# Order with Some Law: Complementarity versus Substitution of Formal and Informal Arrangements

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While some argue that incomplete incentive contracts facilitate the self-enforcement of informal dealings, other authors submit that they substitute for or "crowd out" social norms supporting informal arrangements. We use experimental evidence to test these theories by manipulating the extent to which individuals transact repeatedly and the level of contract costs. We find that, by enforcing contractible exchange dimensions, contracts facilitate the self-enforcement of noncontractible dimensions. This complementarity effect is particularly important when repetition is unlikely and thus self-enforcement is difficult. Although our data suggest the existence of reciprocity as an alternative, informal enforcement mechanism, we do not find evidence that contracts substitute for this social norm.

## 1. Introduction

Formal arrangements such as written contracts are employed jointly with informal dealings to support diverse types of exchanges in diverse countries (e.g., Lane and Bachmann, 1996; Johnson et al., 2002; Poppo and Zenger, 2002). Since "a mixture of both formal and informal relations" is very common in practice (Macneil, 1980:345), an examination of how these

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alternative enforcement mechanisms interact is a fundamental issue in the study of contracting. The nature of the relationship between formal and informal agreements, however, has been widely disputed in the literature. Some argue that formal contracts *complement* informal agreements by facilitating their self-enforcement. Others argue that formal contracts merely *substitute* for social norms that effectively support informal dealings.

The *complementarity* view suggests that the joint use of formal and informal arrangements provides more efficient outcomes than the use of either arrangement in isolation. Thus North (1990:46) posits, “formal rules can complement and increase the effectiveness of informal constraints.” The major and most elaborate argument supporting the complementarity view is based on the idea that (incomplete) formal contracts can facilitate the self-enforcement of informal agreements. Self-enforcement models (Telser, 1980; Klein and Leffler, 1981; Bull, 1987; MacLeod and Malcomson, 1989) depart from the premise that informal dealings are only stable when the long-term payoff conditional on cooperation exceeds gains from short-term defection. Within this perspective, complementarity arguments assert that formal contracts—through incentives or punishments—can reduce the gains from short-term defection, thereby increasing the value of honoring informal dealings (Baker et al., 1994; Schmidt and Schnitzer, 1995; Klein, 1996; Pearce and Stacchetti, 1998; Poppo and Zenger, 2002).

The *substitution* view considers an opposite possibility: that formal rules undermine the operation of social norms supporting informal dealings. Thus Macaulay (1963:64) contends that “detailed negotiated contracts can get in the way of creating good exchange relationships between business units.” In a similar vein, Sitkin and Roth (1993:376) assert that “legalistic remedies can erode the interpersonal foundations of a relationship they are intended to bolster because they replace reliance on an individual’s ‘good will’ with objective, formal requirements.” Recent developments propose specifically that formal contracts damage the *reciprocity* norm embodied in informal agreements, that is, individuals’ voluntary willingness to reciprocate generous offers even if this is against their own self-interest. According to the substitution view, the use of incentives or punishments can signal that no reciprocity is expected, thereby framing the relationship in a strictly economic, rather than social, orientation (Tenbrunsel and Messick, 1999; Fehr and Gächter, 2000; Lubell and Scholz, 2001). As a consequence, incentives or punishments may damage the quality of exchange outcomes by discouraging individual’s voluntary willingness to cooperate, manifested through reciprocity norms. This substitution effect has received the name “motivation crowding out” in economics (Frey, 1997).[1]

1. Although Baker et al. (1994) study the possibility of complementarity, their model also predicts substitution under some circumstances. Roughly speaking, substitution occurs in their setting when the use of formal contracting *alone* is profitable, which may destabilize informal agreements since parties can profitably resort to formal contracts (and possibly enforce second-best outcomes) after the breakdown of an informal dealing. As we discuss later (see footnote 8), this possibility does not show up in our setting.

This study comparatively tests these theories using experimental evidence. Previous studies have used experiments to confirm the crowding out hypothesis in nonrepeated principal-agent settings; they find that incentive contracts under some circumstances decrease cooperation (Fehr and Gächter, 2000; Bohnet et al., 2001; Frey and Benz, 2001; Frey and Jegen, 2001). Other studies provide mixed results. In a finitely repeated principal-agent setting, Güth et al. (1998) find that the effect of formal incentives on cooperation is relatively more pronounced in late repetition periods and when subjects become experienced (i.e., in a second replication of the game). In a finitely repeated prisoner's dilemma, Tenbrunsel and Messick (1999) find that punishments decrease cooperation in early periods of the game, although they increase cooperation in the last period. In a repeated collective action game with an unknown termination date, Lubell and Scholz (2001) find that sanctions reduce cooperation by individuals initially inclined to cooperate, but actually increase cooperation by individuals initially inclined to defect.[2]

None of these studies, however, effectively test competing theories of the *interaction* between formal and informal agreements; they simply compare substitution hypotheses against other predictions—usually standard principal-agent predictions in nonrepeated games. We fill this void by creating an experimental setup in which we can systematically examine evidence of *both* complementarity and substitution. In our experiment, buyers choose to use or not to use a formal contract in repeated exchanges with sellers, who can take actions that potentially harm buyers. The contract is *incomplete*, in the sense that it enforces only certain (contractible) exchange dimensions. To assess complementarity, we manipulate the *probability of continuation* of ongoing relationships, which refers to the likelihood that, after a certain period, the *same* buyer-seller pair will continue transacting in the next period. (This is analogous to the discount factor in infinitely repeated games.)

In this setting, the complementarity view asserts that if contracts reduce gains from short-term defection, then formal contracts should promote cooperation, especially for lower levels of that probability of continuation, because self-enforcement becomes more difficult in this region. By contrast, the substitution (crowding out) view proposes that contracts undermine the reciprocity norm supporting cooperation regardless of the extent to which individuals expect to transact repeatedly. We also manipulate the *costs to use formal contracts* to assess how the prospect of costly formal

2. Some experiments evaluate the effect of sanctions on cooperation (e.g., Ostrom et al., 1992; Fehr et al., 1997; McCabe et al., 1998), but these studies consider ex post punishments instead of contracts imposed ex ante. In this article we focus instead on ex ante contracts, since ex post sanctions can be interpreted as acts of "reciprocity" against past defection (e.g., Fehr et al., 1997). A comparative analysis of ex ante and ex post punishments is provided by Fehr et al. (2001). Andreoni et al. (2003) examine the effect of ex post punishments and rewards, and find that they have a complementary effect.

contracting affects buyers' choice of alternative arrangements to support exchange and the overall surplus that individuals can attain in the exchange.

Consistent with the complementarity hypothesis, our data show that, by enforcing contractible exchange dimensions, incomplete contracts facilitate the self-enforcement of dimensions that are noncontractible. For this reason, buyers are less willing to transact with sellers (i.e., they are more likely to exit) when the probability of continuation is low and contract costs are high, because they cannot profitably employ contracts to facilitate self-enforcement. Although we find evidence of reciprocity as an informal enforcement mechanism, there is no evidence of substitution due to crowding out. Taken together, these results imply that, from a welfare point of view, contracts become crucial to support cooperation when individuals are not likely to transact repeatedly, since self-enforcement becomes more difficult and for this reason buyers refuse to transact more often.

The article is structured as follows. In Section 2 we present the game used in the experiment. In Section 3 we derive main predictions based on the subgame perfect equilibria of the game, which are tested against several alternative predictions based on reciprocity and crowding-out theory, presented in Section 4. Section 5 describes the experimental design, and the results are presented and discussed in Section 6. Concluding remarks follow.

## 2. The Game

Our game is a variation of Kreps' (1990) "trust game" (see also Dasgupta, 1988), to which we add the possibility of formal contracting and endogenous pricing. In the game, a buyer (*B*) wants to purchase a good from a seller (*S*), where this good has two relevant dimensions that are valuable to *B*, but costly to produce by *S*. The good is comprised of a pair of attributes ($a_1$, $a_2$), assumed to take either a low (*L*) or high (*H*) level. Therefore *S* can supply four possible combinations: (*H*, *H*), (*H*, *L*), (*L*, *H*), (*L*, *L*). Each combination costs *S* a certain amount of money denoted by, respectively, $c_{HH}$, $c_{HL}$, $c_{LH}$, and $c_{LL}$, such that $c_{HH} > c_{HL} \geq c_{LH} > c_{LL} = 0$. Similarly *B* values each combination according to a certain amount represented by $y_{HH}$, $y_{HL}$, $y_{LH}$, and $y_{LL}$, respectively, such that $y_{HH} > y_{HL} > y_{LH} \geq y_{LL} = 0$. *B*'s and *S*'s reservation rents are zero. Buyer values, seller costs, and reservation rents are common knowledge.

We assume that $y_{HH} - c_{HH} > y_{HL} - c_{HL} \geq y_{LH} - c_{LH} \geq y_{LL} - c_{LL} = 0$, which means in particular that (*H*, *H*) is the Pareto optimal choice. Thus *B* hopes to purchase the (*H*, *H*) good by paying a price $p > 0$. We also assume that *B* pays fully in advance for the good, that is, before *S* effectively delivers it. This implies that if *B* pays a price above andbeyond the costs to produce the (*H*, *H*) good, *S* can act opportunistically and choose a combination of attributes other than $(H, H)$.[3]

Our assumption that the good is multidimensional serves to operationalize contract *incompleteness*.[4] Namely, the first dimension, $a_1$, is fully contractible: the buyer can measure ex ante if the good contains the desired attribute. The second dimension, $a_2$, is fully noncontractible: the buyer can only measure the attribute after payment to the seller, delivery, and consumption (i.e., ex post). This may be due to the fact that the measurement of $a_2$ is very complex, increasing the costs to write a complete contract, or that it is extremely difficult for third-party enforcers to verify if the good has that attribute or not. Thus every contract on $a_2$ is incomplete: *B* can offer a formal contract for *S* defining a contingent payment based on attribute $a_1$, but not on attribute $a_2$; *B* must resort to some informal mechanism to enforce the latter. Given a price *p* for the $(H, H)$ good, the contract stipulates a price deduction *d*, such that $0 \leq d \leq p$, when *S* chooses a low level of the contractible dimension (i.e., $(L, .)$). The contract costs $x > 0$ to *B* in each transaction, but costs nothing to *S*.

The game is structured as follows (see Figure 1). In the first stage, *B* has three possible actions: (1) to pay for the good without any formal contract, (2) to propose a contract in which payment is contingent on *S*'s choice regarding the measurable attribute ($a_1$), or (3) to exit the relationship. If *B* does not exit, he or she proposes a price *p*. *S* observes *B*'s proposal and takes four possible actions, corresponding to the four combinations of attributes, plus an exit option. (Thus *B*'s offer is essentially a "take-it-or-leave-it," or "ultimatum," offer.) *B* then perfectly observes the action taken by *S*. If either *S* or *B* exits, they both earn zero as a payoff.

In the experiment, this stage game is repeated between the same partners. After each period there is a probability $\delta$ $(0 < \delta < 1)$ that the same partners will transact again in the next period, which we call the

3. The *buyer* can also act opportunistically in naturally occurring settings and pursue price reductions after delivery (Chen, 2000). In the labor market, this usually occurs when there is some bonus (paid ex post) for good performance (Baker et al., 1994). In other circumstances, such as buyer-supplier relationships, buyers usually pay a certain percentage when the deal is made and the remaining portion after delivery (Lane and Bachmann, 1996). We chose to focus on opportunistic actions by the seller (given buyers' full payment in advance) to simplify the experimental setting.

4. Previous studies have operationalized contract incompleteness in experiments as a certain probability (less than one) that a fine will be applied after a defection (Fehr and Gächter, 2000; Bohnet et al., 2001). We think, however, that this operationalization is somewhat inconsistent, since any outcome could be enforced with a very large penalty. For this reason, researchers have to establish an upper bound on the possible fine. Although we focus on different issues, our assumption that the good is multidimensional has parallels with multitask principal-agent models (Fehr et al., 2001; Holmstrom and Milgrom, 1991). Independent of our study, Frey and Benz (2001) also employed a two-dimensional exchange to operationalize contract incompleteness.

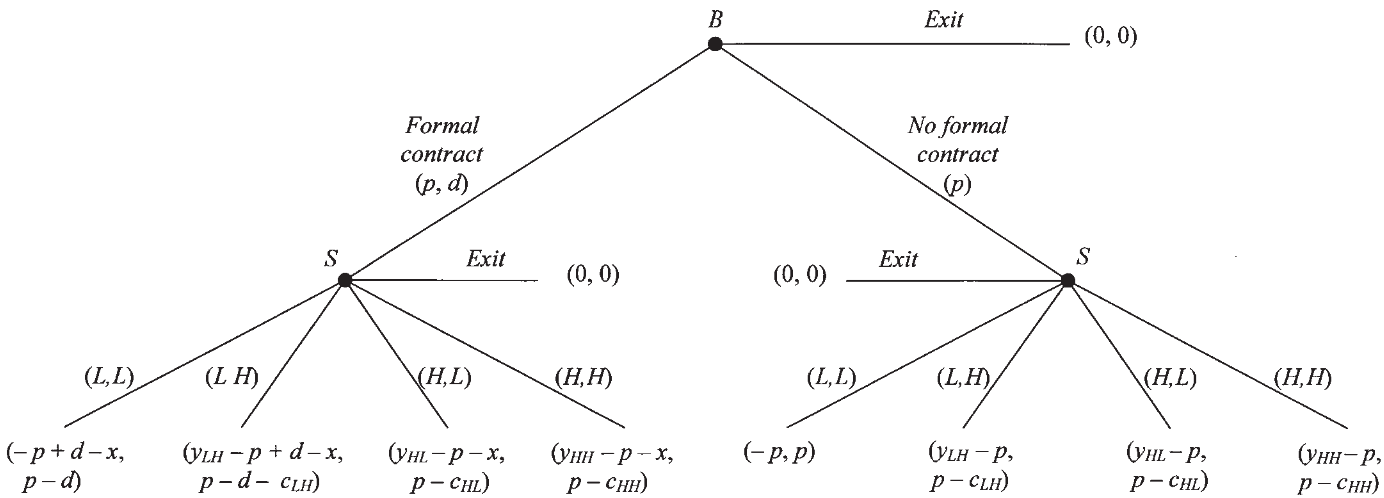


Figure 1. The stage game used in the experiment, where *B* is the buyer and *S* is the seller. Payoffs: (*B*, *S*). (*H*, *H*), (*H*, *L*), (*L*, *H*), and (*L*, *L*) are possible combinations of attributes of that *S* can choose, where the first attribute is contractible and the second is non-contractible. *p* is the price offered by *B* and *d* is the price deduction (if a contract is offered), which is applied if *S* chooses (*L*, .). *x* refers to contract costs, incurred by the seller. $y_{HH}$, $y_{HL}$, and $y_{LH}$ are values that *B* can attain with each combination of attributes chosen by *S*, whereas $c_{HH}$, $c_{LH}$, and $c_{HL}$ are costs incurred by *S*. In the experiment, we apply the following parameter values: $y_{HH} = 6$, $y_{HL} = 3$, $y_{LH} = 0$, $c_{HH} = 4$, $c_{LH} = c_{HL} = 3$.

"probability of continuation." This mimics an infinitely repeated game with discount parameter $\delta$ (Roth and Murnighan, 1978; Palfrey and Rosenthal, 1994).

## 3. Main Hypothesis

To simplify our predictions, we assume that $y_{HL} - c_{HL} < x$, which implies that $B$ cannot make profits by enforcing a second-best outcome $(H, L)$ using a formal contract. Thus only exit—no exchange, which gives both players zero payoff—can be supported as a Nash equilibrium of the stage game.[5] However, due to the repetition of the exchange with probability $\delta$, $B$ may (informally) self-enforce the superior outcome $(H, H)$ by adopting punishment strategies. We consider the following simple trigger strategy as a self-enforcement mechanism (see Baker, Gibbons, and Murphy, 1994): $B$ offers a price schedule $p > c_{HH}$ (to be discussed later), and if $S$ chooses a combination of attributes other than $(H, H)$, $B$ exits afterward as a punishment.[6] In this context, self-enforcement *without* a formal contract will occur if

$$\frac{p - c_{HH}}{1 - \delta} \geq p, \tag{1}$$

since $S$'s most profitable one-shot deviation will be to deliver the $(L, L)$ good, which is associated with zero production cost. On the other hand, if $B$ offers a formal contract with an incentive-compatible price deduction $d \geq c_{HL}$, then $(H, L)$ *will be S's most profitable deviation. This implies that self-enforcement with a formal contract will occur if*

$$\frac{p - c_{HH}}{1 - \delta} \geq p - c_{HL}. \tag{2}$$

Equations (1) and (2) imply two things. First, for the *same* level of price, self-enforcement with a formal contract requires a lower probability of continuation than without a formal contract. The reason is that the contract reduces the gain from short-term defection, represented by the right-hand side of the inequalities. Thus, other things being equal, buyers should more likely use contracts when the probability of continuation decreases, and sellers should be more likely to cooperate (choice of $(H, H)$) when a contract is in place. Second, for the same level of $\delta$, the price that $B$ has to

5. From $S$'s point of view, $(H, L)$ strictly dominates $(H, H)$ and $(L, L)$ strictly dominates $(L, H)$ if $B$ decides to transact, since $c_{HL} < c_{HH}$ and $0 = c_{LL} < c_{LH}$, respectively. In addition, since $y_{LL} = c_{LL} = 0$, any price $p > 0$ always gives $B$ a negative payoff if $(L, L)$ is chosen.

6. This is the worst, perfect, individually rational punishment (Abreu, 1988) of this game, given our assumptions. (Recall that only exit can be supported as a Nash equilibrium of the stage game.) To be sure, other punishment paths may be chosen. Our focus on the worst possible punishment allows us to assess the *minimal* probability of continuation to self-enforce the agreement with or without a formal contract. For this reason, we also abstract from issues of renegotiation proofness.

pay to guarantee self-enforcement—which just satisfies Equations (1) and (2)—is lower when a contract is used. With no contract, $B$ would be able to pay $p^{NC} = c_{HH}/\delta$ to self-enforce the exchange, whereas with the contract, $p^{C} = c_{HH}/\delta - c_{HL}(1-\delta)/\delta < p^{NC}$. The reason is, again, that the contract reduces the gain from one-shot defection, thereby reducing the necessary rent that $B$ has to pay to promote self-enforcement. Thus, other things being equal, buyers should reduce the price offered to sellers when using a contract.

For high values of $\delta$ such that self-enforcement is possible with *and* without the contract, the fact that $B$ can reduce the price by using the contract implies that $B$ may want to *use* the contract simply to redistribute rents from $S$. However, to do so $B$ must incur contract costs $x$. Thus, if the transaction is self-enforceable without the contract, $B$ will *not* use the contract only if $y_{HH} - p^{NC} > y_{HH} - p^{C} - x$, or

$$\delta > \frac{c_{HL}}{c_{HL} + x}. \tag{3}$$

For values of $\delta$ where Equation (3) holds, $B$'s second-best alternative when no contract is used will always be to exit, since the contract is too costly. Thus, if no contract is used, the upper bound on the price will be given by $y_{HH} - p \geq 0$ or $p \geq y_{HH}$. Using this fact and Equation (1), self-enforcement of ($H$, $H$) *without* the contract will be a subgame perfect equilibrium (SPE) only if Equation (3) holds and

$$\delta \geq \frac{c_{HH}}{y_{HH}}, \tag{4}$$

where the offered price will be $p^{NC} = c_{HH}/\delta$. For values of $\delta$ where Equation (3) does not hold, any self-enforcing arrangement with the contract always yields $B$ a higher payoff than without it. Thus, if no contract is used, the upper bound on the price will be given by $y_{HH} - p - x \geq 0$ or $p \geq y_{HH} - x$. Using this fact and Equation (2), self-enforcement of ($H$, $H$) *with* the contract will be a SPE only if Equation (3) does not hold and

$$\delta \geq \frac{c_{HH} - c_{HL}}{y_{HH} - c_{HL} - x}, \tag{5}$$

where the offered price will be $p^{C} = [c_{HH} - c_{HL}(1-\delta)]/\delta$ and the (incentive compatible) deduction will be any $d \geq c_{HL}$.

If contract costs are not too high—more precisely, if $x < c_{HL}(y_{HH}/c_{HH} - 1)$—then the right-hand term in Equation (5) is always lower than the right-hand term in Equation (4). In this case, the contract *complements* the self-enforcing informal arrangement, since it requires a lower probability of continuation to support ($H$, $H$). In other words, the buyer's assurance that the seller will perform on the noncontractible dimension increases when the contractible dimension is safeguarded. If Equation (4)

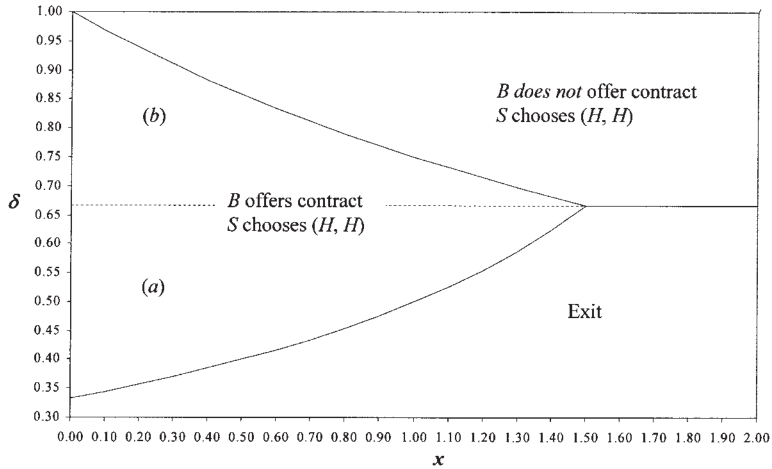


Figure 2. SPE according to the probability of continuation of transactions between the same partners ($\delta$) and contracting costs ($x$).

holds, then the transaction is self-enforceable without any contract. But if Equation (3) does not hold, then the use of the contract is profitable; in fact, buyers will want to use it solely to reduce the price to sellers. On the other hand, if Equation (3) holds—for instance, due to high contracting costs—then it is not profitable for buyers to employ this strategy, and hence they will need to rely on the (self-enforcing) informal agreement if they decide to transact.[7]

Let us provide a numerical example with the parameter values chosen in the experiment: $y_{HH}=6$, $y_{HL}=3$, $y_{LH}=0$, $c_{HH}=4$, and $c_{LH}=c_{HL}=3$. Using the results discussed above, Figure 2 depicts regions with possible SPE given different probabilities of continuation and contracting costs, thereby summarizing our main hypothesis. Region (a) in Figure 2 shows the case where formal and informal arrangements complement one another: self-enforcement is possible *only* with a formal contract. In region (b) of Figure 2, contracts are still used by

7. Baker et al. (1994) note that if formal contracts are fairly profitable if used to enforce a second-best outcome, parties will not be able to implement a harsh, credible retaliation threat (e.g., exit) to guarantee self-enforcement. The offended party would still be willing to enforce a second-best outcome with a formal contract even after a defection (see also Schmidt and Schnitzer, 1995). This case of substitution does not show up in our model because we assume that it is not profitable to buyers to enforce a second-best outcome (such as ($H$, $L$)). If $y_{HL}-c_{HL}>x$, then buyers could enforce the following equilibrium: they could offer $p=c_{HL}$ with a formal contract ($d\geq c_{HL}$) and get the ($H$, $L$) good. This possibility would imply that buyers would still be able to make money in transactions with sellers after a deviation from ($H$, $H$). This would decrease the price buyers would be willing to pay to self-enforce the ($H$, $H$) outcome. We ignore this possibility in our setting because our goal is mainly to assess substitution arguments based on the effect of contracts on social norms.

buyers even though self-enforcement is possible without a formal agreement, since in that region contract costs are low. We note that, as is well known from the theory of infinitely repeated games, $(H, H)$ is not the unique SPE when the transaction is self-enforceable: the inferior equilibrium (exit) cannot be ruled out. However, when the probability of continuation is sufficiently low and buyers cannot profitably use contracts—specifically, if $\delta < \min\{1/(3-x), 2/3\}$—self-enforcement will be unfeasible, and therefore exit is the unique prediction. In other words, we should observe relatively higher rates of buyer exit when the probability of continuation is low *and* contract costs are high.

The welfare implications of these results are interesting. For low probabilities of continuation where cooperation can only be sustained with a contract—that is, when Equation (5) holds but Equation (4) does not hold—an increase in contract costs implies a welfare *loss*, since the contract is the only recourse to facilitate self-enforcement. Without low-cost contracts, there will be no exchange, since buyers will not be able to profitably use a contract to complement the informal dealing. On the other hand, when Equation (4) holds—that is, the informal agreement is self-enforceable without any contract—an increase in contracting costs implies a welfare *gain* if it moves the equilibrium out of region (b). This is because buyers will not find it profitable to employ contracts simply to reduce the price to sellers, thereby avoiding unnecessary contracting expenses.[8] Thus we expect that an increase in contract costs will induce a welfare loss for low probabilities of continuation, but a welfare gain for high probabilities.

## 4. Alternative Hypotheses

We now present alternative arguments that challenge some of the predictions described in Section 3 and support a particular form of substitution between formal and informal agreements.

### 4.1 Reciprocity

Several authors propose that social norms can support cooperation in the absence of legal enforcement (e.g., Granovetter, 1985; Ellickson, 1991; Huang and Wu, 1994). Other authors go beyond this proposition by arguing that social norms can support cooperation even if informal dealings are not self-enforcing in the sense described before—for instance, if individuals are not expected to transact repeatedly. One of the most discussed social norms is *reciprocity*, meaning that individuals tend to cooperatively respond to generous offers even if this is against their own self-interest (Rabin, 1993; Fehr et al., 1997; Hoffman et al., 1998). In our context, reciprocity implies that a high price offered by the buyer

8. See also Chen (2000) for an analysis of how increases in contracting costs may cause efficiency gains in a setting involving asymmetric information.

will elicit a reciprocal, cooperative response by the seller (i.e., the supply of high levels of contractible *and* noncontractible dimensions, ($H$, $H$)) regardless of the expected repetition of the game. This argument supports the alternative hypothesis that, other things being equal, there will be a positive effect of the price offered by the buyer on cooperation. Notice that the self-enforcement model predicts that it is the interaction between the price and expected continuation of the transaction, instead of the price alone, that drives cooperation. This is because, without repetition, the game is one-shot and hence sellers are always better off defecting. With repetition, sellers should assess the extent of the future stream of payoffs they could attain by cooperating, which is equal to the expected duration of the exchange times of the expected rents per period.

Reciprocity also supports the emergence of trust because buyers can hope to get some cooperation even when the transaction is not self-enforceable with or without a contract. To verify this possibility, notice that the discussion in Section 3 predicts exit as the unique SPE when the probability of continuation is low and contract costs are high—more precisely, when $\delta < \min\{1/(3-x),\ 2/3\}$. Hence another alternative hypothesis is that there will be some cooperation even if this condition holds, because buyers will trust sellers and therefore avoid exiting.[9]

### 4.2 Substitution Due to Motivation Crowding Out

Substitution arguments based on motivation crowding out theory argue that formal or extrinsic rules damage the norms or intrinsic rules that support informal dealings, notably reciprocity. This occurs for two reasons. First, when a buyer insists that a seller should sign a formal contract, the seller may interpret this as a signal that no reciprocity is expected in the relationship (Fehr and Gächter, 2000). Thus the contract may undermine the operation of reciprocity, which would otherwise act as an informal enforcement mechanism. Second, as proposed by psychologists (Deci and Ryan, 1985), extrinsic incentives or punishments may reduce individuals' intrinsic motivation to cooperate (Frey, 1997; Frey and Jegen, 2001). Proponents of crowding out theory interpret this intrinsic motivation as a voluntary willingness to act in a reciprocal manner (Falk, Gächter, and Kovács, 1999). These arguments imply the following alternative hypothesis: the use of a formal contract will reduce the reciprocity effect predicted before, that is, the contract will reduce sellers' cooperative response to high prices.

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9. We are not considering trust as some form of assurance that the transaction can be self-enforced—which some refer to as "calculative" trust (e.g., Williamson, 1993). Rather, we consider trust here as an expectation of cooperation by agents even if it is not in their self-interest to do so.

## 5. Experimental Design and Procedures

### 5.1 Design

In our design we employ treatments involving several probabilities of continuation crossed with different levels of contract costs. Namely we apply three different probabilities of continuation (0.85, 0.70, and 0.50), each with two different levels of contract costs (0.10 and 1.50). Notice that these levels of the manipulated variables locate distinct regions in Figure 2. This design allows us to assess both whether contracts facilitate self-enforcement as the probability of continuation drops, and how distinct levels of contracting costs affect buyers' willingness to transact and their use of alternative arrangements. As mentioned earlier, we apply the following parameter values: $y_{HH}=6$, $y_{HL}=3$, $y_{LH}=0$, $c_{HH}=4$, and $c_{LH}=c_{HL}=3$.

Contract costs are manipulated in a between-subjects fashion, whereas probabilities of continuation are manipulated in a within-subjects fashion. We employ a within-subjects design for the manipulation of the probabilities of continuation mainly because it allows us to assess what happens when the same individual is exposed to different probabilities of continuation in transactions with other individuals. For this reason, this within-subjects design is likely to reduce error variance and yield more powerful tests as long as individual characteristics affect behavioral responses (Whitley, 1996). Another advantage is that it requires fewer participants than a full between-subjects design, since the same subjects receive different treatments. A disadvantage of this design, however, is that choices may be subject to "order effects."[10] In an attempt to control for this problem, we run groups with equal levels of contract cost but different orderings of that variable: ascending (i.e., 0.50, 0.70, and 0.85) and descending (i.e., 0.85, 0.70, and 0.50).

### 5.2 Subjects

Our subjects are 102 students at a private midwestern university, both undergraduate and graduate (MBA) students; 62.7% of the subjects are male, 8.8% are MBA students, and the mean age of our subjects is 20.4 years (ranging between 18 and 30 years). Two groups play the game with the contract cost of 0.1, and two groups play the game with the cost of 1.5. Of these two groups playing with the same contract cost, one receives an ascending order of probabilities of continuation, and the other receives a descending order. Subjects are randomly assigned to these groups, as well as to the role of buyer or seller.

### 5.3 Procedures

To facilitate subjects' understanding of the experimental setup, we describe the game as a buyer-supplier relationship involving the procurement of

10. For instance, subjects who are exposed to a high probability of continuation at the outset may learn how to adopt and respond to trigger strategies, thereby increasing cooperation at lower probabilities of continuation.

software services (experimental instructions are reproduced in the appendix).[11] Transactions are mediated by a software system linking buyers' and sellers' computer terminals in a network. Buyers and sellers stay in the same room, seated in cubicles with a computer terminal. However, they are not informed who is playing the role of buyer or seller. Before the experiment begins, instructors read the experimental instructions and verify subjects' understanding of the game and procedures through a quiz. Instructors then demonstrate the software and conduct a practice session where each subject plays against himself or herself (i.e., as both buyer and seller). Next, subjects are privately informed of the role they will play in the experiment and are assigned an anonymous identity code.

In the first period, buyers are randomly assigned to sellers. The manipulation of probabilities of continuation is accomplished as follows. Prior to the first transaction between a buyer and a seller, instructors announce a certain probability of continuation and write it on a blackboard. After buyers and sellers transact in each period (or exit), subjects are informed that a random draw by the computer from 1 to 100 will indicate the termination or the continuation of their ongoing pair. Subjects are told that if the random draw is higher than the probability of continuation announced by instructors, then the ongoing pair is terminated. If the random draw indicates termination, then buyers are assigned to *new* sellers, and vice versa—"new" in the sense that they are sellers (buyers) with whom buyers (sellers) have never transacted in prior periods.[12] If subjects exit in a particular period, they are reassigned to their previous partners in the next period unless the random draw indicates the termination of the relationship. Thus the process of matching is completely controlled in our experiment.[13] In addition, subjects are not informed about the new

11. Although this buyer-seller setup facilitates subjects' understanding of the game, it is possible to argue that it may bias the results against crowding out, which may be stronger in nonbusiness contexts. However, previous experiments that found significant reciprocity and/or crowding out effects also used business contexts in the experimental instructions to participants, such as buyer-seller (Fehr et al., 1997; Fehr and Gächter, 2000) or manager-employee relationships (Falk et al., 1999; Tenbrunsel and Messick, 1999; Frey and Benz, 2001).

12. This is important because, even if in every period subjects are randomly reassigned to each other, they may form some subjective probability that they will be rematched in future periods, thus possibly increasing their willingness to cooperate (Cooper et al., 1996). To facilitate the implementation of this procedure, all participants receive the same random draw. Thus, whenever there is termination of ongoing pairs, the whole group is "rotated."

13. It would be more natural to let subjects switch to new partners in case of defection. However, this would imply that the probability of continuation would not be strictly manipulated anymore; the decision to terminate or continue ongoing relationships would be part of the subjects' strategies. By avoiding this possibility, our procedure guarantees complete control over the expected continuation of buyer-seller pairs. In a companion study (Lazzarini et al., 2002), we assess the role of formal contracts when individuals are free to keep or switch exchange partners.

partner's choices in previous periods with other subjects: choices do not have consequences beyond ongoing buyer-seller pairs.[14]

To generate a similar number of expected periods for each probability of continuation, we apply the probability of 0.50 three times, the probability of 0.70 twice, and the probability of 0.85 only once, that is, after only one reassignment of participants.[15] Therefore the actual orderings of probabilities of continuation are (0.85, 0.70, 0.70, 0.50, 0.50, 0.50) for the descending case and (0.50, 0.50, 0.50, 0.70, 0.70, 0.85) for the ascending case. Notice that subjects transact with six different partners in each group. In their computer terminals, subjects can see the whole history of transactions with current and former partners, including choices and net earnings.

Subjects received a show-up fee of $5, plus a variable compensation depending on the number of points they earned in the experiment, all paid in cash.[16] The average total compensation was $25. Each session took between 1.5 and 2 hours.

## 6. Results and Discussion

### 6.1 Overview

Taking the outcome of each period as a unit of analysis, Table 1 summarizes the average decisions in the experiment. A salient aspect is that cooperation rates are low even when the probability of continuation is high, which is consistent with former studies finding that expected repetition is not by itself a strong feature to induce cooperation (e.g., Palfrey and

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14. This guarantees that the predictions outlined in Section 3 hold even if subjects transact with more than one partner. To see why, suppose that, after the termination of an ongoing relationship, a seller expects to earn $V^N$ in exchanges with new buyers. (Since the number of new partners is finite, $V^N$ is finite.) Considering the case where no contract is offered by the buyer and the trigger strategy described in the beginning of Section 3, the seller will cooperate if $(p - c_{HH}) + \delta(p - c_{HH}) + (1 - \delta)V^N + \cdots \geq p + \delta(0) + (1 - \delta)V^N + \ldots$, which is functionally identical to Equation (1) ($V^N$ affects equally both sides of the inequality).

15. For a given probability of continuation $\delta$, the expected number of periods with the same pair is $1/(1 - \delta)$. Thus the expected number of periods for the probabilities of continuation 0.50, 0.70, and 0.85 are 2, 3.33, and 6.66, respectively.

16. Since our game is expected to generate asymmetric payoffs for buyers and sellers (buyers are in a riskier position), we adjusted subjects' variable payments based on their roles to guarantee similar average compensations. Namely, we defined a buyer's variable compensation based on the relative ranking in terms of points among buyers in the same group, and employed the same procedure for sellers. However, subjects were simply told that their monetary compensation was monotonically increasing with experimental points. When a contract was in place, sellers could double their number of points in a given period by choosing ($L$, $L$) instead of full cooperation ($H$, $H$). When there was no contract, they could earn five times more points by defecting. Such one-shot gains from defection seem to be salient enough, even considering that subjects did not know for sure the dollar value of each experimental point. Alternatively we could have given buyers initial cash to support their possible losses during the experiment. Our concern with this procedure is that it is likely to induce framing effects, and hence certain risk attitudes that are not incorporated in our model.

Table 1. Summary of Experimental Results Based on Individual Periods for the Manipulated Levels of Contract Costs (*x*) and Probabilities of Continuation ($\delta$)

| | $x=0.10$; $\delta=$ | | | $x=1.50$; $\delta=$ | | |
|---|---|---|---|---|---|---|
| | 0.85 | 0.70 | 0.50 | 0.85 | 0.70 | 0.50 |
| *N* (periods) | 256 | 157 | 117 | 181 | 185 | 150 |
| % periods where... | | | | | | |
| Buyers exited | 31.6 | 31.8 | 28.2 | 33.7 | 42.7 | 48.7 |
| Sellers chose (*H*, *H*) | 42.6 | 39.5 | 28.2 | 45.3 | 35.1 | 27.3 |
| Welfare[a]—mean | 0.40 | 0.37 | 0.25 | 0.39 | 0.26 | 0.15 |
| (standard deviation) | (0.48) | (0.48) | (0.44) | (0.56) | (0.52) | (0.48) |
| Offers without a contract[b] | | | | | | |
| % periods | 26.0 | 14.2 | 10.9 | 81.1 | 75.9 | 63.7 |
| Price—mean | 4.12 | 3.24 | 1.88 | 4.46 | 4.34 | 4.22 |
| (standard deviation) | (1.63) | (2.07) | (2.26) | (1.38) | (1.51) | (1.65) |
| (*H*, *H*) choices (% periods) if $p \geq 4$ | 75.7 | 70.0 | 0.0 | 84.8 | 74.0 | 66.7 |
| Offers with a contract[b] | | | | | | |
| % periods | 74.0 | 85.8 | 89.1 | 18.9 | 24.1 | 36.3 |
| Price—mean | 4.13 | 4.16 | 3.94 | 2.86 | 3.29 | 3.31 |
| (standard deviation) | (1.22) | (1.30) | (1.19) | (1.33) | (1.27) | (1.24) |
| Deduction—mean | 3.82 | 3.90 | 3.60 | 2.42 | 2.98 | 2.81 |
| (standard deviation) | (1.37) | (1.34) | (1.21) | (1.19) | (1.14) | (1.32) |
| (*H*, *H*) choices (% periods) if $p \geq 4$ | 81.6 | 70.5 | 60.4 | 44.4 | 73.3 | 73.3 |

[a]Average number of experimental points achieved by all buyer-seller pairs in each period divided by the maximum number of points attainable (2 points per period-pair).
[b]Relative to periods where buyers have not exited.

Rosenthal, 1994). Theoretically this is not surprising, since repeated games are not only about cooperation, but how parties coordinate actions to achieve the superior equilibria (Miller, 1992; Van Huyck et al., 2001). In our experimental setup, coordination was indeed difficult, since no form of "cheap talk" or signaling was allowed.

When contract costs are high and the probability of continuation is low, self-enforcement becomes very difficult, and hence exit is expected to become the unique SPE. This appears to be supported by our data: the treatment with high contract cost shows a larger incidence of exits by the buyer than the treatment with low contract cost when $\delta = 0.70$ and $\delta = 0.50$ ($p < 0.005$); when $\delta = 0.85$, the difference is insignificant.[17] Notice, however, that some cooperation persisted even when contract costs were high and probabilities of continuation were low. Evidence of cooperation in these conditions provides support for the alternative hypothesis that some buyers trust sellers (i.e., do not exit) based on considerations other than

17. We report one-tailed tests whenever there is some prediction about the direction of the effect, and establish a minimum level of significance of $p \leq 0.05$.

self-enforcement. As we shall see later, one of these considerations is apparently the expectation that sellers will reciprocate a sufficiently high price offer.

Another salient, but not surprising result is that the proportion of periods where a contract is used drops as contract costs increase ($p < 0.001$), conditional on the buyer having not exited. It also appears that the use of contract increases as the probability of continuation is reduced: the lowest level, $\delta = 0.50$, exhibits a significantly higher proportion of contracts than the other levels ($p = 0.003$). Although the frequency of contract use is lower when contracting costs are high ($p < 0.001$), many subjects do use contracts for $\delta = 0.85$, where the exchange can possibly be self-enforced without any contract. We hypothesized in Section 3 that this may occur because buyers have an incentive to use contracts to reduce the price paid to buyers. However, Table 1 shows no such effect in a consistent manner: although prices are generally lower with than without a contract when $x = 1.50$ ($p < 0.001$), the effect is reversed when $x = 0.10$ ($p = 0.004$). This suggests that when buyers reduce prices offered with a contract, they do so because they cannot afford high prices if contract costs are too high.[18]

Analyzing sellers' choices across treatments with and without a contract in place, we see that the proportion of periods where sellers choose ($H$, $H$) is higher with than without a contract when $x = 0.10$, though the difference is only significant for the lowest probability of continuation, $\delta = 0.50$ ($p < 0.002$).[19] But in the treatment involving high contract costs ($x = 1.50$), this effect is somewhat reversed: cooperation is lower with than without a contract except when $\delta = 0.50$ (in this case, however, the difference is insignificant). Although, at first glance, this may appear puzzling and inconsistent with the complementarity hypothesis, we note that it is merely the result of an uncontrolled effect: the offered price. Since, as we saw earlier, buyers tend to reduce price offers in the treatment with high contract costs (because they cannot afford to pay high prices when using costly contracts), the decrease in cooperation with this treatment when a contract is present is likely a consequence of the reduction in the prices offered. We carry out later a more detailed analysis of sellers' choices that controls for this effect.

18. Analyzing the data, we see that contracts are not always incentive compatible, that is, associated with $d \geq 3$: in 26.9% of periods where buyers do not exit and offer a contract, the latter is non-incentive compatible (averaging over all treatments). Some buyers choose a non-incentive-compatible contract not only because they do not understand incentive compatibility, but also because in the experiment there was a requirement that the deduction could not exceed the offered price. Thus, for choices involving a price lower than three, any contract is automatically non-incentive compatible. However, even for prices greater than or equal to 3, 11.8% of contracts are non-incentive compatible.

19. We restrict this analysis to the cases where $p \geq 4$, because otherwise sellers cannot choose ($H$, $H$) profitably.

We also predicted in Section 3 that the welfare implications of contract costs are dependent on the probability of continuation: an increase in contract cost should decrease welfare when the probability of continuation is low, but increase welfare when the probability of continuation is high. To assess this effect, we compute welfare as the sum of the experimental points attained by a buyer-seller pair in each period divided by the maximum number of points that a pair could possibly get (two points per period). An analysis of variance (ANOVA) test involving all main effects of treatments and their interactions (results not reported here) disconfirms our prediction. An increase in contract cost reduces welfare for *all* probabilities of continuation ($p = 0.024$); the interactions between contract costs and probabilities of continuation are insignificant. As expected, a drop in the probability of continuation from 0.85 and 0.70 to 0.50 significantly reduces welfare ($p = 0.028$).

## 6.2 Buyers' Exit

Our main hypothesis, presented in Section 3, asserts that buyer exit will be more likely when the probability of continuation is low, and this effect will be moderated by the presence of a formal contract, which will reduce the necessary probability of continuation to self-enforce the exchange. This implies that the possibility of formal contracting will contribute to a reduction in the likelihood of buyer exit, especially when the probability of continuation is low. The possibility of formal contracting, in turn, will be a function of contract costs. In our analysis, the treatments $\delta = 0.50$ and $\delta = 0.85$ are coded by the dummy variables *C50* and *C85*, respectively, which assume the value of one if the treatment is present, and zero otherwise. Therefore we are centering our analysis on $\delta = 0.70$, which becomes represented by the intercept. The treatment related to contract cost is indicated by the dummy variable *HiCost*, which is equal to one if $x = 1.50$, and zero otherwise. This allows us to specify the following probit model:

$$\Pr(BExit_t^{ij} = 1) = \Phi(a_0 + a_1 C85^{ij} + a_2 C50^{ij} + a_3 HiCost^{ij} + a_4 C85^{ij} HiCost^{ij} + a_5 C50^{ij} HiCost^{ij}), \quad (6)$$

where $BExit_t^{ij}$ is a dummy variable that is equal to one if buyer $i$ exits when paired with seller $j$ in period $t$, and zero otherwise, and $\Phi(\cdot)$ denotes the standard cumulative normal distribution. Based on the discussion above, we predict $a_1 < 0$, $a_2 > 0$, $a_3 > 0$, $a_4 < 0$, and $a_5 > 0$.

Since treatments are randomly assigned to buyers, we use the random-effects probit model proposed by Butler and Moffitt (1982) to fit Equation (6). Column (a) in Table 2 presents the maximum-likelihood estimates for this model, computed using Gauss-Hermite quadrature and clustering on

Table 2. Probability of Buyers' Exit

| | (*a*) | (*b*) | (*c*) |
|---|---|---|---|
| Intercept | −0.824 | −1.578 | −1.742 |
| | (0.232) | (0.263) | (0.202) |
| *C85* | 0.074 | −0.004 | −0.021 |
| | (0.163) | (0.190) | (0.188) |
| *C50* | −0.320 | −0.286 | −0.284 |
| | (0.206) | (0.222) | (0.219) |
| *HiCost* | 0.371 | 0.694 | 1.007 |
| | (0.304) | (0.259) | (0.207) |
| *C85* × *HiCost* | −0.495 | −0.511 | −0.678 |
| | (0.243) | (0.261) | (0.266) |
| *C50* × *HiCost* | 0.549 | 0.606 | 0.552 |
| | (0.266) | (0.283) | (0.284) |
| *Past Cooperation* | | −0.259 | −0.254 |
| | | (0.051) | (0.050) |
| *Past Defection* | | 0.416 | 0.448 |
| | | (0.048) | (0.046) |
| *Ascending* | | | 0.851 |
| | | | (0.152) |
| Log-likelihood | −486.83 | −431.39 | −426.30 |
| $\chi^2$ (Wald) | 19.44 | 114.26 | 165.71 |
| *n* | 1046 | 1046 | 1046 |

Estimates of random effects probit model (centered on each buyer) where the dependent variable is a dummy variable coded one if the buyer exits (refuses to transact) in a given period and zero otherwise. Standard errors are in parentheses. The treatments $\delta = 0.50$ and $\delta = 0.85$ are coded by the dummy variables *C50* and *C85*, respectively, while the treatment related to contract cost is coded by the dummy variable *HiCost*, which is equal to one if $x = 1.50$, and zero otherwise. *C85* × *HiCost* and *C85* × *HiCost* are interaction terms. To assess the dynamics of buyer exit, we also add two variables related to the history of play, *Past Cooperation* and *Past Defection*, which code, respectively, the number of times in which the seller to which the buyer is assigned cooperated (i.e., chose (*H*, *H*)) and defected in past transactions with that particular buyer. *Ascending* is a dummy variable to control for the different ordering of the probabilities of continuation, assuming value one if the ordering is ascending and zero otherwise.

each buyer. The coefficient of *HiCost* is positive, but insignificant. The interaction terms *C85* × *HiCost* and *C50* × *HiCost*, on the other hand, are statistically significant ($p = 0.021$ and $p = 0.020$, respectively) and aligned with our theory: an increase in contract costs increases the probability of buyer exit mostly when the probability of continuation is low. Although the main effects of the probabilities of continuation (*C85* and *C50*) have the opposite of the predicted signs, they are both insignificant. Overall, coefficients indicate that buyer exit is more likely when $\delta = 0.50$ and contract costs are high, which is consistent with the pattern depicted in Figure 2.

Exit may also be a response to past outcomes: namely, if sellers defect, buyers are likely to exit; if they cooperate, exit is less likely. Notice, however, that the theory presented in Section 3 does not support this prediction since decisions are equivalent from period to period and, in an SPE, individuals are expected to accomplish optimal choices since the beginning of play (Telser, 1980; Abreu, 1988). Thus buyers should anticipate whether cooperation is self-enforceable and, if not, avoid exchanging with the sellers with whom they are paired. Of course, we could relax our assumption of common knowledge of payoffs by assessing how buyers learn seller types (in terms of their preferences for cooperation) and exit accordingly (e.g. Kreps et al., 1982).[20] But since a formal discussion of such models is beyond the scope of this article, we now assess choices that, in our model, are off the equilibrium path. With this caveat in mind, we expand our regression analysis by including two variables related to the history of play, $\textit{Past Cooperation}_t^{ij}$ and $\textit{Past Defection}_t^{ij}$. These variables code, respectively, the number of times in which seller $j$ cooperated (i.e., chose $(H, H)$) and defected (i.e., chose a combination of attributes other than $(H, H)$) in past transactions (up to $t$) with buyer $i$. (If pairs change at $t$, these variables are reset to zero.) Column (b) in Table 2 reports the estimation results including these variables. Both are highly significant ($p < 0.001$) and in the predicted direction: while past cooperative outcomes tend to reduce exit, past defection tends to increase it. With the inclusion of these variables, inference about the other variables remains qualitatively similar, except for the fact that *HiCost* now becomes significant: buyers are more likely to exit in the treatment involving high contract costs, regardless of the probability of continuation.

Since we implemented two orderings of the probability of continuation, we also verify whether this feature has an impact on subjects' choices. The dummy variable *Ascending* is coded one if the probabilities of continuation are introduced in an ascending order, and zero if the order is descending. When included in the estimation (column (c)), *Ascending* shows a positive and significant effect ($p < 0.001$): when the order is ascending, buyers are more likely to exit. Controlling for this effect, inference about the other variables remains similar.

In sum, the results suggest that buyer exit increases when contract costs are high, and that this effect is magnified when the probability of continuation is low. The history of play also matters, in that buyers are highly likely to exit when faced with past negative outcomes.

## 6.3 Contract Choice

Our main hypothesis suggests that, conditional on buyers having not exited, they will offer a contract only if $x < c_{HL}(1-\delta)/\delta = 3(1-\delta)/\delta$ (see Equation (3)). Thus the probability of a contract being offered decreases with the probability of continuation and contract costs. We therefore

20. For instance, suppose that in an exchange environment there are honest types, cheaters (who always defect), and self-interested types (who may or may not cheat depending on the underlying incentives). By transacting with a seller who defects even when the exchange is self-enforcing, a buyer may learn that the seller is a cheater and exit in the next period (e.g., Kranton, 1996).

Table 3. Probability of Buyers' Use of Formal Contracts

| | (*a*) | (*b*) | (*c*) | (*d*) | | |
|---|---|---|---|---|---|---|
| | | | | All periods | Periods≤7 | Periods≥15 |
| Intercept | 1.377 | 1.387 | 3.626 | 4.041 | 2.855 | 0.939 |
| | (0.191) | (0.195) | (2.062) | (1.994) | (3.654) | (6.171) |
| *C85* | −0.411 | −0.347 | −0.355 | −0.353 | 0.909 | −0.395 |
| | (0.161) | (0.175) | (0.175) | (0.175) | (0.604) | (0.866) |
| *C50* | 0.240 | 0.221 | 0.227 | 0.239 | −0.587 | 1.351 |
| | (0.176) | (0.176) | (0.181) | (0.181) | (0.439) | (0.491) |
| *HiCost* | −2.276 | −2.231 | −1.917 | −1.970 | −2.310 | −2.628 |
| | (0.233) | (0.229) | (0.285) | (0.283) | (0.558) | (0.795) |
| *Past Cooperation* | | −0.054 | −0.060 | −0.061 | −0.305 | −0.038 |
| | | (0.037) | (0.040) | (0.039) | (0.129) | (0.125) |
| *Past Defection* | | 0.018 | 0.064 | 0.059 | −0.188 | 0.210 |
| | | (0.043) | (0.044) | (0.044) | (0.120) | (0.175) |
| *Male* | | | −0.596 | −0.621 | −0.222 | −1.013 |
| | | | (0.192) | (0.187) | (0.421) | (0.856) |
| *Major* | | | −0.810 | −0.838 | −0.524 | −2.604 |
| | | | (0.294) | (0.282) | (0.539) | (1.080) |
| *Graduate* | | | 1.369 | 0.017 | 0.310 | 1.045 |
| | | | (0.612) | (0.510) | (1.259) | (1.851) |
| *Age* | | | −0.080 | −0.097 | −0.076 | 0.126 |
| | | | (0.091) | (0.088) | (0.170) | (0.288) |
| *Experience* | | | −0.061 | −0.031 | −0.184 | −0.184 |
| | | | (0.198) | (0.193) | (0.515) | (0.942) |
| *Ascending* | | | | −0.120 | 1.327 | 0.912 |
| | | | | (0.173) | (0.756) | (0.979) |
| Log-likelihood | −295.63 | −294.43 | −293.10 | −292.93 | −119.03 | −81.43 |
| $\chi^2$ (Wald) | 97.11 | 106.32 | 113.13 | 108.34 | 33.65 | 29.02 |
| *n* | 749 | 749 | 749 | 749 | 274 | 240 |

Estimates of random effects probit model (centered on each buyer) where the dependent variable is a dummy variable coded one if the buyer offers a contract to the seller in a given period and zero otherwise, conditional on the buyer having not exited. Standard errors are in parentheses. The treatments $\delta = 0.50$ and $\delta = 0.85$ are coded by the dummy variables *C50* and *C85*, respectively. *HiCost* is equal to one if $x = 1.50$, and zero otherwise. *Past Cooperation* and *Past Defection* code, respectively, the number of times in which the seller to which the buyer is assigned cooperated (i.e., chose (*H*, *H*)) and defected in past transactions with that particular buyer. *Male*, *Major*, *Graduate*, *Age*, and *Experience* are buyer-specific characteristics. *Male* is coded one if the subject playing the role of buyer is male, and zero otherwise; *Major* is coded one if the buyer's major is either economics or business; *Graduate* is coded one if the buyer is a graduate (MBA) student, and zero otherwise; *Age* is the age of the buyer (years); *Experience* is a dummy variable that assumes the value of one if the buyer has participated in previous experiments at the laboratory where this study was run. *Ascending* is a dummy variable to control for the different ordering of the probabilities of continuation, assuming value one if the ordering is ascending and zero otherwise.

specify the following model:

$$\Pr(Contract_t^{ij} = 1 | BExit_t^{ij} = 0) = \Phi(b_0 + b_1 C85^{ij} + b_2 C50_{ij} + b_3 HiCost^{ij}), \quad (7)$$

where $Contract_t^{ij}$ is a dummy variable that is equal to one if buyer $i$ offers a contract when paired with seller $j$ at period $t$, and zero otherwise. From the discussion above, we predict $b_1 < 0$, $b_2 > 0$, and $b_3 < 0$. Column (a) in Table 3 presents the estimated parameters for this model. The coefficients of *HiCost* and *C85* have the expected signs and are significant ($p < 0.001$ and $p = 0.005$, respectively). Although with the predicted sign, the coefficient of *C50* is insignificant. Thus, although a reduction in the probability of continuation from 0.85 to 0.70 causes an increase in the use of contracts, a further reduction from 0.70 to 0.50 apparently shows no such effect.

Some authors propose that past cooperative outcomes can influence contracting decisions. For instance, Gulati (1995) argues that formal arrangements become unnecessary over time due to, among other things, the formation of trust based on "familiarity" through repeated interaction. Thus buyers can drop their contracts as cooperation unfolds. By the same token, a history of defection when no contract was being used can induce buyers to employ contracts in future transactions.[21] We verify this effect by including in the model the variables coding the history of cooperation—*Past Cooperation*$_t$ and *Past Defection*$_t$—for which, based on the above arguments, a negative and positive sign, respectively, can be expected. Column (b) in Table 3 shows the estimated parameters of the model including these variables. Although the signs of the added variables are aligned with the predictions, they are both insignificant. Results involving the other variables remain similar.

As a robustness procedure, we further extend the model by adding control variables representing buyers' individual characteristics. The variable *Male* is coded one if the subject playing the role of buyer is male, and zero otherwise. *Major* assumes the value of one if the buyer's major is either economics or business.[22] *Graduate* is coded one if the buyer is a graduate (MBA) student, and zero otherwise. *Age* is the age of the buyer, in years. Finally, *Experience* is a dummy variable that assumes the value of one if the buyer has participated in previous experiments at the laboratory where this study was run.[23] Results show that male subjects ($p = 0.002$) and business/economics majors ($p = 0.006$) are less likely to use contracts, whereas graduate students ($p = 0.025$) are more likely to use contracts; the effects of the other characteristics are insignificant. Previous results remain qualitatively unchanged with the inclusion of these variables.

Our final set of regressions (*d*) includes the variable *Ascending*, which codes the ordering of the probabilities of continuation, and splits the sample into subperiods to assess learning effects. The criterion to split

21. We are, again, analyzing behavior off the equilibrium path. According to our theory in Section 3, buyers should adopt contracts at the outset if they perceive that the exchange is not self-enforcing without a contract.

22. This characteristic is relevant because there is some evidence that people with a background in economics tend to act in a more self-interested manner (e.g., Frank et al., 1993). We include business students in this category because they are also trained in economics.

23. Those previous experiments are mostly market or bargaining games, which may represent an opportunity for subjects to learn issues such as best responses and subgame perfection through experience.

periods was based on the fact that subjects, on average, played for 21 rounds with different individuals. Thus our first subset corresponds to the first one-third of play (from the 1st to the 7th round), and our second subset corresponds to the last one-third of play (from the 15th round and on).[24] Since the termination of existing buyer-seller assignments is random and individuals play different orderings of $\delta$, each subset includes transactions between different buyer-seller pairs subject to different probabilities of continuation.

In the whole sample and across subsets of periods, the inclusion of *Ascending* shows statistical insignificance. But the split of the sample between the initial and the final periods shows some interesting findings for some other variables. The coefficient of *Past Cooperation*$_t$ is negative and significant in the initial periods ($p = 0.009$), but insignificant in the last periods, thus suggesting that buyers' trust in sellers who have cooperated in the past diminishes over time. We offer a possible explanation: buyers learn during play that sellers subject to a contract in the past may have cooperated not because they are trustworthy, but because of the existing (albeit incomplete) contractual incentives. Thus past cooperation when a contract is in place should not rationally induce buyers to drop contracts in exchanges with a given seller.

Although the effect of *HiCost* is highly significant across periods ($p < 0.001$), the effects of the probabilities of continuation are very unstable. The signs of *C85* and *C50* are the opposite of the predictions in the initial periods, even though coefficients are insignificant. In the last periods, *C50* becomes significant ($p = 0.003$) and with the expected sign, while *C85* remains insignificant.[25] This suggests that experience may make buyers more sensitive to the hazards of low probabilities of continuation, thereby inducing an increase in the use of contracts for those cases.

In sum, contract choice by buyers is negatively affected by contract costs and appears to be positively affected by a reduction in the probability of continuation, which is aligned with our expectations.

### 6.4 Sellers' Cooperation

Supposing that the buyer has not exited, our main hypothesis (presented in Section 3) predicts that sellers will cooperate by choosing (*H*, *H*) when Equation (2) holds if the buyer offers an incentive-compatible contract, and when Equation (1) holds if there is no incentive-compatible contract. To accommodate alternative predictions based on reciprocity and crowding out theories (discussed in Section 4), we combine and modify

24. We omit the results for the intermediate subset to simplify the exposition and contrast the polar periods of play.

25. A curious result is that *C85* is insignificant in the initial and last periods even though it is significant for the whole sample.

these inequalities as follows, for a seller $j$ facing an offer from a buyer $i$ at period $t$,

$$\frac{p_t^{ij} - c_{HH}}{1-\delta} \geq p_t^{ij} - \rho p_t^{ij} + (-c_{HL} \,|\, IC_t^{ij} = 1) + (\lambda p_t^{ij} \,|\, IC_{ij}^{t} = 1), \tag{8}$$

where $IC_t$ is a dummy variable equal to one if an incentive-compatible contract (i.e., with $d \geq 3$) is offered at period $t$, and zero otherwise. We can interpret Equation (8) in the following way: if there is reciprocity, then the perceived one-shot gain from defection will be reduced according to some parameter $\rho > 0$. This establishes the possibility of a positive association between the price offered by buyers and the probability of cooperation by sellers, regardless of the expected continuation of the relationship. If there is substitution due to crowding out, as defined in Section 4, then the presence of an incentive-compatible contract will attenuate this reciprocity effect according to some parameter $\lambda > 0$. (Our main hypothesis considers that both $\rho$ and $\lambda$ are equal to zero.) This specification is similar to Fehr and Gächter's (2000) assessment of crowding out based on the interaction between the presence of a contract in a transaction and the offered price.

One important point is that we should restrict Equation (8) to price offers greater than or equal to $c_{HH} = 4$, since otherwise no reciprocity can be expected: the seller would lose money by choosing ($H$, $H$).[26] We further modify Equation (8) by defining the variable $Rep_t^{ij} = 1/(1-\delta)$, which is simply the expected number of periods (repetitions) with the same buyer-seller pair $ij$. After some rearranging, Equation (8) becomes

$$\rho p_t^{ij} + p_t^{ij}(Rep^{ij} - 1) - c_{HH} Rep^{ij} + c_{HL} IC_t^{ij} - \lambda p_t^{ij} IC_t^{ij} \geq 0, \tag{9}$$

which, given our assumptions, is the inequality that implies cooperation by the seller, that is, the choice of ($H$, $H$). Assuming that the right-hand side of Equation (9) is subject to some normally distributed random shock,[27] we can specify the following probit model:

$$\begin{aligned}\Pr(Coop_t^{ij} = 1 \,|\, p_t^{ij} \geq 4) = \Phi[&c_0 + c_1 p_t^{ij} + c_2 p_t^{ij}(Rep^{ij} - 1) \\ &+ c_3 Rep^{ij} + c_4 IC_t^{ij} + c_5 p_t^{ij} IC_t^{ij}],\end{aligned} \tag{10}$$

where $Coop_t^{ij}$ is a dummy variable coded one if seller $j$ chooses ($H$, $H$) when paired with buyer $i$ at period $t$—that is, if the seller cooperates by choosing high levels of both the contractible and the noncontractible dimensions—and zero otherwise. Comparing Equation (10) to Equation (9), we obtain that our main hypothesis predicts $c_1 = 0$, $c_2 > 0$, $c_3 < 0$, $c_4 > 0$, and $c_5 = 0$. For the reasons discussed above, the reciprocity

26. Indeed, in all cases where $p < 4$, no seller ever chose ($H$, $H$).

27. Since we use a random effects specification, we assume that the shock is comprised of a time-unvarying, seller-specific effect plus a white-noise, time-varying effect.

hypothesis predicts $c_1 > 0$, whereas the crowding-out hypothesis predicts $c_5 < 0$. Unfortunately the estimation of Equation (10) is problematic since $IC_t$ and $p_t \times IC_t$, as well as $Rep$ and $p_t \times (Rep - 1)$, are highly correlated (correlation coefficients are 0.994 and 0.993, respectively), which is likely to inflate standard errors due to collinearity. To avoid this problem, we proceed with a simple transformation (e.g., Aiken and West, 1991): we evaluate the interactions based on deviations from the *average* price level in our sample, $\mu_p = 4.88$, considering prices greater than or equal to 4. Thus we use instead the interaction terms $\Delta p_t \times IC_t$ and $\Delta p_t \times (Rep - 1)$, where $\Delta p_t = p_t = \mu_p$. The correlation between $IC_t$ and $\Delta p_t \times IC_t$, and between $Rep$ and $\Delta p_t \times (Rep - 1)$, are substantially lower: $-0.181$ and 0.102, respectively. Using the transformed interaction terms, Equation (10) becomes

$$\Pr(Coop_t^{ij} = 1 | p_t^{ij} \geq 4) = \Phi[c_0 + c_1 p_t^{ij} + c_2 \Delta p_t^{ij}(Rep^{ij} - 1) + c_3 Rep^{ij} + c_4' IC_t^{ij} + c_5 \Delta p_t^{ij} IC_t^{ij}]. \quad (10')$$

This specification is identical to Equation (10) except for the fact that we are now evaluating the effect of an incentive contract at an intermediate price level rather than on the intercept (i.e., at $p_t = 4$), since by construction $c_4' = (c_4 + c_5 \mu_p)$. Similarly we are evaluating the interaction between the price offered and the expected repetition of the exchange for an intermediate level of price. As before, crowding out theory predicts $c_5 < 0$ (which, if largely negative, implies that $c_4'$ will also be negative), whereas our main hypothesis predicts $c_5 = 0$ and $c_4' > 0$.

Column (a) in Table 4 presents the results of the random effects probit estimation of Equation (10′) clustering on each seller. Even though the coefficients of $p_t$ and $\Delta p_t \times IC_t$ are with the predicted signs, these variables are insignificant, thus rejecting the reciprocity and substitution (crowding out) hypotheses. The coefficient of $IC_t$, on the other hand, supports the complementarity hypothesis that an incentive-compatible contract applied to the contractible dimension of the exchange significantly increases cooperation on the noncontractible dimension ($p = 0.001$). Although $Rep$ is significantly positive ($p < 0.001$), $\Delta p_t \times (Rep - 1)$ is insignificant, which is inconsistent with the self-enforcement prediction that the rents offered to sellers should interact positively with the expected repetition of the exchange. Apparently repetition of the exchange is operating independently of the effect of prices in our setting.

A possible cause of the insignificance of $p_t$ is that the effect of price on cooperation may be nonlinear. To verify this possibility, we include in the estimation of Equation (10′) the variable $p_t^2$, for which we expect a negative sign. The results in column (b) of Table 4 show that both $p_t$ and $p_t^2$ are strongly significant ($p < 0.001$) and indicate that intermediate price offers, around five experimental points, are most effective to

Table 4. Probability of Sellers' Cooperation

| | (a) | (b) | (c) | (d) | (e) | | | (f) |
|---|---|---|---|---|---|---|---|---|
| | | | | | All periods | Periods≤7 | Periods≥15 | |
| Intercept | −5.368 | −47.463 | −47.017 | −47.731 | −48.761 | −32.559 | −42.394 | |
| | (3.379) | (9.891) | (10.001) | (10.366) | (10.466) | (29.048) | (14.079) | |
| *p* | 1.054 | 18.263 | 18.281 | 18.410 | 18.650 | 10.215 | 17.508 | 37.404 |
| | (0.686) | (3.698) | (3.729) | (3.879) | (3.901) | (11.521) | (5.470) | (7.528) |
| $p^2$ | | −1.756 | −1.741 | −1.738 | −1.756 | −0.826 | −1.593 | −3.625 |
| | | (0.359) | (0.362) | (0.377) | (0.378) | (1.170) | (0.559) | (0.718) |
| $\Delta p \times (Rep - 1)$ | 0.065 | 0.009 | −0.023 | −0.057 | −0.056 | 0.224 | −0.481 | −0.032 |
| | (0.122) | (0.131) | (0.131) | (0.133) | (0.133) | (0.272) | (0.321) | (0.236) |
| *Rep* | 0.141 | 0.152 | 0.153 | 0.173 | 0.175 | 0.213 | 0.307 | 0.412 |
| | (0.039) | (0.041) | (0.041) | (0.047) | (0.047) | (0.202) | (0.183) | (0.094) |
| *IC* | 0.600 | 0.747 | 0.765 | 0.732 | 0.729 | 1.231 | 0.659 | 1.850 |
| | (0.197) | (0.218) | (0.215) | (0.219) | (0.219) | (0.585) | (0.314) | (0.458) |
| $\Delta p \times IC$ | 0.097 | −0.409 | −0.461 | −0.625 | −0.666 | −1.409 | −0.700 | −0.742 |
| | (0.538) | (0.645) | (0.649) | (0.661) | (0.663) | (1.414) | (1.207) | (1.280) |
| *Male* | | | −0.158 | −0.130 | −0.102 | 0.612 | −0.392 | |
| | | | (0.305) | (0.294) | (0.289) | (0.542) | (0.278) | |
| *Major* | | | 0.438 | 0.444 | 0.502 | 0.710 | 0.393 | |
| | | | (0.349) | (0.341) | (0.347) | (0.618) | (0.332) | |
| *Graduate* | | | −0.587 | −0.473 | −0.540 | −1.943 | 1.115 | |
| | | | (0.534) | (0.528) | (0.526) | (1.081) | (0.774) | |
| *Age* | | | −0.034 | −0.036 | −0.018 | 0.093 | −0.271 | |
| | | | (0.067) | (0.065) | (0.065) | (0.119) | (0.119) | |
| *Experience* | | | −0.739 | −0.727 | −0.709 | −1.015 | −0.388 | |
| | | | (0.294) | (0.290) | (0.282) | (0.544) | (0.265) | |

*Continued*

Table 4. *Continued*

| | (*a*) | (*b*) | (*c*) | (*d*) | (*e*) All periods | (*e*) Periods≤7 | (*e*) Periods≥15 | (*f*) |
|---|---|---|---|---|---|---|---|---|
| *Past Cooperation* | | | | −0.002 | −0.005 | −0.118 | −0.023 | −0.170 |
| | | | | (0.045) | (0.045) | (0.160) | (0.077) | (0.089) |
| *Past Defection* | | | | −0.221 | −0.222 | −0.298 | −0.149 | −0.231 |
| | | | | (0.099) | (0.099) | (0.287) | (0.217) | (0.185) |
| *Ascending* | | | | | −0.314 | −0.803 | −0.369 | |
| | | | | | (0.265) | (0.830) | (0.731) | |
| Log likelihood | −254.19 | −241.50 | −236.61 | −234.00 | −233.31 | −73.04 | −76.23 | −131.51 |
| $\chi^2$ (Wald) | 44.01 | 55.04 | 60.14 | 62.54 | 64.32 | 16.90 | 37.64 | |
| $\chi^2$ (LR) | | | | | | | | 77.40 |
| *n* | 528 | 528 | 528 | 528 | 528 | 169 | 184 | 463 |

Estimates of random effects probit model ((*a*)–(*e*)) and fixed-effects logit model (*f*), centered on each buyer, where the dependent variable is a dummy variable coded one if the seller chooses (*H*, *H*) in a given period and zero otherwise, conditional on the buyer having not exited. Standard errors are in parentheses. $p$ is the price offered by the buyer and $p^2$ is its squared value. *IC* is a dummy variable equal to one if an incentive compatible contract (i.e., with $d \geq 3$) is offered and zero otherwise. $Rep = 1/(1-\delta)$ is the expected number of periods (repetitions) with the same buyer-seller pair. $\Delta p \times (Rep - 1)$ and $\Delta p \times IC$ are interaction terms, evaluated at an average price level. (The $\Delta p \times IC$ interaction allows to test the crowding out hypothesis.) *Male* is coded one if the subject is male, and zero otherwise; *Major* is coded one if the seller's major is either economics or business; *Graduate* is coded one if the seller is a graduate (MBA) student, and zero otherwise; *Age* is the age of the seller (years); *Experience* is a dummy variable that assumes the value of one if the seller has participated in previous experiments at the laboratory where this study was run. *Past Cooperation* and *Past Defection* code, respectively, the number of times in which the seller cooperated (i.e., chose (*H*, *H*)) and defected in past transactions with the buyer. *Ascending* is a dummy variable to control for the different ordering of the probabilities of continuation, assuming value one if the ordering is ascending and zero otherwise promote sellers' cooperation—which, excluding contract costs, roughly corresponds to an equal split of the gains from trade between buyers and sellers.[28] Thus an intermediate price level seems to represent an implicit signal that buyers may be using to elicit sellers' reciprocity. This pattern is clearly observed in Figure 3, which depicts the likelihood of seller cooperation for different price levels, using the estimates of the probit regression in column (*b*) of Table 4 for different levels of the probability of continuation. Notice also that the presence of a contract increases the likelihood of cooperation, especially for lower levels of $\delta$. With the inclusion of $p_t^2$, inference of the other variables remains similar.

Column (c) further expands the model by adding seller-specific variables representing the same individual characteristics as in the case of buyers. All seller-specific variables are insignificant except *Experience* ($p = 0.012$): subjects who have previous experience with experiments at the laboratory where this study was run are significantly less cooperative. To assess possible temporal dependencies in sellers' choices, column (d) further expands the model by including *Past Cooperation*$_t$ and *Past Defection*$_t$ (the number of periods where the seller cooperated and defected with the buyer, respectively), but only the latter is significant ($p = 0.013$): sellers who defected in previous transactions are more likely to defect currently. The significance of the other variables does not change much with the inclusion of these additional control variables.[29]

The set of regressions (e) adds the variable *Ascending*, which codes the ordering of the probabilities of continuation and present results for subperiods of play to assess learning effects. We maintain the same criterion of split used in Section 6.3: from the 1st to the 7th round, and from the 15th round and on. In all cases, *Ascending* is insignificant, thus revealing no effect involving the ordering of the probabilities of continuation. Also, the inclusion of *Ascending* in the whole sample also does not change qualitatively previous results. But some key variables show differential effects according to the period of play. The price variables $p_t$ and $p_t^2$, as well as *Rep*, are only significant in the last period of play ($p < 0.001$, $p = 0.002$, and $p = 0.047$, respectively), thereby suggesting that subjects learn over time the role of reciprocity and the expected repetition of the exchange. In contrast, the effect of an incentive-compatible contract ($IC_t$) is significant in all subperiods analyzed here ($p < 0.002$), though the magnitude of the effect appears to be lower in the last periods than in the initial periods of play—possibly because, in the last periods, reciprocity and repetition of the exchange start assuming a role in supporting cooperation.

28. This is because the cost that the seller incurs to deliver (*H*, *H*) is $c_{HH} = 4$, whereas the value that the buyer attains with this superior combination of attributes is $y_{HH} = 6$.

29. To verify the possibility that the crowding out effect may be exacerbated in the case of individuals with an inclination to cooperate (e.g., Lubell and Scholz, 2001), we included the interaction term $\Delta p \times IC \times$ *Past Cooperation* in the estimation. However, this term is insignificant.

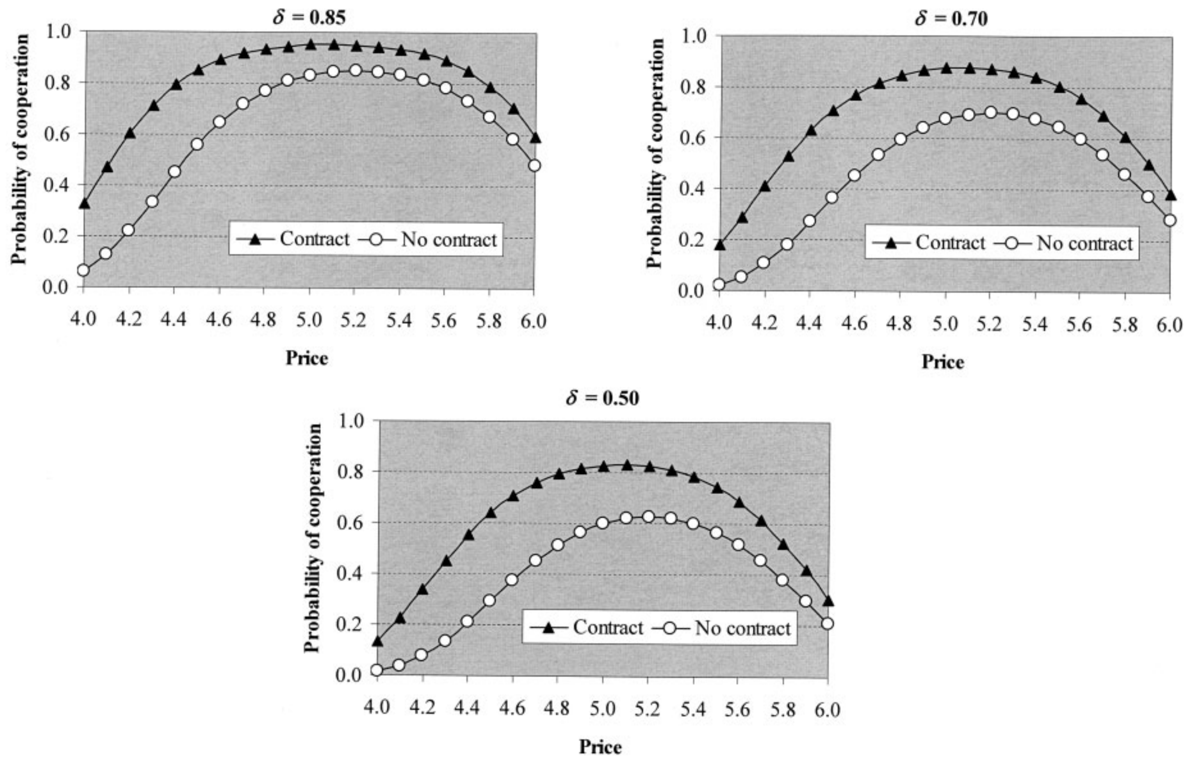


Figure 3. Predicted likelihood of seller cooperation (i.e., choice of $(H, H)$) according to different probabilities of continuation ($\delta$), using the estimates of model (b) in Table 4.

Since it is possible that we are not taking into account seller characteristics that may cause a correlation between unobserved seller-specific attributes and the covariates—which constitutes a violation of a fundamental assumption of the random effects model—we estimate the model with a fixed-effects specification clustering on each seller. This is more important here than in the analysis of buyer choices because the latter are largely dependent on manipulated variables, which are randomly assigned to participants. Seller choices, by contrast, are largely dependent on non-manipulated variables such as the presence of contracts and price levels, which are chosen by buyers. We thus employ a fixed-effects ("conditional") logit model (Chamberlain, 1980) since no satisfactory fixed-effects specification for the probit model is available.

The maximum-likelihood estimates of this model are presented in column (f) of Table 4, considering the whole sample.[30] Due to the lack of within-seller variance with respect to the dependent variable, observations from nine sellers (totaling 65 observations) had to be dropped. $p_t$, $p_t^2$, and *Rep* still show strong significance ($p < 0.001$). The positive effect of an incentive-compatible contract, $IC_t$, also remains highly significant ($p < 0.001$), thus indicating that support for the complementarity hypothesis is robust. The crowding-out term $\Delta p_t \times IC_t$, however, remains insignificant, as well as the interaction term $\Delta p_t \times (Rep - 1)$. Among the variables coding the history of cooperation, *Past Cooperation*$_t$ and *Past Defection*$_t$, only the former show significance ($p = 0.029$), although with a sign that is opposite of what we expected: past cooperation appears to have a negative effect on the seller's willingness to cooperate in a current period. We note, however, that these results are not directly comparable to the other models due to the distinct and reduced sample.

In sum, results provide strong support for the complementarity hypothesis: in our context, contracts applied to contractible exchange dimensions enhance cooperation in noncontractible dimensions. Although we apparently find an effect of reciprocity on sellers' willingness to cooperate (for intermediate price levels), there is no support for the substitution (crowding out) hypothesis that the presence of a contract reduces this effect.

## 7. Conclusion

Our experimental results show that when the probability that the same buyers and sellers will continue transacting in the next period is low—which makes self-enforcement difficult—contracts are crucial to increase buyers' willingness to transact. An increase in contract costs increases the likelihood of buyer exit, since buyers cannot profitably employ contracts to safeguard the exchange. Analyzing sellers' decisions, our data suggest

30. We cannot include *Ascending* since it has no within-subject variance and thus its effect is removed with the fixed-effects specification.

that this is due to the fact that contracts facilitate the self-enforcement of noncontractible dimensions. Thus these results are consistent with the notion that incomplete contracts complement informal dealings.

Even though our data suggest the existence of reciprocity, in the sense that sellers tend to respond cooperatively to generous prices (regardless of the expected repetition of the exchange), there is no evidence that contracts crowd out this reciprocity effect and hence substitute for social norms. Since the rejection of the crowding-out hypothesis in our context is in contrast with previous experiments (e.g., Fehr and Gächter, 2000; Bohnet et al., 2001; Frey and Benz, 2001), further tests are needed.

Overall, from a welfare point of view, our study suggests that low-cost contracts are important mechanisms to support cooperation when it is not very likely that parties will continue transacting in future periods. This result is consistent with North's (1990) observation that societies involving fewer recurring exchanges between the same parties need to rely on formal institutions to promote cooperation. To be sure, self-enforcement may occur, even in nonrepeated settings, provided some form of multilateral retaliation mechanism is in place (e.g., a buyer may boycott a seller who has defected in exchanges with other buyers), and information about past behavior is perfectly disseminated (Kandori, 1992). However, this does not preclude the existence of formal mechanisms to gather information and enforce retaliation strategies: market participants may not have incentives to share information and promote boycotts (Milgrom, North, and Weingast, 1990; Greif, Milgrom, and Weingast, 1994). This distinct form of complementarity between formal and informal agreements is an interesting topic to be examined in future experiments.

## Appendix: Instructions (for $x = 0.10$)

Thank you for your participation in this experiment! This is an experiment about decision making in a market. You will receive $5 as a show-up fee. You may also earn a considerable amount of money depending on the total number of points that you achieve in the experiment. These points will be converted into dollars and paid in cash, along with the show-up fee, when the experiment ends. The more points you get in the experiment, the more dollars you will receive. We expect you to do the best you can to increase your payoff in the experiment. You will always be identified according to a number: nobody will know that you made particular decisions or achieved certain payoffs.

***The experiment.*** The market involves buyers who hypothetically own a certain manufacturing firm, and suppliers who hypothetically own a certain firm specialized in information systems. Buyers will have an opportunity to request services from suppliers, namely development and maintenance of software systems tailored to buyers' needs. Suppliers will have an opportunity to sell those services to buyers.

That service can give the buyer potential benefits that are influenced by two sets of attributes. First, the service is characterized by certain *concrete* attributes that are *easy to describe*, for instance, the tasks that the buyer wants the software to perform, delivery date, a minimum number of visits that the supplier should accomplish for software maintenance, and so on.

When the buyer requests the software, she knows the concrete attributes she wants. It is very easy for anybody to identify if the service has or lacks the concrete attributes that the buyer described. For instance, a direct inspection reveals the tasks that the software performs, and it is straightforward to verify if delivery was on time or not. Thus the service that suppliers deliver can be either AS SPECIFIED or NOT AS SPECIFIED.

However, the service is also associated with certain *intangible*, "fuzzy" attributes that are *hard to describe clearly*. For instance, the buyer wants the supplier to be responsive to her problems, give relevant suggestions, provide a software system that is aligned with "best practices" in her industry, interact smoothly with people from her firm, and so on. These intangible attributes can be generically described as the QUALITY of the service. There are two possible quality levels for the service: HIGH or LOW QUALITY.

The difference between LOW and HIGH QUALITY is hard to describe. However, when suppliers accomplish the service, the buyer can ascertain its quality. For instance, the buyer can tell whether a supplier came up with ideas that helped to improve her information systems, or whether the software "runs well" within her computer network.

Notice therefore that the service that buyers want to purchase from sellers has four combinations of attributes: AS SPECIFIED and with HIGH QUALITY; AS SPECIFIED and with LOW QUALITY; NOT AS SPECIFIED and with HIGH QUALITY; NOT AS SPECIFIED and with LOW QUALITY. Each combination is worth a certain amount of money to buyers and costs a certain amount of money to suppliers, which we will describe below.

Before the experiment begins, you will be randomly assigned to the role of either a buyer or a supplier. The experiment will last a certain number of periods, which is unknown to *all* participants. In each period, buyers and suppliers will have an opportunity to transact with each other.

***Buyer values.*** In the experiment, buyers don't really need to describe the service specifications they want. Just imagine that buyers need a service with particular specifications, and suppliers can deliver a service that is according to those specifications (AS SPECIFIED) or not (NOT AS SPECIFIED).

For buyers, the most valuable service is both AS SPECIFIED and with HIGH QUALITY. If a supplier delivers a service that is AS SPECIFIED with HIGH QUALITY, that service is worth six points to her buyer in each period.

If the service is AS SPECIFIED, but with LOW QUALITY, the buyer's value is lower: three points in each period.

If a supplier delivers a service that is NOT AS SPECIFIED, *regardless* of the level of QUALITY, that service has zero value to the buyer in terms of points.

***Supplier costs.*** The most expensive service to suppliers is also the most valuable to buyers: a service that is AS SPECIFIED and with HIGH QUALITY. The cost to produce such a service is 4 points in each period.

A service that is AS SPECIFIED, but with LOW QUALITY, is less costly to suppliers: three points in each period. This is the same cost for a service that is NOT AS SPECIFIED, but with HIGH QUALITY: three points.

It costs suppliers zero to provide a service that is NOT AS SPECIFIED and that is of LOW QUALITY.

Table A1 summarizes buyer values and supplier costs for each period.

The market is structured as follows. In each period, a particular buyer and a particular supplier will have an opportunity to transact with each other. The sequence of choices is described below:

1. The buyer begins by choosing to transact or not with the supplier, that is, hire or not the service. The buyer can always EXIT and not request the service—in this case, *both* the buyer and the supplier earn zero in that period.
2. If the buyer decides to request the service, she offers a price and a contractual arrangement, which we will explain below.
3. The supplier can accept or not the buyer's proposal in terms of price and arrangement to transact with her. If the supplier decides not to transact with the buyer (i.e., reject her offer), she can EXIT. EXIT yields zero for *both* the buyer and the supplier in that period.
4. If the supplier accepts the buyer's offer, the supplier chooses a service with one of the four possible combinations of attributes: AS SPECIFIED and with HIGH QUALITY; AS SPECIFIED and with LOW QUALITY; NOT AS SPECIFIED and with HIGH QUALITY; NOT AS SPECIFIED and with LOW QUALITY.
5. The buyer is then immediately notified about the supplier's choices in terms of specification and quality.

Table A1. Buyer values and Supplier Costs for Each Period

| | Specifications | |
|---|---|---|
| Quality | As Specified | Not as Specified |
| High | 6 points worth to buyers<br>costs 4 points to suppliers | 0 points worth to buyers<br>costs 3 points to suppliers |
| Low | 3 points worth to buyers<br>costs 3 points to suppliers | 0 points worth to buyers<br>costs 0 points to suppliers |

***Choices and net earnings.*** If the buyer decides to transact with the supplier, she will do two things. First, the buyer will offer a *price* for the service. This price must be higher than zero and *not* higher than six points, since this is the maximum value that the buyer can attain with the service. Second, the buyer will have an opportunity to propose an *arrangement* to transact with the supplier. There are two possible arrangements: FORMAL CONTRACT and NO FORMAL CONTRACT.

**NO FORMAL CONTRACT.** If the buyer chooses to hire the service without a formal contract (the NO FORMAL CONTRACT option), the buyer will simply offer a price for the service. After delivery, the buyer is informed about the service attributes the supplier chose.

When buyers request the service, *they have to pay fully in advance to support suppliers' expenses*. Suppliers then receive the payment and choose to accomplish a service with one of the four possible combinations of attributes.

Therefore, in the NO FORMAL CONTRACT option the buyer pays the price she offered regardless of the combination of service attributes that the supplier chooses. Since the supplier receives the payment beforehand, *the buyer cannot refuse to pay if the supplier chooses an undesirable service* (i.e., either NOT AS SPECIFIED or LOW QUALITY).

There is *no added cost* for *both* the buyer and the supplier when the buyer chooses NO FORMAL CONTRACT. Therefore

> The buyer's net earnings in each period with NO FORMAL CONTRACT are:
>
> The value of the service (according to the attributes that the supplier chose), *minus* the price paid for the service.
>
> The supplier's net earnings with NO FORMAL CONTRACT are:
>
> The price paid for the service, *minus* the cost of the service (according to the attributes that the supplier chose).

For example, suppose that the buyer offers a price of five points with NO FORMAL CONTRACT. Suppose that the supplier accepts the buyer's offer and delivers a service that is AS SPECIFIED and with HIGH QUALITY. Since it costs suppliers four points to deliver a service with these attributes, the supplier will make $5 - 4 = 1$ point, while the buyer will make $6 - 5 = 1$ point in this period.

If, on the other hand, the supplier delivers a service that is NOT AS SPECIFIED and with LOW QUALITY, then the supplier makes $5 - 0 = 5$ points, while the buyer gets $0 - 5 = -5$ points. Since the buyer incurs a loss in this case, it will be subtracted from the sum of her points obtained in other periods.

**FORMAL CONTRACT.** If the buyer chooses to transact with the supplier using a FORMAL CONTRACT, then the buyer will also have an opportunity to define a contract clause that enables her to apply a *price* *deduction* if the supplier delivers a service that is NOT AS SPECIFIED. This deduction cannot exceed the offered price.

For example, suppose that the buyer offers a price of 3.5 points with a FORMAL CONTRACT defining a price deduction of 1.5 points if the supplier delivers a service that is NOT AS SPECIFIED. If the supplier accepts the offer and delivers a service that is NOT AS SPECIFIED, the supplier will receive only $3.5 - 1.5 = 2$ points as a price for her service.

Recall that the service attributes that the buyer specifies are comprised of concrete attributes that are easy to describe. QUALITY is very difficult to describe, and *thus it is not possible to write a contract clause defining a price deduction for the wrong level of quality*. The buyer can *only* define a price deduction for services that are NOT AS SPECIFIED. The buyer cannot get reimbursed when the supplier delivers a service with LOW QUALITY.

A FORMAL CONTRACT *costs the buyer* 0.1 point *in each period*, due to expenses to enforce it (attorney services, judicial costs, etc.). *Only* the buyer incurs these expenses: *a formal contract costs nothing to suppliers* (except the price deduction, but only if the supplier delivers a service that is NOT AS SPECIFIED). Therefore

> The buyer's net earnings in each period with a FORMAL CONTRACT are:
>
> The value of the service (according to the attributes that the supplier chose), *minus* the price paid for the service, *plus* the price deduction (if the supplier delivers a service that is NOT AS SPECIFIED), *minus* the contract cost, 0.1 point.
>
> The supplier's net earnings with a FORMAL CONTRACT are:
>
> The price paid for the service, *minus* the price deduction (if the supplier delivers a service that is NOT AS SPECIFIED), *minus* the cost of the service (according to the attributes that the supplier chose).

For example, suppose that the buyer offers a price of five points with a FORMAL CONTRACT defining a deduction of 3.5 points, which will be applied if the supplier delivers a service that is NOT AS SPECIFIED. Suppose that the supplier accepts the buyer's offer and delivers a service that is AS SPECIFIED but with LOW QUALITY. In this case, no price deduction will be applied since the supplier delivered a service according to the buyer's specifications. Thus, the supplier makes $5 - 3 = 2$ points, whereas the buyer gets $3 - 5 - 0.1 = -2.1$ points. If, however, the supplier delivers a service that is NOT AS SPECIFIED with LOW QUALITY, then the supplier gets $(5 - 3.5) - 0 = 1.5$ points, whereas the buyer gets $0 - (5 - 3.5) - 0.1 = -1.6$ points.

Table A2 summarizes buyer and supplier profits, considering a generic price *p* that the buyer chooses and a price deduction *d* (which is applied if the buyer offers a FORMAL CONTRACT and the supplier delivers a service that is NOT AS SPECIFIED).

***Subsequent periods.*** The experiment will last a certain number of periods, *which is unknown to all participants, both buyers and suppliers*. In the first period, a certain buyer will be randomly assigned to a certain supplier, and they will have an opportunity to transact with each other. Buyers and suppliers are identified as numbers.

After buyers and suppliers make their decisions in one period, there is a certain probability that the same pair will have another opportunity to transact with each other in the next period. The computer will randomly draw a number from 1 to 100. Depending on that probability, which the experimental instructor will announce to you, that random draw will indicate the continuation or the termination of an ongoing pair. If the random draw indicates termination of a buyer-supplier pair, then another supplier will be assigned to that buyer, and another buyer will be assigned to that supplier.

Suppose, for instance, that the instructor announces a probability of 75% that a particular buyer will continue her relationship with a particular supplier. In this case, if the random draw is higher than 75, then another supplier will be assigned to the buyer and vice-versa in the next period. Otherwise the same supplier and the same buyer will have another opportunity to transact with each other again in the next period.

If the random draw indicates the termination of the ongoing relationship between a particular buyer and a particular supplier, then a "new" supplier will be assigned to that buyer, and a "new" buyer will be assigned

Table A2. Buyer and Supplier Profits

| | Buyer chooses . . . | | |
|---|---|---|---|
| Supplier chooses . . . | Exit | No Formal Contract | Formal Contract |
| Exit | Buyer: 0<br>Supplier: 0 | Buyer: 0<br>Supplier: 0 | Buyer: 0<br>Supplier: 0 |
| As Specified High Quality | Buyer: 0<br>Supplier: 0 | Buyer: $6 - p$<br>Supplier: $p - 4$ | Buyer: $6 - p - 0.1$<br>Supplier: $p - 4$ |
| As Specified Low Quality | Buyer: 0<br>Supplier: 0 | Buyer: $3 - p$<br>Supplier: $p - 3$ | Buyer: $3 - p - 0.1$<br>Supplier: $p - 3$ |
| Not As Specified High Quality | Buyer: 0<br>Supplier: 0 | Buyer: $0 - p$<br>Supplier: $p - 3$ | Buyer: $0 - (p - d) - 0.1$<br>Supplier: $(p - d) - 3$ |
| Not As Specified Low Quality | Buyer: 0<br>Supplier: 0 | Buyer: $0 - p$<br>Supplier: $p - 0$ | Buyer: $0 - (p - d) - 0.1$<br>Supplier: $(p - d) - 0$ |

to that supplier. That buyer is "new" in the sense that she has never transacted with that supplier in former periods. Similarly, the supplier is "new" in the sense that she has never transacted with that buyer in former periods.

If the buyer or the supplier EXITS in a given period, this does not necessarily mean that they will be reassigned to other participants or that the experiment will end. If the random draw indicates continuation, the buyer will still have an opportunity to transact with the same supplier in the next period, and vice versa. Also, buyers can always change their choice in terms of price and contractual arrangement from period to period, even if the same supplier is assigned to them in those periods. Suppliers can also freely change their choices in terms of service attributes from period to period.

*The outcome of each period (prices offered, attributes supplied, etc.) is informed only to the specific buyers and suppliers transacting with each other*. If a new buyer is assigned to a new supplier, that buyer will not know what the new supplier chose in previous transactions with other buyers. Similarly, that supplier will not know what the new buyer chose in previous transactions with other suppliers. There will be *at least* six assignments: you will have an opportunity to transact with at least six *different* participants. You will *always* keep the role of either a buyer or a supplier during the whole experiment.

***Total payment.*** When the experiment ends, the total number of points you earned will be converted to U.S. dollars. The more points you get, the more dollars you will make. You will receive this amount in cash, along with the show-up fee ($5), when the experiment ends.

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