirical analysis.<sup>9</sup>

The rest of the paper is organized as follows. Section 2 outlines the theoretical model and predictions. Section 3 discusses the qualitative hypotheses to be tested. Section 4 presents the experimental design. Section 5 examines the results from the experimental sessions. Section 6 outlines an extension of the analysis under privately observed offers. Section 7 concludes the paper and discusses avenues for future research.

## 2 Theoretical Framework

Rasmusen, Ramseyer, and Wiley (1991) and Segal and Whinston (2000), hereafter RRW-SW, considered a general model with two upstream firms – an incumbent monopolist and a potential entrant – and  $N$  downstream buyers. Economies of scale in production implied that entry would be deterred if sufficiently many downstream buyers, denoted by  $N^*$ , signed exclusive deals with the incumbent. Although RRW-SW’s results concerning externalities and market foreclosure are quite general, the key insights can be captured in an environment with  $N = 2$  and  $N^* = 1$ . We therefore assume that there are just two buyers and that the scale economies in production are such that the incumbent can deter entry through an exclusive deal with just a single buyer. Given that coordination among buyers becomes more difficult as the number of buyers increases, an environment with  $N = 2$  provides the strongest test for exclusion.<sup>10</sup> In addition, this simplification streamlines the discussion and avoids unnecessary complexity in the experimental design.

The RRW-SW framework involves three basic stages. In the first stage, the incumbent monopolist simultaneously offers exclusive contracts to the buyers. The exclusive contracts involve simple transfer payments,  $x_1$  and  $x_2$ , from the incumbent to the buyers in exchange for a buyer’s promise

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<sup>8</sup>Sass (2005) provides an empirical investigation of exclusive dealing in the beer industry and concludes that exclusive dealing minimizes manufacturer-dealer incentive conflicts. Anheuser Busch adopted “100% share of mind” contracts after the Sass’ period of analysis. Heide et al. (1998) investigate exclusive dealing in industrial machinery and electronic equipment, focusing on the degree of product differentiation, the likelihood of competitive entry, and the effects on firm size. They find evidence that exclusive dealing is efficient rather than anticompetitive. Chang and Sigman (2000) investigate the settlement of Superfund litigation. They find that joint-and-several liability leads to settlement patterns that are consistent with the theoretical predictions of Kornhauser and Revesz (1994).

<sup>9</sup>See for example, Martin et al. (2001) for an interesting implementation of markets in the laboratory to study vertical foreclosure.

<sup>10</sup>If we observe exclusion with  $N = 2$ , we would expect the likelihood of exclusion to be even higher with  $N > 2$ .

not to buy from the entrant in the future. After observing both offers, the buyers simultaneously decide whether to accept or reject their respective offers. We will refer to this as the “acceptance subgame.”<sup>11</sup> In the second stage, the entrant decides whether or not to enter the market. As described above, entry is assumed to be profitable for the entrant only when *both* buyers reject the incumbent’s offers in stage 1, so the market is foreclosed when even a single buyer signs an exclusive deal.<sup>12</sup> Market prices are determined in the third stage. The incumbent charges a high monopoly price to the “captive buyers” who accepted the exclusive deal in stage 1. The price paid by the “free buyers” (those who rejected the exclusive deal) depends on whether entry took place in stage 2. With entry, competition drives the prices for these free buyers down to competitive levels. Without entry, the free buyers are at the mercy of the incumbent monopolist and are charged the monopoly price. A buyer’s additional consumer surplus from entry is denoted by  $x^*$ , while the incumbent’s lost profit on that buyer is denoted by  $\pi$ . Finally,  $x^* - \pi > 0$  is the deadweight loss (DWL) associated with monopoly pricing.

To minimize subjects’ computational costs, and given that the purpose of this study is to assess the determinants of exclusion, we focus our experimental design on the first stage only. The buyers’ payoffs in the acceptance subgame of course reflect equilibrium behavior in stages two and three.<sup>13</sup> We assign particular numerical values to the model parameters.<sup>14</sup> The incumbent seller’s monopoly profit from a single buyer is assumed to be  $\pi = 975$ . A buyer’s additional consumer surplus from entry is  $x^* = 1000$ . The resulting deadweight loss from monopoly pricing is therefore  $x^* - \pi = 25$ . To reduce the subjects’ computational costs, we also restrict the incumbent seller’s

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<sup>11</sup>SW also consider the case where offers are sequential and find that the exclusionary power of exclusive contracts is enhanced (with respect to the simultaneous-offer case). We decided to test the exclusionary power of exclusive contracts under the least favorable scenario, i.e., under the simultaneous-offer case.

<sup>12</sup>SW’s basic framework does not allow for contract breach. In Section IV, however, SW extend their basic model by allowing for contract breach under privately-stipulated damages and study partially exclusionary contracts. It is assumed that the entrant is more efficient than the incumbent, which provides a rent-extraction motive for the incumbent. This approach is similar to Aghion and Bolton’s (1987) model that involves a single buyer. The ability to profit through partially exclusionary contracts reduces the incumbent’s incentives to deter entry, but “[A] robust set of circumstances still exist in which exclusion is firm  $I$ ’s optimal strategy.” (SW; p. 20). These results are sensitive to the way damages are modeled. Simpson and Wickelgren (2007) model contract breach by using expectation damages. They find that exclusive contracts cannot deter entry if buyers are final consumers.

<sup>13</sup>Including all three stages in the experimental design would require buyers to use backward induction to compute their payoffs at the acceptance subgame. Referring to the play of games by experimental subjects, Camerer and Johnson (2004) state that, “motivated intelligent subjects behave sensibly, but do not exhibit the extent of strategic reasoning which is commonly assumed when game theory is applied to understand ... political maneuvering, incentive design, and so forth” (p. 15). Also Camerer (2003) reports that “[his work with Johnson et al., (2002) indicates that] players in a three round game [do] not look ahead to the second and third rounds as much as backward induction requires” (p. 197; comments added in brackets). Hence, this design would introduce unnecessary noise into the experimental results.

<sup>14</sup>Our numerical examination satisfies all of the model’s assumptions and, therefore, the predictions derived from these assumptions hold.

Table 1: Buyers' Payoffs Matrix for the Acceptance Subgame

	Accept	Reject
Accept	$(x_1, x_2)$	$(x_1, 0)$
Reject	$(0, x_2)$	$(1000, 1000)$

Note: In case of no-discrimination,  $x_1 = x_2 = x$ .

offers to  $x_i \in \{100, 650, 800, 1100\}$ ,  $i = 1, 2$ .<sup>15</sup>

Table 1 shows the buyers' payoff matrix for the acceptance subgame.

*Proposition 1.*<sup>16</sup> *Suppose the incumbent seller is unable to discriminate between the buyers and must choose  $x_1 = x_2 = x$ . There are multiple subgame perfect Nash equilibria, some of which lead to exclusion and others which lead to entry.*<sup>17</sup> *In the exclusion equilibria, the incumbent offers  $x \in \{100, 650, 800\}$  and both buyers accept. In the equilibria with entry, the incumbent offers  $x \in \{100, 650, 800\}$  and both buyers reject.*

When discrimination is impossible, the buyers' acceptance subgame in Table 1 is a symmetric coordination game with two pure-strategy Nash equilibria, (accept, accept) and (reject, reject). The payoff structure of these games is similar to the stag hunt game (also called an "assurance game") where the players choose stag (in our game, reject) only if they are sufficiently confident (or "assured") others will choose stag as well. The two equilibria are Pareto rankable and it is Pareto dominant for the buyers to reject their offers. Moreover, as discussed in SW, none of the exclusion equilibria satisfy the coalition-proof Nash refinement of Bernheim et al. (1987).<sup>18</sup> Still,

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<sup>15</sup>The reasons for choosing this set of offers are as follows: (i) it involves acceptance subgames in which (reject, reject) is a risk-dominant Nash equilibrium, and a risk-dominated Nash equilibrium; (ii) offers equal to (650, 650) generate equal payoffs for seller and buyers, and hence, might be used to assess fairness considerations; (iii) offers equal to (800, 800) allow for comparison with previous studies on coordination games (see Cooper et al. (1992)); finally, (iv) from a behavioral point of view, these offer values are large enough to trigger subjects' attention and effort on maximizing their payoffs, and simple enough to minimize subjects' computational efforts.

To make the experimental environment more subject-friendly, we restricted the seller's payoff to be nonnegative. Then, a pair of offers equal to (1100, 1100), which would generate a negative seller's payoff was not included in the offer set for the no-discrimination conditions.

<sup>16</sup>For a more general version of this proposition and a formal proof, see SW's Proposition 1.

<sup>17</sup>We restrict attention here to pure-strategy equilibria. There are also mixed-strategy equilibria in the acceptance subgame. To avoid addition complexity, we decided not to include a randomization device (see Ochs, 1995) in the design of the experiment.

<sup>18</sup>This refinement requires that equilibria be immune to self-enforcing coalition deviations.



we might expect exclusion equilibria to emerge in practice. So-called “strategic uncertainty” arises from the conflict between the players’ common motive to coordinate on (reject, reject) and earn 1000 each and the private motive to avoid the “risk” of getting nothing if the other person accepts. The (reject, reject) equilibrium is risk dominated in the sense of Harsanyi and Selten (1988) by the (accept, accept) equilibrium for transfers  $x > 500$ .<sup>19</sup> Hence, for offers  $x \in \{650, 800\}$ , the exclusion equilibria are risk-dominant.

*Proposition 2.*<sup>20</sup> *Suppose the incumbent seller is able to discriminate between the buyers. There are multiple subgame perfect Nash equilibria, all of which involve exclusion. In these equilibria,  $x_1 + x_2 \leq 1200$  and both buyers accept.*<sup>21</sup>

When discrimination is possible, the incumbent seller may adopt a *divide-and-conquer* strategy and offer 1100 to one buyer and 100 to the other. The acceptance subgame has a unique Nash equilibrium in this case. It is a dominant strategy for the buyer who is offered 1100 to accept and, knowing this, the buyer with the low offer of 100 will accept as well. Indeed, SW show that this is the unique coalition-proof Nash equilibrium of the game. There are additional discriminatory equilibria where the incumbent seller offers (100, 650), (650, 100), (100, 800), and (800, 100) and both players accept.<sup>22</sup> Finally, the incumbent seller may choose to forego discrimination altogether and offer (100, 100). Although the acceptance of these offers by the buyers in the acceptance subgame is both Pareto dominated and risk dominated by (reject, reject),<sup>23</sup> it is still conceivable for the incumbent seller to exclude the entrant in this way. Finally, note that all equilibria involve exclusion when discrimination is possible.<sup>24</sup>

Table 2 summarizes the results of Propositions 1 and 2.

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<sup>19</sup>Consider a 2X2 game with the following payoffs:  $(A, a)$  if both players choose accept;  $(C, b)$ , if player 1 chooses accept and player 2 chooses reject;  $(B, c)$  if player 1 chooses reject and player 2 chooses accept;  $(D, d)$  if both players choose reject. According to Harsanyi and Selten’s (1988) definition of risk dominance, (reject, reject) risk dominates (accept, accept) if the product of the deviation loss is higher for (reject, reject), i.e., if  $(C - D)(c - d) \geq (B - A)(b - a)$ .

<sup>20</sup>For a more general version of this proposition and a formal proof, see SW’s Proposition 3.

<sup>21</sup>Note that despite offers  $(x_1, x_2)$  such that  $x_1 + x_2 < 1200$  induce exclusion and no-exclusion Nash equilibria in the acceptance subgame, only exclusion equilibria can be part of a subgame perfect Nash equilibrium. The reason is that offers  $(x_1, x_2) \in \{(100, 1100), (1100, 100)\}$  generate a payoff for the incumbent equal to 750, any play which involves offers  $(x_1, x_2)$  such that  $x_1 + x_2 < 1200$  in the first sub-period and rejection in the second sub-period will generate a payoff for the incumbent equal to 0, which is strictly lower than 750. Hence, these plays cannot be part of a subgame perfect Nash equilibrium. Pairs of offers  $x_1 + x_2 > 1200$  are strictly dominated strategies for the incumbent. This rules out offers equal to (650, 650), (800, 800), (650, 800), (800, 650), (650, 1100), (1100, 650), (800, 1100), and (1100, 800). We do not consider mixed-strategy equilibria.

<sup>22</sup>These offers create an asymmetric coordination game for the buyers.

<sup>23</sup>For off-equilibrium offers equal to (650, 650) and (800, 800), (accept, accept) is the risk-dominant equilibrium, and (reject, reject) is the Pareto-dominant equilibrium.

<sup>24</sup>If there was an equilibrium where entry took place, the incumbent could prevent it by offering (1100, 100).

Table 2: Subgame Perfect N.E. (Seller's Offers and Buyers' Responses)

	Seller's Offers	Buyers' Responses
<hr/> No-Discrimination <hr/>		
	(100, 100)	(A, A), (R, R)
	(650, 650)	(A, A), (R, R)
	(800, 800)	(A, A), (R, R)
<hr/> Discrimination <hr/>		
	(100, 100)	(A, A)
	(100, 650)/(650, 100)	(A, A)
	(100, 800)/(800, 100)	(A, A)
	(100, 1100)/(1100, 100)	(A, A)

### 3 Qualitative Hypotheses

The qualitative hypotheses are as follows.

*Hypothesis 1. Discrimination will increase the likelihood of exclusion.*

According to our theoretical point predictions for the discrimination environment, offers equal to (100, 1100) or (1100, 100), *divide-and-conquer* offers, will trigger acceptance by both buyers as the unique Nash equilibrium in the acceptance subgame. For the other equilibrium offers, multiplicity of equilibria, similar to the one encountered in the no-discrimination regime, will occur in the acceptance subgame. Note, however, that, in contrast to the no-discrimination regime, rejection by both buyers cannot be part of any subgame perfect Nash equilibrium in the discrimination regime. As a consequence, we might expect that discrimination will increase the likelihood of exclusion.<sup>25</sup>

*Hypothesis 2. Under no-discrimination, two-sided nonbinding pre-play communication between buyers will reduce the likelihood of exclusion and will increase the amount of the seller's offers.*

Aumann (1990) and Farrell and Rabin (1996) propose two theoretical conditions for nonbinding pre-play communication to induce coordination in situations where messages have literal meanings, i.e., when each message can be mapped into a unique intended action. The first condition, self-commitment, is satisfied when the sender's message is part of a Nash equilibrium strategy profile. The second condition, self-signaling, is satisfied when the sender prefers the receiver to play the best response to a given message if and only if the sender truly intends to play the signaled action.

<sup>25</sup>Note that an exclusion rate equal to 1 is the point prediction only under discrimination.

According to Farrell and Rabin (1996), as mentioned in Duffy and Feltovich (2002), “a message that is both self-signaling and self-committing seems highly credible.”

Experimental evidence on stag hunt suggests that coordination is facilitated when communication is possible (see Ochs, 1995, for a survey on coordination games). Cooper et al. (1992) study costless signaling in stag hunt games (one-sided and two-sided pre-play communication). They find that two-way communication can be more useful than one-way communication. In fact, two-sided communication practically guarantees that subjects coordinate on Pareto-dominant equilibria. Crawford (1998) argues that communication may play an important reassurance role, allowing the sender to signal that she understands the structure of the game and the existence of the payoff dominant equilibrium.<sup>26</sup> Farrell (1987) clearly states a rationale for these findings: if the players’ pre-play announcements constitute a Nash equilibrium, then this equilibrium becomes a focal point that induces players to follow their announced plans. Hence, we might expect that communication will increase the likelihood of coordination on (reject, reject) in the no-discrimination environments.<sup>27</sup>

Blume and Ortmann (2007) argue that communication is less effective in reducing coordination failure when subjects have a safer alternative strategy. Hence, we might expect that communication will have a weaker effect on reducing the likelihood of exclusion in case of offers higher than (500, 500), for which the Pareto efficient outcome is also the risk-dominated one. The seller has then an additional incentive (not present in the no-communication environment) to make higher offers. Hence, under no-discrimination, we might expect higher offer levels under communication as a way to attenuate the negative effect of communication on exclusion.

*Hypothesis 3. Under no-discrimination and offers greater than or equal to (650, 650), endogeneity will increase the likelihood of exclusion; otherwise, endogeneity will reduce the likelihood of exclusion.*

Findings from experimental economics and social psychology suggest that “regard for others” (i.e., interdependent preferences) influences individual decision making. Loewenstein et al. (1989) find that subjects value highly outcomes which support normative expectations about fairness and strongly disfavor outcomes which deviate from them. In addition, “[r]eciprocity [, which] refers to

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<sup>26</sup>Duffy and Feltovich (2002) study the effect of communication in games with different strategic structure and find that communication is more effective in facilitating coordination in stag-hunt games. Blume and Ortmann (2007) find that communication facilitates coordination even in case of more than two players.

<sup>27</sup>Note that despite only (accept, accept) in the acceptance subgame is part of a subgame perfect Nash equilibrium in the discrimination environments (for offers different than the divide-and-conquer offers), (reject, reject) is also a Nash equilibrium in the acceptance subgame. If subjects do not follow the subgame perfect equilibrium concept, we might expect that communication will also increase the likelihood of exclusion under discrimination.

a tendency to respond to perceived kindness with kindness and perceived meanness with meanness and to expect this behavior from others” (Sobel, 2005; p. 392), has been found to influence decision making. Finally, Blount’s (1995)<sup>28</sup> findings suggest that fairness considerations are strongly elicited when the partner is a human subject who has a stake in the outcome, and hence, intentionality behind her choices.

In our experimental environment, the seller (a strategic human partner) makes the offers only under the endogenous payoffs conditions and gets a payoff equal to zero in case of rejection by both buyers. In contrast, under the exogenous payoffs conditions, a non-strategic player (a computer-seller) makes the offers (and buyers are informed about this).<sup>29</sup> We assume here that a division of the pie that involves equal payoffs for all players, i.e., a pair of offers equal (650, 650), reflects the normative expectations about fairness. Hence, under the no-discrimination conditions, we might expect that offers greater than (650, 650) would be perceived by buyers as “kind” offers. Given that buyers’ considerations about fairness will be stronger in case of a human seller, we might expect that their reciprocity considerations will be also stronger under payoffs endogeneity. As a consequence, we might expect that the likelihood of rejection of these offers will be lower for the endogenous payoff conditions. Following the same line of analysis, for offers equal to (100, 100), we expect a higher likelihood of rejection under endogeneity.<sup>30</sup>

*Hypothesis 4. Under no-discrimination, higher seller’s offers will increase the likelihood of exclusion.*

According to our theoretical point predictions for the no-discrimination environments, the three possible sets of equilibrium offers, (100, 100), (650, 650) (800, 800), trigger (accept, accept) and (reject, reject) as Nash equilibria in the acceptance subgame. Cooper et al. (1990) suggest that risk-dominance is generally the equilibrium selection criterion chosen by subjects when there are multiple equilibria.<sup>31</sup> In our setting, the exclusion equilibrium is risk- dominated by the entry equilibrium for offer levels lower than (500, 500). Then, for offers greater than (500, 500), we might

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<sup>28</sup>We thank Rachel Croson for pointing out this study.

<sup>29</sup>To make the exogenous and endogenous payoffs conditions comparable, the computer-seller was programmed to follow the same sequence of offers made by the human-sellers in the corresponding endogenous payoffs conditions (see the Experimental Design section for details).

<sup>30</sup>In case of pairs of offers involving different payoffs for the buyers (and different from the *divide-and-conquer* offers), which by nature depart from the normative expectations about fairness (equal payoffs for all players), we might expect a higher likelihood of rejection. In case of the *divide-and-conquer* offers, and given that these offers violate the normative expectations about fairness, we might expect that the likelihood of rejection would be higher under endogeneity, only if players do not follow the Nash equilibrium concept.

<sup>31</sup>Burton and Sefton (2004) provide additional powerful evidence of the role of riskiness in the choice of a strategy.

expect that the exclusion equilibrium will be selected.<sup>32</sup>

## 4 Experimental Design

In assessing the validity of the theoretical predictions and the behavioral predictions derived from previous experimental studies, our experimental study analyzes the effect of discrimination, non-binding pre-play communication, and payoff endogeneity on the exclusionary power of exclusive contracts.

We specify the experimental setting in a way that satisfies the assumptions of the theory, use a free-context environment and human subjects paid according to their performance. Although our experiment cannot predict the effects of exclusive contracts in richer environments, the experiment can provide a reasonable amount of evidence regarding whether discrimination, nonbinding pre-play communication, and payoff endogeneity in an environment such as the one we have structured here will have the predicted effects.<sup>33</sup>

The experimental design consists of two buyers' payoff treatments, two offer treatments, and two communication treatments. The buyers' payoff treatments are exogenous payoffs and endogenous payoffs. The offer treatments are no-discrimination and discrimination. The communication treatments are no communication and two-way buyer-buyer communication.<sup>34</sup> A combination of these treatments will then generate eight experimental conditions as summarized in Table 3.

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<sup>32</sup>Note that for the case of discrimination, offers equal to (100, 100), (100, 650), (650, 100), (100, 800), (800, 100) trigger (accept, accept) and (reject, reject) as the N.E. in the acceptance subgame, with (reject, reject) as the Pareto-dominant and risk-dominant equilibrium. Then, if we consider riskiness here, despite only (accept, accept) is part of any subgame perfect Nash equilibrium, (reject, reject) is the most likely N.E. to be selected in the acceptance subgame. Note also that offers equal to (100, 1100) or (1100, 100), *divide-and-conquer* offers, which represent the highest sum of equilibrium offers, will trigger (accept, accept) as the unique Nash equilibrium in the acceptance subgame. The *divide-and-conquer* property of those offers (and not the fact that they represent the highest sum of equilibrium offers) is the one that triggers exclusion.

<sup>33</sup>To ensure control and replicability, and given the purpose of this study is to test the game theoretic predictions of Segal and Whinston (2000) and to assess the robustness of these predictions to communication and payoff endogeneity, we use a free-context experiment. If our findings in this simple environment do not conform to the theory, there is little hope that this theory can explain subjects' behavior in more complex settings (see Davis and Holt, 1993). Hence, our experiment might provide useful feedback to improve the theory.

<sup>34</sup>Farrell (1987) states that cheap talk is hard to model because "there are no obviously right rules about who speaks when, what she may say, and when discussion ends" (p. 209). In order to provide useful feedback to game theorists, this experiment will impose a specific structure to the communication treatment: the only message that a buyer can send to the other buyer is whether she intends to accept or reject the offer.

Table 3: Experimental Conditions

	Endogenous Payoffs	Exogenous <sup>(1)</sup> Payoffs
No-Discrimination/ No-Communication	EN/ND/NC [30, 120]	EX/ND/NC [20, 120]
No-Discrimination/ Communication	EN/ND/C [30, 120]	EX/ND/C [20, 120]
Discrimination/ No-Communication	EN/D/NC [36, 144]	EX/D/NC [24, 144]
Discrimination/ Communication	EN/D/C [33, 132]	EX/D/C [22, 132]

Note: <sup>(1)</sup>In the exogenous conditions, each group encompasses 2 human subjects (in addition to the computer-seller); number of subjects, and observations (number of groups for the 12 rounds) are in brackets.

## 4.1 The Games

Procedural regularity is accomplished by developing a software program that permits subjects to play the game by using networked personal computers.<sup>35</sup> The software consists of 8 versions of the game, reflecting the eight experimental conditions. The experiment is a three-player, two-stage game. Subjects play the role of seller (the incumbent monopolist), buyer 1, or buyer 2.<sup>36</sup> We use a laboratory currency called the “token” (650 tokens = 1 US dollar).<sup>37</sup>

The benchmark game corresponds to the environment presented in Segal and Whinston (2000) for the case of no-discrimination (i.e., endogenous payoffs/no-discrimination/no communication condition). In the first stage, the seller makes simultaneous exclusionary offers to both potential buyers. The offers consist of transfers of money from the seller to the buyers in exchange of agreeing to buy only from that seller. In the second stage, after observing both offers, each buyer decides whether to accept or reject the exclusive contract. Variations of this benchmark game satisfy the other experimental conditions. These are as follows: (i) in the no-discrimination conditions, the instructions to the seller specify that both offers should be the same. In the discrimination conditions,

<sup>35</sup>Software screens and a complete set of instructions are available upon request.

<sup>36</sup>We use neutral labels for the subjects' roles (Player A, for the seller, and Players B1 and B2, for the two buyers) because we consider that the use of more realistic labels (i.e., seller and buyer) are not necessary to improve subjects' understanding due to the simple experimental environment, and that these labels might generate noise in the subjects' responses due to the degree of identification with the role described by the label.

Note that the roles of buyer 1 and buyer 2 are similar.

<sup>37</sup>The use of tokens allows us to create a fine payoff grid that underlines the payoff differences among actions (see Davis and Holt, 1993).

however, the instructions specify that both offers might be different; (ii) in the communication conditions, pre-play communication between buyers (through computer terminals) is allowed.<sup>38</sup> The seller is not informed about the content of this communication; (iii) in the exogenous payoffs conditions, the computer chooses the offers in the first stage (i.e., a non-strategic computer-seller) and subjects are informed about this. Each exogenous session is matched with a previously run endogenous session and the computer seller is programmed to follow the pattern of offers made by the human seller in the corresponding endogenous session.<sup>39</sup> Note also that both the exogenous and endogenous conditions involve two stages.

## 4.2 The Experimental Sessions

We ran sixteen 70-minute to 90-minute sessions<sup>40</sup> of 9 to 21 subjects each (two sessions per condition, 215 subjects in total) at experimental laboratories of Northwestern University. The subject pool was recruited from undergraduate and graduate classes at Northwestern University, mostly by posting advertisements on public boards and on an electronic bulletin board.<sup>41</sup>

At the beginning of each experimental session, written instructions were provided to the subjects (see Appendix for a sample of instruction for the EN/D/C condition).<sup>42</sup> The instructions about the game and the software used were verbally presented by the experimenter to create common

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<sup>38</sup>Each buyer has the option to inform her *intention* of acceptance or rejection of the seller's offer to the other buyer. Communication occurs immediately after the information about the offers is provided to the buyers, and before each buyer reports her *decision* of acceptance or rejection of the offer.

<sup>39</sup>Specifically, in order to make the endogenous and exogenous conditions comparable, (i) for each exogenous payoff session, the formation of groups (pair of buyers in this case) replicates the randomization process of forming groups followed by the corresponding endogenous session; (ii) to ensure that the sequence of offers received by each individual buyer in the exogenous conditions followed the same pattern than the sequence of offers made by the sellers to each individual buyer in the corresponding endogenous payoffs condition, each buyer in the exogenous payoff conditions was matched with a buyer in the corresponding endogenous condition and followed the same pattern of offers (and matching process with other buyers).

<sup>40</sup>Given that the exogenous payoffs conditions did not involve a seller's decision, the sessions run on these conditions lasted 70 minutes.

<sup>41</sup>The pool of subjects encompasses graduate and undergraduate students from a wide variety of fields of study.

Note that we could use professionals, such as experienced lawyers as subjects. Croson (2002) states that, "if professionals in this area have particular sets of experiences or biases that have developed in the field, and these will exhibit themselves once the policy is in place, ... you want those experiences also to be exhibited in the lab... [However, there] are also risks to using professionals as subjects ... professionals may bring to the experiment incentives and institutions that exist in the world but not in the experimental design, they may have opinions about implications of the experiment and try to influence the results to impact policy, and they may not prepare for the experiment as carefully as students participants given that it would be more difficult to generate the right monetary incentives" (p. 936). Given the use of minimum context in our experiment and evidence from previous experimental studies, we could expect that both groups, students and professionals, would behave similarly (see Dyer, et al., 1989). Taking into account the potential problems in terms of motivating tools (and the other issues reported in Croson, 2002) in using professionals as subjects, we decided to use students as subjects in our experiment.

<sup>42</sup>Instructions for the other conditions are available upon request.

knowledge. Subjects were informed about the random process of allocating roles and about the randomness and anonymity of the process of forming groups. Game structure, possible choices, payoffs, were common information among subjects. Subjects were informed only about the game version they were assigned to play. Subjects were also instructed that they would receive the dollar equivalent of the tokens they hold at the end of the experiment, and they were informed about the token/dollar equivalence. Finally, subjects were required to fill out a short questionnaire to ensure their ability to read the information tables. The rest of the session was entirely played using a computer terminal and the software designed for this experiment.

The experimental sessions encompassed three practice rounds<sup>43</sup> and twelve actual rounds.<sup>44</sup> After the last practice round, every participant was randomly assigned a role.<sup>45</sup> At the beginning of each round, new three-subject groups were randomly and anonymously formed. Buyers did not play in the same group in two immediately consecutive rounds.<sup>46</sup> At the end of each round, subjects received information only about their group results and payoffs.

Communication between players was done through a computer terminal, and therefore, players were completely anonymous to one another. Hence, this experimental environment did not permit the formation of reputations. Given the randomization process used to form groups, and the diversity of payoff matrices that subjects confronted (due to the heterogeneity of offers), the twelve actual rounds do not represent stationary repetitions of the game. Consequently, we can treat each round as a one-shot experience.

The average payoff was \$26, for a time commitment of approximately 80 minutes.<sup>47</sup> At the end of each experimental session, subjects received their monetary payoffs in cash.

## 5 Results

The main findings will be presented in a series of results.

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<sup>43</sup>In case of the endogenous payoffs conditions, each player experiences the roles of seller and buyer at least once.

<sup>44</sup>Note that the outcomes from the three practice rounds are not considered in the computation of players' payoffs. Hence, during these practice rounds subjects have more incentive to experiment with the different options and hence, learn about the consequence of their choices. Given that the purpose of this study is to test the theoretical predictions of RRW-SW model, and given that equilibrium behavior is more likely to emerge after several rounds of play (Ochs, 1995), we will use only the last six actual rounds in our statistical tests.

<sup>45</sup>If the subject got a role of seller, this role remained until the last round. On the other hand, if the subject got a role of a buyer, the computer randomized between B1 and B2 (buyer 1 and buyer 2) at the beginning of each round.

<sup>46</sup>The computer was programmed to form groups taking into account this restriction and the maximization of the number of different groups in a twelve-period session.

<sup>47</sup>The participation fee was \$10 per hour.



## 5.1 Data Summary

Table 4 provides the descriptive statistics for the sum of seller's offers, exclusion rate, seller's payoff, sum of buyers' payoffs, and the deadweight loss (DWL).

The sum of seller's offers is defined as the sum of offers made by the seller to both buyers. Note that this discrete variable allows us to explore the different combinations of offers a seller can make.<sup>48</sup> The exclusion rate is defined as the percentage of total groups with one or both buyers accepting the seller's offer. The DWL variable is a dichotomous variable, equal to 0 if (reject, reject) is achieved (the efficient outcome), and equal to 50 otherwise.

Table 5 provides a more detailed description of the offers made by the sellers and the buyers' responses per pair of offer (frequencies and exclusion rates per pair of offers). So, for example, in the EN/ND/C condition, the sellers choose to offer (650, 650) in 74 out of 120 observations. In 39% of these observations, one or both buyers accepted. When these offers were part of the exogenous condition, EX/ND/C, then only 7% of the offers were accepted.

Figures 1, 2, and 3 show the exclusion rates by treatment. Figure 1 suggests that, when communication is present, discrimination increases exclusion rate.

[INSERT FIGURE 1]

Figure 2 shows the negative effects of communication on exclusion rates.

[INSERT FIGURE 2]

Note also that communication affects the patterns of offers chosen by seller (see Table 5).<sup>49</sup> For instance, sellers' offers are higher in the communication environment, when discrimination is not allowed. More specifically, in the no-discrimination/no-communication environment, the mode sum of seller's offers is equal to 1300 (93% of all offers are equal to (650, 650), and offers equal

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<sup>48</sup>Note also that each different pair of offers (i.e., pairs of offers that generate *different* strategic structure in the acceptance subgame) maps into a different sum of offers. Pairs of offers equal to  $(a, b)$  and  $(b, a)$  generate the same strategic structure in the acceptance subgame and therefore, map into the same sum of offers. Note also that the ordinal information provided by this variable is relevant only to the analysis of the no-discrimination conditions: higher sums of offers generate lower levels of risk for the (accept, accept) equilibrium. In case of discrimination, however, this ordinal information is irrelevant. Remember that under discrimination, each pair of equilibrium offers (except for the *divide-and-conquer* offers) involve (i) multiple N.E. in the acceptance subgame, (accept, accept) and (reject, reject), with only (accept, accept) as part of any subgame perfect Nash equilibrium. Note also that (accept, accept) is the risk dominated equilibrium for all equilibrium pair of offers, i.e., the sum of offers does not influence the degree of risk of the (accept, accept) equilibrium; and, (ii) (accept, accept) as the unique Nash equilibrium in the acceptance subgame under the *divide-and-conquer* offers. Note that uniqueness is triggered by the *divide-and-conquer* property of the pairs of offers (100, 1100) and (1100, 100) (and not because these pairs of offers represent the highest sum of equilibrium offers in the discrimination environment).

<sup>49</sup>Note that the ability to discriminate by choosing two different offers in the discrimination environment might influence the pattern of offers chosen by subjects and hence, the sum of seller's offers. Hence, it is meaningful only to perform a test of comparisons of sums of seller's offers for the communication and no communication environments.

Table 4: Descriptive Statistics

Condition	Mean Sum of Seller's Offers <sup>(1)</sup>	Exclusion Rate	Mean Seller's Payoff <sup>(2)</sup>	Mean Sum of Buyers' Payoffs	Mean DWL
EN/ND/NC [120]	1261.67 (227.22)	.92	680.42 (311.76)	1273.75 (321.10)	45.83 (13.88)
EN/ND/C [120]	1310.00 (345.54)	.43	302.08 (424.78)	1676.67 (445.61)	21.25 (24.82)
EN/D/NC [144]	1159.38 (161.18)	.82	707.64 (406.47)	1251.39 (422.44)	40.97 (19.30)
EN/D/C [132]	1162.88 (157.22)	.79	646.21 (401.08)	1314.39 (418.45)	39.39 (20.52)
EX/ND/NC [120]	1261.67 (227.22)	.81	729.17 (464.84)	1230.42 (480.17)	40.42 (19.76)
EX/ND/C [120]	1310.00 (345.54)	.12	89.58 (284.83)	1904.58 (298.95)	5.83 (16.12)
EX/D/NC [144]	1159.38 (161.18)	.81	697.22 (405.33)	1262.50 (422.30)	40.28 (19.86)
EX/D/C [132]	1162.88 (157.22)	.61	496.97 (434.92)	1472.73 (457.69)	30.30 (24.52)

Note: <sup>(1)</sup>The offers made by the computer-seller in the exogenous payoffs sessions replicate the pattern of seller's offers in the corresponding endogenous payoffs sessions. <sup>(2)</sup>For the exogenous payoffs conditions, the Mean Seller's Payoff corresponds to the mean computer-seller's payoff; standard deviations are in parentheses; sample sizes (number of groups) are in brackets.

Table 5: Frequency of Seller's Offers and Exclusion Rate per Pair of Offers

Condition	(100, 100)	(100, 650) (650, 100)	(100, 800) (800, 100)	(100, 1100) (1100, 100)	(650, 650)	(650, 800) (800, 650)	(800, 800)	Total Offers
EN/ND/NC	5 [.00, .00]				112 [.96, .84]		3 [1.00, 1.00]	120
EN/ND/C	9 [.00, .00]				74 [.39, .07]		37 [.59, .24]	120
EN/D/NC	0	8 [.25, .00]	20 [.25, .50]	83 [1.00, .99]	31 [.84, .71]	1 [1.00, 1.00]	1 [1.00, 1.00]	144
EN/D/C	2 [.00, .50]	4 [.25, .00]	6 [.00, .17]	113 [.88, .69]	7 [.43, .00]	0	0	132

Note: Exclusion rates are in brackets (the first number corresponds to the endogenous payoffs conditions, and the second number corresponds to the exogenous payoffs conditions); set of offers equal to (650, 1100)/(1100, 650) and (800, 1100)/(1100, 800) were not chosen by any seller in any condition, and hence, are not included in this table.

to (800, 800) are rarely offered (3%). Under communication, however, sums of seller's offers equal to 1300 represent only 62% of total offers, while sums of offers equal to 1600, i.e., offers equal to (800, 800), represent 31% of total offers.

When discrimination is allowed, however, sellers make lower sum of offers in the communication environment. Specifically, under no-communication, the mode sum of seller's offers is equal to 1200, 58% of all offers are equal to (100, 1100) or (1100, 100), and sums of seller's offers equal to 1300, i.e., offers equal to (650, 650), represent 22% of total offers (despite these offers are not equilibrium offers under discrimination).<sup>50</sup> Under communication, however, sum of offers equal to 1300 are chosen only by 5% of sellers, and sums of offers equal to 1200, i.e., offers equal to (100, 1100) or (1100, 100), represent 86% of total offers (mode sum of offers). Note, however, that what matters for exclusion in the discrimination environment is the *divide-and-conquer* property of the (100, 1100) and (1100, 100) offers. These results suggest that communication induces the choice of equilibrium offers in discrimination environments.

The offers chosen by sellers in the discrimination and no-discrimination environments also provide some information about sellers' fairness considerations. Remember first that a sum of seller's

<sup>50</sup>Note that this pattern of choosing off-equilibrium offers equal to (650, 650) when communication is not allowed is also strongly present during the last six rounds of play: 24% of sellers choose these offers during the last six rounds.

offers equal to 1300, a pair of offers equal to (650, 650), represents the *fair* set of offers, in the sense that if these offers are accepted, the payoffs for buyers and sellers will be equal. When communication is not allowed, we observe that, in the no-discrimination environment, 93% of all offers are equal to (650, 650). Under discrimination, however, sums of seller's offers equal to 1300 represent only 22% of total offers, while sums of offers equal to 1200, i.e., offers equal to (100, 1100) or (1100, 100), represent 58% of total offers (mode sum of offers). Similarly, when communication is allowed, we observe that, in the no-discrimination environment, the mode sum of seller's offers is equal to 1300. Note, however, that a lower percentage of sellers (with respect to the no-discrimination/no-communication environment) choose these offers (62% of all offers are equal to (650, 650)). In fact, sellers more frequently choose offers equal to (800, 800) (31% versus 3%, for the communication and no-communication environments, respectively). Under discrimination, however, sum of offers equal to 1300 were chosen only by 5% of sellers, while sum of offers equal to 1200 (i.e., offers equal to (100, 1100) or (1100, 100)), represent 86% of total offers (mode sum of offers). These results might suggest that the choice of (650, 650) does not obey to fairness considerations, and provide some evidence of sellers' strategic behavior (seller's anticipation of higher likelihood of buyers' coordination under communication).

Figure 3 suggests that endogeneity increases exclusion rates.

[INSERT FIGURE 3]

## 5.2 Analysis

We now use regression analysis to more thoroughly test the conclusions from our visual analysis of the data. Such formal tests are of added value for the following reason: the figures implicitly treat each observation within a session as independent even though each person plays in 12 rounds and interacts with other players during the session. Our regression analysis involves standard errors that are robust to general forms of heteroskedasticity and hence, they account for the possible dependence within session.

### *Exclusion Rates*

Table 6 presents a more detailed picture of the effect of each treatment on exclusion. We take pairs of conditions and estimate probit models.<sup>51</sup> Each probit model includes a treatment dummy

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<sup>51</sup>Specifically, we assess (i) the effect of discrimination, in no-communication and endogeneity environments, no-communication and exogeneity environments, communication and endogeneity environments, and communication and exogeneity environments; (ii) the effect of communication, in no-discrimination and endogeneity environments, no-discrimination and exogeneity environments, discrimination and endogeneity environments, and discrimination and

Table 6: Effects of Treatments on the Probability of Exclusion  
(Tests of Differences across Conditions)

Discrimination		Communication		Endogeneity	
Conditions	Marginal Effects	Conditions	Marginal Effects	Conditions	Marginal Effects
EN/ND/NC vs. EN/D/NC Observations	-.097** (.035) 264	EN/ND/NC vs. EN/ND/C Observations	-.496*** (.108) 240	EX/ND/NC vs. EN/ND/NC Observations	.104 (.072) 240
EN/ND/C vs. EN/D/C Observations	.363*** (.115) 252	EN/D/NC vs. EN/D/C Observations	-.031 (.053) 276	EX/ND/C vs. EN/ND/C Observations	.318*** (.112) 240
EX/ND/NC vs. EX/D/NC Observations	-.006 (.104) 264	EX/ND/NC vs. EX/ND/C Observations	-.692*** (.067) 240	EX/D/NC vs. EN/D/NC Observations	.013 (.082) 288
EX/ND/C vs. EX/D/C Observations	.494*** (.060) 252	EX/D/NC vs. EX/D/C Observations	-.200* (.099) 276	EX/D/C vs. EN/D/C Observations	.182** (.077) 264

Note: The columns report the change in the probability of exclusion due to discrimination, communication, and exogeneity (probit analysis using sessions as clusters; marginal effects reported); robust standard errors are in parentheses; \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively; observations correspond to number of groups.

variable and round as its regressors. The treatment dummy variable is constructed as follows. For example, for the case of the probit model that assesses the effect of communication under no discrimination and endogenous offers, the dummy variable will take a value equal to 1 if the observation pertains to the condition EN/ND/C, and a value equal to 0 if the observation pertains to the condition EN/ND/NC.<sup>52</sup> The standard errors computed here are robust to general form of heteroskedasticity and hence, they account for the possible dependence within session. Marginal effects of treatments are reported here.<sup>53</sup>

The effects of discrimination on the probability of exclusion are reported in the second column of Table 6. Discrimination significantly increases the likelihood of exclusion, when communica-

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exogeneity environments; and, (iii) the effect of payoff exogeneity in no-discrimination and no-communication environments, no-discrimination and communication environments, discrimination and no-communication environments, and discrimination and communication environments.

<sup>52</sup>The data for conditions EN/ND/C and EN/ND/NC is pooled to estimate this probit model.

<sup>53</sup>The variable round was statistically significant only for the probit models involving EX/ND/NC vs. EX/D/NC, EN/ND/NC vs. EN/ND/C, and EN/ND/C vs. EX/ND/C. The marginal effects are equal to .018 ( $p$ -value = .002), -.017 ( $p$ -value = .048), and -.027 ( $p$ -value < .001), respectively).

tion is present. In fact, as a result of discrimination, higher exclusion rates are observed: 79 vs. 43%, for the EN/D/C and EN/ND/C conditions, respectively; and, 61 vs. 12%, for the EX/D/C and EX/ND/C conditions, respectively. Thus, when communication is present, there is clear support to Hypothesis 1. When communication is not present and offers are endogenous, we observe, however, that discrimination reduces the likelihood of exclusion: 82 vs. 92%, for the EN/D/NC and EN/ND/NC conditions, respectively. This last result, which was not anticipated by Hypothesis 1, can be explained by the high percentage of sellers (19%) who choose discriminatory offers different from the effective *divide-and-conquer* offers (i.e., offer equal to  $(100, 650)/(650, 100)$  or  $(100, 800)/(800, 100)$  and the low percentage of cases in which at least one buyer accepts those offers (25% for both sets of offers).

*Result 1: When buyers can communicate with each other, discrimination significantly increases the exclusion rate. When the buyers cannot communicate and the offers are endogenous, discrimination reduces the exclusion rate.*

The results about the effects of communication on the probability of exclusion are reported in the fourth column of Table 6. Communication significantly decreases the likelihood of exclusion, when discrimination is not possible. This result supports Hypothesis 2. The comparisons are 43% vs. 92%, for the EN/ND/C and EN/ND/NC conditions and 12% vs. 81%, for the EX/ND/C and EX/ND/NC conditions. Interestingly, communication lowers the exclusion rate in the discrimination environment when offers are exogenous (61% and 81%, for the EX/D/C and EX/D/NC conditions, respectively). This result was not anticipated in Hypothesis 2.<sup>54</sup> Our findings also suggest that communication does not have a significant effect on exclusion when both discrimination and endogeneity are allowed (79% and 82% for the EN/D/C and EN/D/NC conditions, respectively).

*Result 2: When the seller cannot discriminate, communication between the buyers significantly reduces the exclusion rate. When discrimination and exogeneity are allowed, communication reduces the exclusion rate (although to a lesser extent and with smaller significance.)*

The sixth column of Table 6 reports the results on the effects of endogeneity on the probability of exclusion. Endogeneity significantly increases the likelihood of exclusion under no-discrimination

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<sup>54</sup>Without communication, 99% of the buyers accepted *divide-and-conquer* offers. With communication, only 69% did so.

and communication environments. This result can be explained as follows. Under endogeneity, fairness and reciprocity considerations are strongly elicited. Hence, under no-discrimination, buyers will be more willing to accept seller's offers greater than or equal to (650, 650), which represent 93% of the total offers, for the communication environment. As a result, higher exclusion rates are observed under endogeneity (43 vs. 12%, for the EN/ND/C and EX/ND/C conditions, respectively). Thus, there is clear support to Hypothesis 3, under no-discrimination and communication.

Under discrimination, we expect that endogeneity will trigger lower acceptance of *divide-and-conquer* offers (which represent 86% of the total offers in communication environments), only if fairness and reciprocity considerations are strong enough to induce off-equilibrium behavior on buyers. However, contrary to these predictions, the highest exclusion rate occurs under endogeneity (88 vs. 69%, in case of *divide and conquer* offers, and 79 vs. 61%, for all offers; for the EN/D/C and EX/D/C conditions, respectively). These results suggest that, under endogeneity, *divide-and-conquer* offers not only preclude the elicitation of fairness and reciprocity considerations on buyers but also induce equilibrium behavior on buyers.

*Result 3: Under communication, endogeneity significantly increases the exclusion rate.*

In terms of marginal effects, communication shows the strongest effect (with the greatest impact in exogeneity and no-discrimination environments), followed by discrimination (with the greatest impact in exogeneity and communication environments). The lowest effect is shown by exogeneity (with the greatest impact in no-discrimination and communication environments).

### ***Seller's Offers***

Table 7 reports the results of the analysis of the effect of communication on the mode sum of seller's offers, i.e., probit estimations. Robust standard errors and marginal effects are reported.<sup>55</sup> Note that pair of offers equal to (650, 650) are the mode seller's offers for the no-discrimination environments (under no-communication and communication), and pairs of offers equal to (100, 1100) or (1100, 100) are the mode seller's offers for the discrimination environments (under no-communication and communication).

The second column indicates that communication significantly reduces the likelihood of getting pair of offers equal to (650, 650) in environments that do not allow for discrimination. In fact,

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<sup>55</sup>Regression analysis includes round as an additional regressor. The effect of round is statistically significant only in case of the probit model corresponding to EN/ND/NC vs. EN/ND/C. The marginal effect is equal to  $-.005$  ( $p$ -value  $< .001$ ).

Table 7: Effect of Communication on the Likelihood of Mode Seller's Offers  
(Tests of Differences across Conditions)

Conditions	(650, 650)	(100, 1100) or (1100, 100)
EN/ND/NC vs.	-.317***	<i>n.a.</i> <sup>(1)</sup>
EN/ND/C	(.052)	
Observations	240	
EN/D/NC vs.	-.164*	.282*
EN/D/C	(.121)	(.141)
Observations	276	276

Note: Probit analysis using sessions as clusters; <sup>(1)</sup>pairs of offers (100, 1100) or (1100, 100) are not in the set of possible offers under no discrimination; marginal effects are reported; robust standard errors are in parentheses; \*\*\* and \* denote significance at the 1% and 10% levels, respectively; observations correspond to number of groups.

when communication is allowed in those environments, sellers move from offering (650, 650) in the majority of the cases (93%) to offering (650, 650) in 62% of the cases and (800, 800) in 31% of the cases.<sup>56</sup> This seller's behavior might be explained by the seller's anticipation of higher coordination (on rejection) between buyers under communication.

The third column indicates that, in environments where discrimination is allowed, communication seems to elicit equilibrium behavior on sellers. In fact, communication has a (marginally) significant and positive effect on the likelihood of getting a pair of offers equal to (100, 1100) or (1100, 100), i.e., the likelihood of *divide-and-conquer* offers increases with communication, and a significant and negative effect on the likelihood of getting a pair of offers equal to (650, 650). The data suggest that in those environments, sellers move from offering (650, 650) in 22% of the cases and (100, 1100) or (1100, 100) in 58% of the cases to offering (100, 1100) or (1100, 100) in 86% of the cases and choosing (650, 650) in only 5% of the cases.

*Result 4: Communication significantly affects the choice of offers by sellers: It induces the divide-and-conquer offers in discrimination environments and reduces the likelihood of (650, 650) offers in no-discrimination environments.*

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<sup>56</sup>A probit analysis of the effects of communication on the likelihood of getting pair of offers equal to (800, 800) shows that communication significantly increases the likelihood of getting the highest pair of offers, under no-discrimination.



Table 8: Determinants of Buyer's Acceptance

	Marginal Effects
Own Offer	.0009*** (.0001)
Partner's Offer	.0003* (.0002)
Partner's Reject Intention	-.6692*** (.0539)
<i>Divide-and-Conquer</i> Offers	.4546*** (.0421)
Endogeneity	.2890*** (.0522)
Observations (individual buyers)	1008

Note: Probit analysis using sessions as clusters; marginal effects are reported; robust standard errors are in parentheses; \*\*\* and \* denote significance at the 1% and 10% levels, respectively; only observations corresponding to conditions in which communication is allowed are included in this analysis.

### *Buyer's Response*

Thus far we have assessed the effects of the experimental treatments on exclusion and mode seller's offers, using a group-level analysis. We will now turn to an individual-level analysis of the determinants of the buyers' behavior when communication is allowed. We are especially interested in assessing the effects of the intention of rejection from the other buyer and the use of the *divide-and-conquer* offers on the buyers' decision to accept and offer.

Table 8 shows the results from a probit analysis of the determinants of acceptance, at an individual level. Robust standard errors and marginal effects at the sample mean of the regressors (except for dichotomous ones where it gives the difference in probabilities when the variable equals 1 or 0) are reported. The information presented in this table corresponds to pooled data on buyers across conditions that allow for communication, for rounds 1 to 12. The regressors are as follows: seller's offer to the buyer (Own Offer); seller's offer to her partner (Partner's Offer); a dummy variable taking value 1 if the partner's intention is to reject the offer; a dummy variable taking

value 1 if the offers are equal to (100, 1100) or (1100, 100) (*Divide-and-Conquer* Offers); and, a dummy variable taking value 1 if endogeneity is present (Endogeneity).<sup>57</sup>

These results indicate that the offer made to the individual significantly (and positively) affects the likelihood of acceptance. In addition, the offer made to her partner has also a positive and significant effect on the likelihood of acceptance. The regressors are positive and statistically significant. The marginal effects provide information about each factor's relative importance.<sup>58</sup> The variables Own Offer and Partner's Offer take equal average values (616.47), with equal standard deviation (367.44). Thus, increasing the amount of Own Offer by one standard deviation has approximately the same impact as endogeneity, i.e., it increases the probability of acceptance by 33 percentage points. An increase in the amount of Partners Offer by one standard deviation, on the other hand, increases the probability of acceptance in 11 percentage points. These results provide support to Hypothesis 4. They also suggest interdependent preferences on buyers (with the strongest regard on their own payoff). In addition, the partner's intention to reject, the use of *divide-and-conquer* offers, and the presence of endogeneity significantly influence the likelihood of acceptance. The partner's intention to reject shows the strongest relative influence on acceptance: it reduces acceptance by 67 percentage points. *Divide-and-conquer* offers increase acceptance by 45 percentage points. The weakest (but strongly significant) effect is shown by endogeneity: it increases acceptance by 29 percentage points.

*Result 5: The partner's intention to reject significantly reduces the likelihood of the buyer's acceptance of an offer.*

*Result 6: Higher seller's offers made to the buyer and her partner increase the likelihood of the buyer's acceptance of an offer.*

*Result 7: Divide-and-conquer offers significantly increase the likelihood of the buyers acceptance of an offer.*

*Result 8: Endogeneity significantly increases the likelihood of the buyers acceptance of an offer.*

### **5.3 Effect of Communication: A Comparison with Cooper et al. (1992) Study**

Tables 9 and 10 compare Cooper et al. (1992) results with our findings (last six periods of play), for the case of offers equal to (800, 800). We are considering here conditions EX/ND/NC, EX/ND/C,

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<sup>57</sup>Regression analysis includes round as an additional regressor. The effect of round is not statistically significant.

<sup>58</sup>For binary regressors, marginal effects report the change in the probability when the regressor goes from 0 to 1, keeping all other regressors at their sample mean.

Table 9: Action Pair when Offers Are (800, 800)

	Exclusion (A, A), (A, R), (R, A)	No Exclusion (R, R)
No-Communication		
EN/ND/NC	1.00	.00
EX/ND/NC	1.00	.00
Cooper et al. (1992)	1.00	.00
Communication		
EN/ND/C	.59	.41
EX/ND/C	.24	.76
Cooper et al. (1992)	.09	.91

Note: Observations for our study correspond to pooled data for rounds 1 to 12.

EN/ND/NC, and EN/ND/C. Note that our games include a first period in which the seller makes an offer. Hence, the strategic environment differs from the one presented in Cooper et al. (1992).<sup>59</sup>

Table 9 indicates that, when communication is not allowed, coordination failure is observed. Our results and Cooper et al. (1992) findings are aligned: in Cooper et al. (1992), in 97% of the pairs both buyers accepted offers equal to (800, 800), and in 3% of pairs, at least one buyer accepted the offer (i.e., (A, R) or (R, A) occurred). This corresponds to an exclusion rate of 100%. In our study (for the exogenous and endogenous payoffs conditions) all pairs of buyers accepted those offers, and exclusion rate of 100% as well. Cooper et al. (1992) argue, following Harsanyi and Selten (1988), that the play of strategy (A, A) is a consequence of strategic uncertainty over the play of an opponent. That is, unless the player believes that the likelihood an opponent will play strategy *R* is 8/10 or more, the play of strategy (A, A) is optimal. The role of communication then is to provide a basis for the strong beliefs needed to overcome coordination failures. In fact, the coordination problems are almost completely resolved by incorporating communication: in Cooper et al. (1992), 91% of pairs of buyers rejected offers equal to (800, 800). Note that, in our study, 76% of pairs rejected those offers, when exogenous payoffs are present. However, when payoff endogeneity is present, i.e., when a human seller makes an offer, only 41% of pairs of buyers rejected the offers

<sup>59</sup>Note that payoff structures might affect the play of the game. To be able to compare our findings with Cooper et al. (1992) results, then we decided to include the offer (800, 800) in the set of possible offers. Note, however, that the conditions in our study include a first stage in which the seller makes the offers.

Note that in the endogenous payoffs conditions, sellers also chose offers different from (800, 800). Note also that the frequency of offers equal to (800, 800) in the exogenous payoff conditions (with and without communication) correspond to the respective endogenous conditions. Hence, in both, the endogenous and exogenous payoffs conditions, buyers who received offers (800, 800) could also receive offers different from (800, 800). As a result, buyers' responses to offer (800, 800) might be affected by the other offers they received, and by the fact that the acceptance subgame corresponds to the second stage of the game.

Table 10: Intention vs. Action when Offers Are (800, 800)

	Intention		Action	
	Accept	Reject	Accept	Reject
<b>No-Communication</b>				
EN/ND/NC			1.00	.00
EX/ND/NC			1.00	.00
Cooper et al. (1992)			.98	.02
<b>Communication</b>				
EN/ND/C	.27	.73	.54	.46
EX/ND/C	.08	.92	.20	.80
Cooper et al. (1992)	.00	1.00	.05	.95

Note: Observations for our study correspond to pooled data on buyers for rounds 1 to 12.

and achieved coordination. These results suggest that communication is more effective in inducing coordination in exogenous payoffs environments.

The patterns of intentions and actions, displayed in Table 10, are aligned in both studies, for the case of exogenous payoffs: in Cooper et al. (1992), 100% of buyers chose  $R$  as their intention, while in our study, 92% of buyers chose  $R$  as their intention. However, under endogenous payoffs, a lower percentage of buyers reported an intention to reject the offer (73%), result that helps to explain a lower coordination rate.

The findings on the effect of communication on buyers' coordination provide support to the prediction of Harsanyi and Selten (1988, pp. 89-90) that “with preplay communication [players] may come to the conclusion that they can trust each other to choose [the payoff dominant Nash equilibrium].”

## 6 Privately Observable Offers: An Extension

An important assumption of our analysis so far has been that the offers made by the incumbent seller were public information. That is, each buyer observed not only his own exclusive contract, but also the exclusive contract offered to the other buyer. This implied that the payoffs in the acceptance subgame in Table 1 were common knowledge. This section relaxes that assumption and supposes instead that the offers made by the incumbent are privately observed by the buyers. The analysis of private offers is uninteresting when the seller is unable to discriminate, since each buyer can perfectly deduce the others' offer after seeing his own. When the seller can discriminate,

however, then the issues are more subtle. We will focus on this latter case.<sup>60</sup>

## 6.1 Theory

Recall that when offers were public and the incumbent could discriminate, there were multiple subgame perfect Nash equilibria, all of which led to the exclusion of the entrant (Proposition 2). In contrast, when offers are privately observed there is a unique (pure-strategy) perfect Bayesian Nash equilibrium.

*Proposition 3. Suppose the incumbent seller is able to discriminate between the buyers and that offers are privately observed by the buyers. There is a unique (pure-strategy) perfect Bayesian Nash equilibrium where  $x_1 = x_2 = 100$  and both buyers accept.*<sup>61</sup>

The strategies just described are supportable in equilibrium. When offers are privately observed, a buyer's optimal response depends on his beliefs about the offer made to the other buyer after observing an out-of-equilibrium offer. Suppose buyers hold passive beliefs.<sup>62</sup> Then, after receiving any offer, he believes that exclusion occurs regardless of his decision, which makes his strategy a best-response. Given this, firm  $I$ 's offering  $x_1 = x_2 = 100$  is also a best-response.<sup>63</sup>

Although (100, 100) is the only offer which is part of a pure-strategy Perfect Bayesian Nash equilibrium, we are skeptical that it will be regularly adopted in practice. For one thing, the equilibrium of the acceptance subgame, (accept, accept), is both Pareto-dominated and risk-dominated by the (reject, reject) equilibrium. It is therefore unlikely that the incumbent seller could actually

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<sup>60</sup>The case of privately observed offers was outlined in a general environment by Segal and Whinston's (1996) working paper (Appendix C).

<sup>61</sup>Segal and Whinston's (1996) characterization also includes a *divide-and-conquer* equilibrium. In their framework, the offer space was continuous and not bounded below by 100. In their setting, the incumbent could achieve exclusion with offers  $(0, x^*)$  or  $(x^*, 0)$ .

<sup>62</sup>Segal and Whinston (1996; p. 30) define passive beliefs as follows: "buyer  $i$  holds passive beliefs when even after observing an out-of-equilibrium offer, buyer  $i$  continues to believe that firm  $I$  makes its equilibrium offer  $x_j$  to every buyer  $j \neq i$ ."

<sup>63</sup>It is not hard to see why this is the unique (pure-strategy) Perfect Bayesian Nash equilibrium. Imagine instead that there was another set of offers that led to exclusion, say (100, 800), where both buyers accepted the offers. The fact that the entrant is excluded implies that at least one buyer accepts. If one buyer accepts in equilibrium, then the other buyer must accept as well. This cannot be an equilibrium because the seller could profitably deviate and offer 100 to the second buyer as well. The first buyer, not detecting the deviation (since the offers are privately observed), would accept as before. The fact that the first buyer accepts the offer is enough to prevent the entrant from entering the market. Note that the incumbent necessarily profits from this deviation, whether or not the second buyer accepts the offer of 100. Indeed, the incumbent seller is better off in this case if the second buyer rejects the offer.

Finally, there cannot exist a (pure-strategy) perfect Bayesian Nash equilibrium in which entry occurs. The monopolist could always successfully exclude the entrant through a *divide-and-conquer* strategy, offering 100 to one buyer and 1100 to the other. It is a dominant strategy for a buyer to accept 1100. Entry is deterred, so the monopolist could maintain monopoly power over the other buyer (whether or not that buyer accepts as well).

Table 12: Descriptive Statistics for the Privately Observable Offers Condition

Condition	Mean Sum of Seller's Offers	Exclusion Rate	Mean Seller's Payoff	Mean Sum of Buyers' Payoffs	Mean DWL
P/EN/D/NC	1020.83	.73	774.40	1189.29	36.31
[84]	(283.08)		(562.24)	(581.44)	(22.43)

Note: Standard deviations are in parentheses; sample size (number of groups) is in brackets.

succeed in excluding the entrant by offering (100, 100).<sup>64</sup>

## 6.2 Results

To start the exploration of the effects of privately observable offers on exclusion, we run 2 additional experimental sessions on private offers under no-communication (21 subjects in total; 84 groups). The only difference between the E/D/NC and the privately observable offers sessions (P/E/D/NC) is that buyers do not get information about their partners' offers.

Table 12 summarizes the information for the privately observable offers sessions (rounds 1 to 12). Note that the exclusion rate in case of privately observable offers is equal to 73%, and hence, lower than the one experienced under publicly observed offers (82%). As a consequence, the mean DWL generated under this condition is lower (36.31 vs. 40.97).<sup>65</sup>

Table 13 provides a more detailed description of the offers made by the sellers and the buyers' responses per pair of offer (frequencies and exclusion rates per pair of offers). Note that, despite the pair of offers (100, 100) constitutes the unique pair of offers that is part of a perfect Bayesian Nash equilibrium, only 4% of sellers in our sample made these offers. In fact, the mode sum of seller's offers is equal to 900, i.e., pairs of offers equal to (100, 800) and (800, 100). 39% of sellers chose these offers, and 67% of these offers were accepted by at least one buyer. Note also that the *divide and conquer* offers, (100, 1100) and (1100, 100), were chosen by 27% of sellers, and 97% of those offers were accepted by at least one buyer. Finally, note that, in contrast to the E/D/NC

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<sup>64</sup>The incumbent can, on the other hand, succeed in excluding the entrant by offering (100, 1100) or (1100, 100), the *divide-and-conquer* offers. After all, it is a dominant strategy for the buyer who receives the higher offer to accept. Note, however, that these offers cannot arise in a pure-strategy equilibrium. Suppose the incumbent offered (100, 1100) and both buyers accepted with certainty. Then the incumbent could secretly deviate and offer 100 to the first buyer as well. This is profitable for the incumbent, regardless of the second buyer's reaction to the deviation. Acceptance by the first buyer alone (and by assumption he accepts the 100) is enough to exclude the entrant. A full analysis of mixed strategies is beyond the scope of this paper.

<sup>65</sup>Given that the dichotomous variable DWL follows the same pattern than the exclusion variable (i.e., the DWL variable takes a value equal 50 when the exclusion variable takes a value equal 1, and a value equal to 0 otherwise), the probit analysis for both variables is the same. See the results for the probit analysis of the exclusion variable below.

Table 13: Frequency of Seller’s Offers and Exclusion Rate per Pair of Offers for the Privately Observable Offers Condition

Condition	(100, 100)	(100, 650) (650, 100)	(100, 800) (800, 100)	(100, 1100) (1100, 100)	(650, 650)	(650, 800) (800, 650)	(650, 1100) (1100, 650)	Total Offers
P/EN/D/NC	3 [.00]	12 [.42]	33 [.67]	23 [.97]	2 [.50]	10 [1.00]	1 [1.00]	84

Note: Exclusion rates are in brackets; set of offers equal to (800, 1100)/(1100, 800) and (800, 800) were not chosen by any seller, and hence, are not included in this table.

condition, offers equal to (650, 650) were chosen only by 2% of sellers.

We next conduct a probit analysis of the effects of privacy of offers on probability of exclusion. The probit model includes a treatment dummy variable and round as its regressors<sup>66</sup> and robust standard errors that account for the possible dependence of observations within a session. The results suggest that privately observed offers significantly affect the likelihood of exclusion (when communication is not present). In fact, privately observed offers reduce exclusion by 9 percentage points (a significant effect,  $p$ -value < .001).

*Result 9: Privately observable offers significantly decrease the likelihood of exclusion.*

## 7 Summary and Conclusions

Can an incumbent seller profitably foreclose a market through exclusive contracts with its buyers? This important question been debated by legal scholars, economists, and policy makers for decades. Rasmusen, Ramseyer, and Wiley (1991) and Segal and Whinston (2000) consider a theoretical model where economies of scale in production imply that an incumbent can foreclose the market by locking in some, but not all, of the downstream buyers. A collective action problem arises where the buyers are jointly better off refusing exclusive deals but may be individually tempted to accept them. Our experimental analysis shows that, when discrimination is impossible, better communication among the buyers leads to more generous offers from the seller and a greater likelihood of entry. Moreover, the exclusion rates in our study are higher than those predicted by the previous experimental work on coordination games (Cooper et. al., 1992). As predicted by Segal and Whinston (2000), we show that, in communication environments, the ability of the

<sup>66</sup>The treatment dummy variable will take a value equal to 1 if the observation pertains to the condition P/EN/D/NC, and a value equal to 0 if the observation pertains to the condition EN/D/NC. The variable round is not statistically significant.

incumbent to discriminate in the contract terms offered to the buyers enhances the effectiveness exclusionary practices. Indeed, *divide-and-conquer* strategies prove particularly effective for the seller when the buyers can communicate with each other. Exclusion is less likely when the contract offers are privately observed by the buyers. Finally, our experiment shows that endogenizing the payoffs in stag-hunt games changes the way that experimental subjects play these games.

Our results have several implications for public policy. First, our findings suggest that Naked Exclusion may be surprisingly easy for incumbent firms to achieve. Recall that without adequate communication channels and in the absence of discrimination, our subjects failed to coordinate on their preferred equilibria and entry was deterred. Coordination was particularly elusive when the incumbent seller had a human identity, being played by another student in the laboratory. In practice, the human face of a sales representative – an agent for the seller – may well elicit fairness and reciprocity considerations from the agents representing the buyer. The human tendency towards fairness and reciprocity could therefore facilitate the exclusion of faceless rivals, in the event of contracts perceived as “kind.” Second, our paper gives an efficiency rationale for permitting communication among non-competing buyers (and perhaps even allowing formal agreements). Under current antitrust law, such arrangements could be prosecuted as an illegal price-fixing arrangement. In our context, communication among buyers serves the public interest by preventing their joint coercion and facilitating entry.

Our experimental results might be also relevant in settings beyond exclusive dealing, such as the cleanup of toxic waste sites. CERCLA (the Comprehensive Environmental Response, Compensation, and Liability Act) imposes joint-and-several liability on parties who contributed to the contamination. Under this act (which is commonly known as Superfund), individual defendants can be held responsible for the damages caused by the group. Kornhauser and Revesz (1994) show that out-of-court settlement by a single defendant imposes a negative externality on remaining defendants when the defendants’ cases are sufficiently positively correlated.<sup>67</sup> Consequently, the incentives of the individual defendants to accept settlement offers can be very strong, and the defendants may end up settling out of court for far more than their claims are jointly worth. Chang and Sigman (2000) find support for this in their empirical analysis of Superfund litigation. Our experimental study provides complementary evidence for Kornhauser and Revesz’s (1994) predictions. Our findings suggest that communication between defendants will increase their propensity to reject settlement offers. The increased social cost of litigation would, of course, need to be

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<sup>67</sup>If they are uncorrelated, then settlement by one defendant confers a positive externality on the others.



weighed against the potential increases in deterrence.

In addition, our findings may bear on the debate surrounding corporate takeovers. Grossman and Hart (1980) argued that takeovers, even those that are privately and socially valuable, are unlikely to occur in practice. In short, any gains from a change in control would be largely captured by shareholders rather than the acquirer. This happens because the anticipation of a takeover and the future efficiency gains drives up the share price, rendering the takeover unprofitable. Other papers have shown that takeovers are more likely to occur when acquirers can discriminate among the shareholders through restricted bids, two-tier bids, and other mechanisms (Grossman and Hart, 1988; Burkhardt et al., 1998).<sup>68</sup> While these *divide-and-conquer* strategies may promote the common good by encouraging efficient takeovers, they may also allow inferior raiders to gain control of targets. Our experimental study suggests that *divide-and-conquer* strategies may be unnecessary when shareholders cannot coordinate with each other (as might be the case in jurisdictions where shareholder rights are weak). The normative implications for discriminatory bids in corporate takeovers hinge, of course, on whether we believe that on average there are too many takeovers or too few (as in Grossman and Hart, 1980).<sup>69</sup>

One concern with our study, a concern that is common to all experimental research, is its external validity. Can we really use experimental studies conducted in college laboratories to draw inferences about the real world? Our experiments provide evidence regarding discrimination, payoff exogeneity and communication especially in real-world environments that share our basic strategic structure. A second concern is that our subject pool contained university students, while the real-world settings feature experienced business people. In their experimental study on bidding in auctions, Dyer, et al., (1989) find no significant difference between the bidding behavior of experienced business executives and the behavior of student subjects. Both groups of subjects exhibited the very same failures on judgment known as the winner's curse.<sup>70</sup> A third concern is

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<sup>68</sup>Partial bids are generally legal in the United States while discriminatory bids are often prohibited. See Burkhardt et al. (1998) and the references therein.

<sup>69</sup>There may be fundamental differences between these real-world settings and our experimental setting. In our experiment, all of the laboratory subjects were similarly situated students. In contrast, the defendants in Superfund litigation are likely to view themselves as being very different from the plaintiff and will have little sympathy for his plight. Similarly, the shareholders in a takeover battle may feel unsympathetic towards a corporate raider. The greater proclivity of our experimental subjects to accept endogenous offers might well be absent in some of these examples.

<sup>70</sup>As an explanation to the differences in the successful behavior of experience subjects in the field and their behavior observed in the lab, the authors state, “[w]e believe that the executives have learned a set of situation specific rules of thumb which permit them to avoid the winner's curse in the field but which could not be applied in the lab. Success in the field is in part a function of detailed knowledge about a particular market environment; when removed from this environment the executives' behaviour parallels that of 'naive subjects' ” (p. 115).

that our subjects were paid relatively little: they received on average \$26 for an 80-minute time commitment. While the effect of stakes on experimental behavior is mixed, there are many studies where increasing the stakes does not change the likelihood of equilibrium behavior (see for example, Beattie and Loomes (1997), Camerer and Hogarth (1999), Smith and Walker (1993)).

In many real world applications, the rival firm is not an entrant per se but is already a participant in the market. It could be interesting to extend our experimental study to the situation where the incumbent and the rival firms compete in trying to reach agreements with buyers, and to assess how endogeneity and communication affect exclusion in this setting. As Whinston (2001) suggests, two basic changes would need to be made to the framework we studied here. First, instead of an entrant, we should consider an existing rival that must pay  $f$  to remain active and can offer to make a payment to the buyer for not signing an exclusive contract with the other firm (the incumbent in Segal and Whinston's (2000) model). Second, if the incumbent gains an exclusive contract with the buyer, then in some other sphere of competition, the incumbent's profits are increased, the rival's profits are reduced, and the incumbent's gain exceeds the rival's loss so that their joint profits in this other sphere increase. If these joint profits are at least as large as the deadweight loss we had under Segal and Whinston's (2000) basic framework, then the incumbent will find it worthwhile to pay enough for the exclusive to get the buyer to accept despite the payments offered by the rival and the buyer's loss from being monopolized (see Bernheim and Whinston, 1998).

Another empirically relevant extension to our work would be to explore in the laboratory the case in which buyers are competing firms, assess the effects of the intensity of downstream competition on exclusion under contract breach, and study how endogeneity and communication affect exclusion in those settings. Simpson and Wickelgren (2007) extend Segal and Whinston's (2000) framework by allowing buyers to breach exclusive contracts and pay expectation damages. They find that strong downstream competition reduces the benefit a buyer obtains from greater upstream competition. Given that downstream competition drives prices toward marginal cost, most of the benefits from lower input prices are passed on to final consumers. As a result, an upstream incumbent can induce downstream buyers to sign exclusive contracts by offering them small side payments. These, and other extensions, may be fruitful topics for future research.

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Figure 1: Exclusion Rate - Discrimination Effect

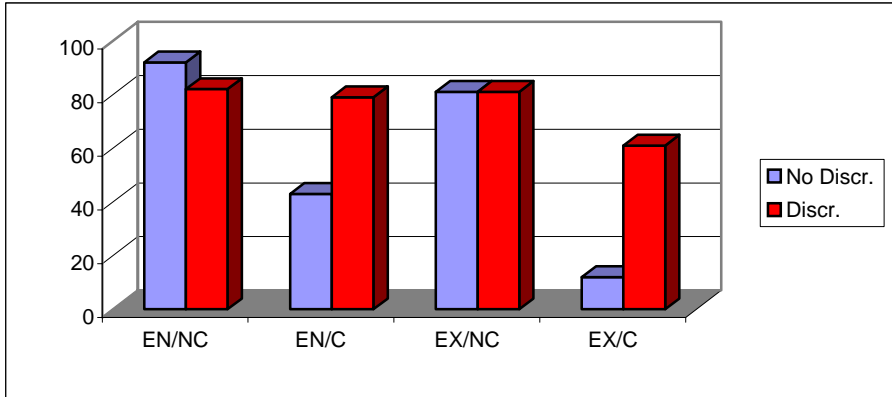


Figure 2: Exclusion Rate - Communication Effect

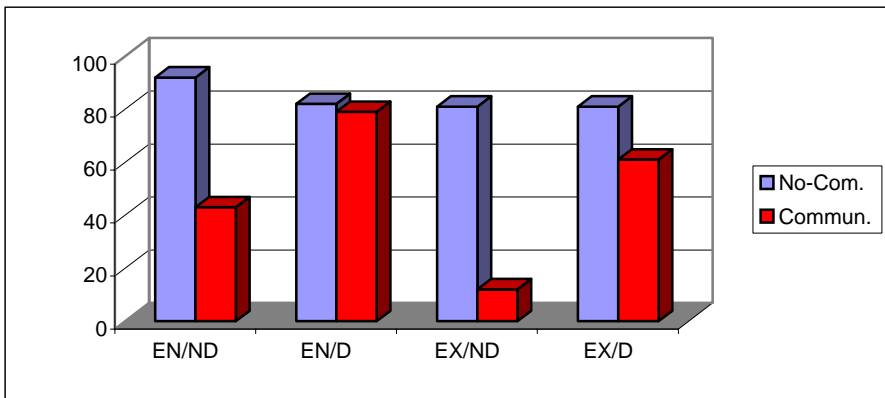
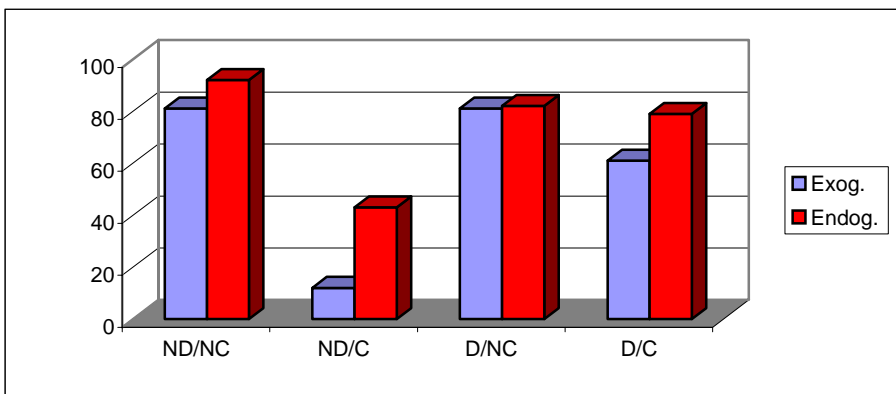


Figure 3: Exclusion Rate - Endogeneity Effect



**PLEASE GIVE THIS MATERIAL TO THE**  
**EXPERIMENTER AT THE END OF THE SESSION**

## INSTRUCTIONS

This is an experiment in the economics of decision-making. Carnegie Mellon University and Northwestern University have provided the funds for this research.

In this experiment you will be asked to play an economic decision-making computer game and to make decisions in several rounds. The experiment currency is the “token”. The instructions are simple. If you follow them closely and make appropriate decisions, you may make an appreciable amount of money. At the end of the experiment you will be paid your total game earnings in CASH along with your participation fee. If you have any questions at any time, please raise your hand and the experimenter will go to your desk.

## SESSION AND PLAYERS

The session is made up of 15 rounds. The first 3 rounds are practice-rounds and will not be counted in the determination of your final earnings.

- 1) Before the beginning of each practice round, the computer will randomly form groups of three people: one **Player A** and two **Players B (B1 and B2)**. The roles will be randomly assigned. During the practice rounds, each person will play at least once the roles of **Player A** and **Player B (B1 or B2)**.
  
- 2) After the third practice round, twelve rounds of the game will be played. Every participant will be randomly assigned a role. The role of **Player A** will remain the same during the twelve rounds. At the beginning of each round, new groups of three people, one **Player A** and two **Players B (B1 and B2)**, will be randomly formed.

You will not know the identity of the other two players who pertain to your group in any round.



# THE ROUND

Each round has two stages.

## STAGE 1

- 1) Player A **simultaneously makes proposals** to Players **B1** and **B2**. Both proposals **might be different**. The possible proposals are **100, 650, 800, or 1100** tokens. If the proposal is accepted, there will a transfer from Player A to the Player(s) **B** who accepted the proposal. Note that, if one or both offers are accepted, the round payoff for Player A will be equal to 1,950 tokens minus the amount of offers accepted. Hence, the sum of both offers should **NOT** be greater than 1,950 tokens. If both proposals are rejected, the round payoff for EACH Player **B** will be equal to 1000 tokens, and Player A's round payoff will be equal to 0 tokens. Before deciding his/her proposals, Player A should note that the possible outcomes are as follows.

If **BOTH PLAYERS B ACCEPT** the offers:

Player A's payoff = 1950 tokens – Offer to Player B1 – Offer to Player **B2**

Player **B1**'s payoff = Offer to Player B1

Player **B2**'s payoff = Offer to Player B2

If **BOTH PLAYERS B REJECT** the offers:

Player A's payoff = 0 tokens

Player **B1**'s payoff = 1000 tokens

Player **B2**'s payoff = 1000 tokens

If **ONLY PLAYER B1 ACCEPTS** the offer:

Player A's payoff = 1950 tokens – Offer to Player **B1**

Player **B1**'s payoff = Offer to Player B1

Player **B2**'s payoff = 0 tokens

If **ONLY PLAYER B2 ACCEPTS** the offer:

Player A's payoff = 1950 tokens – Offer to Player **B2**

Player **B1**'s payoff = 0 tokens

Player **B2**'s payoff = Offer to Player B2

- 2) Both proposals are **immediately** revealed to players **B1** and **B2**.

## **STAGE 2**

- 1) After observing **A**'s proposals, each Player **B** should **send a message** to the other Player **B** about his/her **intended choice**, i.e., whether he/she **plans to accept or reject** the proposal **A** made to him/her).
- 2) After receiving the message from the other Player **B**, each Player **B** should **decide whether to accept or reject** Player **A**'s proposal. If the proposal(s) is(are) accepted, there will a transfer from Player **A** to the Player(s) **B** who accepted the proposal. Note that, if one or both offers are accepted, the round payoff for Player **A** will be equal to 1,950 tokens minus the amount of offers accepted. If both proposals are rejected, the round payoff for EACH Player **B** will be equal to 1000 tokens, and Player **A**'s round payoff will be equal to 0 tokens.

When making their decisions, Players **B1** and **B2** should take into account that their round payoff will depend on their decision and on the decision of the other Player **B**. Players **B1** and **B2** should also check the final payoffs of the round associated to **their decisions and the decision of the other player B.**

- 3) The **round ends**.

# ROUND PAYOFF

The Payoff Table shows the possible round payoffs for players **A**, **B1**, and **B2**.

## Payoff Table

<b>Role</b>	<b>PAYOFFS IF B1 AND B2 ACCEPT</b>	<b>PAYOFFS IF B1 AND B2 REJECT</b>	<b>PAYOFFS IF B1 ACCEPTS AND B2 REJECTS</b>	<b>PAYOFFS IF B1 REJECTS AND B2 ACCEPTS</b>
<b>A</b>	1950 – (OFFER B1 + OFFER B2)	0	1950 – OFFER B1	1950 – OFFER B2
<b>B1</b>	OFFER B1	1000	OFFER B1	0
<b>B2</b>	OFFER B2	1000	0	OFFER B2

Four exercises related to the Payoff Table are presented below. Please fill the blanks.

### Exercise 1. Column 1 of Payoff Table (B1 AND B2 ACCEPT)

Suppose Player **A** offers **X** tokens to **B1** and **Y** tokens to **B2**, and both, **B1** and **B2**, **accept** the offers. Then, A's round payoff is equal to \_\_\_\_\_ tokens, B1's round payoffs is equal to \_\_\_\_\_ tokens, and B2's round payoff is equal to \_\_\_\_\_ tokens.

### Exercise 2. Column 2 of Payoff Table (B1 AND B2 REJECT)

Suppose Player **A** offers **X** tokens to **B1** and **Y** tokens to **B2**, and both, **B1** and **B2**, **reject** the offers. Then, A's round payoff is equal to \_\_\_\_\_ tokens, B1's round payoffs is equal to \_\_\_\_\_ tokens, and B2's round payoff is equal to \_\_\_\_\_ tokens.

### Exercise 3. Column 3 of Payoff Table (B1 ACCEPTS AND B2 REJECTS)

Suppose Player **A** offers **X** tokens to **B1** and **Y** tokens to **B2**, and **B1 accepts** the offer and **B2 rejects** the offer. Then, A's round payoff is equal to \_\_\_\_\_ tokens, B1's round payoffs is equal to \_\_\_\_\_ tokens, and B2's round payoff is equal to \_\_\_\_\_ tokens.

### Exercise 4. Column 4 of Table (B1 REJECTS AND B2 ACCEPTS)

Suppose Player **A** offers **X** tokens to **B1** and **Y** tokens to **B2**, and **B1 rejects** the offer and **B2 accepts** the offer. Then, A's round payoff is equal to \_\_\_\_\_ tokens, B1's round payoffs is equal to \_\_\_\_\_ tokens, and B2's round payoff is equal to \_\_\_\_\_ tokens.

## SESSION PAYOFF

The game earnings in tokens will be equal to the sum of payoffs for the 12 rounds. The game earnings in dollars will be equal to (Game Earnings in tokens)/650 (650 tokens = 1 dollar). Hence, the total earnings in dollars will be equal to the participation fee plus the game earning in dollars.

## GAME SOFTWARE

The game will be played using a computer terminal. You will need to enter your decisions by using the mouse. In some instances, you will need to wait until the other players make their decisions before moving to the next screen. Please **be patient**. There will be two boxes, displayed in the upper right-hand side of your screen, that indicate the “Round Number” and “Your Role.”

Press the NEXT >> button to move to the next screen. Please, **do not try to go back** to the previous screen and **do not close the browser**: the software will stop working and you will lose all the accumulated tokens.

Next, the **3 PRACTICE ROUNDS** will begin. After that, 12 rounds of the game will be played. **You can consult these instructions at any time during the session.**

**THANKS FOR YOUR  
PARTICIPATION IN THIS  
STUDY!!**

**PLEASE GIVE THIS MATERIAL TO THE  
EXPERIMENTER AT THE END OF THE SESSION**