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ABSTRACT

This paper is about face–to–face bargaining. It attempts to shed some light on the contradictory evidence provided by laboratory face–to–face bargaining experiments and real–world data. The problem is that while face–to–face bargaining seems efficient in the lab, it appears to break down often in the real world. Our explanation for this discrepancy relies on the fact that in the real world face–to–face bargaining is usually conducted not between principals but between the agents of principals, i.e., between fiduciaries like lawyers. Hence while people meet face to face and bargain, the fact that these bargainers are acting as agents for others leads to a breakdown of efficiency. In short, the efficiency of laboratory face–to–face bargaining relative to real–world experience is not an artificial aspect of a laboratory environment, but rather a result of the fact that in the real world bargaining is often done through agents and not directly by principals. A set of experiments run to investigate this hypothesis is reported on here. We find a substantial increase in inefficiency when bargaining is conducted through agents rather than through principals and offer an explanation for this rise in inefficiency.

FACE-TO-FACE BARGAINING THROUGH AGENTS: AN EXPERIMENTAL STUDY

1. Introduction

In a recent experimental study Radner and Schotter (1989) point out that in an incomplete-information environment the efficiency of face-to-face bargaining in the laboratory appeared to be much higher than anonymous bargaining mechanisms in which bargaining is structured by having subjects play some type of non-cooperative game without direct communication. This laboratory stylized fact is born out by other studies as well. For example, in the experiments on Coasian bargaining performed by Hoffman and Spitzer (1982) and others, face-to-face bargaining seemed to be remarkably efficient in attaining first-best gains from trade while anonymous procedures like those of Roth and Murdigham (1982), where bargainers communicate in a virtually unrestricted manner through computer terminals, were less successful. These results led Radner and Schotter (1989) to comment that:

> "The success of the face-to-face mechanism, if replicated, might lead to halt in the search for better ways to structure bargaining in situations of incomplete information. It would create, however, a need for a theory of such unstructured bargaining in order to enable us to understand why the mechanism is so successful" (Radner and Schotter (1989, p.210).

The relative superiority of face-to-face bargaining in the laboratory does not seem to be supported in the field. For example, Ashenfelter and Currie (1990) report evidence that in a broad variety of situations, including private sector contracts, public sector contracts, collective bargaining agreements, medical malpractice cases, child custody cases,

etc., bargaining tends to break down and results in costly and inefficient litigation and strikes. Other investigators such as Kennan and Wilson (1990), Salop and White (1988) and Card (1990) report similar results. In all of these studies disagreement rates seem to be closer to those of the anonymous laboratory experiments than to those of the face–to–face variety.

The contradictory evidence presented by the lab and the field has led Roth and Prasnikar (1990) to examine whether the supposed superiority of face–to–face bargaining over anonymous structured bargaining was merely an experimental artifact "having to do with social interactions in the laboratory, rather than a more general phenomenon" (p.1). Roth and Prasnikar argue in particular that "the negligible frequency of disagreements observed in face–to–face bargaining experiments is due to uncontrolled social pressures that have little relation to the substance of the bargaining" (p. 11). They later note that these social pressures are transmitted between experimental subjects not only verbally but also through channels of "social" or "nonverbal communication" (p. 5).

In support of this claim, Roth and Prasnikar report the results of a study of their own in which ultimatum bargaining game experiments were conducted under three bargaining mechanisms: (1) an anonymous mechanism permitting no communication between subjects; (2) a face–to–face mechanism in which communication between subjects was restricted to social conversation with no discussion of the bargaining game allowed; and (3) a face–to–face mechanism permitting unrestricted communication. They report disagreement rates of 33% with the anonymous mechanism, 6% with the restricted face–to–face mechanism, and 4% with the unrestricted face–to–face mechanism. The 27% decline in disagreement frequency when social communication is allowed is held to support the hypothesis that "the lower disagreement frequency [in face–to–face bargaining experiments (FFBEs)] is due to social pressures arising directly from the face–to–face encounter and unrelated to what the bargainers say to each other about the bargaining" (p. 7).

In this paper we comment on this controversy. The resolution, we believe, comes from the very simple fact that while all of the field studies cited are examples of face–to–face bargaining they are also examples of face–to–face bargaining between fiduciaries (e.g., lawyers, union leaders) or agents and not between the principals themselves. It is our hypothesis here that, because such agents must act on the instructions of their principals and are constrained by their fiduciary relationships, inefficiencies result that would not result if the principals could meet by themselves. This is the common cry against lawyers that they tend to create conflict rather than solve it. In fact in a number of disputes the court has dictated that in order to facilitate agreement principals must be present at some of the negotiations between lawyers (their agents). The idea is that their presence is more likely to facilitate settlement.[1]

To test this hypothesis we ran a series of bargaining experiments in which agents, representing, respectively, the buyer and seller of an imaginary commodity, engaged in face–to–face bargaining on behalf of their principals. We refer to such experiments as *indirect* FFBEs, as distinguished from *direct* FFBEs in which bargaining is conducted directly by the principals. In one subset of the experiments, the bargaining agents were paid a percentage of the profits from any transaction; in the remaining experiments, the agents were paid a fixed fee each time they agreed on a transaction, irrespective of its terms. We find that the frequency of inefficient disagreements in face–to–face bargaining experiments (FFBEs) is non–negligible when bargaining is conducted by agents rather than directly between principal buyers and sellers. In a comparison of the results of FFBEs

[1]It should be pointed out that our hypothesis that agency leads to increases in inefficiencies is counter to the literature on complete information delegation games (see Fershtman, Judd, and Kalai (1991) and Vickers (1985))) where delegating functions to agents or managers fosters cooperation in a sense comparable to the folk theorem in repeated games. but Similar results do not carry over to incomplete information games, however, (see Polo and Tedeschi (1992)).

with and without bargaining agents we find that disagreement rates are significantly higher when bargaining is conducted through agents than in a face–to–face manner between principals and are more similar to the type of disagreement rates observed by Radner and Schotter (1989), using the sealed–bid mechanism. We interpret our results as evidence that the principals in FFBEs with agents treat the process of giving instructions to their agents as if they were making bids in an anonymous sealed–bid mechanism and, by acting strategically through their agents, distort the bargaining process between agents sufficiently to cause inefficiencies.

Section II of this paper presents the experimental design used to investigate our hypothesis. Section III presents a discussion of our results while Section IV offers a possible explanation for them. Section V offers some conclusions.

2. The Experiment and Experimental Design

The Experiment

Each experiment was run using New York University undergraduates as subjects and lasted 15 rounds. Subjects arrived in groups of four and were randomly assigned one of the four roles of seller principal, buyer principal, seller bargainer (agent) and buyer bargainer (agent) for the duration of the experiment. The principal and agent of each type (buyer and seller) were then paired for the duration of the experiment. After reading the instructions, the seller pair and buyer pair were taken to separate rooms for the first pre–negotiation phase which lasted two minutes. In the sellers' room, the cost C of the object to be transacted in the first round was randomly generated from the distribution $C = (C/100)^{0.4}$ defined over the interval [0,100]. This distribution skews the random cost realizations toward the low end of the support making it more likely that the seller will have a relatively low cost than a high cost. The seller principal then instructed the agent on the lowest acceptable price that the seller bargainer could accept in the bargaining

phase. This price limit was binding on the agent since he was penalized severely if he violated these instructions. Simultaneously, in the buyers' room, the value V for the first round was drawn from a distribution $V = 1-[(100-V)/100]^{0.4}$ defined on the interval [0,100]. This distribution skewed the random realizations for the buyer toward the upper end of the interval [0,100] making high realizations more likely than low ones. Given the two prior distributions, the existence of beneficial trade was more the rule in these experiments than the exception. The buyer principal then instructed his agent on the highest acceptable price he or she was willing to pay for the good. (These distributions were identical to the ones used by Radner and Schotter (1989) and are one representative of a one-parameter family of distributions.) Each pair was permitted to use any time remaining in the pre-negotiation phase as they wished, e.g., to discuss bargaining strategy, as long as they did not engage in threats or discussion of side payments.

After the pre-negotiation phase was over, each principal remained in his room while the two bargaining agents met in a third room for the bargaining phase. Bargainers had three minutes to agree on a price, and were permitted to bargain in any manner they wished barring physical threats, discussion of side payments or the disclosure of parameters (V, C or acceptable price limits). After the end of the bargaining phase each bargainer reported the outcome to his principal and round 2 began and was carried out in an identical manner to round 1. There were 15 rounds in each experiment.

Two sets of indirect FFBEs were conducted, one in which bargainer payoffs were calculated using a percentage-fee system, and one that used a fixed-fee system. We refer to these experiments as the *percentage-fee FFBE* and the *fixed-fee FFBE*, respectively. In the percentage-fee FFBE, the principal received 2/3 of the profits generated by the transaction for his pair and bargainers received 1/3, where the seller-pair profits were $P - C$ and the buyer-pair profits $V - P$ (P is the negotiated price). In the fixed-fee FFBE, the principal received all of the profits and the bargainer received \$1.00 for each round in

which a transaction was agreed to by the two bargainers, irrespective of the agreed–upon price. In addition, bargainers were penalized if they violated the price limits they agreed to with their respective principals; these penalties ensured that it was never in a bargainer's interest to violate his agreement with his principal. Payoffs, with the exception of the $1.00 payments to bargainers under the fixed–fee system, were denominated in "francs"; francs were converted to dollars at the rate of one franc = $.05 at the end of each experiment. In addition, each subject received a fixed payment at the end of the experiments; the fixed payments were set at levels that ensured that all four subject roles, on the average, were approximately equally remunerative. Appendix A presents the instructions for the indirect face–to–face bargaining experiments conducted here.

Experimental Design

Our experimental design is summarized in Table 1 below:

Table 1 : Experimental Design

Experiment	Type of Bargaining	Source of Data	Number of Bargaining Pairs	Number of Rounds
1)	Direct Face–to–Face	Linhart,Radner, Schotter (1990)	10	15
2)	Indirect Percentage Fee	Schotter, Snyder Zheng	10	15
3)	Indirect Fixed Fee	Schotter, Snyder, Zheng	10	15
4)	Sealed–Bid Mechanism	Linhart, Radner Schotter (1990)	10	15

Note that two of the four experiments that we will be commenting upon have been performed previously by Radner and Schotter while two have been performed to demonstrate the point being made here. We wish to make comparisons between the indirect face–to–face bargaining mechanisms run here and the direct face to face and sealed bid

experiments run by Radner and Schotter. The results of these comparisons are presented in our next section.

3: Results

The results of our two indirect FFBEs are summarized in Table 2 below. For purposes of comparison, also included in Table 2 are the results of the direct FFBE (without bargaining agents) and of the anonymous bargaining experiment employing the sealed–bid mechanism (SBM). The data for the latter two experiments are taken from Radner and Schotter (1989) and Linhart, Radner and Schotter (1990), respectively. .

TABLE 2 HERE:

We will assess and compare the performance of the four bargaining mechanisms using various measurements of *inefficiency*, or the failure to realize potential gains from trade when these potential gains are positive. The potential gains from trade for a particular round are the difference between the value V to the buyer and the cost C to the seller. Provided that the value exceeds the cost, any price P such that $C < P < V$ would generate positive profits for both parties. One way of measuring the inefficiency of a bargaining experiment is the *disagreement rate*: the ratio of the number of rounds in which no agreement was reached despite positive potential gains from trade, to the total number of rounds in which potential gains were positive. An alternative measure, which we call the *inefficiency rate*, is the ratio of the sum of unrealized positive potential gains from trade to total positive potential gains.

We begin with an examination of the disagreement rates in the two indirect FFBEs, and a comparison with the results from the direct FFBE. Table 2 indicates that the

TABLE 2: Disagreement Rates and Inefficiency Rates[1]

Experiment Type	Number of Observations	Disagreement Rate (%)			Inefficiency Frequency (%)		
		First 7 rds[2]	Last 8 rds[3]	Total	First 7 rds	Last 8 rds	Total
FBE with agents & percentage fee	150	19	14	16	8	7	7
FBE with agents & fixed fee	150	22	7	14	7	2	4
FBE without agents	150	6	6	6	1	1	1
Sealed-bid bargaining	150	25	32	30	13	14	13

Notes: 1) For the definitions of these two measures, please see the context below. The distribution functions for random value and for random cost are the same in all experiments: $1-((100-V)/100)^{0.4}$ for buyers and $(C/100)^{0.4}$ for sellers; 2) This refers to the grouping of first 7 rounds; 3) This refers to the grouping of last 8 rounds.

introduction of bargaining agents results in a sharp rise in the disagreement rate: from 6% in the direct FFBE to 16% in the percentage–fee FFBE and 14% in the fixed–fee FFBE. (Values and costs were generated by the same probability distributions in all three experiments.) A Wilcoxon test of the null hypothesis that the probability of disagreement in an indirect FFBE equals the probability in a direct FFBE, is rejected at the 5 percent level for both the percentage–fee and the fixed–fee FFBE. The 14% and 16% rates are also well above the 4% and 6% rates reported for the "ultimatum" games given in Roth and Prasnikar (1990) and for the similar face–to–face bargaining mechanisms in other studies cited there. It is interesting to note that our results for indirect FFBEs parallel the field data reported by Roth and Prasnikar (1990, p. 10) in their criticism of previous FFBEs: The 16% and 14% disagreement rates fall within the range of disagreement frequencies (11% to 49%) observed in the studies cited by them. However, the disagreement rates for the indirect FFBEs still remain well below the 30% rate observed by Radner and Schotter for experiments using the sealed–bid mechanism.

It is somewhat surprising that the percentage–fee and fixed–fee indirect bargaining mechanisms had such similar disagreement rates. Under the fixed–fee system, bargainers' payoffs are affected only by the number of transactions completed and not by the gains from trade. Thus, at least if the repeated–game elements of the experiment are ignored, the fixed–fee system creates divergent incentives for the principal and bargainer within each pair. We speculate that, in order to prevent his bargainer from being too "agreeable"–– too willing to complete a transaction at prices unfavorable to the principal––the principal would impose a more restrictive price limit than under the percentage–fee system. But the more restrictive are the price limits (the higher the lowest acceptable price, or the lower the highest acceptable price), the more difficult it is for the bargainers to conclude agreements. On balance, therefore, we expected the disagreement rate to be higher under the fixed–fee system than under the percentage–fee system. In fact, the fixed–fee

disagreement rate (16%) is slightly higher than the percentage–fee rate (14%). However, the hypothesis that the disagreement rates for both indirect FFBEs are the same cannot be rejected at any reasonable significance level.

We now turn to a consideration of the second performance measure for bargaining experiments, the inefficiency rate, or the ratio of unrealized positive potential gains to total positive potential gains. The results for all four experiments are again listed in Table 2, and parallel the comparison of disagreement rates. The introduction of bargaining agents raised the inefficiency rate from 1% in the direct FFBE to 7% and 4% in the indirect percentage–fee and fixed–fee experiments, respectively. These inefficiency rates for the indirect FFBEs are still considerably below the 13% rate reported by Radner and Schotter for the sealed–bid mechanisms.

One interesting feature of the indirect FFBEs is that the inefficiency rates vary substantially from one run of the experiment to another, ranging from 0% to 16% and from 1% to 12% under the percentage–fee and fixed–fee systems, respectively. This high variance of inefficiency, in contrast to the low variance of inefficiency observed in the direct FFBE, led us to hypothesize that inefficiency frequencies in FFBEs with agents and without agents may not come from the same population. We conducted a Kruskal–Wallis one–way test and rejected the null hypothesis, that the inefficiency rates observed in the direct and indirect FFBEs come from the same population, at a 5 percent significance level.

Variances of prices formed, by contrast, are considerably lower in the indirect FFBEs than in the direct FFBE. An interesting feature of the direct FFBE reported in Radner and Schotter (1989, p. 210) is the high variance of prices formed. But with the introduction of bargaining agents the price variance declined more than three–fold (from 546 in the direct FFBE to 160 and 158 in the percentage–fee and fixed–fee FFBEs, respectively). The range of prices formed was narrowed and the actual prices formed were more concentrated in the center of the interval. This is not very surprising when account

is taken of the price limits imposed by the principals; these limits restrict the behavior of the bargainers in such a way as to make any price in either end of the price range highly unlikely. The mean price formed centered around 50: 50.4 for the direct FFBE, 47.1 for the indirect percentage–fee FFBE, and 48.2 for the indirect fixed–fee FFBE. The histograms of negotiated prices for the three experiments are presented in Figure 1.

FIGURE 1 HERE

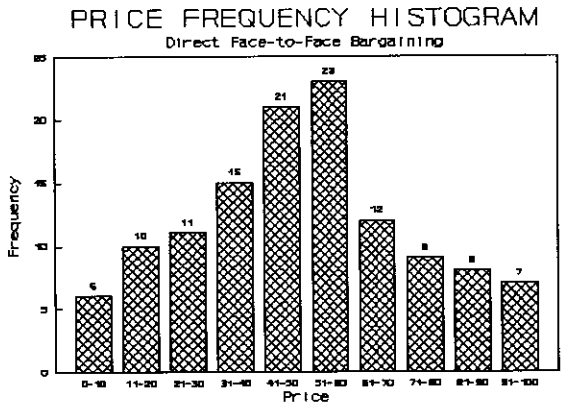
The problem of rationalizing observed inefficiency would be less serious if disagreements generally occurred only when the gains from trade were minimal. Indeed, this is the case in experiments when bargaining agents are absent. In the direct FFBE, among eight non–trade rounds in which the value for the buyer pair is larger than the cost for the seller pair, only two rounds had potential gains greater than 10; the rest had potential gains ranging only from 0.3 to 5.2. However, matters are different in the indirect FFBEs. Under each system for bargainer payoffs, most non–trade rounds had potential gains exceeding 10. The highest uncaptured gains were 60 and 39 under the percentage–fee and fixed–fee systems, respectively. Hence, while direct face–to–face bargaining fails to make beneficial trade only when the benefits of such trades are minimal, indirect face–to–face bargaining mechanisms are capable of failing even when the gains to trade are substantial.

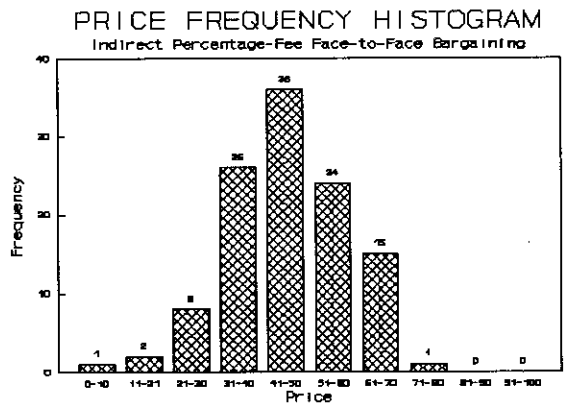
A Possible Explanation

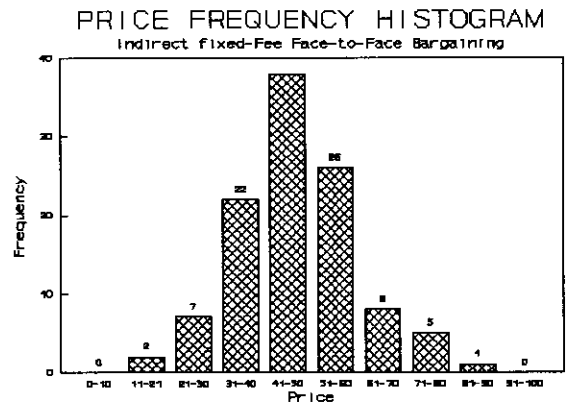
The results discussed above establish that the introduction of bargaining agents into FFBEs results in non–negligible levels of inefficiency comparable to those observed in field studies of real–world bargaining processes. They do not offer an explanation of why this occurs, however. It is our belief that the key to understanding why disagreement rates are higher for indirect FFBEs than direct ones comes from the fact that principals treat these

FIGURE 1: Histograms For Prices Formed

FIGURE 1







mechanisms as if they were sealed–bid non–cooperative mechanisms and act in a strategic manner when giving instructions to their agents on how to bargain. It is this strategizing that accounts for the higher inefficiency and disagreement rates. To understand this argument, let us quickly review the sealed–bid bargaining mechanism.

The sealed–bid mechanism

The sealed bid mechanism is a mechanism with an extremely simple structure. Assume that a potential buyer, B, and a potential seller, S, are bargaining over the terms of a possible trade of a single object. If the object is traded, the value to B is V and the cost to S is C. (The seller incurs no cost if there is no trade.) The sealed–bid mechanism works as follows: B and S simultaneously choose bids, v and c, respectively. If $v \geq c$, then the trade takes place, and B pays S the price $P = k(v) + (1-k)c$, $0 \leq k \leq 1$; i.e., the price for the good is the weighted average of the bid and ask made by the buyer and the seller. Note that the greater is k, the more influence the buyer's bid has on the determination of the price of the good given that $v \geq c$. That would imply that high k's are disadvantageous to the buyer since he or she would prefer as low a price as possible or a price as close to the seller's ask as possible. If $v < c$, then no trade takes place and B pays S nothing.

Suppose that at the time of bidding, B knows V but not C, and S knows C but not V. The situation is modelled by supposing that V and C are random variables with a joint probability distribution called the prior, which is known to both parties. As stated in our experimental design section, for our experiments we will assume that the values and costs of the buyers and sellers are drawn independently from the closed interval [0,100] using distributions with the following cdf's:

$$F(V) = 1-[(100-V)/100]^{0.4},$$
$$G(C) = (C/100)^{0.4}.$$

Before the bidding takes place, B observes V but not C, and S observes C but not V. B's strategy is a function β that determines his bid v for each value of V, and S's strategy is a function γ that determines his bid c for each value of C. Thus

$$\begin{aligned} v &= \beta(V). \\ c &= \gamma(C). \end{aligned} \tag{3.1}$$

For a given k the buyers' and sellers' profits are, respectively,

$$\Phi_B = \begin{cases} V-[k(v) + (1-k)c]. & v \geq c, \\ 0 & v < c, \end{cases} \tag{3.2}$$

$$\Phi_S = \begin{cases} [k(v) + (1-k)c] - C, & v \geq c, \\ 0 & v < c. \end{cases} \tag{3.3}$$

Suppose that the parties are risk neutral, so that, for a given pair of strategies, β and γ, the expected utilities are

$$\pi_B(\beta,\gamma) = E\ \Phi_B$$

$$\pi_S(\beta,\gamma) = E\ \Phi_S$$

where the expectation is taken with respect to the prior distribution of V and C. Equations (3.1) – (3.3) determine a non–cooperative game. As usual, an equilibrium of the game is a pair of strategies such that neither player can increase his expected utility (expected profit) by unilaterally changing his strategy.

If F and G are uniform distributions and k = 0.5, then as Chatterjee and Samuelson (1983) have demonstrated, there exists a pair of linear bidding strategies which together form an equilibrium of the game defined by the sealed–bid mechanism. These strategies are as follows:

$$v = \begin{cases} V, & V < 25 \end{cases}$$

$$\begin{cases} 25/3 + (2/3)V, & V \geq 25 \end{cases}$$

$$c = \begin{cases} C, & C > 75 \\ 25 + (2/3)C, & C \leq 75 \end{cases} \qquad (3.4)$$

With the distributions used in our experiments, which are skewed and not uniform, the equilbrium bid distributions are as follows when, again, $K = 0.5$.

$$v = \begin{cases} V, & V < 36 \\ 20.25 + 0.438V, & V \geq 36 \end{cases}$$

$$c = \begin{cases} C, & C > 64 \\ 36.00 + 0.438C, & C \leq 64 \end{cases} \qquad (3.5)$$

It is our claim here that principals in indirect FFBEs view their situation as strategically identical to that faced by bidders in the sealed–bid mechanism. In the sealed–bid mechanism a strategy is a function from the set of random values (costs) to the set of bids (asks). Trade fails to be realized when the bids made by the buyer are less than the offers made by the seller and since this may occur when there are actually positive gains from trade existing (i.e., when the true value is greater than the true cost), the sealed bid–mechanism yields efficiencies which are typically less than first–best optimal efficiencies. In short[2], the sealed–bid mechanism can be viewed as a black box into which bids and asks are placed and, depending upon the k used by the mechanism, out of which pops a price at which successful trade will occur.

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[2]Myerson and Satterthwaite have proven that the linear equilibrium to the sealed–bid mechanism yields the second–best efficiency levels which may be substantially below the first–best optimal levels.

For principals, the indirect face–to–face bargaining mechanism appears to be identical. For them a strategy is an instruction function mapping their value (cost) realizations into the price limits they place on their agents. Prices are formed in the black box of negotiations conducted by the agents. The assessment of the bargaining ability of their agents strictly defines a k which the principal feels characterizes the price formation process of the negotiations. If our analogy between the indirect bargaining mechanism and the sealed–bid mechanism is correct, we should observe two patterns in the data we have generated. First, we should observe trade inefficiencies in the indirect mechanism which mimic the patterns observed in the sealed–bid mechanism experiments of Radner and Schotter in the sense that when inefficiencies occur they should do so because the instruction functions lead to sets of instructions for which no trade can be negotiated despite the fact that benefits from trade do exist (i.e., the highest acceptable price for the buyer's agent is below the lowest acceptable price for the seller's agent despite the fact that the buyer's value is greater than the seller's cost). Further, the instruction function observed should appear similar, at least qualitatively, to those bid functions observed in that experiment as well. Let us examine these two pieces of evidence one at a time.

In the sealed–bid mechanism inefficient disagreements can only occur when the bid submitted by the buyer is less than the offer made by the seller. In indirect FFBEs, inefficiencies can occur, despite potential gains from trade, for two reasons. First, the price limits placed on the buyer's agent may be less than the price limit place on the seller's agent (despite the fact that the true value may be greater than the true cost). As a result, unless agents violate the instructions of their principals, there is no room for trade to take place. This failure process is identical to the one that created inefficiencies in the sealed–bid mechanism. The other reason why beneficial trade may fail to take place in indirect face–to–face mechanisms is that despite having price limits that allow mutually beneficial trade to take place, negotiations break down for seemingly irrational reasons. If our analogy

between the sealed bid mechanism and indirect bargaining mechanisms is correct, then we should see breakdowns in efficiency of the first type only or at least in the vast majority of cases. An examination of the pattern of disagreements in the two indirect FFBEs offers support to our conjecture, since a substantial majority of disagreements, especially in the fixed–fee FFBE, occur when the price constraints are binding. In fact, in 17 out of the 22 non–trade rounds with positive potential gains in the percentage–fee FFBE, and in 17 out of 18 such rounds in the fixed–fee FFBE, the seller's lowest acceptable price exceeded the buyer's highest acceptable price. That is, in only five out of 22 non–trade rounds in the percentage–fee FFBE and in only one out of 18 in the fixed–fee FFBE, would it have been possible for the bargainers to have concluded transactions without incurring penalties. This pattern is consistent with our hypothesis about principal behavior.

It is harder to establish that the instruction functions used by our principals are similar to the bid functions observed Radner and Schotter (1989) or Linhart, Radner and Schotter (1990) or even close to the theoretical linear bid functions predicted, in part, by the theory. In Radner and Schotter (1989) and Linhart, Radner, and Schotter (1990) it was observed that bidders employed linear bid functions similar to those predicted by the theory although systematic deviations were found (especially in Linhart, Radner and Schotter (1990)). The reason for these difficulties has to do with the fact that our current experiments only contain 15 observations per bargaining pair (they repeated the experiment only 15 times). These are skimpy data upon which to estimate a piece–wise linear bid function of the type depicted in (3.4) and (3.5) above. (In Linhart, Radner and Schotter there were 75 rounds). Second, in the Radner and Schotter (1989) and Linhart, Radner and Schotter (1990) experiments subjects knew the k that was being used to set prices while in our experiments principals would have to estimate it and that estimate might come too late in the experiment to be observed in the pattern of instructions.

Despite these reservations there are some facts about the manner in which our subject principals gave instructions which are consistent with our hypothesis. First,

principal–agent theory would indicate that subject principals would give price limits to their agents which were identical to their true values and costs in the percentage–fee indirect bargaining experiment but not in the fixed–fee experiments.[3] More precisely, since the incentives of agents in fixed–fee experiments are simply aimed at making trades no matter what their price, we might expect principals to try to tie their hands by placing strict limits on the prices acceptable to them. In the percentage–fee experiments, however, the incentives of principals and agents are aligned and hence we would expect the principals to simply set their agents' price limits equal to their values or costs and instruct their agents to get the best price they can from the other agents. Therefore, principal–agent theory would predict instruction functions which are linear and with slope 1 in the percentage–fee experiments but whose slope is less than 1 in the fixed–fee experiments. (These instruction functions in the percentage–fee experiments need not, of course, be linear.) Second, our sealed–bid bidding hypothesis is consistent with instruction functions which have two properties: they are not of slope 1 (rather, they have slopes less than 1 if they are linear and at least have the property that principals constrain the prices they will allow their agents to accept) and these instructions functions should vary depending on the estimated slope of the agent's bargaining strength. These features are expected to be true of both fixed and percentage fee experiments.

Table 3 presents estimates of linear regressions run for each buyer and seller in each indirect experiment along with the mean of the estimated coefficients for these subjects.

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[3]When we refer to principal–agent theory here we mean the static theory governing a one–shot version of this experiment. There may be repeated game considerations here involving reputation building, that might alter these results.

TABLE 3: Regression Results

TABLE 3A Percentage-Fee Face-to-Face Bargaining

Regressions	SELLER PAIRS				BUYER PAIRS			
Number of runs	α	β	Std Err	R^2	α	β	Std Err	R^2
1	12.13	0.86	0.06	0.94	1.31	0.92	0.04	0.98
2	10.32	0.86	0.03	0.99	3.87	0.76	0.15	0.65
3	2.91	0.96	0.02	0.99	11.23	0.52	0.12	0.58
4	27.88	0.60	0.08	0.80	-2.47	0.92	0.01	0.99
5	45.1	0.29	0.08	0.53	4.50	0.81	0.02	0.99
6	14.83	0.86	0.12	0.80	3.44	0.77	0.07	0.91
7	46.95	0.30	0.04	0.81	-1.00	1.00	0.00	1.00
8	2.90	0.97	0.03	0.99	8.45	0.61	0.16	0.54
9	15.18	0.80	0.11	0.80	3.24	0.83	0.05	0.96
10	3.57	0.95	0.04	0.98	4.19	0.63	0.04	0.96
Pooled	18.22	0.76	0.04	0.69	2.05	0.80	0.04	0.77
MEAN	18.18	0.74	0.06	0.86	3.68	0.78	0.07	0.86

TABLE 3B Fixed-Fee Face-to-Face Bargaining

Regressions	SELLER PAIRS				BUYER PAIRS			
Number of runs	α	β	Std Err	R^2	α	β	Std Err	R^2
1	12.13	0.85	0.04	0.98	10.89	0.63	0.06	0.89
2	30.37	0.51	0.11	0.63	26.19	0.36	0.07	0.64
3	10.12	0.80	0.07	0.90	5.88	0.76	0.06	0.92
4	32.69	0.45	0.15	0.41	5.51	0.77	0.11	0.79
5	27.30	0.68	0.05	0.93	6.30	0.71	0.06	0.93
6	20.78	0.71	0.04	0.95	15.12	0.58	0.07	0.84
7	25.25	0.69	0.07	0.87	-2.35	0.89	0.06	0.95
8	18.34	0.71	0.06	0.92	7.95	0.54	0.03	0.96
9	26.9	0.71	0.07	0.90	4.85	0.83	0.04	0.97
10	19.87	0.72	0.06	0.91	15.39	0.56	0.09	0.74
Pooled	22.76	0.70	0.03	0.83	7.60	0.70	0.03	0.83
MEAN	22.38	0.68	0.07	0.84	9.57	0.66	0.06	0.86

TABLE 3 HERE

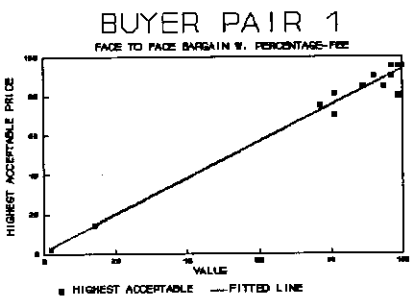
As can be seen, in both experiments the observed bid functions have slopes which are significantly far away from unity. This is as true in the percentage–fee experiments as it is in the fixed–fee experiments, with mean slopes of .68 and .66 for seller and buyer subjects in the fixed fee experiment and .74 and .78 for sellers and buyers in the percentage–fee experiment. Note also that in the overwhelming majority of cases, the R^2 of these regressions is rather high indicating that linearity is an assumption that helps explain much of the variation in the data. Finally, when one tests whether these intercepts and slopes were different from regressions fit using the data of Linhart, Radner and Schotter (1990) where sealed–bid experiments were similarly run with 15 round horizons and employing the same distribution functions as we used here (with $k = 0.5$), we find, using a Kruskal–Wallis one–way analysis, that there is no significant difference between either the slopes or intercepts of these instruction functions and the bid functions observed there at the 5% level of significance. From looking at the data one would not be able to recognize the institution which generated them. To further illustrate this point, we present in Figures 2 and 3 the linear approximations to the instruction functions (Figure 2) and bid functions (Figure 3) for the indirect FFBEs and sealed–bid experiments of Linhart, Radner and Schotter (1990). As we can see, there is a striking similarity between the instruction and bid/ask behavior of the sealed–bid and indirect face–to–face mechanisms. These similarities support our belief that the behavior of agents in these experiments were qualitatively similar.

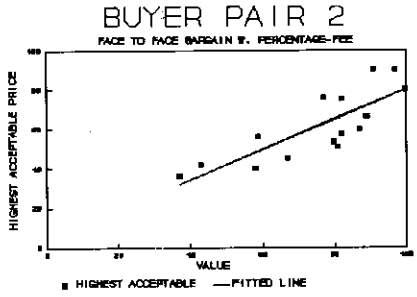
FIGURES 2 AND 3 HERE

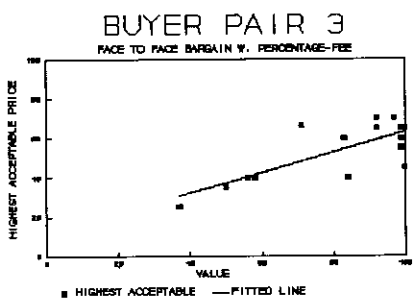
Finally, one would expect that the instruction function used by our bidders would vary according to their estimate of the k defined by their agents. For example, when k is

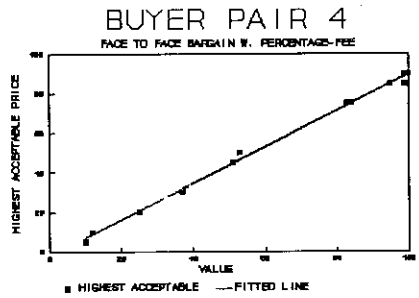
Figure 2a Instruction functions: Indirect Face-to-Face Mechanism

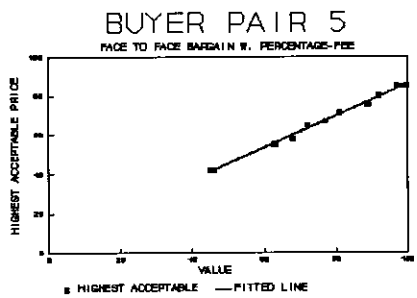
Percentage-Fee Face-to-Face Bargaining Experiments: Buyers

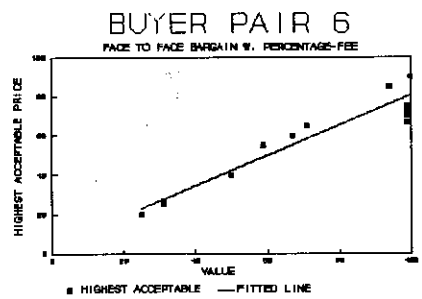


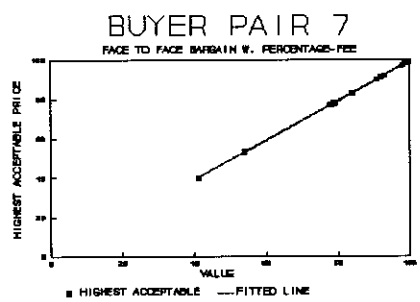


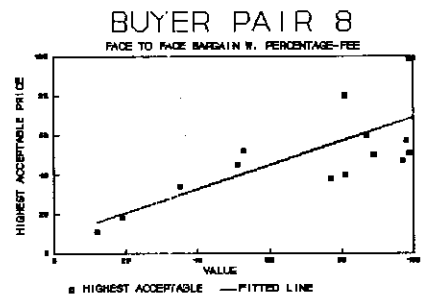


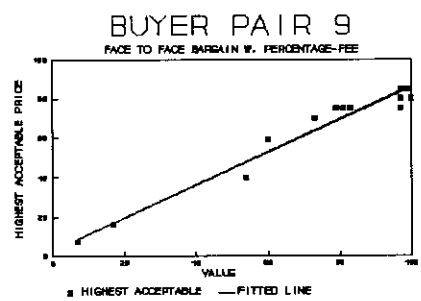


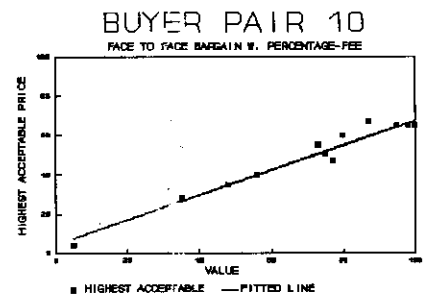








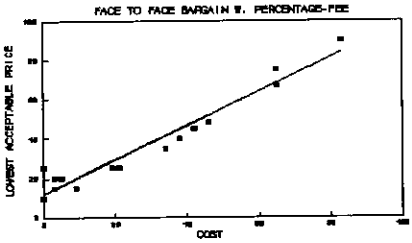




Percentage-Fee Face-to-Face Bargaining Experiments: Sellers

SELLER PAIR 1

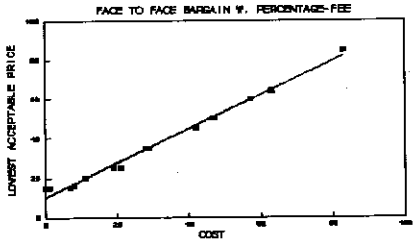
FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 1

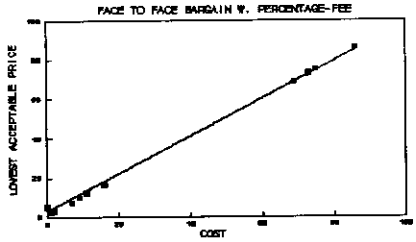
FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 3

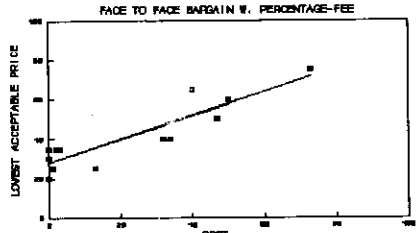
FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 4

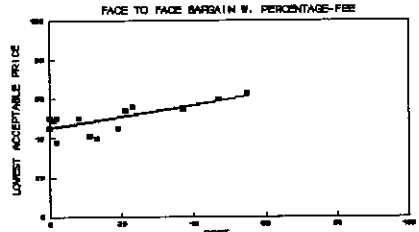
FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 5

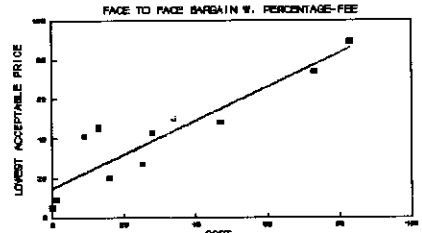
FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 6

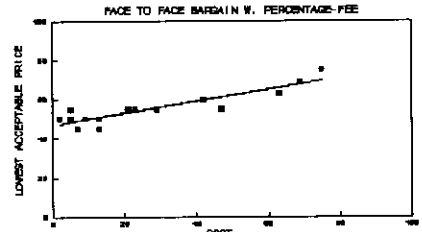
FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 7

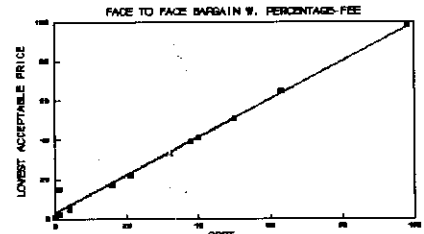
FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 8

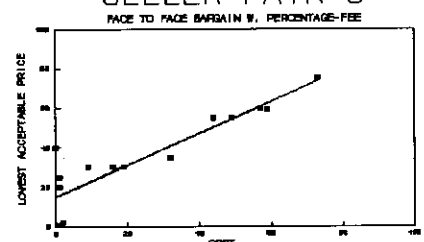
FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 9

FACE TO FACE BARGAIN W. PERCENTAGE-FEE



LOWEST ACCEPTABLE P —FITTED LINE

SELLER PAIR 10

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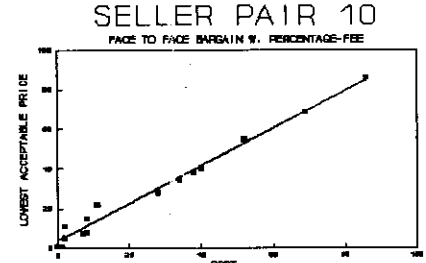
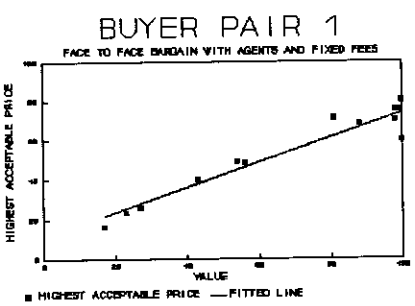
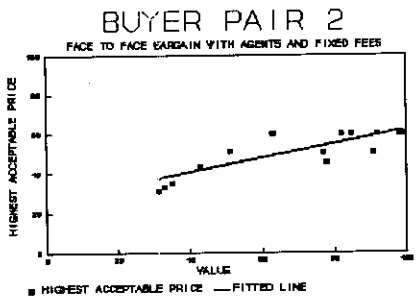


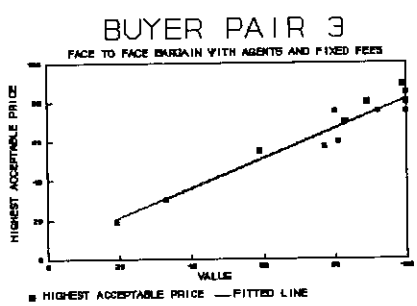
LOWEST ACCEPTABLE P —FITTED LINE

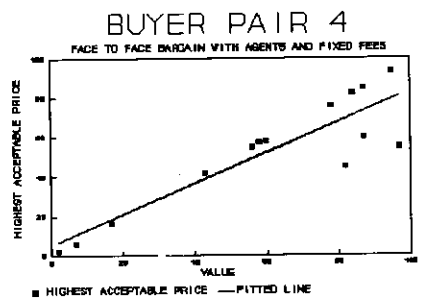
Figure 2b Instruction Functions: Indirect Face-to-Face Mechanism

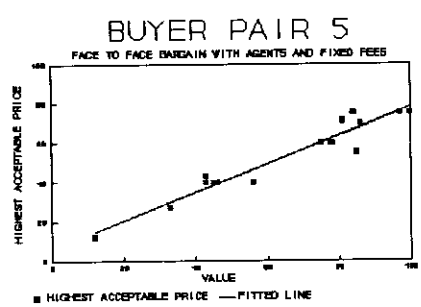
Fixed-Fee Face-to-Face Bargaining Experiments: Buyers

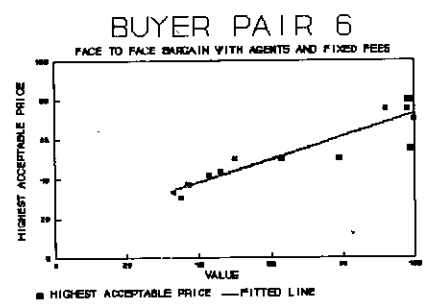


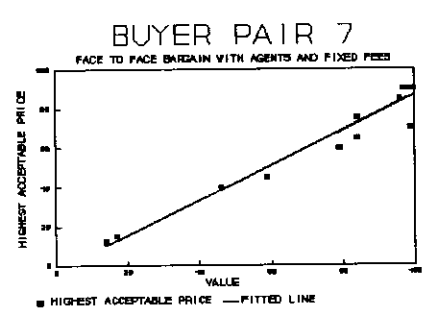


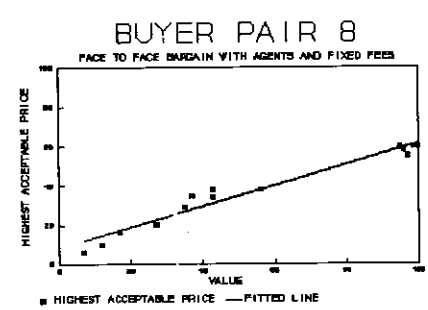


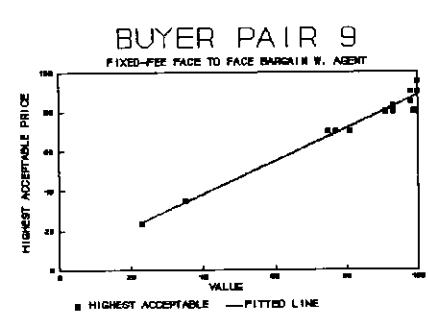


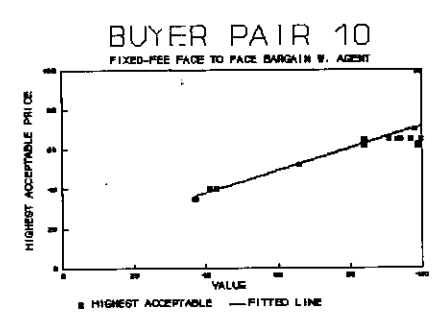








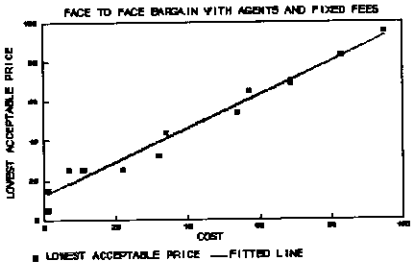




Fixed-Fee Face-to-Face Bargaining Experiments: Sellers

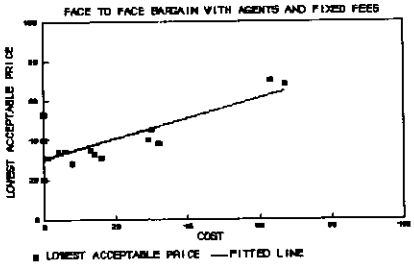
SELLER PAIR 1

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES



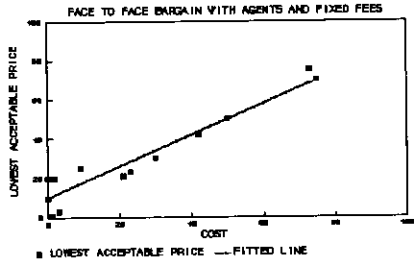
SELLER PAIR 2

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES



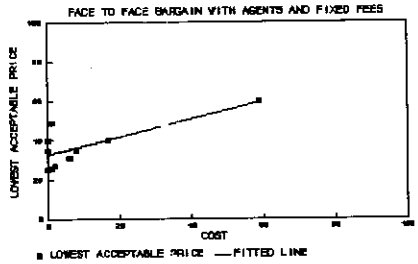
SELLER PAIR 3

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES



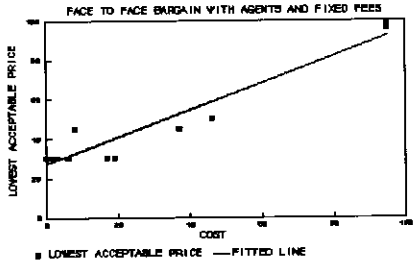
SELLER PAIR 4

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES



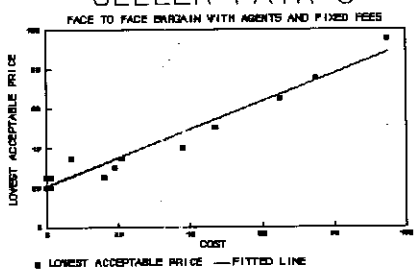
SELLER PAIR 5

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES



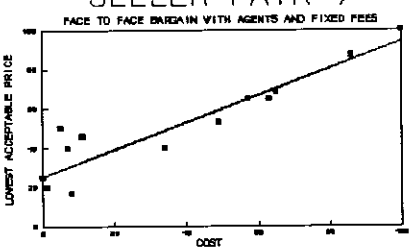
SELLER PAIR 6

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES



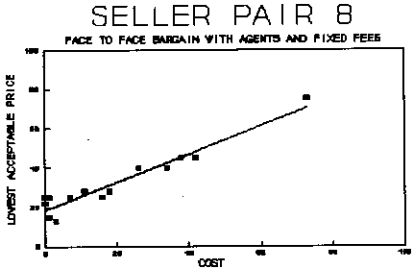
SELLER PAIR 7

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES



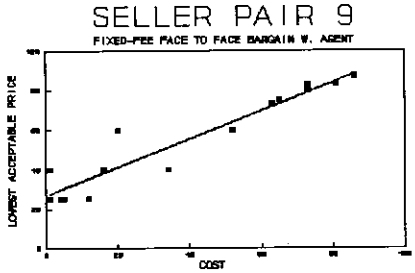
SELLER PAIR 8

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES



SELLER PAIR 9

FIXED-FEE FACE TO FACE BARGAIN W. AGENT



SELLER PAIR 1

FACE TO FACE BARGAIN WITH AGENTS AND FIXED FEES

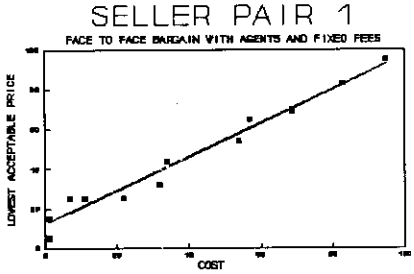
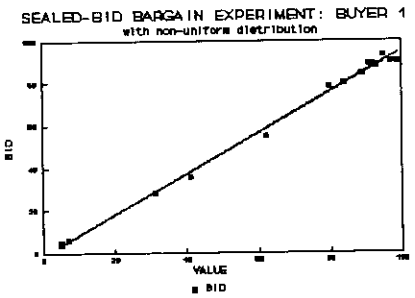
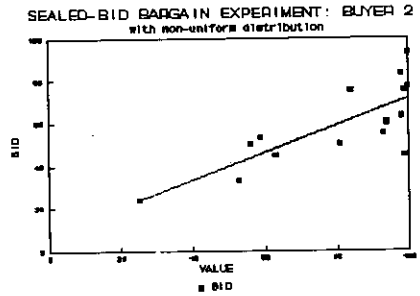
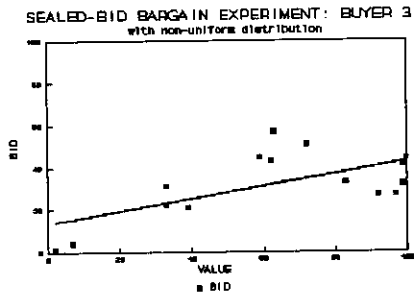
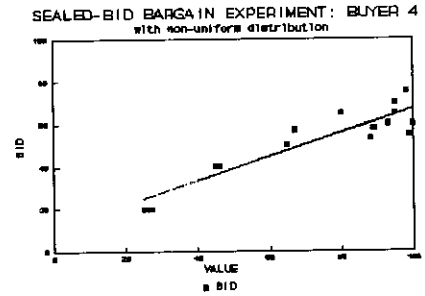


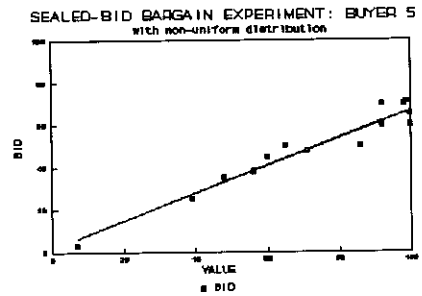
Figure 3a Bid Functions: Sealed-Bid Mechanism
Buyers (Radner-Schotter 1989)

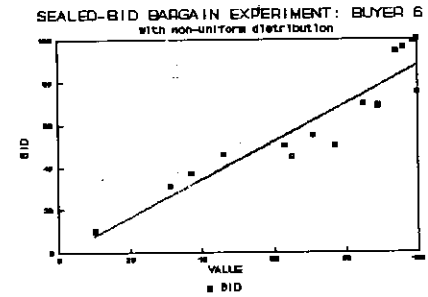


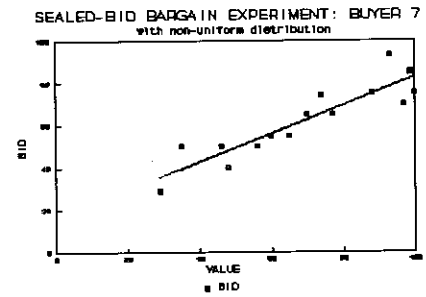


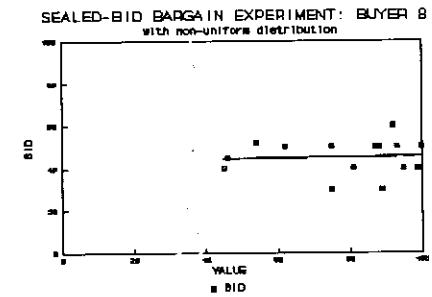


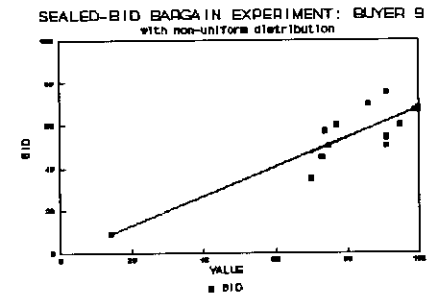












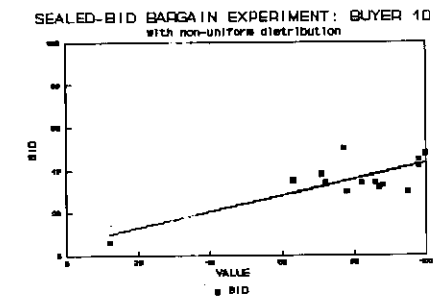
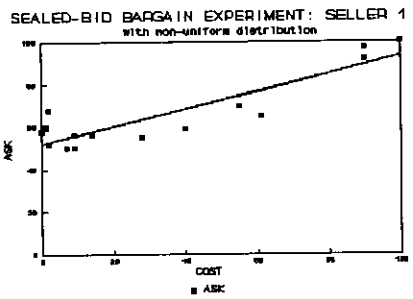
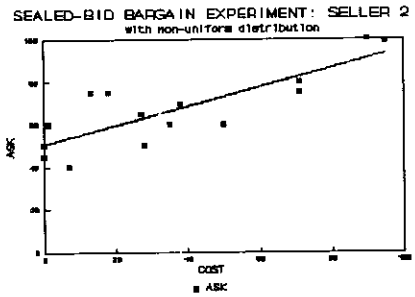
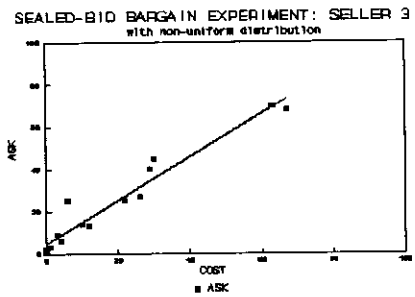
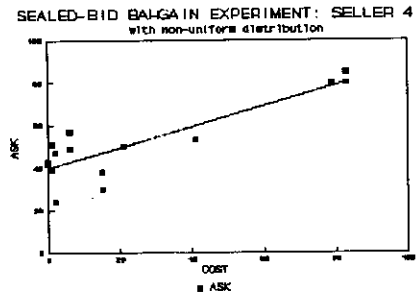


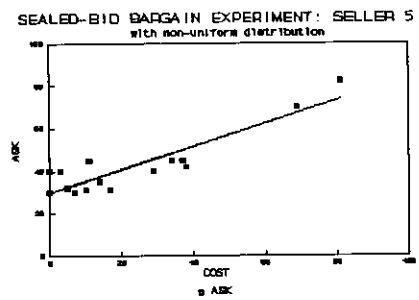
Figure 3b Bid Functions: Sealed-Bid Mechanism
Sellers (Radner-Schotter 1989)

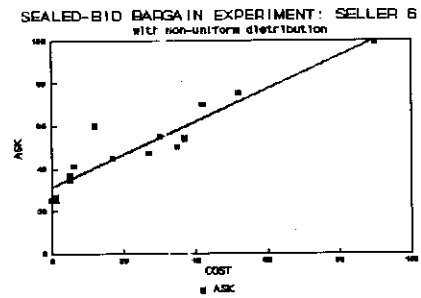


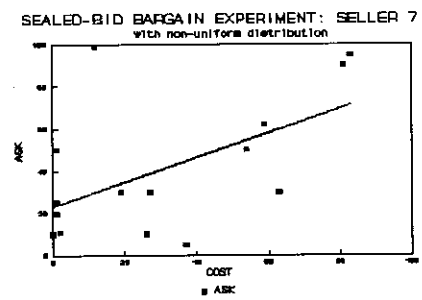


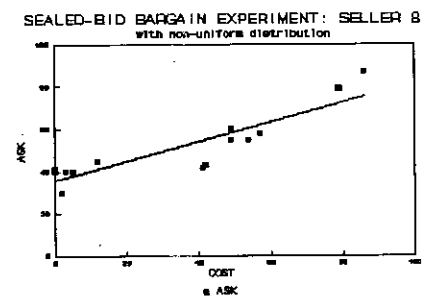


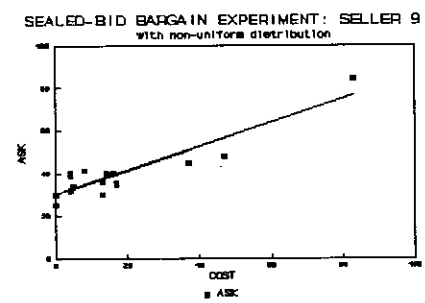


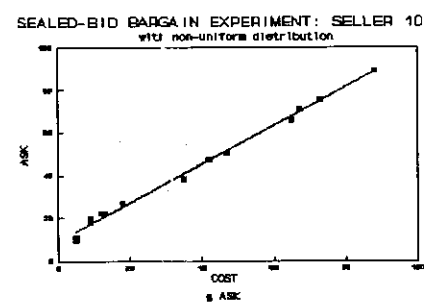












estimated to be equal to 1 price is determined strictly by the seller's agent since, in analogy to the sealed bid mechanism, it will equal the price limit of the buyer. If both buyer and seller principals share this estimate of k, then it is a dominant strategy for the seller to use an instruction function which is linear with a constant of 0 and a slope equal to 1, while the equilibrium instruction function for the buyer would involve shaving one's value and instructing a price limit less than value be set. This is true because such a price–setting mechanism shares all the properties of truth–revealing mechanisms for the seller in the sense that his or her bid does not affect the price of the transaction but only the probability of trade. Hence, truthful instructions are dominant. As k moves toward zero, the opposite occurs. Hence, we would expect an inverse relationship between the size of k and the slope of the buyer's instruction function while a positive relationship between k and the slope of the seller's instruction function.

Table 4 presents some simple linear correlations run between the k estimated for each pair and the constant and slopes of the instruction functions used by these buyers and sellers. (Appendix B presents our estimates of the average k for each pair.)

TABLE 4 HERE

As we can see, there is a strong correlation between the coefficients of the subject's instruction functions and the estimated mean value of k for each pair using the percentage fee mechanism. While the strength of the correlation is weaker in the fixed–fee case, in both cases the sign of the correlation is consistent with the logic presented above since the sign of the correlation between the buyer's bid function and k is negative while it is positive for the sellers.

On the basis of the data discussed above, there appears to be at least qualitative support for the hypothesis we have put forward that subjects in indirect bargaining

TABLE 4: Correlations Between the Estimated K and the Coefficients of the Estimated Linear Instruction Functions

Indirect Fixed-Fee Face-to-Face Bargaining Experiments	Correlation Coefficients	Observations Number	Significance Level
BUYER PAIR CONSTANT, K	0.073514	10	0.8401
BUYER PAIR SLOPE, K	-0.13514	10	0.7097
SELLER PAIR CONSTANT, K	-0.49203	10	0.1486
SELLER PAIR SLOPE, K	0.316453	10	0.373
Indirect Percentage-Fee Face-to-Face Bargaining Experiments			
BUYER PAIR CONSTANT, K	0.865028	10	0.0012
BUYER PAIR SLOPE, K	-0.8109	10	0.0044
SELLER PAIR CONSTANT, K	-0.79491	10	0.006
SELLER PAIR SLOPE, K	0.771011	10	0.009

experiments tend to behave in a manner that is similar to that observed in previous sealed–bid experiments.

4: Conclusions

This paper has attempted to shed some light on the contradictory evidence of laboratory face–to–face bargaining experiments and real world experience with this same mechanism. The problem is that while face–to–face bargaining seems efficient in the lab, it appears to break down often in the real world. Our explanation for this discrepancy relies on the fact that in the real world face to face bargaining is usually conducted not between principals but between the agents of principals, i.e., between fiduciaries like lawyers. Hence while people meet face to face and bargain, the fact that these bargainers are acting as agents for others leads to a breakdown of efficiency. In short, the efficiency of laboratory face–to–face bargaining, relative to real–world experience, is not an artificial aspect of a laboratory environment, but rather a result of the fact that in the real world bargaining is often done through agents and not directly by principals.

To explain how this principal–agent relationship interferes with efficiency, we hypothesize that subject principals in our experiments treat the mechanism as if it were a sealed–bid mechanism and, as a result, place restrictions on the bargaining of their agents that get in the way of efficiency. This hypothesis is supported by data on the type of bargaining breakdowns that occur as well as the shape of instruction functions each principal uses to instruct his agent.

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APPENDIX A

Percentage–Fee Indirect Face–to–Face Bargaining Experiment:

INSTRUCTIONS

Introduction

You are about to engage in an experiment concerning decision–making. Various research institutions have provided funds for these experiments and if you make appropriate decisions you will earn a good monetary payment.

The Experiment

As you arrived, two things occurred. First, you were randomly arranged in pairs, and within each pair one of you has been designated as the **bargainer** and the other has been called the **principal**. Second, each pair has also been designated as either a **buyer pair** or a **seller pair**. Hence you may be either a **buyer principal**, a **buyer's bargainer**, a **seller principal**, or a **seller's bargainer**. Check the top of your instructions to see which one you are. You will be matched with the other member of your pair for the duration of the experiment. The buyer pair and seller pair will bargain repeatedly over the course of the experiment. In each round the buyer pair will be bargaining to buy an fictitious object from the seller pair; the seller pair will be bargaining to sell this object to the buyer pair. The fictitious object will be completely described by two numbers: its **value** to the buyer pair, and its **cost** to the seller pair. These numbers will be generated randomly, and independently in each round, in a manner to be described below.

After you read these instructions and the procedures of the experiment are described to you, the buyer pair will be placed in a separate room from the seller pair. Although the

principals in these pairs will not meet again until the experiment is over, the bargainers will meet repeatedly to bargain with each other in a pre–designated third room. The experiment will last for 15 rounds and each round will have two phases which we will call the **pre–negotiation phase** and the **bargaining phase**. The way the experiment works is as follows.

The Pre–Negotiation Phase

The first step is the generation of the random numbers defining the value of the object to the buyer pair and its cost to the seller pair. In each round, in the privacy of your room, the principal in each pair will be asked to choose a number from one to five, and then another number from one to 75. The experimental administrator will then read out the number from one of five lists each containing 75 numbers. The buyer pair's random number (value) represents the amount of a fictitious currency called "francs" we will pay the buyer principal if the buyer's bargainer is successful in purchasing the object during the bargaining phase of that round. The buyer pair's random number is the buyer principal's "redemption value" for the object. The seller pair's random number (cost) represents how much the seller principal will have to pay in order to obtain the object for sale to the buyer pair. The seller pair's random number is the fictitious object's "production cost" to the seller principal. Note that only your pair knows your random number and that you will not be told the random number of the other pair. After you observe your number, the principal will write it in column 1 of his worksheet.

After the buyer pair's value and the seller pair's cost are known to them, each pair will discuss the way the bargainer in that pair is to conduct the negotiations with the other bargainer during the bargaining phase. In this discussion the buyer principal and buyer's bargainer must agree on a **highest acceptable price**, or a price "ceiling". In the subsequent bargaining phase, the buyer's bargainer may agree on any price less than or equal to the highest acceptable price, but if the agreed–upon price is higher than the

highest acceptable price then the buyer's bargainer will be penalized by having money subtracted from his final payoff. Similarly, the seller principal and seller's bargainer must agree on a **lowest acceptable price**, or a price "floor". The seller's bargainer, in the bargaining phase, may agree on any price higher than or equal to the lowest acceptable price, but he will be penalized if he agrees to a price that is lower than the lowest acceptable price. These penalties ensure that it will never benefit a bargainer to violate the instructions of his principal. These acceptable prices will be written in column 2 of the principal's worksheet. Note that the bargainer on each pair will be bargaining for the principal and must follow the principal's instructions in order to make a positive payoff. If either the seller pair or the buyer pair cannot agree on an acceptable price within the two-minute pre-negotiation phase, that round of the experiment will end and all payoffs to all people will be zero for that round. The bargainer's payoff at the end of the experiment will not be identical to the principal's payoff. (Payoffs are explained in detail below.) The pre-negotiation phase will last two minutes and at this point the bargaining phase will begin.

The Bargaining Phase

After the pre-negotiation phase is over, the bargaining phase will begin by having the bargainers of each pair leave their respective rooms and go to a third room in which they will bargain. The bargaining rules are as follows. After each bargainer has observed the random number of his principal, and discussed bargaining strategy with his principal, the two bargainers will be given three minutes to discuss whether they want to make a transaction in this period of the experiment and if so at what price. They will be told when there are three minutes, two minutes, one minute and 30 seconds left in the period. The experimental administrator will also count down the seconds left from 10 to 0.

Payoffs

If a price is agreed on within the three minutes, the franc payoff to the buyer pair will be

Buyer franc payoff = value − price,

while the seller pair's franc payoff will be

Seller franc payoff = price − cost.

For example, say the buyer pair receives a value of 60 while the seller pair receives a cost of 20. If a price of 50 is negotiated, the payoffs will be

60 − 50 = 10 for the buyer pair, and

50 − 20 = 30 for the seller pair.

If the price agreed on is 30, then the payoffs will be

60 − 30 = 30 for the buyer pair, and

30 − 20 = 10 for the seller pair.

Note that the payoff to a buyer pair can be negative if and only if the buyer's bargainer agrees on a price which is greater than the value. Similarly, the payoff to a seller pair can be negative if and only if the seller's bargainer agrees on a price which is less than the cost.

If no price is agreed on during the three minutes, i.e. if time runs out before a price is agreed on, all players' payoffs will be zero for that period. We will wait until the three minutes are over before proceeding to the next round if no price is agreed on. If both the buyer's bargainer and the seller's bargainer agree on a price, you must tell the experimental administrator sitting with you that an agreement is reached.

For each round in which a price agreement is reached, and in which the negotiated price is not greater than the highest acceptable price determined in the buyer pair's pre-negotiation phase, the buyer principal will receive 2/3 of the payoff to the buyer pair and the buyer's bargainer will receive the remaining 1/3. If the negotiated price exceeds the highest acceptable price, the buyer principal will receive all of the payoff to the buyer pair for that round; the buyer's bargainer will receive no payoff for that round, and in addition the buyer's bargainer will have a penalty subtracted from his final payoff at the end of the

experiment. Similarly, for each round in which a price agreement is reached and in which the negotiated price is not less than the lowest acceptable price determined in the seller pair's pre-negotiation phase, the seller principal will receive 2/3 of the payoff to the seller pair and the seller's bargainer will receive the remaining 1/3. If the negotiated price is less than the lowest acceptable price, the seller principal will receive all of the payoff to the seller pair for that round; the seller's bargainer will receive no payoff for that round and will have a penalty subtracted from his final payoff. The formula for these penalties is given below. The important point, however, is simply that it will never be in the interest of a bargainer to violate the instructions of his principal.

Once either a trade has been made or the three minutes of the round are over, this round will end. The bargainers will then return to their principals and report to them whether or not a trade was made and if so at what price. The principal will write in column 3 of his worksheet whether a transaction has been agreed to in period 1 by writing yes or no. In column 4 he will write the price and in column 5 the payoff. If no trade occurred, zeros should appear in columns 4 and 5.

After period 1 is over, you will proceed to period 2 by generating your new random numbers (cost for the sellers, value for the buyers), and then engage in another two-minute pre-negotiation phase and another three-minute bargaining phase. There will be 15 rounds. At the end we will convert your franc payoff into dollar payoffs in a manner to be described below.

In the discussions of the bargainers certain rules will be strictly enforced by the experimental administrator sitting with you. If they are violated, the experiment will be terminated and the violating person given a minimal payoff.

(1) A bargainer must not announce his random number (cost or value) or price limit to the other bargainer, nor may he take a piece of paper on which these numbers are written, into the bargaining room.

(2) No personal threats or abusive language will be tolerated, nor any disparaging remarks about the actions of other persons engaged in the experiment.

(3) In each period of the experiment you may only discuss the price of the fictitious good being sold in *that* period. For instance, no price arrangements about objects to be sold in later rounds may be discussed. You must discuss each object separately.

(4) Finally, no discussion of payments outside of the experiment will be tolerated. For instance, you may not say "if you agree to such and such price in this period I will pay you $X after we leave the experiment."

Penalties

If the negotiated price exceeds the buyer pair's highest acceptable price, then an amount will be subtracted from the final payoff of the buyer's bargainer equal to the difference between the value and the highest acceptable price (if the negotiated price is less than the value) or the difference between the negotiated price and the highest acceptable price (if the negotiated price exceeds the value). If the negotiated price is less than the seller pair's lowest acceptable price, then an amount will be subtracted from the final payoff of the seller's bargainer equal to the difference between the lowest acceptable price and the negotiated price (if the negotiated price exceeds the cost) or the difference between the lowest acceptable price and the negotiated price (if the negotiated price is less than the cost). These penalties ensure that it can never benefit a bargainer to violate the acceptable price limit specified by his principal.

Final Payoffs

When the 15 rounds of the experiment are over, the final payoffs will be determined by adding all of the francs accumulated over the 15 rounds of the experiment. These francs will be converted into dollars at the rate of 1 franc = $.05. Each bargainer will also receive a fixed payment of $6.00 for participating, while each principal will receive a fixed payment of $3.00. If by the end of the experiment a bargainer's total franc payoff

is negative, these losses will be subtracted from the fixed payment of the principal. You will be paid when you leave. If any rules are violated, the violating party will receive the fixed payment of $3.00 minus any losses that have occurred while the other person will be paid by calculating his average payoff up until the violation and then multiplying it by 15.

Random Numbers

The random numbers on the lists held by the experimental administrators were generated independently depending upon whether you are a buyer or a seller. What we mean by a "random number" can be explained by looking at Figures 4 and 5.

FIGURE 4 HERE

Figure 4 describes how the random values of the buyers were generated. The graph shows possible values between 0 and 100 on the horizontal axis and a probability number on the vertical axis. The probability number tells you how likely it is that a buyer will receive a random number (value) less than or equal to any particular number. For instance, this graph indicates that the probability that a buyer will receive a value less than or equal to, say, 25 is .108 (while the probability that the buyer receives a value *greater* than 25 is .892). Similarly, the probability that the buyer receives a value less than or equal to 50 is .242 (while the probability that the buyer receives a value greater than 50 is .758). The probability that the buyer receives a value of 75 or less is .425 (the probability of receiving a value greater than 75 is .575). Table 5 gives you more information about the way your random values are generated if you are a buyer. A point to note is that if you are a buyer the likelihood of getting a "high" (greater than 50) value is substantially greater than the probability of getting a "low" value (i.e. a value less than 50). In fact, the probability that a buyer will receive a value less than 50 is only .24.

TABLE 5 HERE

For a seller, just the opposite is true, as Figure 5 illustrates. Here we place all possible seller costs between 0 and 100 on the horizontal axis and a probability number of

FIGURE 4

Probability that Buyer receives a
Value less than (greater than) X

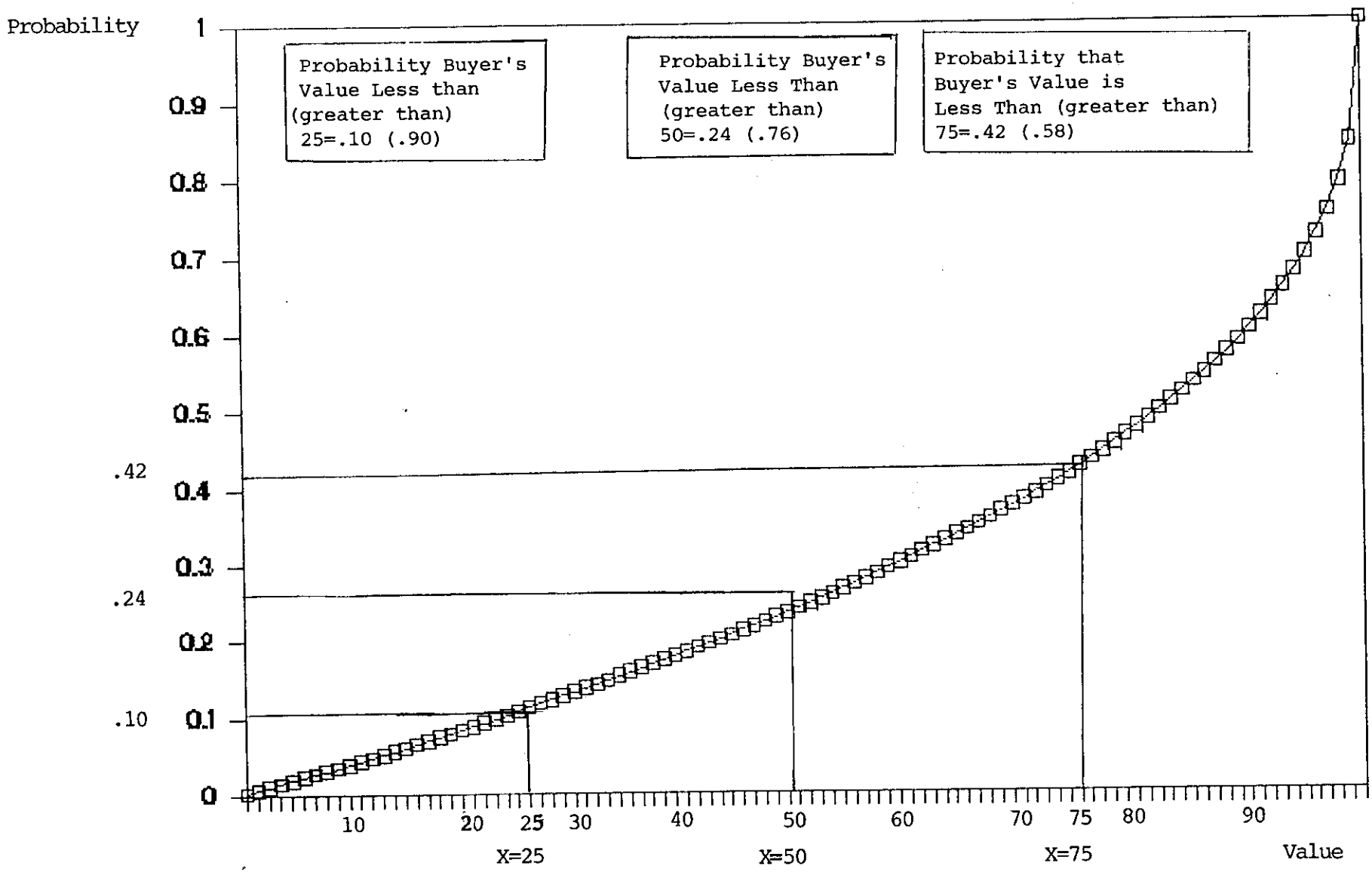

TABLE 5

Buyer Value Probability

Value in Points (X)	Probability Value Less Than X	Probability Value Greater Than X
1	0.004012	0.995987
5	0.020308	0.979691
10	0.041268	0.958731
15	0.062939	0.937060
20	0.085389	0.914610
25	0.108698	0.891301
30	0.132959	0.867040
35	0.158284	0.841715
40	0.184806	0.815193
45	0.212691	0.787308
50	0.242141	0.757858
55	0.273417	0.726582
60	0.306855	0.693144
65	0.342906	0.657093
70	0.382199	0.617800
75	0.425650	0.574349
80	0.474694	0.525305
85	0.531794	0.468205
90	0.601892	0.398107
95	0.698291	0.301708
100	1	0

the vertical axis. Again the probability number defines the probability that if you are a seller you will receive a cost less than or equal to any particular cost. For instance, the probabilities that a seller will have a cost less than either 25, 50, or 75 are .575, .758, and .891, respectively. Table 6 below lists other such probabilities.

FIGURE 5 HERE

TABLE 6 HERE

A point to note is that, as opposed to the buyers, sellers have a greater chance of getting a low number (i.e., a cost less than or equal to 50) than a high number (greater than 50). In fact, the probability that a seller will receive a cost less than 50 is .757.

To give you a feel for these numbers the experimental administrator will generate a few illustrative random numbers from the sellers' and buyers' lists, respectively. Since the numbers on the lists were generated in a manner consistent with the graphs described above, they should familiarize you with the random numbers you could draw. After this is done, we will begin our experiment.

Instructions for Fixed–Fee Indirect Face–to–Face Bargaining Experiment:

The instructions for the fixed–fee FFBE are identical to those for the percentage–fee FFBE except for the following changes:

(1) In place of the section entitled "Payoffs" in the percentage–fee instructions, the fixed–fee instructions contain two sections entitled "Payoffs to Principals" and "Payoffs to Bargainers."

(2) The "Payoffs to Principals" section of the fixed–fee instructions is identical to the first four paragraphs of the "Payoffs" section of the percentage–fee instructions, except that references to the "buyer pair" or "seller pair" are replaced by references to the "buyer principal" or "seller principal," respectively.

FIGURE 5

Probability That Seller Receives
A Cost Less Than X

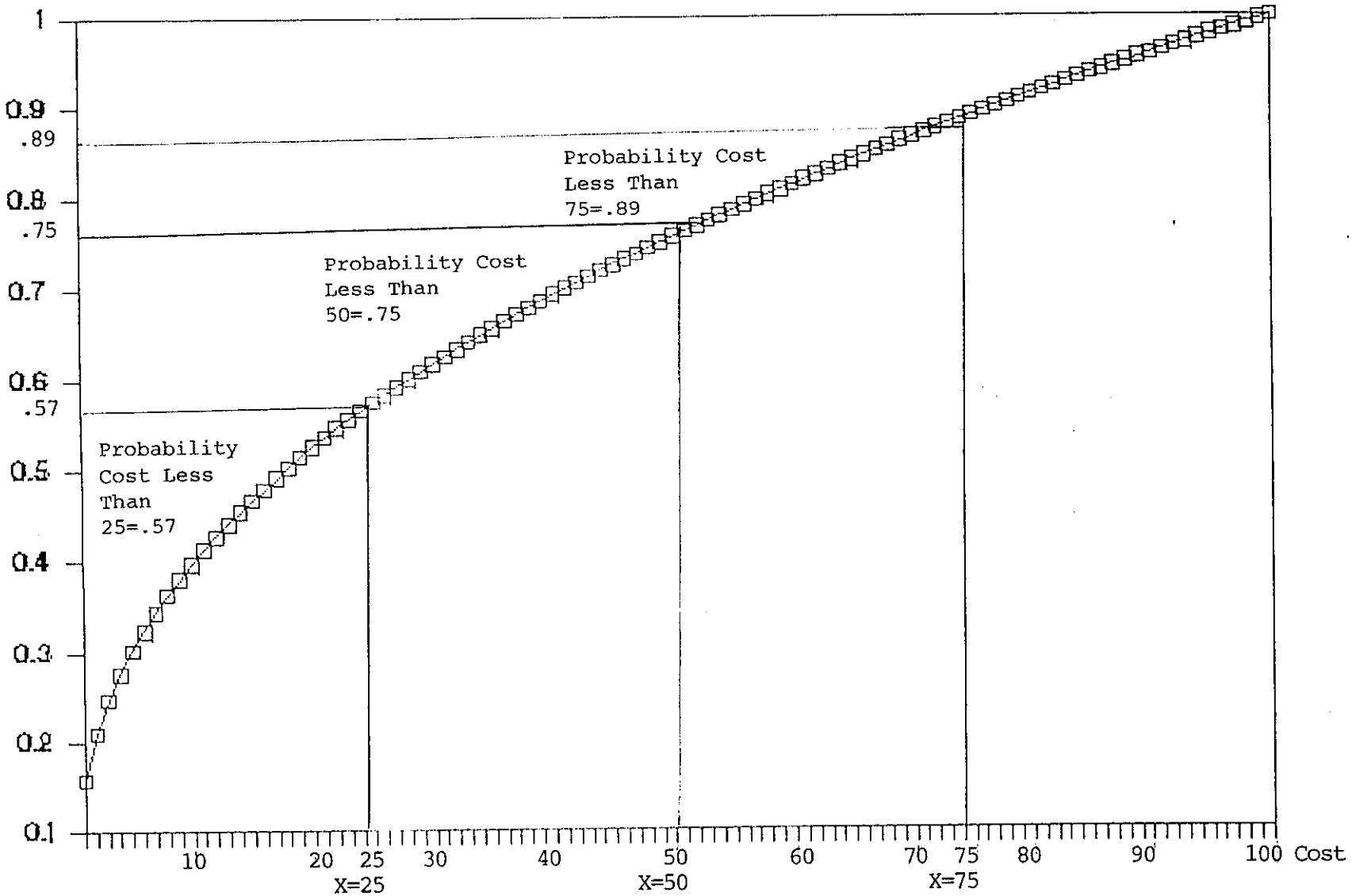

FIGURE 6
Seller Cost Probability

Cost in Points (X)	Probability Cost Less Than X	Probability Cost Greater Than X
1	0.158489	0.841510
5	0.301708	0.698291
10	0.398107	0.601892
15	0.468205	0.531794
20	0.525305	0.474694
25	0.574349	0.425650
30	0.617800	0.382199
35	0.657093	0.342906
40	0.693144	0.306855
45	0.726582	0.273417
50	0.757858	0.242141
55	0.787308	0.212691
60	0.815193	0.184806
65	0.841715	0.158284
70	0.867040	0.132959
75	0.891301	0.108698
80	0.914610	0.085389
85	0.937060	0.062939
90	0.958731	0.041268
95	0.979691	0.020308
100	1	0

(3) The first paragraph of the "Payoffs to Bargainers" section of the fixed–fee instructions reads as follows:

"For each round in which a price agreement is reached, the buyer's bargainer and the seller's bargainer will each receive a fixed payment of $1.00, provided that the agreed–upon price does not violate the acceptable price limits specified by the principals for that round. Otherwise, the bargainer who violated his principal's price limit will receive no payment for that round and will also have penalties subtracted from his final payoff. The formula for these penalties is given below. The important point, however, is simply that it will never be in the interest of a bargainer to violate the instructions of his principal."

(4) The remainder of the "Payoffs to Bargainers" section of the fixed–fee instructions is identical to the last seven paragraphs of the "Payoffs" section of the percentage–fee section.

(5) In place of the first two sentences of the section entitled "Final Payoffs" in the percentage–fee instructions, the corresponding section of the fixed–fee instructions contains the following three sentences:

"When the 15 rounds of the experiment are over, the principals' final payoffs will be determined by adding all of the francs accumulated over the 15 rounds of the experiment. These francs will be converted into dollars at the rate of 1 franc = $.04. Each of the bargainers will receive $1.00 for each round in which an acceptable price was agreed upon."

Appendix B

The Estimates of K for Each Subject Pair

Indirect Fixed-Fee Face-to-Face Bargaining Experiment						
Subject Number	Average Lowest Acceptable Price	Average Highest Acceptable Price	Average of Column 2 and Column 3	Average Actual Price	Column 5 minus Column 4	Estimated K
1	23.44	68.67	46.06	46.22	0.17	0.51
2	34.09	52.91	43.50	39.82	-3.68	0.35
3	20.50	72.58	46.54	60.92	14.38	0.79
4	32.83	63.58	48.21	47.71	-0.50	0.46
5	31.36	60.09	45.73	51.91	6.18	0.70
6	31.25	56.08	43.67	43.08	-0.58	0.41
7	38.55	75.91	57.23	44.00	-13.23	0.14
8	25.75	52.50	39.13	40.50	1.38	0.54
9	45.80	83.80	64.80	57.30	-7.50	0.34
10	26.15	60.38	43.27	48.46	5.19	0.62
Total	30.95	64.64	47.80	48.22	0.43	0.52
Indirect Percentage-Fee Face-to-Face Bargaining Experiment						
Subject Number	Average Lowest Acceptable Price	Average Highest Acceptable Price	Average of Column 2 and Column 3	Average Actual Price	Column 5 minus Column 4	Estimated K
1	25.00	86.70	55.85	49.20	-6.65	0.40
2	28.85	61.38	45.12	41.44	-3.68	0.38
3	6.82	51.91	29.36	48.64	19.27	0.92
4	35.50	82.00	58.75	38.50	-20.25	0.08
5	48.00	70.92	59.46	51.88	-7.58	0.16
6	23.56	74.44	49.00	43.56	-5.44	0.41
7	56.00	91.75	73.88	59.67	-14.21	0.11
8	21.55	57.91	39.73	47.36	7.64	0.65
9	28.58	77.42	53.00	57.00	4.00	0.59
10	20.38	53.38	36.88	33.62	-3.27	0.44
Total	29.73	70.25	49.99	47.11	-2.88	0.45