

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

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## Abstract

This paper reports the results of an experiment on exclusive contracts. We replicate the strategic environment described by Rasmusen, Ramseyer, and Wiley (1991) and Segal and Whinston (2000). Our findings are as follows. First, when the buyers can communicate, discrimination raises the likelihood of exclusion. Second, when the incumbent seller is unable to discriminate and must make the same offers to the buyers, communication reduces the likelihood of exclusion. Communication also induces more generous offers when the seller cannot discriminate, and *divide-and-conquer* offers when the seller can discriminate. Third, when communication is allowed, payoff endogeneity increases the likelihood of exclusion.

**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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In the mid-1990s, Anheuser-Busch Inc., the largest beer company in the United States with 46 percent of domestic beer shipments and 70 percent 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 percent 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 (Robert H. 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. Eric B. Rasmusen, J. Mark Ramseyer and John S. Wiley, Jr. (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 Ilya R. Segal and Michael D. Whinston (2000), extended by Chiara Fumagalli and Massimo Motta (2006) and John Simpson and Abraham Wickelgren (2007), among others.<sup>4</sup> It has also been highlighted in the more general theoretical literature on contracting with externalities (Segal 2003, 1999).<sup>5</sup> Our paper contributes

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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>See Louis 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>Robert Innes and Richard J. Sexton (1994) explore the power of exclusive contracts when buyers can form coalitions with the entrant.

<sup>5</sup>Another branch has focused on contracts with stipulated damages for breach of contract. Philippe Aghion and Patrick Bolton (1987) and Kathryn E. 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

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. 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, Segal and Whinston (2000) showed that 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 different 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

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entrant by influencing the entrant’s future pricing behavior.

<sup>6</sup>Nicholas Dopuch, Daniel E. Ingberman, and Ronald R. King (1997) experimentally assess the effects of joint-and-several liability on the frequency and amounts of settlements. They do not restrict the players’ demands. Hence, this study does not provide a comprehensive analysis of the coordination games with endogenous payoffs. John B. Van Huyck, Raymond Battalio, and Richard O. Beil (1993) present experimental evidence of the effects of auctioning the right to participate in a median game on equilibrium selection. Vincent Crawford and Bruno Broseta’s (1998) theoretical model captures these findings. Note that auctioning the right to participate induces a coordination game with endogenous participation of only a subset of players, and affects payoffs in the coordination game in different ways than contracting with a *third party* does. See Gary Charness, Guillaume R. Frechette, and Cheng-Zhong Qin (2007) for an experimental study of the prisoners’ dilemma game with endogenous transfers made in the first period by the *same* players who move in the second period.

non-binding pre-play communication has on equilibrium selection (see, for instance, Russell W. Cooper et al. 1992). However, the effect of communication on the incumbent 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 main findings are as follows. First, when the buyers can communicate with each other, discrimination raises the likelihood of exclusion. Second, when the incumbent seller is constrained not to discriminate and must make the same offers to the buyers, communication among the buyers reduces the likelihood of exclusion. 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. Third, when communication between the buyers is allowed, endogeneity increases the likelihood of exclusion. 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. Our findings underscore the importance of combining experimental and behavioral observation with theoretical modeling.

Our paper is motivated by exclusive dealing and market foreclosure. We believe, however, that our findings and insights might apply to other contexts as well. Contracts with externalities are prevalent in environments such as licensing, mergers, debt bailouts, corporate takeovers (Segal 2003, 1999).<sup>8</sup> Moreover, these issues arise in a variety of bargaining

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<sup>7</sup>In recent work conducted independently of ours, Angela M. Smith (2007) studies the effect of the number of buyers in the market and the percentage of buyers required to exclude. Her study does not allow for discrimination, endogeneity or private offers. Smith's experimental design is also very different from ours.

<sup>8</sup>Sanford J. Grossman and Oliver D. Hart (1980) argue that takeovers, even those that are privately and socially valuable, are unlikely to occur in practice. Takeovers are more likely to occur when acquirers can

situations including class action litigation (Yeon-Koo Che and Spier 2008), plea bargaining with criminal defendants (Oren Bar-Gill and Omri Ben-Shahar, forthcoming), influence over voting decisions (Pedro Dal Bó 2007), and joint and several liability (Lewis A. Kornhauser and Richard L. Revesz 1994).<sup>9</sup> 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>10</sup> Conducting experiments to assess the predictions from these theoretical models is a valuable alternative to traditional empirical analysis.<sup>11</sup>

The rest of the paper is organized as follows. Section II outlines the theoretical model and predictions. Section III discusses the qualitative hypotheses to be tested. Section IV presents the experimental design. Section V examines the results from the experimental sessions. Section VI outlines an extension of the analysis under privately observed offers. Section VII concludes the paper and discusses avenues for future research.

## I 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  $N$  non-competing 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

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discriminate among the shareholders (Grossman and Hart 1988; Mike Burkhart, Denis Gromb, and Fausto Panunzi 1998). These *divide-and-conquer* strategies, however, may allow inferior raiders to gain control of targets. Our findings suggest 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).

<sup>9</sup>Under the CERCLA (the Comprehensive Environmental Response, Compensation, and Liability Act), individual defendants can be held responsible for the damages caused by the group. Consequently, the defendants may end up settling out of court for far more than their claims are jointly worth. Our findings suggest that communication between defendants might increase their propensity to reject settlement offers.

<sup>10</sup>Tim R. Sass (2005) provides an empirical investigation of exclusive dealing in the beer industry. Anheuser Busch adopted “100 percent share of mind” contracts after the Sass’ period of analysis. Jan B. Heide, Shantanu Dutta, and Mark Bergen (1998) investigate exclusive dealing in industrial machinery and electronic equipment.

<sup>11</sup>See for example, Stephen Martin, Hans Theo Normann, and Christopher M. Snyder (2001) for an interesting implementation of markets in the laboratory to study vertical foreclosure.

deter entry through an exclusive deal with just a single buyer. 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 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>12</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>13</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 reflect equilibrium behavior in stages two and three.<sup>14</sup> We assign particular numerical values to the model parameters.<sup>15</sup> The

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<sup>12</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>13</sup>SW's basic framework does not allow for contract breach. Simpson and Wickelgren (2007) model contract breach by using expectation damages. These results are sensitive to the way damages are modeled.

<sup>14</sup>Including all three stages in the experimental design would require buyers to use backward induction to compute their payoffs in the acceptance subgame. Eric J. Johnson et al. (2002) report that players in a three-round game do not look ahead to the second and third rounds as much as backward induction requires. Hence, this alternative design might introduce noise into the experimental results. Note, however, that a potential shortcoming of our design might come from the vulnerability of players' decisions to game specification due to the violation of truncation consistency (truncation consistency implies that replacing a subgame with its equilibrium payoffs will not affect play elsewhere in the game). See Kenneth Binmore et al. (2002).

<sup>15</sup>Our numerical examination satisfies all of the model's assumptions and, therefore, the predictions derived from these assumptions hold. From a behavioral point of view, however, a numerical examination different

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 offers to  $x_i \in \{100, 650, 800, 1100\}$ ,  $i = 1, 2$ .<sup>16</sup>

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

[INSERT TABLE 1 HERE]

*Proposition 1.*<sup>17</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>18</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 Douglas B. Bernheim, Peleg Bezalel, and Whinston (1987).<sup>19</sup> Still, we might expect exclusion equilibria to emerge in practice. So-called “strategic uncertainty” arises from the

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from the one presented here (one that includes, for instance, larger deadweight loss and/or smaller scale economies) might affect the results.

<sup>16</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 non-negative. 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>17</sup>For a more general version of this proposition and a formal proof, see SW’s Proposition 1.

<sup>18</sup>There are also mixed-strategy equilibria in the acceptance subgame. We restrict attention here to pure-strategy equilibria.

<sup>19</sup>This refinement requires that equilibria be immune to self-enforcing coalition deviations.

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 John C. Harsanyi and Reinhard Selten (1988) by the (accept, accept) equilibrium for transfers  $x > 500$ . 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.

[INSERT TABLE 2 HERE]

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<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).

## II 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.*

Robert Aumann (1990) and Joseph Farrell and Matthew 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. According to Farrell and Rabin (1996), as mentioned in John Duffy and Nicholas Feltovich (2002, 6), "a message that is both self-signaling and self-committing seems highly credible."

Experimental evidence on stag hunt games suggests that coordination is facilitated when communication is possible (see Jack 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)

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

<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. Andreas

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 (where offers are made by human subjects) 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. George F. Loewenstein, Leigh Thompson, and Max H. Bazerman (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 a tendency to respond to perceived kindness with kindness and perceived meanness with meanness and to expect this behavior from others” (Joel Sobel 2005, 392), has been found to influence decision making. Finally, Sally 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 role of a seller is played by a strategic human partner only under the endogenous payoffs conditions. The seller gets a payoff equal to zero in case of rejection by both buyers. Under the exogenous payoffs conditions, on the other hand, the offers are made by a computer-seller. Buyers know the nature of the seller. We assume here that a division of the pie that involves equal payoffs for all players, i.e.,

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Blume and Andreas Ortmann (2007) find that communication facilitates coordination even in case of more than two players.

<sup>27</sup>In discrimination environments, for equilibrium offers different from the *divide-and-conquer offers*, (reject, reject) is also a N.E. of the acceptance subgame. Then, we might expect that communication will increase the likelihood of coordination also in these environments.

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

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>29</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>30</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 expect that the exclusion equilibrium will be selected.<sup>31</sup>

### III Experimental Design

In assessing the validity of the *qualitative* predictions derived from the theory and the behavioral predictions derived from previous experimental work, our study analyzes the effect

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<sup>29</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>30</sup>Anthony Burton and Martin Sefton (2004) provide additional powerful evidence of the role of riskiness in the choice of a strategy.

<sup>31</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.

of discrimination, nonbinding 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. To ensure control and replicability, a free-context environment is constructed.<sup>32</sup> Human subjects paid according to their performance are used in this study.<sup>33</sup> A concern with our study, a concern that is common to all experimental research, is its external validity. Although our experiment cannot predict the effects of exclusive contracts in richer environments, the experiment provides 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>34</sup>

The experimental design consists of two buyers' payoff treatments, two offer treatments, and two communication treatments. The buyers' payoff treatments are exogenous payoffs (EX) and endogenous payoffs (EN). The offer treatments are no-discrimination (ND) and discrimination (D). The communication treatments are no-communication (NC) and two-way buyer-buyer communication (C).<sup>35</sup> A combination of these treatments generates eight experimental conditions as described in Table 3.

[INSERT TABLE 3 HERE]

## A The Games

Procedural regularity is accomplished by developing a software program that permits subjects to play the game by using networked personal computers.<sup>36</sup> The experiment is a

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<sup>32</sup>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 Douglas Davis and Charles Holt 1993). Hence, our experiment might provide useful feedback to improve the theory.

<sup>33</sup>Note that a minimum context was required to replicate the theoretical environment in the lab. Evidence from previous experimental studies (Douglas Dyer, John H. Kagel, and Dan Levin 1989) suggests that students and professionals behave similarly in such environments. In addition, Rachel T.A. Croson (2002) indicates that potential problems in using professionals as subjects might be related to motivating tools and controlling the institutions that these subjects use to make decisions in the lab. Hence, we decided to use students as subjects.

<sup>34</sup>There is a trade-off between control and external validity. Experimental methods are complementary techniques to field data analysis.

<sup>35</sup>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.

<sup>36</sup>The software consists of 8 versions of the game, reflecting the eight experimental conditions. Software screens and instructions are available upon request.

three-player, two-stage game. Subjects play the role of seller (the incumbent monopolist), buyer 1, or buyer 2.<sup>37</sup> We use a laboratory currency called the “token” (650 tokens = 1 US dollar).<sup>38</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: (i) in the no-discrimination conditions, the instructions specify that both offers should be the same. In the discrimination conditions, 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>39</sup> The seller is not informed about the content of this communication; (iii) in the exogenous payoffs conditions, the computer makes the offers in the first stage. Subjects are informed that the offers are made by a computer-seller. 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>40</sup> Note also that both the exogenous and endogenous conditions involve two stages.

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<sup>37</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>38</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).

<sup>39</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>40</sup>To make the endogenous and exogenous conditions comparable, (i) for each exogenous payoff session, the formation of groups (pair of buyers in this case) replicated 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 and endogenous conditions followed the same pattern, 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).

## B The Experimental Sessions

We ran sixteen 70-minute to 90-minute sessions<sup>41</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>42</sup>

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

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<sup>41</sup>Given that the exogenous payoffs conditions did not involve a human-seller, the sessions run on these conditions lasted 70 minutes.

<sup>42</sup>The pool of subjects encompasses graduate and undergraduate students from a wide variety of fields of study.

<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 an incentive to experiment with the different options and hence, learn about the consequence of their choices.

<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.

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.

## IV Results

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

### A 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).

[INSERT TABLE 4 HERE]

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.

The data indicate that discrimination increased exclusion (when communication was present), communication negatively affected exclusion (especially under no-discrimination and, endogeneity increased exclusion (when communication was present).

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

<sup>48</sup>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. Theoretically, 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).

[INSERT TABLE 5 HERE]

Table 5 describes the offers made by the sellers and the buyers' responses per pair of offer (frequencies and exclusion rates per pair of offers). For example, in the ND/C condition, the sellers chose to offer (650, 650) in 74 out of 120 observations. When these offers were endogenous, in 39 percent of these observations, one or both buyers accepted. When these offers were part of the exogenous condition, then only 7 percent of the offers were accepted.

Offers equal to (650, 650) were the mode offers under no-discrimination (93 and 62 percent of total offers, for the ND/NC and ND/C conditions, respectively). Under discrimination, on the other hand, *divide-and-conquer offers*, i.e., offers equal to (100, 1100) or (1100, 100), were the mode offers (58 and 86 percent of total offers, for the D/NC and D/C conditions, respectively).

RRW-SW model suggests that, when discrimination is not possible, exclusion might be achieved at a low cost if buyers fail to coordinate. In our experimental environment, exclusion at a low cost implies acceptance of offers equal to (100, 100) at least by one buyer. Our findings indicate that these offers were rarely made by the sellers (4 and 8 percent of total offers, for the ND/NC and ND/C environments, respectively), and were always rejected by the buyers. Buyers' responses are aligned to the risk dominance predictions.<sup>49</sup> These findings might also suggest seller's strategic behavior (i.e., anticipation of buyers' rejection).

The offers chosen by the seller in the discrimination and no-discrimination environments provide some information about sellers' fairness considerations. Remember that offers equal to (650, 650) represent the *fair* set of offers (if these offers are accepted, the payoffs for buyers and sellers will be equal). First, under the ND/NC conditions, 93 percent of all offers were equal to (650, 650); under D/NC, however, these offers represented only 22 percent of total offers. Second, under the ND/C conditions, offers equal to (650, 650) were the mode offers. Note, however, that a lower percentage of sellers (with respect to ND/NC) chose these offers (62 percent of all offers were equal to (650, 650));<sup>50</sup> under D/C, however, offers equal to (650, 650) were chosen only by 5 percent of sellers. These results might suggest that the choice of (650, 650) did not obey to seller's fairness considerations. These findings also provide evidence of sellers' strategic behavior, i.e., sellers' anticipation of higher likelihood of buyers' coordination under communication.

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<sup>49</sup>Note that (*reject, reject*) is the risk-dominant N.E. of the acceptance subgame. These results might also suggest buyers' fairness considerations.

<sup>50</sup>Sellers more frequently chose offers equal to (800, 800): 31 percent versus 3 percent, for the communication and no-communication environments, respectively.

## B Analysis

Our regression analysis involves standard errors that are robust to general forms of heteroskedasticity and hence, they account for the possible dependence of observations within session.<sup>51</sup>

### *Exclusion Rates*

[INSERT TABLE 6 HERE]

Table 6 presents the effect of each treatment on exclusion. We take pairs of conditions and estimate probit models.<sup>52</sup> Each probit model includes a treatment dummy 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>53</sup> Marginal effects of treatments are reported here.<sup>54</sup> The standard errors computed are robust to general form of heteroskedasticity and hence, they account for the possible dependence within session.<sup>55</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 communication is present. In fact, as a result of discrimination, higher exclusion rates are observed: 79 vs. 43 percent, for the EN/D/C and EN/ND/C conditions, respectively; and, 61 vs. 12 percent, for the EX/D/C and EX/ND/C conditions, respectively. Thus, when communication is present, there is clear support to Hypothesis 1.<sup>56</sup> When communication is

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<sup>51</sup>Note that each person plays in 12 rounds and interacts with other players during the session.

<sup>52</sup>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 exogeneity environments; and, (iii) the effect of payoff endogeneity in no-discrimination and no-communication environments, no-discrimination and communication environments, discrimination and no-communication environments, and discrimination and communication environments.

<sup>53</sup>The data for conditions EN/ND/C and EN/ND/NC are pooled to estimate this probit model.

<sup>54</sup>Given that probit magnitudes are difficult to interpret, we report the marginal effects.

<sup>55</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.

<sup>56</sup>The effects of discrimination on the seller's payoff and on the sum of buyers' payoffs are significant and qualitative similar to the effect of discrimination on exclusion, under communication. OLS regressions are available upon request.

not present and offers are endogenous, we observe, however, that discrimination reduces the likelihood of exclusion: 82 vs. 92 percent, for the EN/D/NC and EN/ND/NC conditions, respectively. However, this last result, which was not anticipated by Hypothesis 1, vanishes as subjects acquire more experience. In fact, when only the last six rounds of play are considered, we observe that the effect of discrimination is not significant ( $p$ -value = .248).<sup>57</sup>

*Result 1: When buyers can communicate with each other, discrimination significantly increases 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 percent vs. 92 percent, for the EN/ND/C and EN/ND/NC conditions and 12 percent vs. 81 percent, for the EX/ND/C and EX/ND/NC conditions.<sup>58</sup> Interestingly, communication lowers the exclusion rate in the discrimination environment when offers are exogenous (61 percent and 81 percent, for the EX/D/C and EX/D/NC conditions, respectively). This result was not anticipated in Hypothesis 2.<sup>59</sup> Our findings also suggest that communication does not have a significant effect on exclusion when both discrimination and endogeneity are allowed (79 percent and 82 percent 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 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 percent of the total offers, for the communication environment.

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<sup>57</sup>Probit estimations for all treatments and data corresponding to the last six rounds of play are available upon request. Note that the other qualitative results still hold when only the last six rounds of play are considered.

<sup>58</sup>The effects of communication on the seller's payoff and on the sum of buyers' payoffs are significant and qualitative similar to the effect of communication on exclusion, under no-discrimination. OLS regressions are available upon request.

<sup>59</sup>Without communication, 99 percent of the buyers accepted *divide-and-conquer* offers. With communication, only 69 percent did so.

As a result, higher exclusion rates are observed under endogeneity (43 vs. 12 percent, 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 percent 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 percent, in case of *divide and conquer* offers, and 79 vs. 61 percent, 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.<sup>60</sup>

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

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 endogeneity (with the greatest impact in no-discrimination and communication environments.)

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

[INSERT TABLE 7 HERE]

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>61</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.

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<sup>60</sup>The effects of endogeneity on the seller's payoff and on the sum of buyers' payoffs are significant and qualitative similar to the effect of endogeneity on exclusion, under communication (for both, no-discrimination and discrimination environments). OLS regressions are available upon request.

<sup>61</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  $< .001$ ).

In fact, when communication is allowed in those environments, sellers move from offering (650, 650) in the majority of the cases (93 percent) to offering (650, 650) in 62 percent of the cases and (800, 800) in 31 percent of the cases.<sup>62</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 percent of the cases and (100, 1100) or (1100, 100) in 58 percent of the cases to offering (100, 1100) or (1100, 100) in 86 percent of the cases and choosing (650, 650) in only 5 percent of the cases. These results suggest that, in discrimination environments, communication induces the choice of equilibrium offers.

*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 and discrimination environments.*

### ***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 an offer.

[INSERT TABLE 8 HERE]

Table 8 shows the results from a probit analysis of the determinants of the buyers’ acceptance. 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

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<sup>62</sup>In the no-discrimination/no-communication environment, offers equal to (800, 800) are rarely offered (3 percent). 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 these offers, under no-discrimination.

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 first three covariates control for the effect of the seller’s offers on the likelihood of buyer’s acceptance: the offer made to the buyer (Own Offer); the offer made to her partner (Partner’s Offer); and, a dummy variable that provides a control for the “non-linear” effect of the seller’s offer when the *divide-and-conquer* strategy is used. This dummy variable takes the value 1 if the offers are equal to (100, 1100) or (1100, 100).<sup>63</sup> The last two covariates control for the effects of the partner’s intention to reject and endogeneity: a dummy variable taking the value 1 if the partner’s intention is to reject the offer (Partner’s Reject Intention) and, a dummy variable taking the value 1 if endogeneity is present (Endogeneity).<sup>64</sup>

Our results suggest that the seller’s offers influence the buyer’s likelihood of acceptance: the effects of the offer made to the individual, the offer made to her partner, and the *divide-and-conquer* offers are positive and significant. Marginal effects provide information about each factor’s relative importance. Increasing the amount of Own Offer by one standard deviation increases the probability of acceptance by 33 percentage points. An increase in the amount of Partners Offer by one standard deviation increases the probability of acceptance in 11 percentage points.<sup>65</sup> These results provide support to Hypothesis 4. They also suggest interdependent preferences on buyers (with the strongest regard on their own payoff). A stronger effect is produced by *Divide-and-conquer* offers: they increase acceptance by 45 percentage points. Our findings also suggest that, the partner’s intention to reject and 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. The weakest (but strongly significant) effect is exhibited by endogeneity: it increases acceptance by 29 percentage points.

*Result 5: Higher seller’s offers made to the buyer and to her partner, and divide-and-conquer offers significantly increase the likelihood of the buyer’s acceptance of an offer.*

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<sup>63</sup>In theory, (*accept, accept*) will emerge as the unique N.E. of the acceptance subgame as a result of the elimination of strictly dominated strategies. Hence, each buyer will accept the offer even if it is equal to 100. In our experiment, high acceptance rates are observed under *divide and conquer* offers. However, the acceptance rate is always lower for those buyers who received the 100 offers (86 vs. 100 percent, 81 vs. 85 percent, 89 vs. 98 percent, 52 vs. 67 percent, for the EN/D/NC, EN/D/C, EX/D/NC, and EX/D/C conditions, respectively.)

<sup>64</sup>Regression analysis includes round as an additional regressor. The effect of round is not statistically significant.

<sup>65</sup>The variables Own Offer and Partner’s Offer take equal average values (616.47), with equal standard deviation (367.44).

*Result 6: The partner's intention to reject significantly reduces the likelihood of the buyer's acceptance of an offer.*

*Result 7: Endogeneity significantly increases the likelihood of the buyer's acceptance of an offer.*

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

Cooper et al. (1992) study stag hunt games and provide experimental evidence about the effect of nonbinding preplay communication on the selection of the Pareto efficient equilibrium. Table 9 compares Cooper et al. (1992) results with our findings, for the case of offers equal to (800, 800). We are considering here conditions EX/ND/NC, EX/ND/C, 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>66</sup>

[INSERT TABLE 9 HERE]

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 percent of the pairs both buyers accepted offers equal to (800, 800), and in 3 percent 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 percent. In our study (for the exogenous and endogenous payoffs conditions) all pairs of buyers accepted those offers, and exclusion rate of 100 percent 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. 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 percent of pairs of buyers rejected offers equal to (800, 800). Note that, in our study, 76 percent of pairs rejected those offers, when exogenous payoffs are present. However, when payoff endogeneity is present, i.e.,

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<sup>66</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, we decided to include the offer (800, 800) in the set of offers. Note, however, that our study includes a first stage in which the seller makes the offers. Note also that, in the endogenous payoffs conditions, sellers might also choose offers different from (800, 800), and that these offers are used in the exogenous conditions. Then, in both, the endogenous and exogenous payoffs conditions, buyers who receive (800, 800) offer might also receive offers different from (800, 800). Hence, 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.

when a human seller makes an offer, only 41 percent of pairs of buyers rejected the offers and achieved coordination. These results suggest that communication is more effective in inducing coordination in exogenous payoffs environments.<sup>67</sup>

## V Privately Observable Offers: An Extension

An important assumption of our analysis so far has been that the offers made by the seller were public information.<sup>68</sup> This section relaxes that assumption and supposes instead that the offers made by the seller 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>69</sup>

### A 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.<sup>70</sup>

*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>71</sup>

It is not hard to see why this is the unique pure-strategy equilibrium. First, suppose instead that there existed an equilibrium where entry took place and the incumbent earned

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<sup>67</sup>The patterns of intentions and actions are aligned in both studies, for the case of exogenous payoffs: in Cooper et al. (1992), 100 percent of buyers chose  $R$  as their intention, while in our study, 92 percent of buyers chose  $R$  as their intention. However, under endogenous payoffs, a lower percentage of buyers reported an intention to reject the offer (73 percent), result that helps to explain a lower coordination rate.

<sup>68</sup>This implied that the payoffs in the acceptance subgame in Table 1 were common knowledge.

<sup>69</sup>The case of privately observed offers was outlined in a general environment by Segal and Whinston's (1996) working paper (Appendix C).

<sup>70</sup>This result diverges from the outcome in Segal and Whinston (1996) where both exclusion and entry are possible in equilibrium. The difference in our results stems from our restricting the seller's offers to be bounded away from zero. If we allowed our incumbent seller to offer 0 (or to make no offer at all) to one of the buyers, then the *divide-and-conquer equilibrium* would exist here as well.

<sup>71</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  $(x^*, 0)$ .

zero profits. The incumbent could do better by employing a *divide-and-conquer* strategy, offering 1100 to the first buyer and 100 to the second buyer. The first buyer would certainly accept 1100 (acceptance is a dominant strategy) and entry would be deterred. Interestingly, the beliefs and the acceptance decision of the second buyer are immaterial for the success of this deviation, since the incumbent earns positive profits whether the second buyer accepts the 100 or rejects it.<sup>72</sup> Therefore the equilibrium of this game must involve exclusion.

Next, suppose that there existed an exclusion equilibrium where the incumbent offered strictly more than 100 to at least one of the buyers and that both buyers accepted.<sup>73</sup> For example, suppose that the seller offers 100 to the first buyer and 800 to the second buyer. It is easy to see why this cannot be an equilibrium. Suppose the seller deviated and offered 100 to the second buyer as well as the first. The first buyer, not detecting the deviation (since the offers are privately observed), would accept the offer of 100 and entry would be deterred. The incumbent clearly profits from this deviation whether or not the second buyer accepts the “surprise” offer of 100. As before, the beliefs and the acceptance decision of the second buyer are immaterial for the success of the seller’s deviation.<sup>74</sup> We conclude that the only exclusion equilibrium involves offers of 100 to both of the buyers.

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 succeed in excluding the entrant by offering (100, 100). Instead, we might expect that the likely outcome would involve mixing on the parts of the incumbent seller and the buyers.<sup>75</sup>

## B 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.

[INSERT TABLE 10 HERE]

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<sup>72</sup>That is, our argument holds whether the buyers hold “passive” or “active” beliefs. See Segal and Whinston (1996).

<sup>73</sup>The fact that the entrant is excluded implies that at least one buyer accepts. But if one buyer accepts in equilibrium, then the other buyer must accept as well.

<sup>74</sup>Indeed, the incumbent seller is better off if the second buyer rejects the offer than if he accepts it.

<sup>75</sup>In keeping with the literature, we have focused our attention on pure strategy equilibria.

Table 10 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 percent, and hence, lower than the one experienced under publicly observed offers (82 percent). As a consequence, the mean DWL generated under this condition is lower (36.31 vs. 40.97).<sup>76</sup>

[INSERT TABLE 11 HERE]

Table 11 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 percent 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). Thirty nine percent of sellers chose these offers, and 67 percent 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 percent of sellers, and 97 percent of those offers were accepted by at least one buyer. Finally, note that, in contrast to the E/D/NC condition, offers equal to (650, 650) were chosen only by 2 percent of sellers.

We next conduct a probit analysis of the effects of privacy of offers on probability of exclusion.<sup>77</sup> The probit model includes a treatment dummy variable and round as its regressors,<sup>78</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 8: Privately observable offers significantly decrease the likelihood of exclusion.*

## VI Summary and Conclusions

Can an incumbent seller profitably foreclose a market through exclusive contracts with its buyers? This important question has been debated by legal scholars, economists, and policy

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<sup>76</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.

<sup>77</sup>The qualitative results hold if we consider the last six rounds of play only.

<sup>78</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.

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 (due to strategic uncertainty).

Our findings suggest first that without adequate communication channels and in the absence of discrimination, our subjects failed to coordinate on their preferred equilibria and entry was deterred. Second, as predicted by Segal and Whinston (2000), we show that the ability of the incumbent to discriminate in the contract terms offered to the buyers enhances the effectiveness of exclusionary practices, when buyers are allowed to communicate. *Divide-and-conquer* strategies proved particularly effective for the seller. Third, our experimental analysis suggests that, better communication among the buyers leads to more generous offers from the seller and a greater likelihood of entry, when discrimination is not allowed. Fourth, endogenizing the payoffs in stag-hunt games changes the way that experimental subjects play these games, when communication is allowed. Coordination was particularly elusive when the incumbent seller had a human identity. Finally, our experiment shows that exclusion is less likely when the contract offers are privately observed by the buyers.

Our analysis is focused on the *qualitative* theoretical predictions derived from subgame perfection, and the robustness of these predictions to communication and endogeneity. Although non-modeled issues such as fairness and reciprocity considerations and strategic uncertainty are observed, RRW-SW's theoretical predictions provide a good fit for the data. Possible extensions can be related to study the degree of strategic sophistication and the importance of decision errors using models of bounded rationality. We might relax the assumption that players have perfectly accurate beliefs about how the other players make their choices, and estimate a structural model of decision rules (see Miguel Costa-Gomes, Crawford and Broseta 2001, for an excellent experimental investigation of decision rules, iterated dominance, and subjects' attention to payoff information).<sup>79</sup> We might also relax the deterministic approach to the best response functions by allowing for decision errors.<sup>80</sup> A logit-agent quantal response equilibrium model (logit-AQRE) might account for those errors (see Richard McKelvey and Thomas Palfrey 1998).<sup>81</sup>

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<sup>79</sup>Limitations on the application of the iterated elimination of strictly dominated strategies might account for buyers' deviations from N.E. point-predictions in case of EX/D/C and *divide-and-conquer* offers.

<sup>80</sup>Decision errors might account for sellers' deviations from subgame perfection in case of EN/D/NC and choice of offers equal (650, 650).

<sup>81</sup>Logit-AQRE allows for imperfect best responders in extensive form games. At each information set, players choose better actions with higher probabilities than worse actions but do not choose best responses with probability one. The structural model will need to incorporate fairness and reciprocity considerations.

In many real world applications, the rival firm is a participant in the market. It might be interesting to experimentally study environments in which the incumbent and the rival firms compete in trying to reach agreements with buyers, and to assess how endogeneity and communication affect exclusion in these settings. These, and other extensions, may be fruitful topics for future research.

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See Charness and Rabin (2002) for a conceptual model of social preferences that accounts for decision errors (in the spirit of Daniel McFadden 1981) in simple two-person games.

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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,  $x_1 = x_2 = x$ .

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

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

Table 3: Experimental Conditions

	Endogenous Payoffs	Exogenous <sup>(a)</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>(a)</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.

Table 4: Descriptive Statistics

Condition	Mean Sum of Seller's Offers <sup>(a)</sup>	Exclusion Rate	Mean Seller's Payoff <sup>(b)</sup>	Mean Sum of Buyers' Payoffs	Mean DWL
EN/ND/NC [120]	1261.67 (227.22)	0.92	680.42 (311.76)	1273.75 (321.10)	45.83 (13.88)
EN/ND/C [120]	1310.00 (345.54)	0.43	302.08 (424.78)	1676.67 (445.61)	21.25 (24.82)
EN/D/NC [144]	1159.38 (161.18)	0.82	707.64 (406.47)	1251.39 (422.44)	40.97 (19.30)
EN/D/C [132]	1162.88 (157.22)	0.79	646.21 (401.08)	1314.39 (418.45)	39.39 (20.52)
EX/ND/NC [120]	1261.67 (227.22)	0.81	729.17 (464.84)	1230.42 (480.17)	40.42 (19.76)
EX/ND/C [120]	1310.00 (345.54)	0.12	89.58 (284.83)	1904.58 (298.95)	5.83 (16.12)
EX/D/NC [144]	1159.38 (161.18)	0.81	697.22 (405.33)	1262.50 (422.30)	40.28 (19.86)
EX/D/C [132]	1162.88 (157.22)	0.61	496.97 (434.92)	1472.73 (457.69)	30.30 (24.52)

Note: <sup>(a)</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>(b)</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. See Table 3 for a description of the experimental conditions.

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
ND/NC	5 [0.00, 0.00]				112 [0.96, 0.84]		3 [1.00, 1.00]	120
ND/C	9 [0.00, 0.00]				74 [0.39, 0.07]		37 [0.59, 0.24]	120
D/NC	0	8 [0.25, 0.00]	20 [0.25, 0.50]	83 [1.00, 0.99]	31 [0.84, 0.71]	1 [1.00, 1.00]	1 [1.00, 1.00]	144
D/C	2 [0.00, 0.50]	4 [0.25, 0.00]	6 [0.00, 0.17]	113 [0.88, 0.69]	7 [0.43, 0.00]	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.

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	-0.097** (0.035) 264	EN/ND/NC vs. EN/ND/C Observations	-0.496*** (0.108) 240	EX/ND/NC vs. EN/ND/NC Observations	0.104 (0.072) 240
EN/ND/C vs. EN/D/C Observations	0.363*** (0.115) 252	EN/D/NC vs. EN/D/C Observations	-0.031 (0.053) 276	EX/ND/C vs. EN/ND/C Observations	0.318*** (0.112) 240
EX/ND/NC vs. EX/D/NC Observations	-0.006 (0.104) 264	EX/ND/NC vs. EX/ND/C Observations	-0.692*** (0.067) 240	EX/D/NC vs. EN/D/NC Observations	0.013 (0.082) 288
EX/ND/C vs. EX/D/C Observations	0.494*** (0.060) 252	EX/D/NC vs. EX/D/C Observations	-0.200* (0.099) 276	EX/D/C vs. EN/D/C Observations	0.182** (0.077) 264

Note: The columns report the change in the probability of exclusion due to discrimination, communication, and endogeneity (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. See Table 3 for a description of the experimental conditions.

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. EN/ND/C Observations	-0.317*** (0.052) 240	<i>n.a.</i> <sup>(a)</sup>
EN/D/NC vs. EN/D/C Observations	-0.164* (0.121) 276	0.282* (0.141) 276

Note: Probit analysis using sessions as clusters; <sup>(a)</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. See Table 3 for a description of the experimental conditions.

Table 8: Determinants of Buyer's Acceptance

	Marginal Effects
Own Offer	0.0009*** (0.0001)
Partner's Offer	0.0003* (0.0002)
<i>Divide-and-Conquer</i> Offers	0.4546*** (0.0421)
Partner's Reject Intention	-0.6692*** (0.0539)
Endogeneity	0.2890*** (0.0522)
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.

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	0.00
EX/ND/NC	1.00	0.00
Cooper et al. (1992)	1.00	0.00
Communication		
EN/ND/C	0.59	0.41
EX/ND/C	0.24	0.76
Cooper et al. (1992)	0.09	0.91

Note: Observations for our study correspond to pooled data for rounds 1 to 12. See Table 3 for a description of the experimental conditions.

Table 10: 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 [84]	1020.83 (283.08)	0.73	774.40 (562.24)	1189.29 (581.44)	36.31 (22.43)

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

Table 11: 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 [0.00]	12 [0.42]	33 [0.67]	23 [0.97]	2 [0.50]	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.

**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**