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# Resistance to truthful revelation in bargaining: Persistent bid shading and the play of dominated strategies

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A B S T R A C T

We report results from a simultaneous bilateral bargaining experiment with attention to the effects of a settlement bonus on strategic decision-making behavior. In instances with a sufficiently large settlement bonus, truthful revelation emerges as the dominant strategy. However previous work (Parco & Rapoport, 2004) has experimentally tested this "Bonus Effect" and found that although the presence of a settlement bonus improves efficiency, behavior falls drastically short of the normative predictions. This finding illustrates the persistent tendency of decision makers to bid strategically, i.e. shading their bids, even when truthful revelation is a strictly dominant strategy. Herein we investigate the influence of the framing of information and look for ways to nudge decision makers toward making better choices in these strategic environments. Additional results from an adaptive reinforcement-based learning model are discussed as they relate to a potential innate bias for strategic misrepresentation even when contrary to self-interest and collective-interest.


## 1. Introduction

Bargaining has long attracted the attention of scholars. Siegel and Fouraker (1960) were the first to experimentally investigate information effects in bilateral bargaining. Since then, bargaining models have prominently emerged into the economic literature. Ståhl (1972) and Rubinstein (1982) formalized the sequential bilateral bargaining model where each player takes turns making an offer to be accepted or countered, which has been also been experimentally investigated (Rapoport, Weg & Felsenthal, 1990; Zwick, Rapoport, & Weg, 2000). The special case of the sequential bargaining model, where bargaining is confined to a single-stage game, has become known as the Ultimatum Game (Güth, Schmittberger, & Schwarze, 1982). Although noncooperative game theory predicts the first mover to take nearly all the surplus for himself and offer the smallest possible nonzero proportion to the other player, the experimental literature finds such a prediction problematic at best (Anderson, Ertac, Gneezy, Hofman, & Listet, 2011; Harbaugh, Krause, & Vesterlund, 2007; Hoffman, McCabe, Shachat, & Smith, 1994; Janssen, 2006; Van Poucke, & Buelens, 2002). Related literature reporting on the Dictator

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Game (Hoffman, McCabe, & Smith, 1996), a variant of the Ultimatum Game, where the game ends after the first-mover makes his decision, has similarly concluded that other regarding behaviors are a primary behavioral driver in cases of bilateral bargaining. Taken together, this growing body of research raises the question of the ability of institutions to restore rationality (Cherry, Crocker, & Shogren, 2003; Cherry, Frykblom, & Shogren, 2002; Cherry & Shogren, 2007; Shogren, 2006) and raises the question as to whether we can create bargaining institutions that correct behavioral failures which deviate from equilibrium predictions.

One of the most understudied bargaining institutions is the sealed-bid *k*-double auction. Unlike the Ultimatum and Dictator bargaining games in which players have complete information about one another, bidders in the sealed-bid *k*-double auction do not. Not only do players in this institution not know each other's individual valuations for the item being bargained over, they also do not know each other's offer since under the rules of the game, both offers (the buyer and the seller's) are simultaneously revealed. Game theoretical solutions to simultaneous bilateral bargaining problems under incomplete information (Chatterjee & Samuelson, 1983; Leininger, Linhart, & Radner, 1989; Myerson & Satterthwaite, 1983; Satterthwaite & Williams, 1989; Linhart et al., 1992; ) dictate that decision makers should behave strategically (i.e. shade their bids) and as a result should sometimes be willing to walk away from otherwise profitable agreements. However both buyers and sellers could jointly do better if each player offered their honest reservation value as their bid. Doing so would not only guarantee a profitable settlement whenever such could exist, but also truth-telling would distribute any potential gains from the trades that are realized. Truth-telling is appealing in that it maximizes both collective gains and the probability of reaching an agreement. Unfortunately it is not an equilibrium solution as players have a persistent incentive to strategically misrepresent their reservation values and shade their bids in an effort to claim more of the bargaining surplus and thus increase their personal earnings.

Vickrey (1961) showed the fundamental impossibility of designing a bargaining mechanism in such a way that (1) honest revelation is the dominant strategy for all the players; (2) no outside subsidy is needed; and (3) the final allocation of goods is always Pareto-efficient ex post. Additional formal progress was made on bargaining problems when Chatterjee and Samuelson (1983) demonstrated the complexity of the strategic situation by proving that on a continuous interval, there were an infinite number of solutions to a given bargaining problem. Up until then, limited advice was available to decision makers on what each *should* do to maximize their potential earnings, given that any agreement was itself a strategically stable point. Addressing this underspecificy, Chatterjee and Samuelson developed the refining normative prediction of a linear equilibrium strategy (hereafter, the LES) that had two very appealing properties. First, it is the unique linear (or in some cases, piece-wise linear) equilibrium. This made it cognitively appealing in that it was rather simple. Second, and more importantly, the LES maximized the expected value of the negotiation interaction for the decision makers given equilibrium play. The LES is not welfare maximizing as pointed out by Myerson and Satterthwaite (1983) who showed the general impossibility of achieving perfect (ex post) efficiency in two-party negotiations with incomplete information without external subsidies. But the LES answered the question of when and how much an optimal decision maker should shade her bid when bargaining with another rational decision maker under conditions of incomplete information.

Brams and Kilgour (1996) extended this normative theory in two ways: first they effectively addressed the feasibility of incorporating exogenous subsidies into the bargaining situation; and second they developed theoretical procedures to improve bargaining efficiency by inducing individuals to truthfully reveal their respective reservation values. Specifically, they proposed a refinement to the Chatterjee–Samuelson LES that yields a unique dominant strategy of "honest bidding." Parco and Stein (2001) extended the Brams–Kilgour theory by generalizing the Bonus Procedure for any level of bonus payment and for any overlapping prior information assumptions of the parties. Subsequently, Parco and Rapoport (2004) developed a series of behavioral experiments and reported on the predictive validity of the Bonus Procedure regarding human choice behavior in a laboratory setting. They found that the introduction of an exogenous bonus did in fact improve the frequency of agreements between the players, but not nearly to the level that had been predicted theoretically. They suggested "in the short term, the inclination of players to strategically misrepresent their valuations is too strong for bonuses to produce the desired effect at a reasonable relative cost, regardless of the level of the bonus" (p. 557).

Common to research in bargaining is the general result that decision makers should, and in practice do, shade their true reservation values when making offers (e.g. buyers bidding less than their maximum willingness to pay, and sellers asking more than their minimum willingness to accept). This shading, or strategic misrepresentation, is traditionally consistent with normative predictions in most bilateral bargaining games, but when an exogenous bonus payment is provided, truthful revelation can emerge as the dominant strategy. In general, decision makers are good at intuiting how much to shade their bids when bargaining. Parco and Rapoport (2004) show the persistence this generally well-adapted strategic behavior, even when it is a strictly dominated strategy that undermines both individual earnings as well as collective welfare. When noting this departure from the normative predictions, Parco and Rapoport conjectured that perhaps the inclination for decision makers to strategically misrepresent their minimum demands in formulating settlement proposals was because the decision makers simply did not understand the experimental context.

The primary motivation for the current paper is to investigate the extent to which decision makers remain strategically resilient in a single-stage, simultaneous, bilateral bargaining situation under incomplete information where truth-telling is the strictly dominant strategy. The fundamental question is whether information in the decision environment can be framed in such a way as to induce the decision makers to honestly reveal their reservation values and thus ensure an agreement is reached whenever feasible. To this end, a previously reported experiment is replicated in every detail but only differs in the way that information and instructions are presented and framed for the experimental participants. By explicitly designing the experiment to nudge decision makers toward honest revelation, this study aims to determine whether or not decision makers will continue to misrepresent their true reservation values when engaged in bargaining, even when honest revelation of private values is a strictly dominant strategy.

The rest of the paper is organized as follows. Section 2 describes the mechanism used to structure the simultaneous, two-player negotiation under incomplete information. Section 3 describes the experimental design of the *reframed bonus* experiment and Section 4 presents the results. The results show that even when alleviating potential ambiguity in the experimental procedures through explicit reframing, and in direct contrast to the normative predictions, providing decision makers with a bonus for reaching agreements does not eliminate strategic play and decision makers persist in shading their bids. Section 5 concludes with a discussion.

## 2. Bargaining under incomplete information

Bargaining models[1] consist of two players, a buyer and a seller with each player having private information regarding the value of a common object that may be traded; these values are called reservation values and are denoted $v_b$ for the buyer and $v_s$, for the seller. Players may have different valuations for the common object for which the bargaining is taking place. When values overlap (i.e. the object is worth more to the buyer than it is to the seller), there is an opportunity for beneficial trade that can make both players better off.

### *2.1. Sealed-bid mechanism*

In the sealed-bid bargaining framework, players make simultaneous sealed offers; the seller's offer is denoted $s$ whereas the buyer's offer is denoted $b$. If $b \geqslant s$ then a trade of occurs immediately and with no transaction cost nor risk. The trade price is a function of both players' bids, and is defined as $p_k = (kb + (1 - k)s)$, where $k$ is the parameter that determines how the overlap (e.g. bargaining surplus) in bids is split between the players.[2] Given a trade has happened, the payoff for the buyer is $(v_b - p_k) + \boldsymbol{R}$ and the payoff for the seller is $(p_k - v_s) + \boldsymbol{R}$ where $\boldsymbol{R} = (b - s)/2$. $\boldsymbol{R}$ is an exogenous trade bonus that may exist. In standard bargaining contexts, $\boldsymbol{R} = 0$ as there is no exogenous reward for trades, but in the following experiments R may be positive. In any case, if no trade occurs, because $b < s$, then the payoff for both buyer and seller is 0. Brams and Kilgour (1996) proved that truthful revelation is a dominant strategy Nash equilibrium in the special case of $k = 1/2$ in Theorem 1. Regardless of the ranges of F and G, buyer and seller should bid their reservation value.

It is common knowledge that the buyer's reservation value $v_b$ is a random variable distributed according to some well-defined probability function **G**; in parallel it is common knowledge that the seller's reservation value is also a random variable distributed via function **F**. These random variables are independent from each other. $B(\cdot)$ denotes the pure strategy for the buyer, specifying a bid of $b = B(v_b)$ for each possible reservation value. Likewise, $S(\cdot)$ denotes the seller's offer of $s = S(v_s)$ for possible reservation values. In some instances $B(\cdot) < v_b$; this is the result of strategic misrepresentation or bid shading. A buyer has an incentive to underbid their reservation price a bit in an effort to increase individual payoff. Concordantly a seller has a similar incentive and shades her bid higher than her reservation value, $S(\cdot) > v_s$, in an effort to increase individual payoff as well.

### *2.2. Equilibrium*

The original LES formulation published by CS contained several typographical errors, which have been verified (Parco & Stein, 2001) and correctly annotated below for any pair of prior probability distributions where $\boldsymbol{F} \sim U[\alpha_s, \beta_s]$ and $\boldsymbol{G} \sim U[\alpha_b, \beta_b]$:

$$S^*(v_s) = \frac{\alpha_b - s_0}{1+k} + s_0, \quad \text{if } \alpha_s \leqslant v_s < \frac{2-k}{1+k}(\max(s_0, \alpha_b) - s_0) + \alpha_s \tag{2.1}$$

$$S^*(v_s) = \frac{v_s - \alpha_s}{2-k} + s_0, \quad \text{if } \frac{2-k}{1+k}(\max(s_0, \alpha_b) - s_0) + \alpha_s \leqslant v_s \leqslant \min(s_1, \beta_s) \tag{2.2}$$

$$B^*(v_b) = \frac{v_b - s_0}{1+k} + s_0, \quad \text{if } \max(s_0, \alpha_b) \leqslant v_b \leqslant \frac{1+k}{2-k}(\min(s_1, \beta_s) - \alpha_s) + s_0 \tag{2.3}$$

$$B^*(v_b) = \frac{\beta_s - \alpha_s}{2-k} + s_0, \quad \text{if } \frac{1+k}{2-k}(\min(s_1, \beta_s) - \alpha_s) + s_0 < v_b \leqslant \beta_b \tag{2.4}$$

where $s_0 = [(1+k)\alpha_s + (1-k)\beta_b]/2$ and $s_1 = [k\alpha_s + (2-k)\beta_b]/2 = s_0 + (\beta - \alpha)/2$.

[1] The same framework is being evaluated in the present study. It is also referred to as the sealed-bid $k$-double auction in the economics literature.

[2] Development of the LES (Chatterjee & Samuelson, 1983) provided the basis for experimental inquiry into bilateral bargaining by describing linear strategies for both the buyer and seller in a single parameter model. This parameter, $k$, is the ratio between the buyer's offer and the seller's offer which determines the trade price, $p$, given that $b \geqslant s$ as $p = kb + (1 - k)s$. By setting $k = 1/2$, trade occurs with no delay at the price $p = (b + s)/2$. If $b < s$, then no trade occurs.If $k = 0$, the trade price would be equal to the seller's offer. If $k = 1$, the buyer's offer would unilaterally dictate the trade price. In the current study, $k = 1/2$, meaning that in the bargaining surplus is evenly divided between buyer and seller. This is the most common value for $k$ used in bargaining contexts.

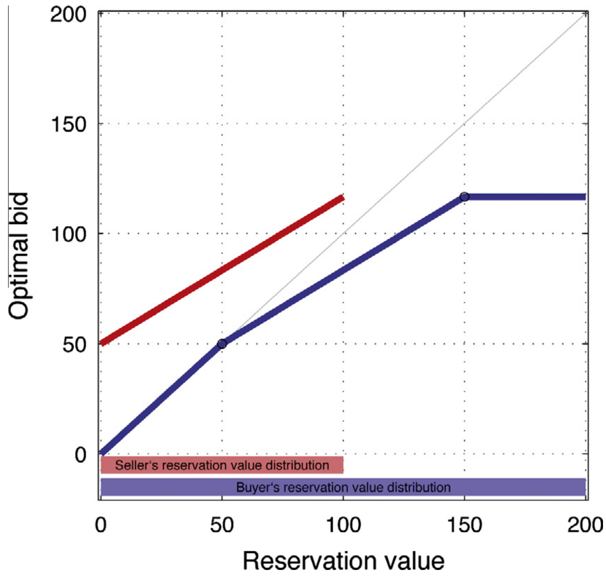


**Fig. 1.** Linear equilibrium strategy.

To illustrate the LES concretely, consider a bargaining situation without any trade bonus (***R*** = 0). Seller's reservation values are distributed uniformly between 0 and 100 inclusive: $\mathbf{F} \sim U(0,\ 100)$. Buyer's reservation values are distributed uniformly between 0 and 200 inclusive: $\mathbf{G} \sim U(0,\ 200)$. The parameter $k = 1/2$, thus indicating an even split between positive overlaps in bids. According to the Chatterjee–Samuelson LES solution, the optimal bargaining strategy is shown below.

For the seller:

$$S^*(v_s) = 2/3\,v_s + 50 \quad \text{if } 0 \leq v_s \leq 100 \tag{2.5}$$

And for the buyer:

$$B^*(v_b) = v_b \quad \text{if } 0 \leq v_b \leq 50 \tag{2.6}$$

$$B^*(v_b) = 2/3\,v_b + 50/3 \quad \text{if } 50 < v_b \leq 150 \tag{2.7}$$

$$B^*(v_b) = 350/3 \quad \text{if } 150 < v_b \leq 200 \tag{2.8}$$

Fig. 1 is a graphical representation of the optimal bargaining strategy for both players over all possible reservation values with no trade bonus. Notice how the optimal seller always shades his bid upward and the optimal buyer shades his bid downward if his reservation value is greater than 50. Truth-telling is indicated by the diagonal line. However, under conditions where the Brams–Kilgour Bonus Procedure is implemented, the equilibrium converges to truthful revelation as the dominant strategy.

### *2.3. Bonus procedure*

When the bargaining situation is augmented with the Brams–Kilgour trade bonus refinement and ***R*** = $(b - s)/2$, rendering the optimal LES strategy for both parties to bid honestly. In other words, given a sufficient trade bonus, it strictly dominates for both players to always bid their reservation values exactly.

One important aspect of the Brams–Kilgour trade bonus refinement is particular to the buyer given that the distribution, **G**, of possible buyer reservation values is larger than (and overlaps) the seller's distribution, **F**. Specifically, when a buyer draws a value in excess of the maximum possible value of the seller (in this case, when $v_b \geqslant 100$, any offer $100 \geqslant b \geqslant 200$) is strategically stable. Moreover, because of the unique level of the bonus, the earnings from the exogenous subsidy are equal to share of the surplus that the buyer/seller receives, collusive offers of $s = 0$ and $b = 200$ (the seller offers to give the item away and the buyer offers to pay everything for it, would result in 100% efficiency (every interaction would result in a deal, even if $v_s \geqslant v_b$) with each party collecting a payment of 100 on each interaction. Thus, when the value of R exceeds the gains from trade, it offers a new collusion equilibrium where each player bids the maximum (for the buyer) and minimum (for the seller) to guarantee a trade to occur. Even if a loss in incurred on the trade, the compensation from the bonus will guarantee a nonnegative return.

## 3. Experiment

The present experimental condition, hereafter referred to as the "reframed full bonus" condition is introduced and presented as a structurally identical mechanism to the Parco and Rapoport (2004) "full bonus" condition and differs only in how information is framed to the experimental subjects. In the full bonus condition, the payoff from each trial was presented in two separate components of trade price: (1) gains from trade; and, (2) gains from the bonus. The reframed bonus condition greatly simplifies the reporting of the payoff function by explicitly identifying to each player that his individual bid has no effect on his earnings, other than determining whether or not a deal is made. By making the effect of the trade bonus patently explicit to the decision makers, the causal explanation of decision maker confusion can be evaluated.

### *3.1. Subjects*

Forty undergraduate students participated in two experimental sessions with each group consisting of twenty subjects. The subjects were recruited through an automated system comprised of students who had volunteered for participation in such experiments which promised $5.00 for showing up on time to any experiment in which they were called to participate in as well as further payment which was contingent upon performance. Prior to each session, all subjects were given the opportunity to leave the experiment (without penalty) after receiving their show-up fee. No one accepted this option. Verbal communication between subjects was strictly prohibited. All communication occurred via networked computers, and all subjects were guaranteed anonymity. Each group participated in a single session that lasted approximately 60 min. Payments varied considerably across subjects ranging from $28.28 to $17.56. The mean payoff for the buyers and sellers was $25.11 and $22.04, respectively.

### *3.2. Protocol*

Prior to each session, participants drew a poker chip from a bag containing chips numbered from 1 to 20 to determine their seat assignment in the laboratory. Since more subjects were recruited than needed, additional colored chips (the numbered chips were white) were added to the bag to equal the number of volunteers. Any volunteer who drew a colored chip was paid $5.00 and dismissed with the understanding that if they again were recruited and showed up, they would be given priority. Three volunteers were randomly selected not to participate under this procedure.

For the volunteers who drew numbered chips, subjects 1 through 10 were assigned the role of "buyers" and 11 through 20 as "sellers." Once seated, subjects proceeded to read the instructions at their own pace. When all the subjects completed reading the instructions, the experiment supervisor entertained a brief question and answer period to ensure that everyone understood the task.

Each research subject participated in fifty trials of bargaining making a single offer during each round. Each round was identically structured at two levels. *Within* the experiment, each round consisted of a random, and unknown partner. Because it was commonly known that there were ten subjects assigned to the buyer role with the remaining ten participants acting as sellers, each participant could infer that he/she would likely participate against all other participant assigned to the opposite role about five times each. *Between* this experiment and the Full Bonus experiment of Parco and Rapoport, the identical parameters, random variable values and subject pairing was used to control for confounding effects. Thus, given the interdependence of the trials, the unit of analysis is the experimental session. The experiment was replicated to control for any random effects. A between-subjects randomized design was used to prevent reputation effects by randomly pairing buyers and sellers on each round. All the buyers sat on one side of the computer lab and all the sellers on the other to prevent any transfer of private information. Additionally, the twenty computer terminals were well isolated from one another in cubicles to prevent any communication between the participants. All participants were expressly (verbally) informed that their negotiation partners were randomly varied from round to round prior to the first round of negotiation.

All fifty trials were structured in exactly the same way. At the beginning of each round, players privately received their reservation values (seller-minimum/buyer-maximum demand for the negotiation) randomly and independently drawn from their respective distributions. To facilitate comparison between groups and experiments, each participant was assigned the same fifty randomly chosen reservation values[3] in a different random order. To re-emphasize, these values were not only identically structured between sessions, but also identical to those used in the Parco–Rapoport full bonus study for direct comparison. The same procedure was used for the sellers. Bargaining continued with the buyer (seller) being prompted to state his bid (offer) for the trial. The computer required each subject to confirm her response and warned her if the offer could result in a loss (i.e., if $b > v_b$ or $s < v_s$). Prior to making an offer, all participants could review their previous offers and outcomes by calling up a separate screen. After all participants had confirmed their best and final negotiation proposals in the computer program, the program automatically determined for each pair separately whether a deal was struck, and calculated the payoff for each trader. Participants were then informed of their bid, the other party's bid, and the earnings for the round. Information about the

[3] All buyers had the same 50 values, and all sellers had the same 50 values; but the values of buyers were different than those of the sellers as they were drawn from the uniform distribution $U(0, 200)$ compared to the smaller distribution of the sellers, $U(0, 100)$. This randomization of stimuli mitigates the differences between individuals in the experiment.

decisions and outcomes of the other traders in the session was not disclosed. If a deal was reached, players were also informed of the trade price.

### 3.3. Instructions and information framing

In their discussion of findings, Parco and Rapoport (2004) questioned the level to which subjects understood the effects of their individual offers on earnings in the Full Bonus condition – specifically, how the payoff function was framed to the participants. Although the description of the payoff function in the original study was both technically correct and consistent with their control condition in which no bonus was paid, it was not clear that subjects sufficiently understood the conjoint effect of earnings from a feasible agreement and earnings from the exogenous bonus. Consider the relevant excerpts from the presentation of the payoff function in the experimental instructions from the original study (Parco & Rapoport, 2004):

> If the trial ends in disagreement (because the seller's offer exceeds the buyer's offer price), then you will earn nothing for this trial. If the trial ends in agreement (because the seller's offer is equal to or lower than the buyer's offer), then your earnings will be the sum of two components that are determined by the following formulas:
>
> $$\textbf{Buyer's earnings} = (\textbf{buyer's reservation value} - \textbf{contract price}) + (\textbf{buyer's offer} - \textbf{seller's offer})/2$$
>
> $$\textbf{Seller's earnings} = (\textbf{contract price} - \textbf{seller's reservation value}) + (\textbf{buyer's offer} - \textbf{seller's offer})/2$$
>
> For the buyer, the first component is the difference between her valuation of the object and the contract price. For the seller, the first component is the difference between the contract price and his valuation of the same object. The second component is the same for both traders. It is simply a fraction (50% in this case) of the difference between the buyer's and seller's offers.
> The following example illustrates the computations: Suppose the buyer is assigned a reservation value of 110, and the seller is assigned a reservation price of 65. If the buyer bids 90 and the seller asks 80, then an agreement is reached at a contract price of 85 (add the offers and divide by two; in this case, (90 + 80)/2). Using the formulas from the previous page, the earnings are calculated to be:
>
> $$\text{Buyer's earnings} = (110 - 85) + (90 - 80)/2 = 25 + 5 = 30$$
>
> $$\text{Seller's earnings} = (85 - 65) + (90 - 80)/2 = 20 + 5 = 25$$

In the experimental design, because participants would earn as much from the full bonus as from the gains from trade, it was always in everyone's interest to bid truthfully. Moreover, one's own offer in the bargaining process has no direct effect on his or her own earnings, but did directly affect the other party's earnings. The only direct effect of one's offer was in the determination of whether or not a feasible agreement would be reached. However, from direct inspection of the original articulation, it is not clear that the participants would have discerned this (or taken the time to work through the math and figure it out). Thus, one of the principal aims of the present study was to determine to what effect the reframing of the payoff function in the instructions had on participant behavior in the experiment. To clarify the description of the payoff function, a bit of simple algebra after substituting the term "(buyer's offer + seller's offer)/2" for "contract price" results in a reframing the originally framed payoff function (Parco & Rapoport, 2004):

$$\textbf{Buyer's earnings} = (\textbf{buyer's reservation value} - \textbf{contract price}) + (\textbf{buyer's offer} - \textbf{seller's offer})/2$$

$$\textbf{Seller's earnings} = (\textbf{contract price} - \textbf{seller's reservation value}) + (\textbf{buyer's offer} - \textbf{seller's offer})/2$$

into the reframed payoff function (present study):

$$\textbf{Buyer's earnings} = \textbf{Buyer's reservation value} - \textbf{Seller's offer}$$

$$\textbf{Seller's earnings} = \textbf{Buyer's offer} - \textbf{Seller's reservation value}$$

Note that the revised description of the payoff function for the reframed full makes is far simpler by never mentioning the bonus payment and instead combining everything into a single payoff function. Revising the instructions for the present study, they were reframed as shown below:

During this experiment, your offer will only be important to you in determining whether or not a deal is made. If no deal is made, neither you nor your co-bargainer will earn anything. If a deal is made, your offer will have no effect on how much you earn. It will only affect your co-bargainer's earnings. The earnings formulae are:

**Buyer's earnings = Buyer's reservation value − Seller's offer**

**Seller's earnings = Buyer's offer − Seller's reservation value**

Thus, neither player's offer will affect his/her earnings. If a deal is reached, your offer will only have an effect on your co-bargainer's earnings. Likewise, your co-bargainer's offer will have no effect on his/her earnings; it will only affect your earnings.
The following example illustrates the earnings computations:
Suppose the buyer is randomly assigned a reservation value of 110, and the seller is randomly assigned a reservation value of 65. If the buyer submits an offer to buy at 90 and the seller submits an offer to sell at 80, a deal is made since the buyer's offer is greater ($90 \geqslant 80$) the seller's offer. Thus, the earnings are calculated to be:

Buyer's earnings $= 110 - 80 = 30$

Seller's earnings $= 90 - 65 = 25$

Based on the discussion above, it is obvious that the only difference between the Full Bonus and Reframed Full Bonus (hereafter FB and RFB) was that in the former condition the subjects were explicitly instructed about receiving a bonus and the payoff functions included two parts reflecting this fact. In the latter condition, no bonus was ever mentioned, and the payoff functions simply reflected the effects illustrated above. Although nothing else differed between the FB and RFB instructions to the subjects, the payoff formula was greatly simplified in the latter. Subjects in the RFB condition were explicitly shown that one's earnings were independent of his or offer. Although a subject's offer would determine if a trade was to take place, if a trade did occur, the offer would have no effect on the subsequent earnings from that particular round for the subject, but would only affect the other subject's earnings.[4]

## 4. Results

Although the implementation of the reframed bonus moved behavior towards the equilibrium prediction, like the FB condition, observed behavior in the RFB condition differed significantly from theoretical predictions just as it did in the FB condition. Despite some notable decrease in strategic behavior, even after removing the potential effects of framing, strategic resiliency in formulating settlement proposals persisted.

### *4.1. Aggregate results*

A Wilcoxon Rank Sum test for two independent samples was used to test the null hypothesis of equality of number of deals made by the two independent groups comparing the No Bonus (NB), Full Bonus (FB) and Reframed Full Bonus (RFB) conditions.[5] The hypothesis could not be rejected in each of the cases ($z = 0.703$, 0.284, and 1.380) for conditions NB, FB, and RFB, respectively). Analyses conducted on the individual payoffs yielded similar results. Consequently, each of the two groups in each conditions discussed herein were combined in all subsequent analyses.

Using the same dependent variable, a Kruskal–Wallis test for the three independent conditions identified a significant between-condition difference ($H = 497.8$, $p < 0.0001$). Condition FB differed significantly from conditions NB ($z = 2.132$, $p < 0.037$) and RFB ($z = 4.411$, $p < 0.001$). The actual percentage of deals in conditions NB, FB, and RFB was 54.4%, 60.4%, and 67.7%, respectively.

### *4.2. Results of different offers*

As aggregate results typically mask individual differences, this section begins with presentation of the individual bids and offers. Individual decisions of the FB condition (Parco & Rapoport, 2004) are presented in Figs. 2 and 3 for buyers and sellers

[4] All other aspects of the experimental instructions of the present study were identical to Parco & Rapoport, 2004, which are available in full text as an appendix to the original study.
[5] Parametric tests one-way ANOVA with post-hoc comparisons yielded consistent results with the non-parametric test results reported above.

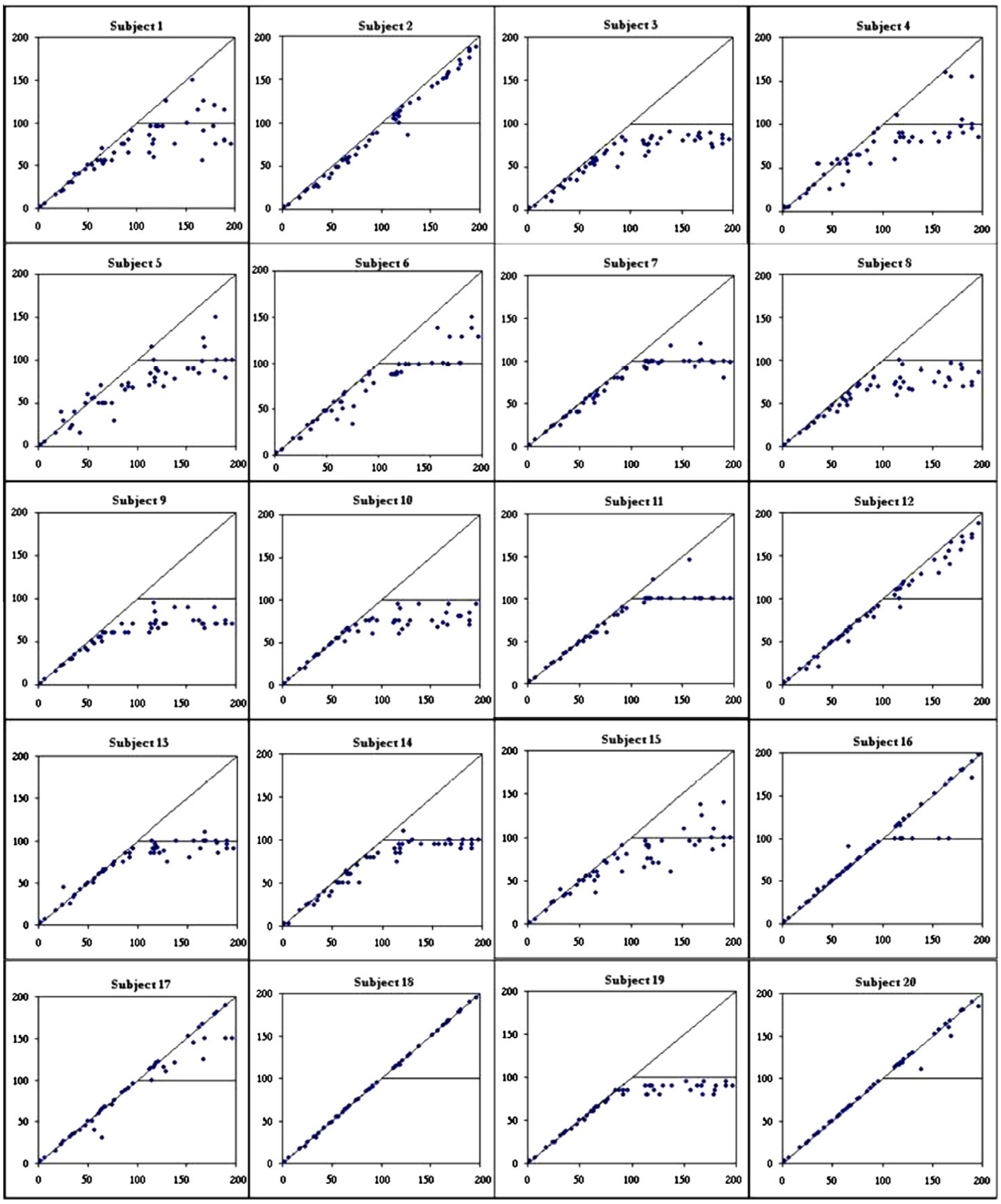


**Fig. 2.** Full bonus condition, buyer's bids.

respectively for a baseline comparison to RFB condition in the present study. The primary focus of this study was to evaluate the effects of the unique (full) bonus, or FB, in which the equilibrium prediction was for every player to truthfully reveal her own reservation value as the offer in that doing so would maximize individual gains from trade. The bids of all buyers in condition FB are shown in Fig. 2. Note that although the seller has a (weakly) dominant strategy to make truthful offers for all values of $v_s$, truthful bidding holds for the buyer only up to $\beta_s$, the upper limit of the seller's distribution, *F*. When $v_b > \beta_s$, the buyer could bid any amount up to $\beta_b$, the upper limit of the buyer's distribution, *G*, and still maintain ex post efficiency. Thus, bids falling in the upper-left triangle of each individual plot do not contradict the normative LES. Half of the buyers (subjects 2, 7, 11, 12, 13, 16, 17, 18, 19, 20) closely approximated truthful revelation for $0 \leqslant v_b \leqslant \beta_s = 100$. Of these ten buyers, subjects 2, 12, 16, 18, and 20 continued to bid more or less truthfully for $v_b > \beta_s$, whereas subjects 7, 11, 13, and 19 deliberately suppressed the sellers' earnings by shaving their bids considerably for $v_b > \beta_s$.

Other buyers (subjects 1, 3, 4, 5, 8, 9, 10, and 14) bid more aggressively than the LES. Bids exceeding the reservation values occurred infrequently (subjects 4 and 5). Plots of individual sellers in condition FB are shown in Fig. 4. Subject 24 was the only one with a sizeable number of offers below her reservation value. Evidence for truthful revelation with minor degree of exaggeration comes from subjects 22, 26, 29, and 32. Subject 25 also converged to truthful revelation after 20 trials. Subjects 28, 30, 35, 36, 38, and 40 all deviated from truth-telling to their detriment. The remaining sellers shaved their offers consistent with seller behavior in the NB conditions reported in earlier studies (Daniel, Seale, & Rapoport, 1998; Parco & Rapoport, 2004).

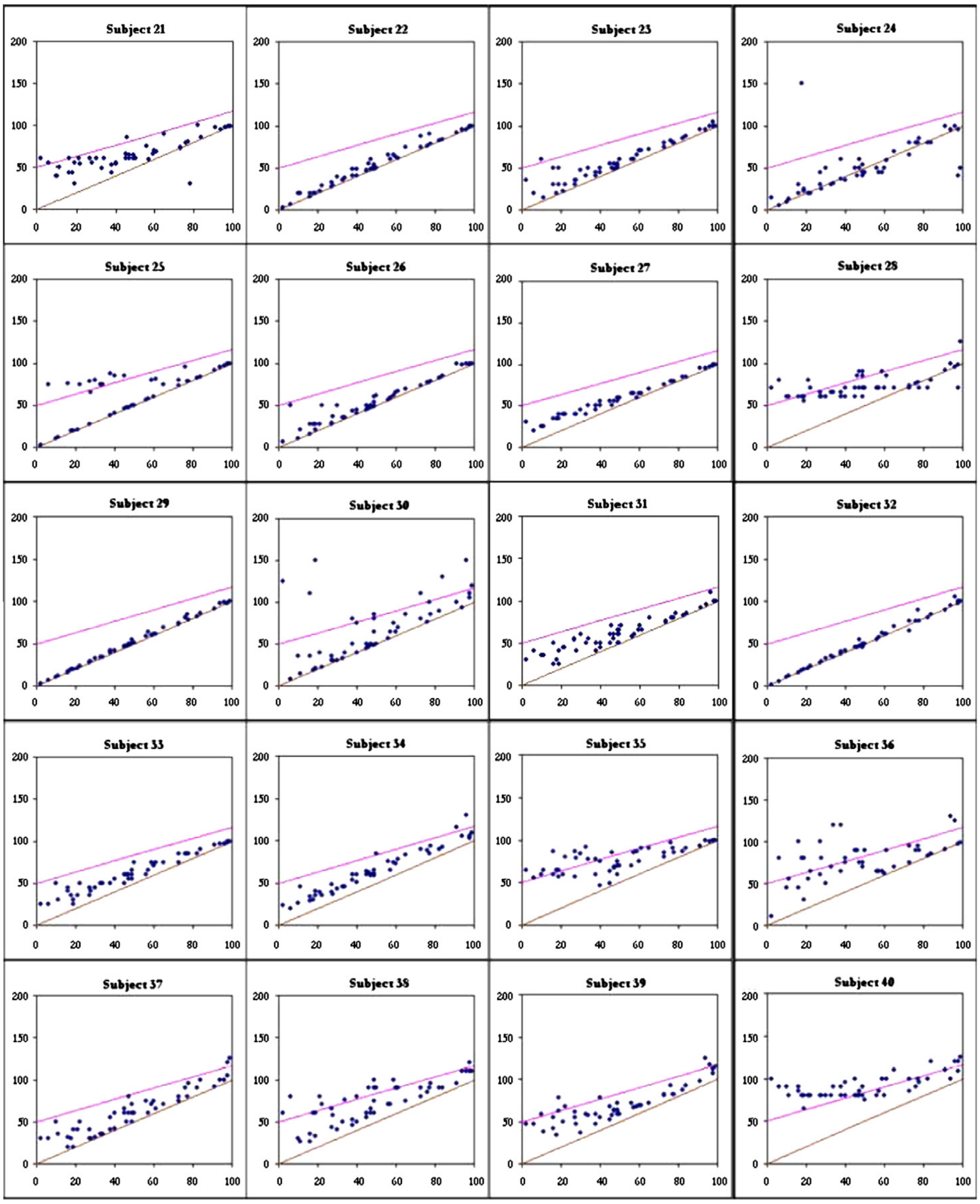


**Fig. 3.** Full bonus condition, seller's offers.

Theoretically, results from the RFB condition should not differ from results of the FB condition. Nevertheless, analysis of buyer behavior revealed a statistically significant difference at $p = 0.013$ between the FB and RFB conditions. This difference was primarily the result a marked increase in truthful revelation by individual subjects in the RFB condition as compared to the FB condition. Nevertheless, when comparing the results of the RFB condition to the LES prediction of truthful revelation, the difference was also significant at the $p < 0.05$ level indicating that despite the simplified reframed condition, strategic misrepresentation of offers persisted.

Similarly to the interpretation of results for the buyers of the FB condition, the bids of interest for the buyers in the RFB condition also lie in the range $50 < v_b < 100$. Subjects 42 and 52 differed from all other buyers in either FB or RFB conditions in that each made an attempt at collusion. Despite the theoretical prediction of bidding at max($\boldsymbol{G}$), there is stronger evidence with data from Subject 42 to bid at max($\boldsymbol{F}$) when endowed with an information advantage. Only twice did Subject 42 bid 200, and both times for high values of $v_b$. She bid 100 eight times when $b > v_b$. In total, Subject 42 made 31 out of 50 bids where $b > v_b$.[6] Subject 52 also made an attempt at collusion bidding $b > v_b$ ten times. The first occurrence of $b > v_b$ was for a $v_b < 100$ and resulted in a loss. Subject 52 continued to make nine more $b > v_b$ offers, but for $v_b > 100$ and all resulted in gains. After four

[6] Subject 2 bid $b > v_b$ twice during Trials 1–10 but bid $b > v_b$ consistently during Trials 40–50. Twenty-eight of the 32 $b > v_b$ offers yielded non-negative outcomes. The negative outcomes ranged from $-2$ to $-47$ with the largest losses incurred at very low values of $v_b$.

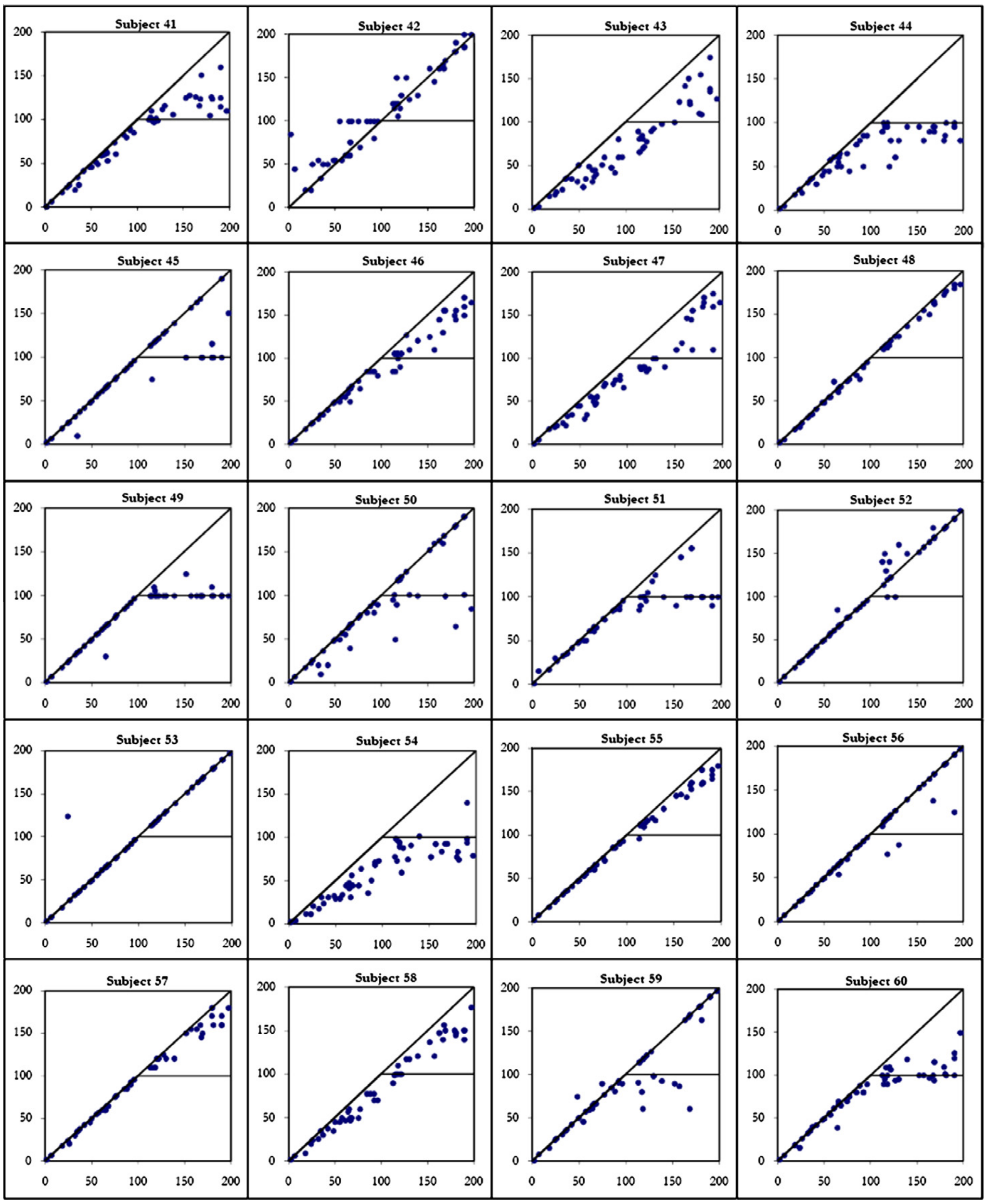

**Fig. 4.** Reframed full bonus, buyer's offers.

additional $b > v_b$ bids, no further indication of collusive behavior emerged. The outlier evident in Subject 53 is clearly an error as he bid $b = v_b$ for all trials except Trial 4. On Trial 4, Subject 53 bid 124 when it is presumed he meant to bid 24. The other three $b > v_b$ bids made by Subject 48 and Subject 59 appear to be deliberate decisions "testing the water" with none resulting in negative outcomes.

Similar to the FB condition, six subjects (Subjects 41, 43, 44, 47, 50, 54, and 58) bid strategically to their detriment. However, the remaining subjects showed more consistency with a truth-telling strategy, particularly on later trials. Subjects 49, 51, and 60 bid $b = v_b$ for $v_b < 100$, and shaved all $b \geqslant 100$ unilaterally suppressing seller earnings just as did three subjects in the FB condition. The primary difference between the FB and RFB conditions with respect to the buyers was in the degree of shaving offers for high values of $v_b$. The amount of shaving decreased significantly with the revised payoff function of the RB condition.

Evaluation of seller behavior of the RFB condition (Fig. 5) was consistent with results reported for the buyers: significant differences emerged not only between the FB and RFB conditions, but also was manifest between the RFB condition and the LES prediction of truthful revelation. Like the buyers, although the sellers significantly reduced the amount of their strategic misrepresentation of value between the FB and RFB condition ($p = 0.004$), the strategic misrepresentation persisted when compared to the LES prediction of truthful revelation ($p < 0.05$).

Unlike buyer behavior in the RFB condition, multiple sellers engaged in what appears to be signaling behavior to incite collusion, which resulted in a larger standard deviation of offers in the RFB condition (30.98) compared to that of the FB

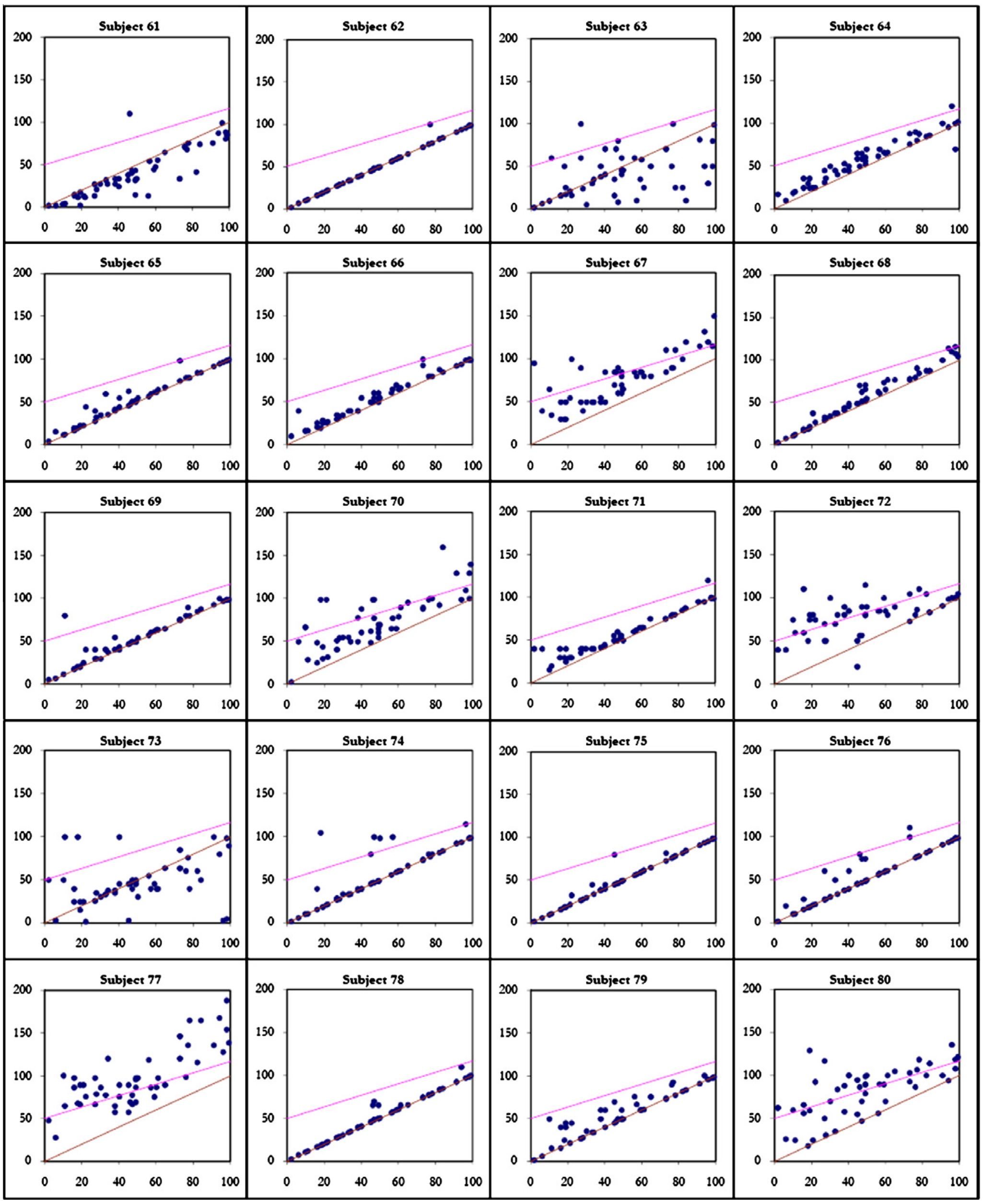


**Fig. 5.** Reframed full bonus, seller's offers.

condition standard deviation (25.87). It should be noted that in this particular mechanism with a unique full bonus, if subjects were to bid at the extremes of their distributions (buyers bid at the upper limit and sellers, at the lower limit, earnings are maximized by making deals even when subject would "lose money" as the amount of the exogenous bonus compensates for the loss at the expense of the experimenter). Although no indication was evident in the FB condition, such was mildly apparent in the RFB condition with three subjects.

In the RFB condition, Subjects 61, 63, and 73 submitted a considerable number of offers where $s < v_s$. Subject 61 was the most consistent but least aggressive seller in attempting to collude. Only during the first two trials of play did $s > v_s$ for Subject 61. During Trials 3–45, Subject 61 offered $s < v_s$ with an average deviation between $s$ and $v_s$ of 10.8. In the remaining five trials, Subject 61 offered $s = v_s$. Not once did Subject 61 make the minimum offer of $s = 1$. Even with $v_s = 2$, Subject 61 offered $s = S(2) = 2$. Subject 63 made fewer collusive offers of $s < v_s$, but had nearly twice as large of a deviation ($s - v_s = 21$) for $s < v_s$ offers. Nevertheless, Subject 63 made the most (33 out of 50) offers of $s < v_s$. Like Subject 61, Subject 63 never made the minimum offer of $s = 1$. Making 56% $s < v_s$ offers with an average deviation on these offers of 18.4, Subject 73's behavior was very similar to that of Subject 63. Unlike Subjects 61 and 63, Subject 73 did make a minimum offer of $s = 1$, but only once and early in play during Trial 4. Only two other points occurred with $s < v_s$, once each with Subject 64 and 72. Subject 64 made a single $s < v_s$ offer on Trial 33 which resulted in a negative outcome. Subject 72 also made a single $s < v_s$ offer on Trial 49, which resulted in a gain. Neither of the decisions appears to be erroneous. Most of the remaining sellers strategically misrepresented

**Table 1**
Percentage of offer types by condition.

| Buyers | | | Sellers | | |
|---|---|---|---|---|---|
| NB | FB | RFB | NB | FB | RFB |
| *Strategic offers* | | | | | |
| 67.9% | 57.3% | 44.9% | 81.2% | 60.5% | 40.5% |
| *Negligible shaving* | | | | | |
| 19.5% | 23.9% | 19.0% | 14.6% | 24.8% | 26.6% |
| *Truthful offer* | | | | | |
| 9.7% | 17.0% | 30.9% | 2.5% | 10.6% | 22.2% |

their true reservation values only occasionally and usually in earlier trials in varying and limited degrees. Six of the sellers pursued predominantly truthfully revealing strategies. Also similar to the FB condition, five subjects, Subjects 67, 70, 72, 77, and 80 acted far too aggressively to their detriment. The preponderance of the decisions from nine sellers fell between the truth-telling and LES functions. Even when explicitly informed that individual offers would have no effect on earnings, given that a deal was made, Subjects 70, 72, 77, and 80 made a considerable number of strategic offers and consequently forfeited a substantial amount of earnings. RFB Sellers for comparison purposes only but has no relevance otherwise.

### 4.3. Accounting for individual differences

In an attempt to account for individual differences, buyers and sellers were placed into three categories. Truthful bids and offers were defined as $b = v_b$ for the buyer and $s = v_s$ for the seller. Strategic bids and offers were defined by shaving ($b < v_b$ and $s > v_s$). However, for purposes of comparison, bids and offers that were classified as "strategic" but were within five units of the reservation values were categorized as "Negligible shaving." The results are summarized in Table 1. They show that the propensity to bid strategically decreased monotonically across the conditions NB, FB, and RFB for both buyers (from 67.9% to 44.9%) and sellers (from 81.2% to 40.5%). More dramatic is the increase in truthful revelation (for buyers from 9.7% to 30.9%, and for sellers from 2.5% to 22.2%). Clearly, there is a systematic trend in both bids and offers to truthful revelation as the value of the bonus value $R$ increases. However, even if the two categories "Truthful offer" and "Negligible shaving" are combined, nearly half of the offers and bids in condition RFB continue to be characterized as "strategic" with considerable amount of shaving with regard to LES.

Fig. 6 displays the aggregate results by player type (buyer and seller) and condition (NB, FB, and RFB). Each plot shows the LES predicted function and the observed function. For all three conditions, the LES functions for the seller are linear, as are the observed functions. The LES functions for the buyers in conditions NB and PB are piecewise linear with three segments. Spline functions were fitted to the observed bids using the same breaking points as the corresponding LES functions. For the buyers' bids in conditions FB and RFB we fitted spline functions with only two segments, with a breaking point at $\beta_s$.[7]

### 4.4. Effectiveness and efficiency of different strategies

Table 2 compares the (1) effectiveness of the RFB to that of the FB in achieving feasible agreements and (2) the efficiency of the bonus conditions at achieving the players' potential combined expected payoff. The top part of the table shows the observed number of deals by condition, the number of *feasible* deals (when $v_b \geqslant v_s$ for the same sequence of reservation values) under truthful revelation (which, given no change in the parameter values of the mechanism across conditions, are the same for all four conditions), and the effectiveness in achieving feasible agreements (obtained by dividing the observed by the possible number of deals). Although the subjects moved in the direction of truthful revelation, Table 2 shows that the effectiveness measure increased steadily from 79.5% to 88.8%. However, it did not reach the predicted 100% in either of the conditions FB and RFB (see Fig. 7).

Table 3 reports the bonus costs and earnings efficiency by condition. Although aggregate earnings were monotonically higher with the bonus implementation, efficiency levels actually *decreased* in the FB condition due to players continuing to bid strategically despite its dominated characteristics foregoing not only the gains from trade, but also an equal amount of bonus earnings for each missed deal. Although efficiency in the RFB condition improved, it still was 20% less than the LES predicted outcome. Considering only the gains from trade, the actual size of the surplus was constant across conditions. Ignoring the bonus payoffs, efficiency in achieving gains from trade increased to 90% and 94.4% in the FB and RFB conditions, respectively. The costs incurred for these improvements, however, were quite large (38,723 francs in condition RFB). The bonuses comprised 20–41% of the total earnings across the bonus conditions. Observed percentage of agreements increased monotonically from 68.5% in the NB condition to 89.0% in the RFB condition was well below normative LES predictions for the samples of reservation values drawn during the experiment.

[7] In condition NB, the slopes of the spline segments for the buyer are 0.955, 0.578, and 0.169 for the intervals [0, 50], [50, 150], and [150, 200], respectively, as compared to the LES slopes of 1, 2/3, and 0.

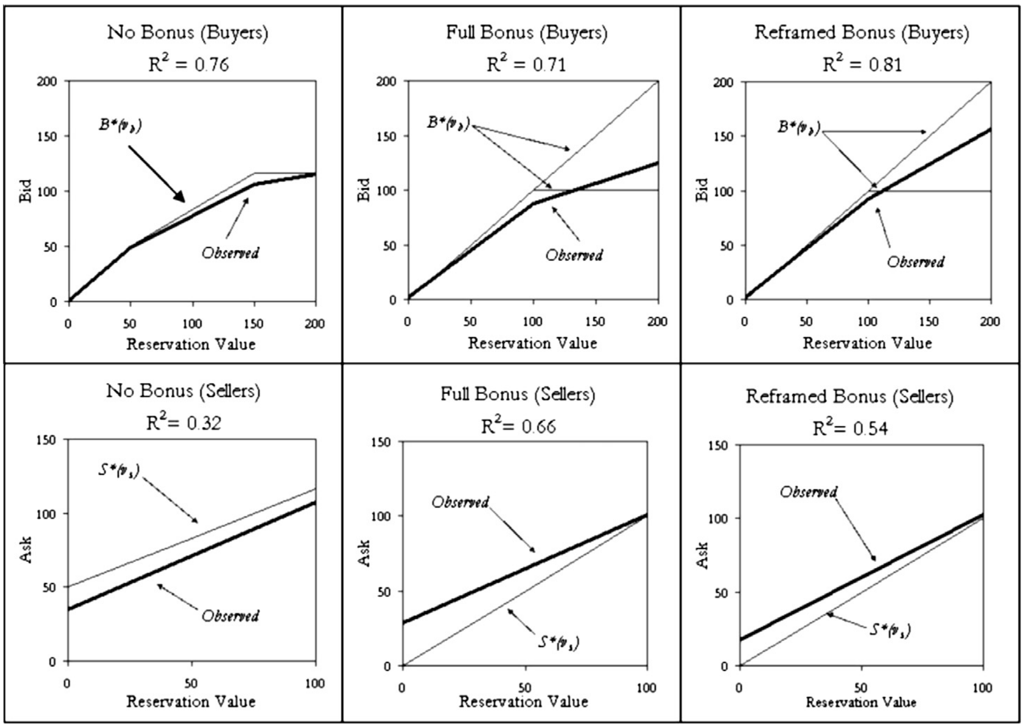


**Fig. 6.** Regression plots by player type and condition.

**Table 2**
Measures of effectiveness and efficiency.

| Number of deals | NB | FB | RFB |
|---|---|---|---|
| Observed | 522 | 604 | 677 |
| Feasible with truthful revelation | 762 | 762 | 762 |
| Effectiveness | 68.5% | 79.5% | 88.8% |
| Combined earnings | NB | FB | RFB |
| Observed | 50,734 | 78,710 | 94,303 |
| Feasible with truthful revelation | 58,862 | 117,724 | 117,724 |
| Efficiency | 86.2% | 66.9% | 80.1% |

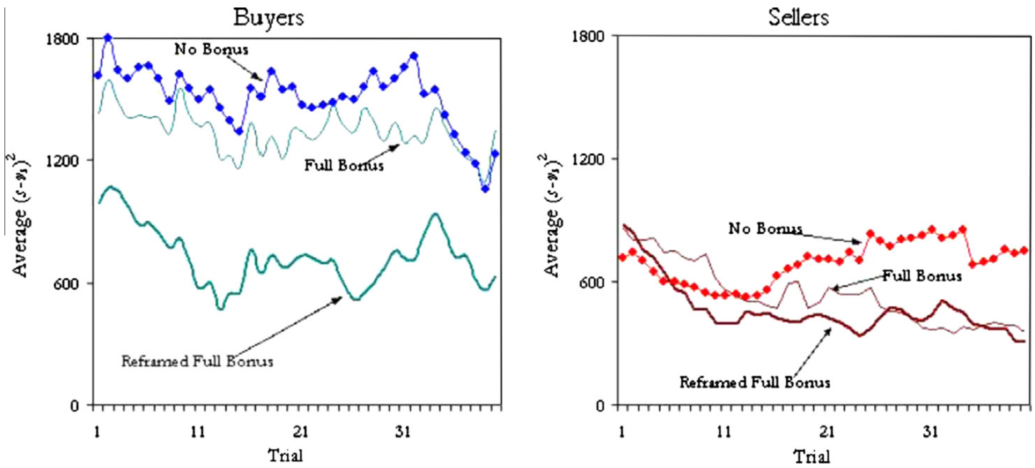


**Fig. 7.** Mean squared deviation running average (step 10) between offer and reservation value.

Table 3 also reports the number of observed deals by subject for all conditions separately as well as the simulated number of deals that would have been realized if either party had played a truthful strategy. Let A–A (actual–actual)[8] denote the

[8] The player's decision is listed on the left of the hyphen and the co-bargainer's decision is listed on the right.

**Table 3**
Efficiency results by condition.

| | No bonus | Full bonus | Reframed bonus |
|---|---|---|---|
| Observed deals | 68.5% | 79.4% | 89.0% |
| Predicted deals | 66.7% | 100.0% | 100.0% |
| Observed efficiency with bonus | – | 66.9% | 80.1% |
| Observed efficiency without bonus | 74.1% | 90.0% | 94.4% |
| Predicted efficiency | 65.4% | 100.0% | 100.0% |
| Cost of Bonus implementation | – | 25757 | 38723 |
| Percentage of overall earnings | – | 32.7% | 41.1% |

observed results of both players and T–T (truth–truth) denote a game with each player playing $b = v_b$ or $s = v_s$. Due to the heteroskedastic nature of the observed variance, medians are reported in lieu of means. The median number of deals for the buyers increased monotonically from 26.5 in the NB condition to 31.0 in the FB condition. The RFB condition induced an increase to 34.0. Likewise for the sellers, median number of deals achieved increased monotonically from 27.5 in the NB condition to 30.0 in the FB condition. The RFB condition further induced an increase to 34.5.

### *4.5. Regression analysis*

Because both the normative LES predictions and truthful revelation functions are linear in all conditions for the sellers, a simple linear regression model is sufficient for estimating slope and intercept coefficients. In the NB condition, the normative solution (represented by the LES function) dictates an intercept of 50 and a slope of 2/3. All of the coefficients reported in Table 4 are significant at $p < 0.001$. The slope coefficients for the FB condition increased by 0.07 between the first block (Trials 1–25) and last block (Trials 26–50) while the respective intercepts decreased. The RFB condition yielded intercepts decreasing from 28.5 to 17.8 and a slope increasing from 0.72 to 0.85. However, neither coefficient came close to the truthful predictions of a 1.0 slope and 0 intercept in either the FB or RFB conditions. In all of the conditions, the amount of variance explained by the regression model, denoted by $R^2$, increased between the first and last blocks. However, because of the diversity of individual strategies of the sellers within each condition, the aggregate $R^2$ results are not higher.

Due to the theoretical piece-wise nature of the normative solution for buyers in the NB condition, spline regression was used to isolate slopes and conjoining pivot points at $v_b = 50$ and $v_b = 150$. The spline model is merely an extension of the single linear regression model and any non-significant changes in slope can be interpreted as the dummy variable accounting for negligible variance.

Table 5a shows the results of the spline model for Block 1 and Table 5b for Block 2. Table 5c shows results across all trials. In both conditions of the bonus implementation, the slope coefficient for $v_b < 50$ approached 1.0 as predicted by both the LES and truth-telling equilibrium. All intercept coefficients for $v_b < 50$ are insignificant at $p < 0.05$ for both blocks. The FB condition yielded quite unexpected results. Although the expected slope coefficient is 1.0, the observed coefficients of 0.60 and 0.65 are not only considerably more aggressive than the dominant strategy, but also more aggressive than the dominated LES. The slope coefficient for the FB condition in the upper-range of $v_b$ decreased from 0.40 in the first block to zero in the second block. Note that Block 2 observed coefficients of the FB condition are nearly identical to the (irrelevant) No Bonus LES. The RFB results are a drastic improvement over the FB condition with insignificant slope and intercept coefficients in Block 1 for the mid- and upper-ranges of $v_b$ reducing the spline model to a simple linear regression model. However, in Block 2, the buyers became more aggressive yielding a slope coefficient of 0.34, which is significant at the $p < 0.001$ level. This evidence demonstrates that although the subjects move in the direction of the dominant truthful revelation equilibrium, they do not reach it.

The $R^2$ scores for the buyer spline model are much improved over the seller model accounting for 70–80% of the variance across conditions.

**Table 4**
Regression results, sellers.

| | Block1: Trials 1–25 | | | Block 2: Trials 26–50 | | | Trials 1–50 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Slope | Intercept | $R^2$ | Slope | Intercept | $R^2$ | Slope | Intercept | $R^2$ |
| *Predicted* | | | | | | | | | |
| $\theta = 0.00$ (NB) | 0.67 | 50.0 | | 0.67 | 50.0 | | 0.67 | 50.0 | |
| $\theta = 0.50$ (FB/RFB) | 1.0 | 0 | | 1.0 | 0 | | 1.0 | 0 | |
| *Observed* | | | | | | | | | |
| NB | 0.74 | 32.6 | 0.60 | 0.70 | 38.0 | 0.20 | 0.72 | 35.2 | 0.32 |
| FB | 0.69 | 32.7 | 0.51 | 0.76 | 23.9 | 0.64 | 0.72 | 28.5 | 0.56 |
| RFB | 0.88 | 17.2 | 0.53 | 0.81 | 18.6 | 0.56 | 0.85 | 17.8 | 0.54 |

*Note*: All reported statistics are significantly different than zero at $p < 0.001$, $\alpha = 0.05$.

**Table 5a**
Spline regression results, buyers, Block 1: Trials 1–25.

| | $v_b < 50$ | | $50 \leqslant v_b \leqslant 150$ | | $150 < v_b$ | | |
|---|---|---|---|---|---|---|---|
| | Slope | Intercept | Slope | Intercept | Slope | Intercept | Adj. $R^2$ |
| LES | 1.00 | 0.0 | 0.67 | 50.0 | 0.00 | 116.7 | |
| NB | 0.90*** | 2.7 | 0.57*** | 47.9 | 0.25** | 104.6 | 0.75 |
| FB | 1.03*** | −2.3 | 0.60*** | 49.3 | 0.40* | 109.7 | 0.75 |
| RFB | 0.87*** | 4.0 | ## | ## | ## | ## | 0.81 |
| Truth-telling | 1.00 | 0.0 | 1.00 | 50.0 | 1.00 | 150.0 | |

* $p < 0.1$ Testing whether the coefficient is significantly different than zero.
** $p < 0.01$ Testing whether the coefficient is significantly different than zero.
*** $p < 0.001$ Testing whether the coefficient is significantly different than zero.
\## Indicates insufficient data to estimate a different spline function in the particular range.

**Table 5b**
Spline regression results, buyers, Block 2: Trials 26–50.

| | $v_b < 50$ | | $50 \leqslant v_b \leqslant 150$ | | $150 < v_b$ | | |
|---|---|---|---|---|---|---|---|
| | Slope | Intercept | Slope | Intercept | Slope | Intercept | Adj. $R^2$ |
| LES | 1.00 | 0.0 | 0.67 | 50.0 | 0.00 | 116.7 | |
| NB | 1.01*** | −1.2 | 0.57*** | 47.9 | 0.25*** | 104.6 | 0.77 |
| FB | 1.03*** | −1.4 | 0.65** | 50.2 | −0.01*** | 115.0 | 0.67 |
| RFB | 0.99*** | -0.6 | ## | ## | 0.34*** | 147.9 | 0.81 |
| Truth-telling | 1.00 | 0.0 | 1.00 | 50.0 | 1.00 | 150.0 | |

* $p < 0.1$ Testing whether the coefficient is significantly different than zero.
** $p < 0.01$ Testing whether the coefficient is significantly different than zero.
*** $p < 0.001$ Testing whether the coefficient is significantly different than zero.
\## Indicates insufficient data to estimate a different spline function in the particular range.

**Table 5c**
Spline regression results, buyers, Trials 1–50.

| | $v_b < 50$ | | $50 \leqslant v_b \leqslant 150$ | | $150 < v_b$ | | |
|---|---|---|---|---|---|---|---|
| | Slope | Intercept | Slope | Intercept | Slope | Intercept | Adj. $R^2$ |
| LES | 1.00 | 0.0 | 0.67 | 50.0 | 0.00 | 116.7 | |
| NB | 0.96*** | 1.0 | 0.58*** | 48.8 | 0.169*** | 106.6 | 0.76 |
| FB | 1.04*** | -2.0 | 0.62*** | 49.9 | 0.19*** | 112.3 | 0.71 |
| RFB | 0.93*** | 1.9 | ## | ## | 0.51*** | 139.8 | 0.81 |
| Truth-telling | 1.00 | 0.0 | 1.00 | 50.0 | 1.00 | 150.0 | |

* $p < 0.1$ Testing whether the coefficient is significantly different than zero.
** $p < 0.01$ Testing whether the coefficient is significantly different than zero.
*** $p < 0.001$ Testing whether the coefficient is significantly different than zero.
\## Indicates insufficient data to estimate a different spline function in the particular range.

## 5. Conclusion

In their classic paper "Organisms misbehaving," Breland and Breland (1961) discuss the enduring propensity of particular animals to resist learning in spite of clear rewards and unambiguous reinforcement. Particularly memorable is the image of miserly raccoons, unwilling to relinquish coins for food, preferring instead to clutch the coins and rub them together, even when hungry. Breland and Breland report, "Now the raccoon really had problems (and so did we). Not only could he not let go of the coins, but he spent seconds, even minutes, rubbing them together (in a most miserly fashion), and dipping them into the container. He carried on this behavior to such an extent that the practical application we had in mind - a display featuring a raccoon putting money in a piggy bank – simply was not feasible. The rubbing behavior became worse and worse as time went on, in spite of nonreinforcement" (p. 288). Evidence like this challenged the tenants of behaviorism and suggested limits to conditioning theory in explaining behavior. Moreover it undermined the description accuracy of *tabla rasa* and suggested that not all behavioral responses are equally conditional to all possible stimuli; there were just some simple things that organisms would not learn how to do.

The current study is presents similarly surprising results, challenges the limits of what rationality and payoff dominance can explain about decision making behavior in bargaining situations. The Bonus Procedure has been proposed as a theoretical mechanism that modifies the payoffs of the two players so that truthfully bidding one's reservation value is a dominant strategy. By choosing a bonus level that "doubles" the benefit for reaching an agreement, this procedure is designed to induce honesty in bargaining and thereby avoid inefficient outcomes.

The results of the present study are surprising in two ways. First, directly comparing the present study with the Full Bonus condition of the Parco and Rapoport (2004) study, there should have been no difference in the observed behavior between the two conditions given that the parameterization of each condition was identical. The conditions only differed in how the payoff functions were restated (using simple algebra) inducing a potential framing effect. And yet, the framing effect mattered. The observed behavior of the Reframed Full Bonus did in fact move subject behavior in the direction of truthful revelation. Nevertheless, it continued to fall short of normative predictions with robustly persistent strategic behavior from buyers and sellers alike. Although truthful-revelation was the strictly dominant strategy, the majority of players, both buyers and sellers, continued to engage in strategic behavior to their individual detriment. The results of this experiment provide further support for the hypothesis that individuals are inclined to bid strategically and misrepresent their true reservation values despite the fact that doing so will reduce their gains from trade. Even when placed in a situation (as with this experimental condition) where truthful revelation is expressly described as a dominant strategy, the potential benefits that would otherwise result from this "unnatural" mechanism are overridden by an entrenched belief in the concept of strategic play making it very difficult for individuals to recognize that truthful revelation can sometimes be an optimal strategy. A second possible explanation is that the players simply did not understand the payoff functions and falsely believed that their individual offers had an effect on their respective outcomes. However, this latter explanation is increasingly less plausible in light of the results of the Reframed Full Bonus condition where subjects were explicitly and repeatedly informed that "individual offers [had] no effect of one's earnings and only determined whether or not a deal was made." The resultant inefficient outcome persisted despite the reframing of the experimental instructions. Thus, even when players knew that their offer could not affect their earnings, they continued to resist truthful revelation. The result is apparently simple: strategic resiliency in the formulation of settlement proposals in a bilateral bargaining game of incomplete information is indeed robust.

Bargaining is a success story for experimental game theory. Nonetheless, this study stands as an outlier against that backdrop. Here, we tested a bargaining institution and gave that institution the best chance possible to work as normative theory predicts. We clarified the equilibrium and implemented a full experimental design to specifically eliminate any potential confusion regarding payoff functions, and yet we find that the bonus procedure failed to work as predicted. What emerged from the data in this study was a resilient bidding pattern of strategic misrepresentation, and that pattern makes good sense when considered globally. Such "bid shading" is not a bad heuristic in the wild. This heuristic often works well in real life and does so across different bargaining mechanisms and conditions of incomplete information. However, the bonus condition negates the effectiveness of this heuristic and what we observe is that even with clear instructions and incentives, players are not sufficiently responsive to the new context but instead show a strong propensity to "carry over" behavior even when it is strictly dominated.

One conjecture to explain this observed effect is that the social preferences of players (like social value orientation, reciprocity, or inequality aversion) could have been a factor in our experimental design. However, we feel it is important to note that such a conjecture, albeit interesting, predicts behavior in the opposite direction than is observed in the current experiment. Assume players have some degree of other regarding preferences. In the standard bargaining (no bonus) institution, players would have mildly conflicting preferences at work. On one hand, they would have an incentive to truth-tell as this maximizes joint expected gain, but they would also have a (self-regarding) preference to shade their bids a little to increase their own payoff. In this case, there would be necessary tradeoffs given some degree of other-regarding preferences. What is interesting to note is that in the Bonus Procedure experiment, self-regarding and other-regarding preferences are perfectly aligned. Both the institutional incentive and the individual preference for utility maximization (of self and others) are all simultaneously in the direction of truth telling. There are no tradeoffs to be made. Thus, the observed pattern is puzzling at best from the standpoint of social preferences. The only reasonable explanation drawing on social preferences is that people are strongly motivated to pay to punish and thus destroy the total value of the exchange. This is not a plausible explanation in our opinion for the current results as these kinds of social preferences are only very rarely observed (only approximately 2%, see for example Murphy, Ackermann, & Handgraaf, 2011) in people. The bottom line is that we see no evidence to substantiate a claim of negative other regarding preferences as the result of a change in mechanism design or as a potential explanation for the observed results.

These findings not only provide further evidence of the Siegel and Fouraker (1960) hypothesis that bidders tend to fare worse with additional information, but also lends support to a potential "hard wired" propensity to strategically misrepresent one's value when engaged in bilateral bargaining. Be it nature or nurture, analysis of the data indicate that players seem so entrenched in the concept of strategic play that they do not recognize that truthful revelation can be beneficial under conditions of two-sided uncertainty. It is reasonable to assert, in light of the evidence provided in this study that subjects in the RFB condition may have been so overcome with task ambiguity that they instead found themselves anchoring and adjusting on individual reservation values as focal points simply to cope with the unfamiliar environment. And yet, given the very common nature of bilateral negotiation, one must question how much ambiguity is present with the average person with a relatively straight-forward task.

Traditional bargaining institutions in the real-world are likely to continue to rely upon the "gold standard" concept of trade price as a focal point of bargaining. Thus, if the results from this study indicate inform us of anything, it is that by redesigning bargaining mechanisms that remove the concept of trade price from the equation (literally, as in condition RFB) could have unforeseen effects. Even the simplest of bilateral trading mechanisms that do not rely on trade price as a basis to determine individual gains can be self-defeating. What might otherwise be perceived as a familiar environment to negotiators who focus on trade price, could quickly become confounded with other components, even if apparently very simple to the designers of the system.

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