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Running title: RESISTANCE TO TRUTHFUL REVELATION

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

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ABSTRACT

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 and 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.

Keywords: Bilateral bargaining, information framing, truthful revelation, sealed bid mechanism, *k*-double auction, linear equilibrium strategy

JEL Classification: C72, C78

1. Introduction

Bargaining has long attracted the attention of scholars. Sigel 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 (Weg et al., 1990; Zwick et al., 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. 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 (Hoffman et al., 1994; Van Poucke and Buelens, 2002; Janssen, 2006; Harbaugh et al., 2007).

Research into simultaneous bilateral bargaining games of incomplete information is far less common. Game theoretical solutions to simultaneous bilateral bargaining problems under incomplete information (Chatterjee and Samuelson, 1983; Myerson and Satterthwaite, 1983; Leininger et al., 1989; Satterthwaite and 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.

Vickery (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 <u>any</u> agreement was itself a strategically stable point. Addressing this underspecificity, 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 (1990, 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 that "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). Empirical findings of shading, or strategic misrepresentation, is traditionally consistent with normative predictions in most bilateral bargaining games. (Daniel et al., 1998; Rapoport et al., 1998; Seale et al., 2001; Gabuthy, 2004; Parco, 2006) However, 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 <u>does not</u> 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 an 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. As is common in the wild, different players may have different valuations for the same thing. When values overlap (i.e. the object is

[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.

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. In the bargaining framework, players make simultaneous sealed offers; the seller's offer is denoted s whereas the buyer's offer is denoted b. If $b \geq s$ 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 $p_k = (kb + (1\text{-}k)s)$, 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 Kigour (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. $B(\bullet)$ denotes the pure strategy for the buyer, specifying a bid of b=$B(v_b)$ for each possible reservation value. Likewise, $S(\bullet)$ denotes the seller's offer of $s = S(v_s)$ for possible reservation values. In some instances $B(\bullet) < v_b$; 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, $S(\bullet) > v_s$, in an effort to increase individual payoff as well.

[2] 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= ½ , 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.

To illustrate the LES concretely, consider a bargaining situation without any trade bonus ($\boldsymbol{R}$ = 0). Seller's reservation values are distributed uniformly between 0 and 100 inclusive: **F** ~ U(0, 100). Buyer's reservation values are distributed uniformly between 0 and 200 inclusive: **G** ~ U(0, 200). The parameter k = 0.5, 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:

$S^*(v_s) = 2/3\ v_s + 50$ if $0 \leq v_s \leq 100$ (1)

And for the buyer:

$B^*(v_b) = v_b$ if $0 \leq v_b \leq 50$ (2)

$B^*(v_b) = 2/3\ v_b + 50/3$ if $50 < v_b \leq 150$ (3)

$B^*(v_b) = 350/3$ if $150 < v_b \leq 200$ (4)

Figure 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 gray diagonal line.

--INSERT FIGURE 1 ABOUT HERE --

When the bargaining situation is augmented with the Brams-Kilgour trade bonus refinement and $\boldsymbol{R}=(b+s)/2$, 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 $v_b \geq 100$, any offer $100 \geq b \geq 200$) 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 $v_s \geq v_b$) 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 positive 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-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 <u>no effect</u> on his earnings, other than determining whether or not a deal is made (see the Appendixes for the experimental instructions). 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 minutes. 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 Procedure

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

[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.

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 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 earning in the Full Bonus conditions. Appendix B presents the experimental instructions for the Parco-Rapoport Full Bonus condition. The important aspect here is how the payoff function was framed to the participants. Although the description of the payoff function in the Parco-Rapoport study was both technically correct and consistent with their control condition in which no bonus was paid (See Appendix A), 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 Parco-Rapoport study below (see Appendix B for the entire set of instructions):

contract price = (buyer's offer + seller's offer)/2

Buyer's earnings = (buyer's reservation value - contract price) + (buyer's offer – seller's offer)/2
Seller's earnings = (contract price - seller's reservation value) + (buyer's offer – seller's offer)/2

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 of the payoff function as:

Buyer's earnings = Buyer's reservation value – Seller's offer
Seller's earnings = Buyer's offer – 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.

Based on the discussion above and inspection of the subject instructions (Appendixes B and C), 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 <u>no effect</u> on the subsequent earnings from that particular round for the subject, but would only affect the other subject's earnings.

4. Results

4.1 Aggregate 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.

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.[4] 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.

--INSERT FIGURE 2 ABOUT HERE --

--INSERT FIGURE 3 ABOUT HERE --

3.4 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 and Rapoport, 2004) are presented in Figures 2 and 3 for buyers and sellers 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

[4] Parametric tests (one-way ANOVA with post-hoc comparisons yielded consistent results with the non-parametric test results reported above.

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 Figure 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 β_s, the upper limit of the seller's distribution, F. When $v_b > \beta_s$, the buyer could bid any amount up to β_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 $0 \leq v_b \leq \beta_s = 100$. 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 Figure 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 et al., 2001; Parco and Rapoport, 2004).

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(***G***), there is stronger evidence with data from Subject 42 to bid at max(***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 $b > v_b$.[5] 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 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 $b \geq 100$ 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

[5] 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.

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 (Figure 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 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.

--INSERT FIGURE 4 ABOUT HERE --

--INSERT FIGURE 5 ABOUT HERE --

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 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.

3.5 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.

--INSERT TABLE 1 ABOUT HERE --

Figure 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 β_s.[6]

--INSERT FIGURE 6 ABOUT HERE --

3.6 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 $v_b \geq v_s$ 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

[6] 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.

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.

--INSERT TABLE 2 ABOUT HERE --

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.

--INSERT TABLE 3 ABOUT HERE --

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)[7] denote the 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

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

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.

3.7 Theoretical Simulation Analysis

Although mutual truthful revelation is not a dominant strategy in the NB condition, it is the Pareto efficient outcome given the assumption of interim individual rationality. In the FB and RFB conditions, mutual truth-telling becomes the Bayesian-Nash (albeit Pareto deficient) equilibrium. With the unique full bonus implemented to theoretically induce truthful revelation, only a collusion equilibrium achieves Pareto efficiency[8]. Table 5 reports the earnings of the subjects in each bonus condition as well as simulated earnings[9] in a format similar to that reported in Table 4. Observed behavior (A-A) and mutual truth-telling (T-T) for the NB, FB and RFB conditions where the Pareto-efficient strategy was C-C and the Bayesian-Nash strategy was T-T. T-T strictly dominates all strategies except for C-C. Additionally, T-A strictly dominates all A-A strategies demonstrating the unilateral deviation away from truth-telling was detrimental to the deviating player. Playing a collusion strategy against actual opponent play would have reduced earnings of all players with the exception of Buyer 9 in the Full Bonus condition. Because Buyer 9 engaged in such aggressive strategic behavior, the losses due to missed deals and consequently missed bonuses were greater than any losses incurred by bidding 200 each trial.

--INSERT TABLE 4 ABOUT HERE --

[8] See Parco and Rapoport (2004) for a theoretical discussion of the collusion equilibrium.

[9] The "simulation" referred to for both the deals-made and earnings results are computed by pitting hypothetical offers against one another for the actual reservation values of each pairing to ascertain "what would have been."

--INSERT TABLE 5 ABOUT HERE –

The lower part of Table 5 lists the observed combined payoff for all buyers and sellers including the bonus (row 1), and the corresponding values under truthful revelation (row 2). The efficiency measures of achieving the players' potential combined payoffs are presented in row 3. Although aggregate earnings increased monotonically with the value of the bonus in conditions NB and FB, the efficiency measure actually decreased from 86.2% in condition NB and 66.9% in condition FB. Although efficiency under condition RFB increased dramatically, illustrating the framing effect of the full bonus, it was still 20% less than the LES predicted outcome (truthful revelation).

Figure 7 illustrates the running average (over steps of 10) mean squared deviation (MSD) between reservation values and offers for both player types. The graphs illustrate that the buyers generally demonstrated a stronger propensity to shave than the sellers in all conditions. The results illustrate a propensity to bid more truthfully not only with the implementation of the unique full bonus, but also when the full bonus is reframed. Furthermore, in both the FB and RFB conditions, learning is evident for both buyers and sellers as the MSD decreases over time.

--INSERT FIGURE 7 ABOUT HERE --

3.8 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 6 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.

--INSERT TABLE 6 ABOUT HERE –

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 7a shows the results of the spline model for Block 1 and Table 7b for Block 2. Table 7c 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

--INSERT TABLE 7 ABOUT HERE --

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.

3.9 Dynamics

In the previous sections the LES served as a static benchmark model to which behavior was compared. Of course, subjects do not compute Bayesian Nash equilibria—whether a bonus is introduced or not—and their behavior during the course of the experiment may not correspond to any theoretical normative solution at all. When the stage game is iterated in time, as in the present study, subjects may experience the mechanism, gather information about the behavior of their co-bargainers, and adjust their behavior. The previous analyses have combined the results across all 50 trials. In this section, a learning model is tested that was first proposed by Daniel et al. (1998), and subsequently tested by Rapoport et al. (1998) and Seale et al. (2001), to explain the process by which the strategies of the buyers and sellers evolve over iterations of the game.

There are two main reasons to focus on testing a single model, rather than proceed with the more desirable method of competitively testing alternative models. First, in contrast to many models of learning in interactive decision-making, the focus of the present model is on individual not aggregate behavior, and the goal is to account for round-to-round changes in the behavior of individual buyers and sellers. Second, the adaptive reinforcement-based learning model accounts naturally for continuous strategy spaces. In contrast, the aforementioned models assume a discrete strategy space with relatively small number of elements. The only way they can handle continuous strategy spaces is by dividing them—quite arbitrarily—into mutually exclusive categories.

The present model makes minimal demands on the rationality of the players. Consistent with the basic principles of learning, particularly with the well-documented effects of reinforcement, it assumes that the subject—buyer or seller—remembers what worked well (poorly) for him in the past and then repeats it more (or less) in the future. The buyer's bid on round t is assumed to be determined by a *bid function* of the form:

$$b_t = \min\{v_{b,t}, y_{t-1}[1 - e\exp(-v_{b,t}/y_{t-1})]\},$$

where $v_{b,t}$ is the buyer's reservation value on round t, b_t is his bid on round t, and y_t is a free parameter that determines the shape of the exponential bid function at round t. Smaller values of y_t result in more aggressive bids. Thus, the buyer's strategy space is represented by a one-parameter family of exponential functions that lie below the 45-degree line that corresponds to truthful revelation. Although this family does not account for the piecewise linear LES function, a close approximation may be achieved with appropriate choice of the value of y_t. The learning model can not account for collusive bidding, namely for $b_t > v_{b,t}$.

The model assumes that the value of y_t (and, consequently, the shape of the bid function) may change from round to round as a function of the previous outcome. The equations governing the motion of y_t are given by:

$$y_t = \quad y_{t-1}[1 - w_{y,t}^{+}(v_{b,t} - p_t)], \qquad \text{if } b_{t-1} \geq s_{t-1}$$

$$y_t = \quad y_{t-1}\{\max[1, 1 + w_{y,t}^{-}(v_{b,t} - s_t)]\}, \qquad \text{if } b_{t-1} < s_{t-1}$$

where $w_{y,t}^{+} = (1-\delta_b)w_{y,t-1}^{+}$, $w_{y,t}^{-} = (1-\delta_b)w_{y,t-1}^{-}$, and $0 \leq \delta_b \leq 1$. The two parameters w^{+} and w^{-} affect the changes due to an agreement or no agreement reached on the previous round, and the parameter δ_b governs the depreciation of the effect of these two parameters over time. The discounting of the effects of w^{+} and w^{-} implies that the bid function will converge. The top motion equation is rather straightforward: if a deal is reached on round t-1, then realizing that he could have made more money the buyer will bid more aggressively on round t. The bottom motion equation covers two contingencies. If the buyer bids below the seller's offer on round t-1, then y_t is adjusted upwards (resulting in less aggressive bidding) in proportion to the payoff that the buyer could have made had he correctly forecast the seller's offer. But if no deal occurred because the seller's offer exceeded the buyer's reservation value, then the buyer has no reason to change his bid function.

The learning model for the seller assumes a similar form. The seller's offer at round t is determined by an *offer function* that has the form

$$s_t = \max\{v_{s,t}, \beta_b - z_{t-1}[1-\exp[-(\beta_b - v_{s,t})/z_{t-1}]]\}$$

where $v_{s,t}$ is the seller's reservation value at round t, s_t is her offer at the same round, and z_t is a free parameter. As with the buyer, successful or unsuccessful deals on round t-1 control the change in the parameter z_t, and consequently the shape of the offer function on round t. The motion equations for the seller have the form

$$z_t = \quad z_{t-1}(1-w_{z,t}^{+}(p_t - v_{s,t})], \qquad \text{if } b_t \geq s_t$$

$$z_t = \quad z_{t-1}[\max[1, 1+w_{z,t}^{-}(b_t - v_{s,t})], \qquad \text{if } b_t < s_t$$

where $w_{z,t}^{+}=(1-\delta_s)w_{z,t-1}^{+}$, $w_{z,t}^{-}=(1-\delta_s)w_{z,t-1}^{-}$, and $0 \leq \beta_s \leq 1$. The interpretation of these equations is the same as for the buyer.

The four parameter values were estimated separately for each buyer and seller. They were estimated so as to maximize the squared correlation, R^2, between the observed and predicted bids/offers in round 1-30. Then, the fitted model was tested for each subject separately on the data in the remaining out-of-sample trials (31-50). In addition to the value of R^2, the root mean square error (RMSE) was also computed between observed and predicted bids/offers for both the in-sample and out-of-sample data. Table 8 presents the medians of these two measures of goodness of fit as well as the medians of the model parameters. The results for buyers and sellers are shown separately.

Table 8 shows that for the NB, FB and RFB conditions, $w_{t=1}^{-} > w_{t=1}^{+}$. Foregone gains from trade had a stronger effect on the bid/offer functions than actual gains, with both sellers and buyers becoming slightly less aggressive with experience. Indeed, we see very little evidence for more aggressive bids and offers after a successful trade. Table 8 also shows that $\delta_z > \delta_y$, indicating a higher rate of learning for sellers than buyers in each of the conditions. A faster rate of learning was also observed for both buyers and sellers when a positive bonus was introduced than when the bonus value was set to zero in condition NB. The mean R^2 values are seen to be approximately the same for both the in-sample and out-of-sample bids and offers, and they are consistently higher for buyers than sellers. The medians of the two measures of goodness of fit, R^2 and RMSE, are slightly better than those reported by previous studies (Daniel et al, 1998), thereby validating the learning model with a new set of data. Of particular interest are the values of the parameters $y_{t=1}$ and $z_{t=1}$ of the bid and offer functions at round $t = 1$ just before the first round of play. As reported by Parco and Rapoport (2004), the individual differences in these two parameters are substantial, suggesting that different subjects approached the bargaining game with considerably different propensities to exaggerate their bids and offers. However, on average, we observe only minor differences in the medians of the prior propensities between conditions NB and FB. The effect of framing the full bonus by conditioning each trader's payoff on the bid/offer made by his co-bargainer is to change the original propensities of both buyers and sellers in the direction truthful revelation.

--INSERT TABLE 8 ABOUT HERE --

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.

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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APPENDIX A. INSTRUCTIONS, NO BONUS CONDITION

This study investigates bargaining between a buyer and seller. If you make good decisions, you may earn a considerable amount of money. The money you earn will be paid to you in cash at the end of the session.

In case you have any questions while reading the instructions, please raise your hand and the supervisor will come to help you.

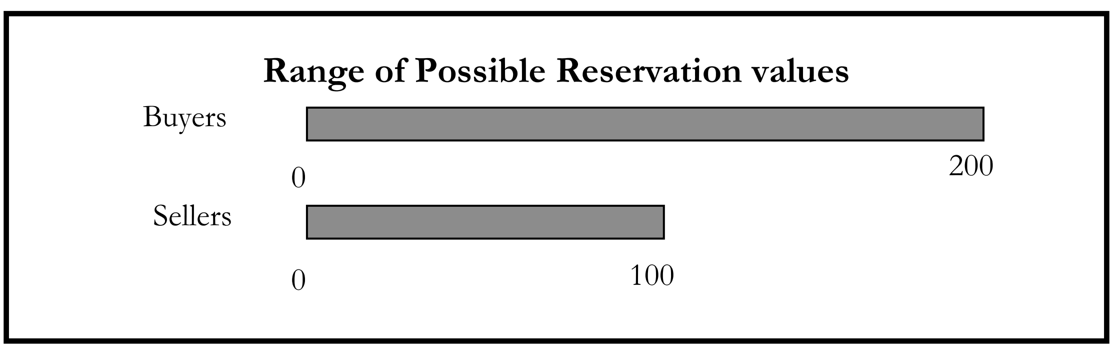
<u>Description of the task</u>

Before the session begins, the subjects in the Laboratory will be divided randomly into two equal size groups of Buyers and Sellers.

You will participate in 50 trials. On each trial, a Buyer and a Seller will be randomly paired, and will bargain on the price of an unspecified object. Since you will communicate with each other via the computer, you will not know your co-bargainer's identity nor will he know yours. You will play the same role (either a Buyer or Seller) on all trials. However, the identity of your co-bargainer will change randomly from trial to trial.

At the beginning of each trial the computer will display your <u>reservation value</u> for the object. The reservation value represents how much the object is worth to you on this trial. It will change from trial to trial.

Reservation values are determined randomly before each trial. For Buyers, reservation values will range from 0 to 200, with each value in this range equally likely. For Sellers they will range from 0 to 100, with each value in this range equally likely. The ranges will be shown graphically on the computer screen before each bargain begins (see the display below). On each trial, you will know your own reservation value (assigned to you by the computer) but not the exact reservation value of your co-bargainer (you will only know that it is equally likely to be within a certain range).



How do you bargain on the price?

After the computer displays your reservation value, you will have an opportunity to submit a bid (Buyer) or an ask (Seller) for the object. If you are the Buyer, your bid price represents the price you propose to pay for the object, and if you are the Seller, your ask price represents the price you propose to accept for the object.

- If the Seller's ask price is higher than the Buyer's bid price, then no deal is struck and you end this trial in disagreement.

- If the Seller's ask price is equal to or lower than the Buyer's bid price, then a deal is struck and you end this trial in an agreement. The contract price in this case is computed to be halfway between the buyer's bid and the seller's ask prices:

contract price = (buyer's bid price + seller's ask price)/2

Note that on each trial, the buyer and the seller make only a single offer (bid price or ask price). These offers determine whether an agreement is reached, and if so at what contract price. There are no second or third rounds of bidding on any particular trial.

How are your earnings determined on each trial?

- If the trial ends in disagreement (because the Seller's ask price exceeds the Buyer's bid price), then you will earn nothing for this trial.

- If the trial ends in agreement (because the Seller's ask price is equal to or lower than the Buyer's bid price), then your earnings will be computed as follows

Buyer's earnings = (Buyer's reservation value - contract price)

Seller's earnings = (contract price - Seller's reservation value)

For the Buyer, her payoff is the difference between her valuation of the object and the contract price. For the Seller, his payoff is the difference between the contract price and his valuation of the same object.

The following example illustrates the computations:

Suppose the Buyer is assigned a reservation value of 110, and the Seller is assigned a reservation value of 65. If the Buyer bids 90 and the seller asks 80, then an agreement is reached at a contract price of 85 ((90 + 80)/2). Using the formulas given above, the earnings are calculated to be:

Buyer's earnings = (110 - 85) = 25

Seller's earnings = (85 - 65) = 20

Please note the following. If the Buyer, in an effort to increase her payoff, decides to lower her bid price from 90 to 80, while the Seller with a similar motivation to increase his payoff, changes his ask price from 80 to 85, then no deal is struck (because the Buyer's bid price is less than the Seller's ask price), and both players will earn nothing on this trial. Hence, a tradeoff exists for both the Buyer and the Seller. The more money they try to earn by decreasing their bid price (Buyer) or increasing their ask price (Seller), the more likely it is that no agreement will be reached. The key uncertainty is that each player does not know the reservation value of the other. The traders only know the range from which these prices are randomly selected.

Procedure

You will play a total of 50 trials. Each trial follows the same sequence: First, the computer will randomly match you with another trader of the opposite type, and will display your reservation value for the object (you will not know your co-bargainer's reservation value, only that it is equally likely to be within a certain range). Next, you will be asked to submit your bid price (Buyer) or ask price (Seller). After both bargainers submit their offers, the computer will inform you of your co-bargainer's offer, and calculate your payoff if an agreement is reached. If an agreement is not reached, your payoff on this trial is zero. After you review your payoffs, you will move to the next trial, if it is not the last one.

Payment at the end of the session

At the end of the session, the computer will sum up all your earnings from the 50 trials. The supervisor will pay you in cash this amount divided by 100.

Please raise your hand to indicate to the supervisor that you have completed reading the instructions. The supervisor will then set your computer for the game. Please be patient; the game will start when everyone is ready.

APPENDIX B. INSTRUCTIONS, FULL BONUS CONDITION

This study investigates bargaining between a buyer and seller. If you make good decisions, you may earn a considerable amount of money. The money you earn will be paid to you in cash at the end of the session.

In case you have any questions after reading the instructions, please raise your hand and the supervisor will come to answer them.

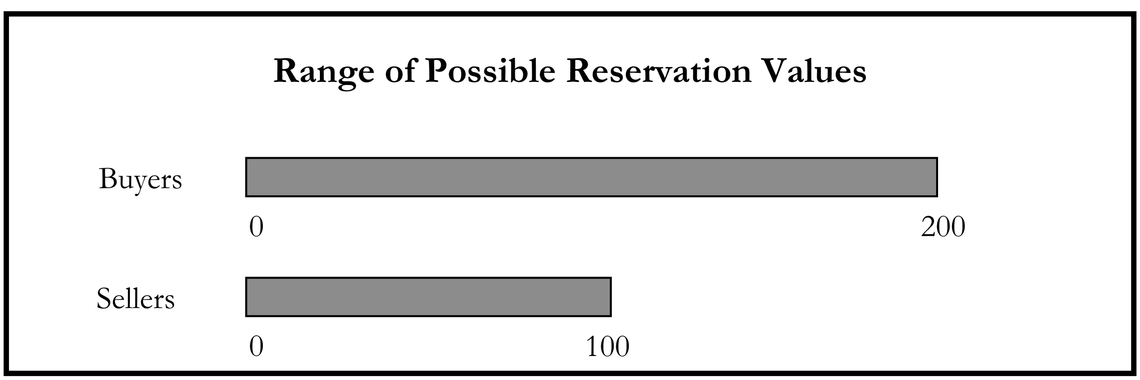
<u>Description of the task</u>

Before the session begins, the subjects in the laboratory will be divided randomly into two equal size groups of buyers and sellers.

You will participate in 50 trials. On each trial, a buyer and a seller will be randomly paired, and will bargain on the price of an unspecified object. Since you will communicate with each other via the computer, you will not know your co-bargainer's identity nor will he or she know yours. You will play the same role (either a buyer or seller) on all 50 trials. However, the identity of your co-bargainer will be changed randomly from trial to trial.

At the beginning of each trial the computer will display your <u>reservation value</u> for the object. The reservation value represents how much the object is worth to you on this trial. If you are the buyer, the reservation value is the most you are willing to bid for it. If you are the seller, your reservation value is the least you are willing to ask for it.

Reservation values are determined randomly before each trial. For buyers, reservation values will range from 0 to 200, with each value in this range equally likely. For sellers, they will range from 0 to 100, with each value in this range equally likely. The ranges will be shown graphically on the computer screen before each bargain begins (see the display below). On each trial, you will know your own reservation value (assigned to you by the computer) but not the reservation value of your co-bargainer (his or her reservation value will be drawn from the range below).



How do you bargain on the price?

After the computer displays your reservation value, you will have an opportunity to submit an offer to buy (buyer) or an offer to sell (seller) the object. If you are the buyer, your offer represents the price you propose to pay for the object, and if you are the seller, your offer represents the price you propose to accept for the object.

- If the seller's offer is higher than the buyer's offer, then no deal will be struck and you will end this trial in disagreement.

- If the seller's offer is equal to or lower than the buyer's offer, then a deal will be struck and you will end this trial in an agreement. The contract price in this case is computed to be halfway between the buyer's offer and the seller's offer:

contract price = (buyer's offer + seller's offer)/2

Note that on each trial, the buyer and the seller make only a single offer (offer to buy by the buyer or offer to sell by the seller). These two offers determine whether an agreement is reached, and if so the contract price. There are no second or third rounds of bargaining on any trial.

How are your earnings determined on each trial?

- 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:

Buyer's earnings = (buyer's reservation value - contract price) + (buyer's offer – seller's offer)/2
Seller's earnings = (contract price - seller's reservation value) + (buyer's offer – 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:

Buyer's earnings = (110 - 85) + (90 – 80)/2 = 25 + 5 = 30

Seller's earnings = (85 - 65) + (90 – 80)/2 = 20 + 5 = 25

Please note the following. In the previous example, if the buyer (in an effort to increase her payoff) decreases her offer from 90 to 80, while the seller (with a similar motivation to increase his payoff) increases his offer from 80 to 85, then no deal is struck (because the buyer's offer is less than the seller's offer). In this case, both players will earn nothing on this trial. Hence, a tradeoff exists for both the buyer and seller. The more money each tries to earn by decreasing his or her offer to buy (buyer) or increasing his or her offer to sell (seller), the more likely it is that no agreement will be reached. The key uncertainty is that each player does not know the reservation value of the other. The traders only know the range from which these values are randomly drawn. Note, too, that a buyer can lose money if her offer to buy is above her reservation value. Similarly, it is possible for a seller to lose money if his offer to sell is below his reservation value. Otherwise, no trader can lose money.

Procedure

You will play a total of 50 trials. Each trial follows the same sequence. First, the computer will randomly match you with another trader of the opposite type, and will display your reservation value for the object. (Remember that you will not know your co-bargainer's reservation value, only that it is equally likely to be within a certain range.) Next, you will be asked to submit your offer. After all the bargainers submit their offers, the computer will inform you of your co-bargainer's offer, and calculate your payoff if an agreement is reached. If an agreement is not reached, your payoff for this trial will be zero. After you review your payoffs, you will move to the next trial, if it is not the last in the sequence.

Payment at the end of the session

At the end of the session, the computer will sum up all your earnings in francs from the 50 trials. The supervisor will then pay you in cash this amount divided by 100.

Please look up to indicate to the supervisor that you have completed reading the instructions. We will start the experiment in just a few minutes.

Appendix C. Instructions, “Reframed” Full Bonus Condition

This study investigates bargaining between a buyer and seller. If you make good decisions, you may earn a considerable amount of money. Your earnings will be converted into dollars and paid to you in cash immediately after the experiment.

In case you have any questions after reading the instructions, please raise your hand and the supervisor will come to answer them.

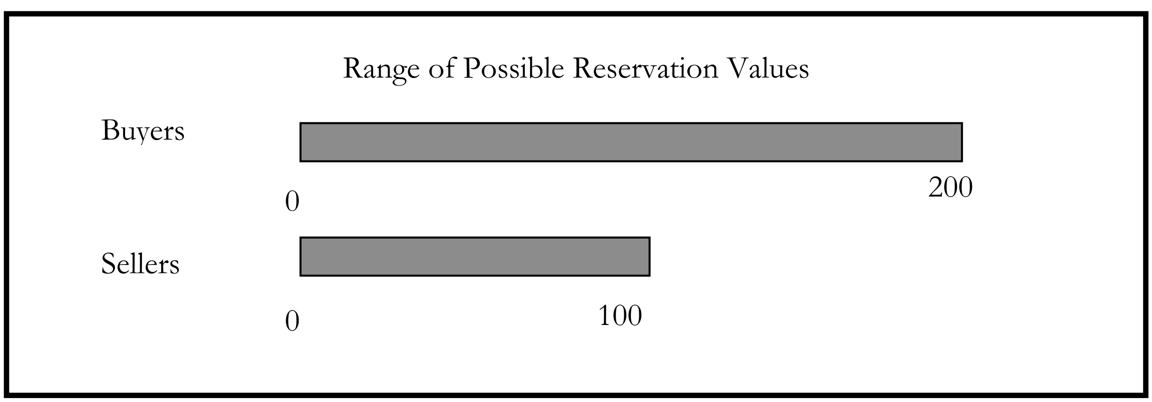
Description of the task

Before the session begins, the subjects in the laboratory will be divided randomly into two equal size groups of buyers and sellers. Once you are assigned a particular role, you will maintain this role throughout the duration of the experiment.

You will participate in 50 trials. On each trial, a buyer and a seller will be randomly paired, and will bargain on the price of an unspecified object. Since you will communicate with each other via the computer, you will not know your co-bargainer’s identity nor will he or she know yours. However, the identity of your co-bargainer will be changed randomly from trial to trial.

At the beginning of each trial the computer will display your reservation value for the object. The reservation value represents how much the object is worth to you on this trial. If you are the buyer, the reservation value is the most you are willing to bid for it. If you are the seller, your reservation value is the least you are willing to ask for it.

Reservation values are determined randomly before each trial. For buyers, reservation values will range from 0 to 200, with each value in this range equally likely. For sellers, they will range from 0 to 100, with each value in this range equally likely. The ranges will be shown graphically on the computer screen before each bargain begins (see the display below). On each trial, you will know your own reservation value (assigned to you by the computer) but not the reservation value of your co-bargainer (his or her reservation value will be drawn from the range below).



How do you bargain on the price?

After the computer displays your reservation value, you will have an opportunity to submit an offer to buy (buyer) or an offer to sell (seller). If you are the buyer, your offer represents the price you propose to pay for the object, and if you are the seller, your offer represents the price you propose to accept for the object.

- If the seller's offer to sell is higher than the buyer's offer to buy, then no deal will be made and you will end this trial in disagreement.

- If the seller's offer to sell is equal to or lower than the buyer's offer to buy, then a deal will be made and you will end this trial in an agreement.

Note that on each trial, the buyer and the seller make only a single offer. These two offers determine whether an agreement is reached, and if so, jointly determine each other's earnings. There are no second or third rounds of bargaining on any trial.

How are your earnings determined on each trial?

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 $(90 \geq 80)$ the seller's offer. Thus, the earnings are calculated to be:

Buyer's earnings = 110 - 80 = 30

Seller's earnings = 90 - 65 = 25

Please note the following. In the previous example, if the buyer decreases her offer from 90 to 80, while the seller increases his offer from 80 to 85, then no deal is struck (because the buyer's offer is less than the seller's offer.) In this case, both players will earn nothing on this trial.

Procedure

You will play a total of 50 trials. Each trial follows the same sequence. First, the computer will randomly match you with another trader of the opposite type, and will display your reservation value for the object. (Remember that you will not know your co-bargainer's reservation value, only that it is equally likely to be within a certain range.) Next, you will be asked to submit your offer. After all the bargainers submit their offers, the computer will inform you of your co-bargainer's offer, and calculate your payoff if an agreement is reached. If an agreement is not reached, your payoff for this trial will be zero. After you review your payoffs, you will move to the next trial, if it is not the last in the sequence.

Payment at the end of the session

At the end of the session, the computer will sum up all your earnings in francs (a fictitious currency used in the experiment) from the 50 trials. The experiment supervisor will then pay you in cash this amount divided by 200.

Please look up to indicate to the supervisor that you have completed reading the instructions. We will start the experiment in just a few minutes.

Table 1

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%

Table 2

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%

Table 3

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	*na*	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	*na*	25757	38723
Percentage of overall earnings	*na*	32.7%	41.1%

Table 4

TABLE 4. Deal simulation

		No Bonus (NB)				Full Bonus (FB)				Reframed Bonus (RFB)			
Sub		*A-A*	*T-T*	*A-T*	*T-A*	*A-A*	*T-T*	*A-T*	*T-A*	*A-A*	*T-T*	*A-T*	*T-A*
1	Buyer	26	36	33	29	31	36	32	34	33	36	33	37
2	Buyer	29	36	34	32	31	36	36	35	37	36	39	34
3	Buyer	27	38	34	32	26	38	32	33	33	38	36	36
4	Buyer	25	37	35	32	33	37	36	37	33	37	32	38
5	Buyer	31	37	34	31	34	37	35	36	36	37	37	37
6	Buyer	26	40	39	34	29	40	37	33	38	40	37	38
7	Buyer	36	42	41	35	32	42	37	38	34	42	36	38
8	Buyer	30	38	34	34	29	38	30	37	34	38	38	36
9	Buyer	25	41	39	32	31	41	34	38	36	41	40	36
10	Buyer	25	36	33	32	26	36	32	32	35	36	36	37
11	Buyer	29	36	32	30	26	36	36	29	26	36	35	29
12	Buyer	25	36	35	31	28	36	35	31	33	36	37	34
13	Buyer	27	38	39	32	27	38	35	31	38	38	38	37
14	Buyer	29	37	35	31	30	37	34	34	26	37	29	35
15	Buyer	26	37	37	37	31	37	36	35	33	37	37	34
16	Buyer	26	40	39	29	32	40	40	33	35	40	39	35
17	Buyer	22	42	41	34	34	42	41	36	40	42	41	40
18	Buyer	26	38	36	32	32	38	38	32	30	38	34	34
19	Buyer	27	41	39	29	29	41	39	32	35	41	41	38
20	Buyer	27	36	32	30	33	36	36	33	32	36	33	35
21	Seller	25	34	32	32	28	34	32	30	37	34	39	32
22	Seller	27	43	38	41	38	43	43	38	42	43	43	42
23	Seller	27	36	25	33	27	36	32	32	39	36	39	33
24	Seller	27	39	39	37	33	39	38	33	34	39	38	36
25	Seller	33	38	37	38	33	38	36	38	36	38	38	37
26	Seller	26	36	31	34	30	36	33	34	33	36	33	36
27	Seller	31	35	22	33	30	35	33	32	29	35	31	34
28	Seller	34	40	37	37	25	40	33	36	35	40	38	39
29	Seller	20	38	23	34	33	38	38	34	32	38	36	35
30	Seller	30	42	39	37	25	42	35	34	32	42	32	40
31	Seller	32	34	22	31	30	34	31	33	29	34	32	31
32	Seller	33	43	39	42	42	43	43	40	30	43	34	40
33	Seller	28	36	16	36	28	36	29	34	35	36	36	35
34	Seller	23	39	31	37	33	39	34	39	37	39	38	38
35	Seller	29	38	38	37	30	38	34	37	35	38	38	35
36	Seller	19	36	30	33	26	36	27	35	34	36	36	35
37	Seller	19	35	35	33	31	35	32	35	25	35	26	35
38	Seller	29	40	38	39	29	40	32	39	38	40	40	40
39	Seller	22	38	33	38	28	38	33	37	35	38	37	35
40	Seller	30	42	33	39	25	42	31	41	30	42	34	40
Total Deals		522	762	680	680	604	762	695	695	677	762	723	723
Median (B)		26.5	37.5	35.0	32.0	31.0	37.5	36.0	33.5	34.0	37.5	37.0	36.0
Median (S)		27.5	38.0	33.0	37.0	30.0	38.0	33.0	35.0	34.5	38.0	36.5	35.5
Median		27.0	38.0	35.0	33.0	30.0	38.0	34.5	34.0	34.0	38.0	37.0	36.0
Deals Made		52.2%	76.2%	68.0%	68.0%	60.4%	76.2%	69.5%	69.5%	67.7%	76.2%	72.3%	72.3%

Table 5

TABLE 5. Earnings Simulation, All Conditions

		No Bonus					*Full Bonus*					*Reframed Bonus*				
		A-A	*T-T*	*T-A*	*C-T*	*C-A*	*A-A*	*T-T*	*T-A*	*C-T*	*C-A*	*A-A*	*T-T*	*T-A*	*C-T*	*C-A*
1	Buyer	1803	1439	1168	-1228	-1602	2495	2877	2582	2500	2099	2457	2877	2485	2500	1965
2	Buyer	1578	1390	1073	-1295	-1699	2413	2780	2427	2366	1866	2363	2780	2442	2366	1884
3	Buyer	1395	1417	1096	-1287	-1630	2140	2834	2540	2381	1929	2472	2834	2545	2381	1926
4	Buyer	1628	1458	1145	-1216	-1632	2292	2915	2528	2524	2062	2554	2915	2829	2524	2378
5	Buyer	1552	1424	1127	-1219	-1635	2383	2847	2501	2518	2087	2768	2847	2827	2518	2442
6	Buyer	1638	1517	1125	-1062	-1615	2490	3033	2605	2832	2247	2786	3033	2786	2832	2518
7	Buyer	1400	1481	1125	-1164	-1618	2232	2962	2521	2627	2102	2544	2962	2577	2627	2120
8	Buyer	1452	1570	1231	-1098	-1596	2560	3139	2802	2759	2156	2828	3139	2834	2759	2407
9	Buyer	1647	1533	1194	-1068	-1512	2300	3065	2663	2819	2302	2680	3065	2680	2819	2344
10	Buyer	1743	1495	1207	-1156	-1568	2170	2989	2462	2644	2014	2822	2989	2936	2644	2499
11	Buyer	1474	1439	944	-1228	-1780	1962	2877	1991	2500	1378	2299	2877	2343	2500	1620
12	Buyer	1444	1390	1038	-1295	-1857	2121	2780	2136	2366	1443	2169	2780	2206	2366	1567
13	Buyer	1105	1417	890	-1287	-1998	1709	2834	1989	2381	1255	2382	2834	2406	2381	1869
14	Buyer	1195	1458	1123	-1216	-1721	2173	2915	2332	2524	1773	2140	2915	2467	2524	1854
15	Buyer	1521	1424	1068	-1219	-1714	2029	2847	2178	2518	1740	2610	2847	2621	2518	1914
16	Buyer	1388	1517	1046	-1062	-1724	2194	3033	2204	2832	1747	2691	3033	2691	2832	2256
17	Buyer	1227	1481	967	-1164	-1827	2077	2962	2106	2627	1603	2439	2962	2439	2627	2027
18	Buyer	1470	1570	1024	-1098	-1797	2319	3139	2319	2759	1629	2527	3139	2589	2759	2058
19	Buyer	1669	1533	1108	-1068	-1685	2281	3065	2468	2819	1854	2246	3065	2387	2819	1892
20	Buyer	1738	1495	1132	-1156	-1762	2425	2989	2425	2644	1799	2450	2989	2517	2644	1975
21	Seller	960	1259	745	-202	-772	1390	2518	1413	1995	757	1846	2518	1910	1995	1309
22	Seller	1139	1727	825	413	-535	1646	3454	1646	3223	1328	2277	3454	2277	3223	2041
23	Seller	930	1365	753	-26	-720	1340	2729	1355	2347	874	1818	2729	2052	2347	1553
24	Seller	1014	1540	798	196	-609	1433	3080	1559	2789	1104	2219	3080	2262	2789	1871
25	Seller	1039	1600	895	245	-492	1503	3199	1641	2887	1281	2189	3199	2201	2887	1825
26	Seller	919	1490	780	85	-660	1615	2980	1657	2567	1171	2384	2980	2388	2567	1931
27	Seller	991	1537	859	136	-564	1459	3073	1468	2670	961	2320	3073	2370	2670	1919
28	Seller	906	1249	741	-147	-652	898	2497	1300	2104	836	1756	2497	1776	2104	1423
29	Seller	1041	1366	809	25	-591	1280	2732	1284	2447	891	2137	2732	2198	2447	1890
30	Seller	1089	1580	929	262	-456	1320	3159	1483	2921	1142	2207	3159	2391	2921	2127
31	Seller	838	1259	823	-202	-701	2072	2518	2083	1995	1504	2059	2518	2065	1995	1472
32	Seller	1117	1727	952	413	-366	2222	3454	2226	3223	1982	2414	3454	2651	3223	2371
33	Seller	978	1365	825	-26	-595	1746	2729	1772	2347	1355	2079	2729	2219	2347	1761
34	Seller	1207	1540	923	196	-457	2048	3080	2113	2789	1802	2242	3080	2251	2789	1933
35	Seller	1237	1600	926	245	-458	2051	3199	2199	2887	1868	2579	3199	2579	2887	2159
36	Seller	1083	1490	901	85	-531	2213	2980	2385	2567	1938	2533	2980	2545	2567	2116
37	Seller	913	1537	746	136	-706	2260	3073	2289	2670	1841	2387	3073	2657	2670	2241
38	Seller	997	1249	787	-147	-655	1437	2497	1680	2104	1279	2020	2497	2039	2104	1638
39	Seller	1080	1366	778	25	-590	2081	2732	2208	2447	1881	2251	2732	2251	2447	1918
40	Seller	1197	1580	878	262	-471	1931	3159	2390	2921	2116	2359	3159	2530	2921	2216
Total	Earnings	50734	58862	38493	-21610	-45544	78710	117724	83930	103840	64996	94303	117724	97219	103840	79229
Mean	Buyer	1503	1472	1091	-1179	-1698	2238	2943	2389	2596	1854	2511	2943	2580	2596	2076
Mean	Seller	1034	1471	833	99	-579	1697	2943	1808	2596	1396	2204	2943	2281	2596	1886
Overall	Mean	1268	1472	962	-540	-1139	1968	2943	2098	2596	1625	2358	2943	2430	2596	1981

Table 6

TABLE 6. 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
<u>Predicted</u>									
θ=0 (NB)	0.67	50.0		0.67	50.0		0.67	50.0	
θ=0.50 (FB)	1.0	0		1.0	0		1.0	0	
<u>Observed</u>									
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 7

TABLE 7a. Spline Regression Results, Buyers, Block 1: Trials 1-25

	$v_b < 50$		$50 \le v_b \le 150$		$150 < v_b$		
	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	

TABLE 7b. Spline Regression Results, Buyers, Block 2: Trials 26-50

	$v_b < 50$		$50 \le v_b \le 150$		$150 < v_b$		
	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	

TABLE 7c. Spline Regression Results, Buyers, Trials 1-50

	$v_b < 50$		$50 \le v_b \le 150$		$150 < v_b$		
	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	

Note 1: *$p<0.1$, **$p<0.01$, ***$p<0.001$ testing whether the coefficient is significantly different than zero
Note 2: ## indicates insufficient data to estimate a different spline function in the particular range

Figure 1

FIGURE 1. Linear equilibrium strategy

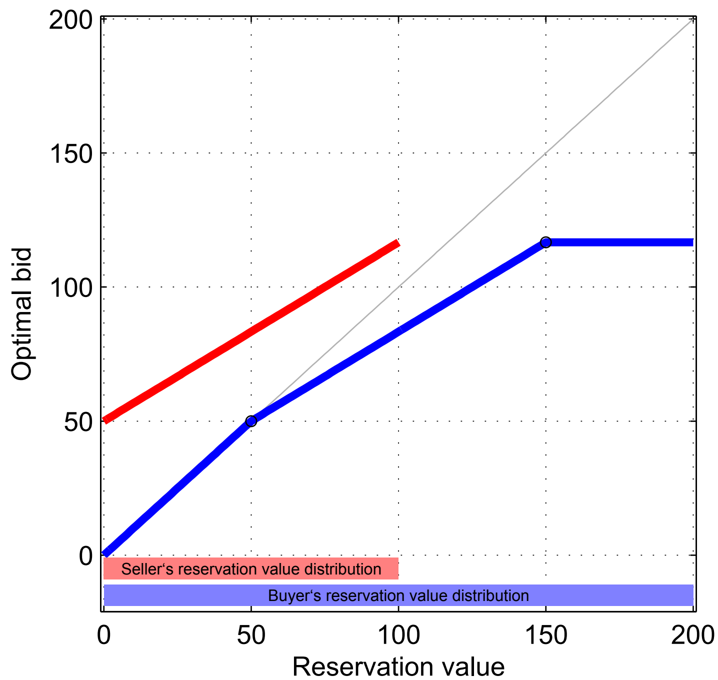


Figure 2

FIGURE 2. Full Bonus Condition, Buyers' Bids

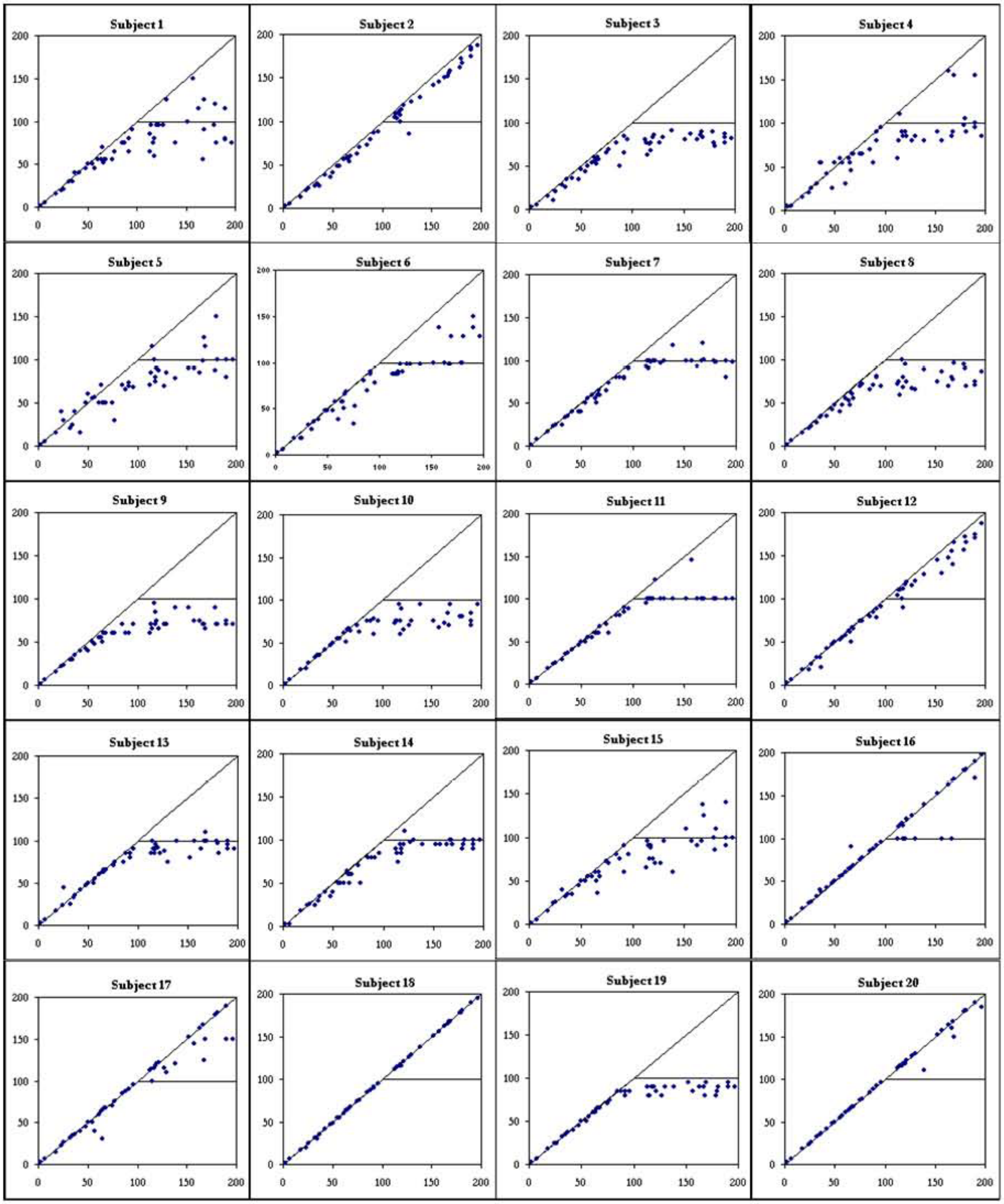


Figure 3

FIGURE 3. Full Bonus Condition, Sellers' Offers

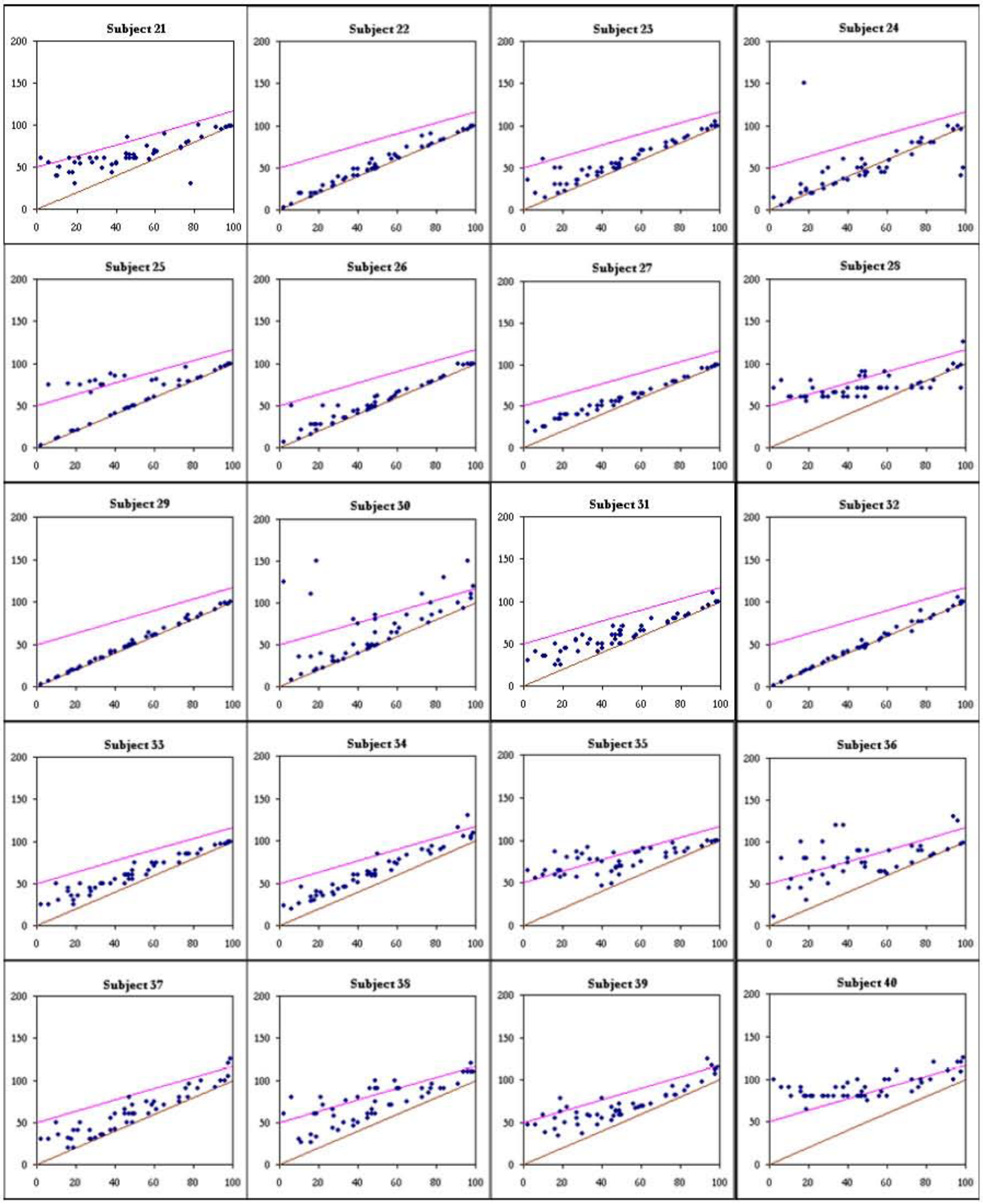


Figure 4

FIGURE 4. Reframed Full Bonus, Buyer's Offers

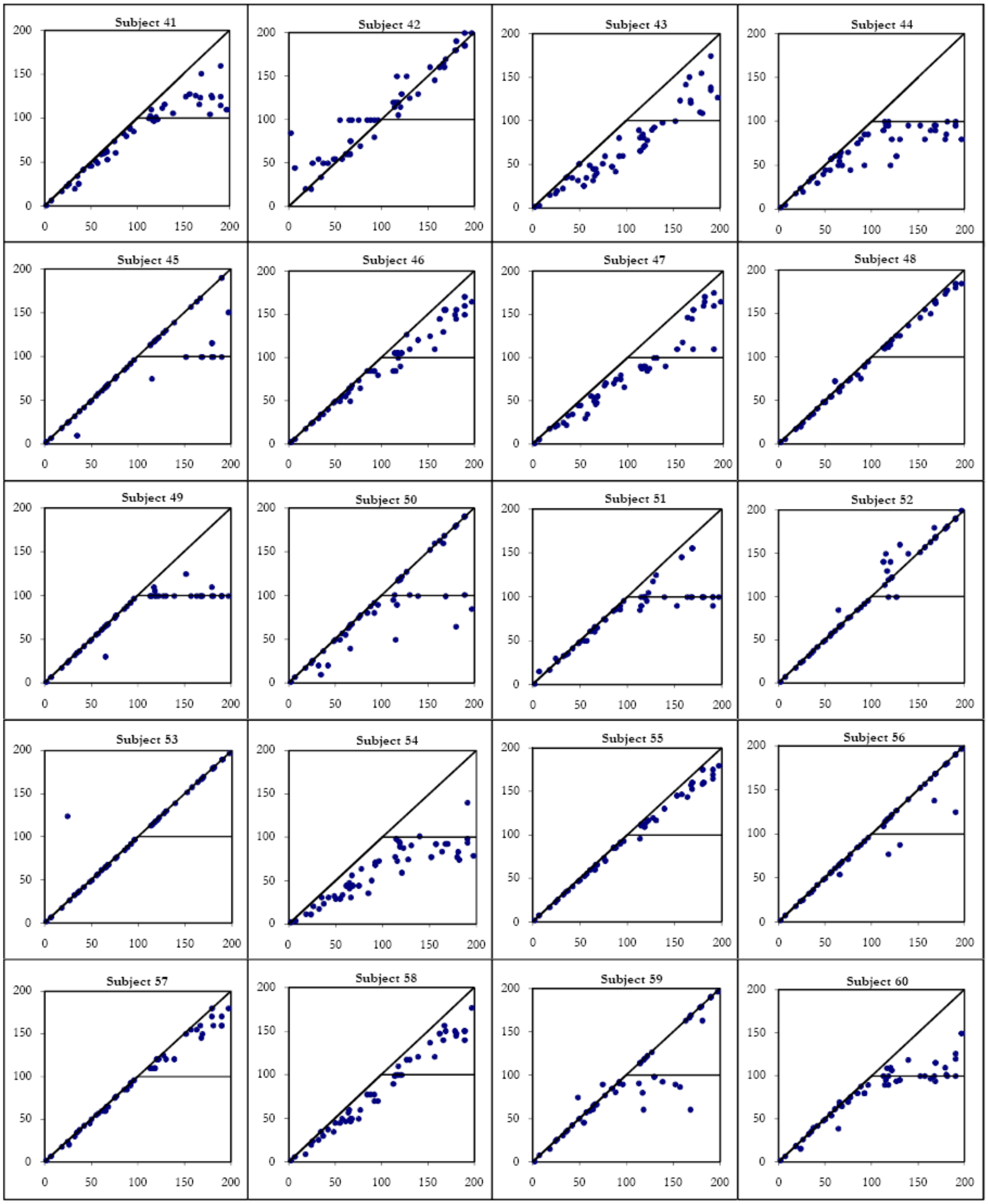


Figure 5

FIGURE 5. Reframed Full Bonus, Seller's Offers

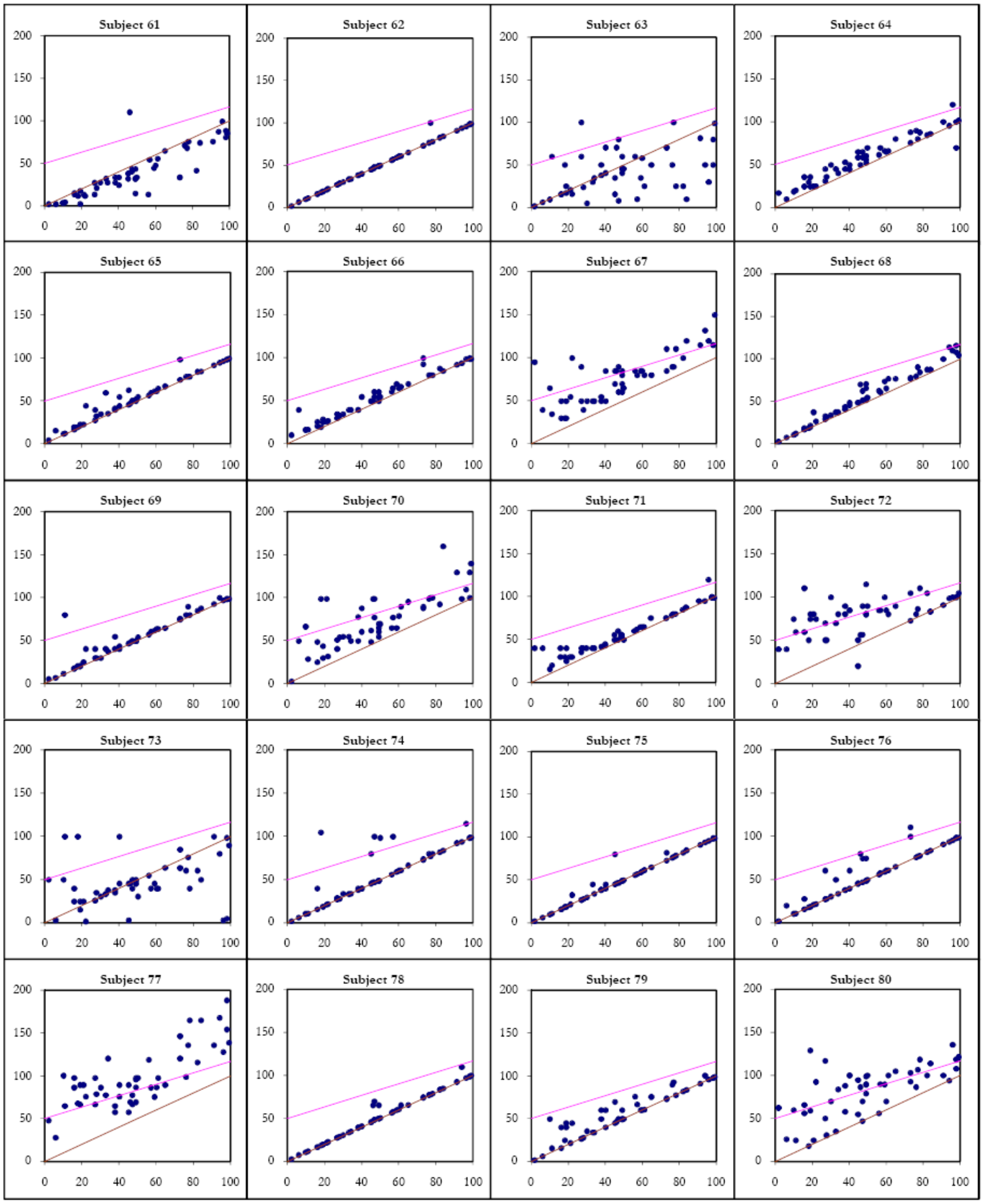


Figure 6

FIGURE 6. Regression Plots by Player Type and Condition

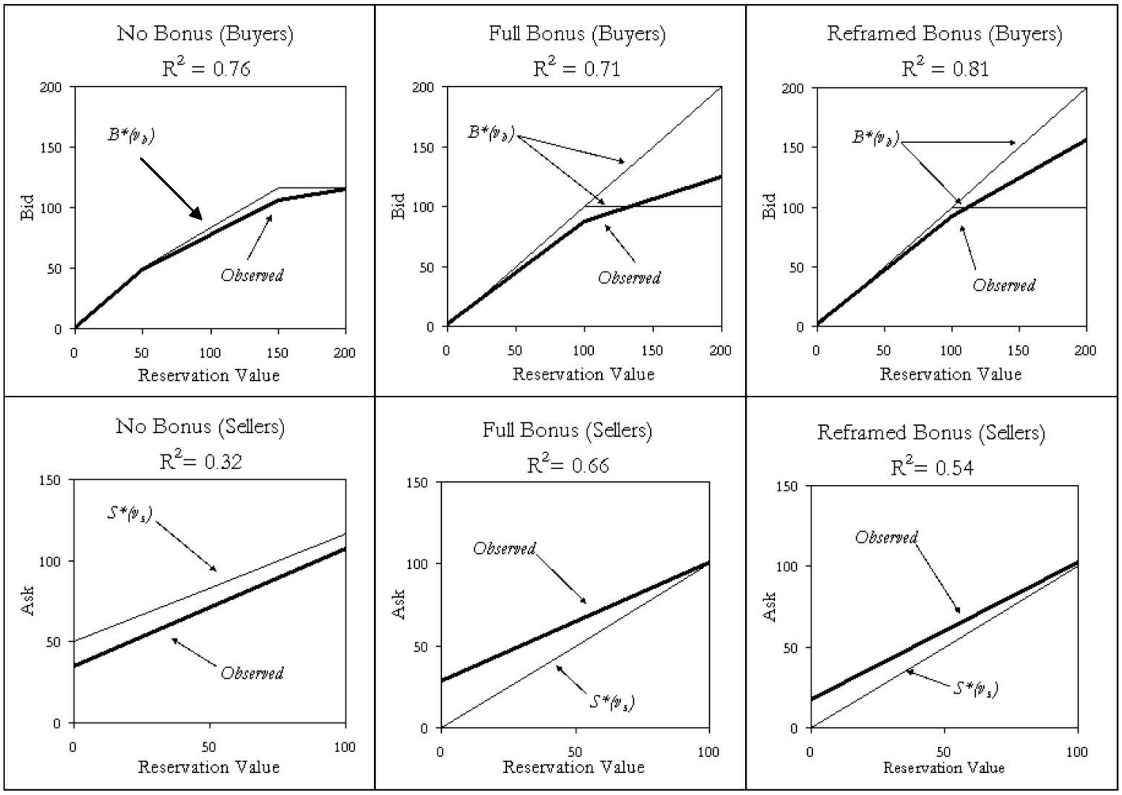


Figure 7

FIGURE 7. Mean Squared Deviation Running Average (step 10) Between Offer and Reservation Value