

**ECONOMIC RESEARCH REPORTS**

***A PRACTICAL PERSON'S GUIDE  
TO MECHANISM SELECTION:  
SOME LESSONS FROM EXPERIMENTAL  
ECONOMICS***

***BY***

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***RR # 93-27***

***July, 1993***

**C. V. STARR CENTER  
FOR APPLIED ECONOMICS**



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**March 3 1993**

The financial assistance of the C.V. Starr Center for Applied Economics at New York University is gratefully acknowledged as is the technical assistance of Ken Rogoza.

## ABSTRACT

### A PRACTICAL PERSON'S GUIDE TO MECHANISM SELECTION: SOME LESSONS FROM EXPERIMENTAL ECONOMICS

Andrew Schotter

One of the most interesting developments in economic theory over the past twenty years has been the emergence of the theory of mechanism design. In short, mechanism design theory investigates whether it is possible to design an economic institution (represented formally as a game form) which, when imposed upon a set of individualistic agents, will lead them to take actions consistent with some a priori chosen performance (social welfare) criterion.

In the real world, however, mechanisms compete for adoption. By this I mean that for any given allocation problem an organization might face, there might be a number of mechanisms available to solve it. The organization's leaders must then choose between these mechanisms based on their characteristics and if, for example, the mechanisms have different distributional consequences for the power groups within the organization, a political battle may ensue with each power group lobbying for the adoption of their own mechanism. The mechanism that is ultimately chosen will emerge from this bargaining process within the organization. The process of mechanism design is therefore different from the process of mechanism selection.

In this paper we concern ourselves with the selection criteria that organizations might use to choose between mechanisms. It is called a practical person's guide because the criteria I will be discussing are not the elegant criteria used by economic theorists to justify their mechanisms but rather the criteria likely to be used by some no-nonsense corporate C.E.O. or government official. Seven criteria are offered which we think are reasonable ones to be considered when the mechanism selection problem arises. Evidence from a number of experimental studies is then offered to evaluate these criteria using the mechanisms investigated by these experimental studies.

# **A PRACTICAL PERSON'S GUIDE TO MECHANISM SELECTION: SOME LESSONS FROM EXPERIMENTAL ECONOMICS**

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## Section 1: Introduction.

One of the most interesting developments in economic theory over the past twenty years has been the emergence of the theory of mechanism design. Starting with the pioneering work of Hurwicz (1972), this theory has become increasingly rich in detail and analysis. (For a wonderful survey of the field see Moore (1993)). In short, mechanism design theory investigates whether it is possible to design an economic institution (represented formally as a game form) which, when imposed upon a set of individualistic agents, will lead them to take actions consistent with some a priori chosen performance (social welfare) criterion. For instance, an early question arose as to whether it is possible to design a mechanism for the allocation of public goods which will lead economic agents to reveal their true preferences for the public good as a dominant strategy equilibrium to the game defined by the mechanism. This question was answered in the affirmative by Theodore Groves (1973) in his famous article "Incentives in Teams". Other such examples are easy to offer.

In the real world, however, mechanisms compete for adoption. By this I mean that for any given allocation problem an organization might face, there might be a number of mechanisms available to solve it. The organization's leaders must then choose between these mechanisms based on their characteristics and if, for example, the mechanisms have different distributional consequences for the power groups within the organization, a political battle may ensue with each power group lobbying for the adoption of

their own mechanism. The mechanism that is ultimately chosen will emerge from this bargaining process within the organization. The process of mechanism design is therefore different from the process of mechanism selection. Mechanisms that seem natural to a well trained economist may strike real world decision makers as bizarre. The reason for this difference is that the criteria by which we economists judge economic institutions is quite different from those used by real world decision makers. This is the prime reason why so few of our theoretically elegant mechanisms have actually been adopted for use.

In this paper we concern ourselves with the selection criteria that organizations might use to choose between mechanisms. I have called this a practical person's guide because the criteria I will be discussing are not the elegant criteria used by economic theorists to justify their mechanisms but rather the criteria likely to be used by some no-nonsense corporate C.E.O. or government official.

In the remainder of the paper I will proceed as follows. In the Section 2 I will outline and discuss the criteria I have found relevant for the mechanism selection decision. Some of these criteria I have discovered by speaking to corporate leaders while others I have simply dreamed up myself. I will let you guess which is which. In Section 3 I will offer some experimental results which demonstrate some of the properties listed in Section 2. In this section I will rely heavily on my own work much of which was done jointly with Roy Radner. My egocentric bias here is justified only on the basis of the fact that these are the works I am most familiar with and with which I have the raw data necessary to present some of the calculations required to make my point. There are obviously many other works that could be used as well. Finally, in Section 4 I offer some comments and conclusions.

## **Section 2: Selection Criteria**

There are many criteria which should be met by an allocating mechanism before an organization would consider using it in the real world. These criteria combine the theoretical properties that economists

cherish with the practical concerns of practitioners. In this section we offer a number of such criteria. While no mechanism can possibly satisfy them all, we do expect that a satisfactory mechanism will go at least part of the way in satisfying some of them.

### 1) Understandability

Our first criterion requires that whatever mechanism is suggested, it be understandable to those agents who are going to use it. By understandable we can mean one of two things. One is that the participants simply understand the rules of the mechanism and hence physically know what to do when using it. A more demanding criterion would require that the participants understand the theory underlying the mechanism. However, it is rare that the theory underlying a mechanism is included in the user's manual for that mechanism when it is distributed to the general population for use. (The IRS while distributing tax tables, never distributes journal articles on optimal income taxation to citizens or tips on how to exploit the loopholes in the law.)

Understandability is obviously essential since confusing mechanisms may be badly misinterpreted by the agents using them and may lead to behavior that is totally unexpected and detrimental to the profitability of the organization. Some times a mechanism is perceived as being more understandable if it can be couched in a metaphor that is familiar to the agents. For example, since at least in the United States we are inculcated with the jargon of competitive markets, mechanisms in which people place bids and goods are allocated by something resembling prices may be easier for agents to comprehend than mechanisms requiring more abstract messages like preference orderings. Hence, they are likely to be taken more seriously as candidates for adoption.

### 2) Fairness-- Strategic Symmetry

If a mechanism is ever going to be employed it must be perceived as being "fair". We call a mechanism "fair" if it is strategically symmetric: any strategy available to one side of the market has a comparable strategy available to the other side. In addition, each side has strategies that affect the payoff

function in an equivalent manner, given the action of others. The outcomes that result may, of course be unequal, but that may be an artifact of the types of preferences the agents have. (A double-oral auction mechanism is fair because both sides are treated symmetrically. Prices may be skewed to favor one side of the market simply because the other side have high willingnesses to pay (or low costs).) Our emphasis on the symmetry of the strategy sets of agents is motivated by the fact that economic agents, when presented with a mechanism, judge it to a large extent by the rules and if one side is offered strategies that the others can not avail themselves of, a red flag is automatically raised.

There are a number of reasons why perceived equity might be important. First, in many industries a mechanism must be agreed upon by all parties involved in trade. For example, in many labor negotiations if talks are stalemated, some type of arbitration is resorted to. Many different arbitration mechanisms exist, however, including final offer arbitration, Tri-offer arbitration (see Ashenfelter (1992)), just to mention a few. Not all schemes are equivalent with respect to how they treat the bargaining parties however, and if each side has a veto on the matter, no arbitration mechanism which systematically favors one side will be likely to be chosen.

### 3) Efficiency

As we know, efficiency is the ultimate economic criterion. Still a successful mechanism may have to trade off efficiency for other characteristics that may be desirable. Further, in addition to the overall efficiency of a mechanism the manner in which that efficiency is determined may be important. For instance, it is possible to have a set of mechanisms all of which are close to being second-best efficient but which achieve this efficiency in different ways. For example, consider a set of different bargaining mechanisms each of whose purpose is to consummate deals between buyers and sellers in an incomplete information environment. In such situations, buyers have only probabilistic information about the costs of sellers who have only probabilistic information about the values of buyers. However, instead of having one buyer and one seller who could be of different types, let us assume that there are many buyers and

many sellers who will be matched pair-wise and asked to bargain. At a first best outcome, all trades for which there are positive gains from trade should be made and those buyers and sellers should consummate deals. As we know, while no mechanism can achieve such first best outcomes, given the incomplete information described above, mechanisms achieving or approaching second-best results are sometimes available.

But near second-best outcomes could be achieved in several ways. One mechanism might make all of the very profitable trades available (i.e. trades between high value buyers and low cost sellers) but miss a large number of trades on which the gains are small. Another mechanism might miss a few big and profitable trades, but be much better in being successful on the small-gain trades. If the ex poste efficiencies of these two mechanisms are comparable, which is chosen will depend on how exactly these efficiencies are determined. For example, if there are relatively many more small-gain situations than large gain ones, the cries of small-gain traders may well drown out those of the large-gain traders. Put differently, since high cost sellers and low value buyers are most likely to be in situations in which the gains from trade are small, they are more likely to prefer that mechanism which makes a majority of the small-gain trades. Again, despite the equality in the over all efficiencies the composition of these gains may be important.

#### 4) Strategic Robustness

A successful mechanism should be robust against small or even considerable mistakes or miscalculations on the part of the agents using it. For example, one could not consider a mechanism as satisfactory, if despite its ability to implement Pareto-optimal outcomes at a Nash equilibrium, it produces disastrous outcomes for reasonably small mistakes (say mistakes larger than mere trembles) or deviations. In essence, we are talking here about the shape of the efficiency surface of the mechanism around the Nash equilibrium point and asking that it be flat.

#### 5) Personality Robustness

In addition to being robust with respect to strategic actions, we might like our mechanism to be robust to the personalities who use it. For example, if the outcomes of mechanism are greatly influenced by the personalities actual people who use it, we can expect a larger than usual variance in outcomes and a greater sense of uncertainty about the mechanism's outcomes. For instance, assume that a mechanism implements Pareto optimal outcomes but the exact outcome on the Pareto surface that is chosen depends on how the game defined by the mechanism is actually "played" (i.e., different players might select different equilibria). Since we can think of organizations as infinitely lived entities, any choice of a mechanism commits the players to a game to be played by yet unknown fiduciaries in the future. If the outcomes are sensitive to the play of these yet unknown agents, the choice of a mechanism today may expose future agents of one's type to dismal outcomes. A mechanism which is not personality robust would therefore be a risky choice and therefore be rejected by a risk averse agent today.

#### 6) Agent Profitability

New institutions are never imposed in a historical vacuum. In almost every instance where a new institution is called for it replaces an old one. When it does so it must make sure to provide a profitable role for all actors who participated in the previous institution especially if those agents have the ability to veto the use of the new mechanisms. In addition, a new mechanism would have a better chance of being implemented if it were "in the idiom" of the one it is replacing. For example, if an industry has historically set its wages by bargaining, a new wage setting institution might have a better chance of being used if it provided a role for bargaining in it as well. To illustrate this point, take the process of wage determination in the professional baseball industry. In this industry we have a set of agents who have historically played an active role in the wage setting process. These include the team owners, the players association, the players themselves and the lawyers of the players. In addition, salaries have been set by negotiation. This industry, however, is one desperately in need of a new salary determination mechanism since both sides are dissatisfied with the outcomes of the current "free-agent" system. However, any new

mechanism which does not provide a profitable role for the current set of agents (i.e. for the lawyers of the players) is likely to be rejected since no lawyer is likely to endorse a system which eliminates his or her future rents.

### 7) Collusion Freeness

If a mechanism is to be acceptable to economic agents, it should be resistant to collusive behavior among the participants using it. Collusion is most easy when participants on one side of the mechanism can cheaply signal their intentions and when defections from an implicitly agreed to convention of behavior are easily detected.

## Section 3: Experimental Evidence

In this section of the paper I will review the results of a number of different experimental studies. Each study is presented in an effort to highlight how the mechanisms examined there satisfies the criteria specified in Section 2.

### 3.1: Personality Robustness and Efficiency: The Sealed-bid Mechanism vs. Face-to-Face Bargaining in Incomplete Information Environments.

Consider the following bargaining mechanism that can be used to structure bargaining between two economic agents say, for example, between two profit centers within a large scale organization. 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  $P = (v+c)/2$ , i.e. the average of the two bids. 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. For the experiments discussed below 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:

$$F(V) = 1 - ([1 - V/100])^{r_1},$$

$$G(C) = (C/100)^{r_2}.$$

By varying  $r_1$  and  $r_2$  from 0 to 1, we can move these distributions from the perfect certainty case ( $r_1 = 0$ ) to the case of a uniform distribution ( $r_1 = 1.0$ ). When  $r_1 = r_2$  we will call the mechanism "symmetric", while when  $r_1 \neq r_2$ , the mechanism is "asymmetric". Before the bidding takes place, B observes  $V$  but not  $C$ , and S observes  $C$  but not  $V$ . B's strategy is a function  $\beta$  that determines his bid  $v$  for each value of  $V$ , and S's strategy is a function  $\gamma$  that determines his bid  $c$  for each value of  $C$ . Thus

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

The buyers' and sellers' profits are, respectively,

$$\phi_B = \begin{cases} \frac{V - (v+c)}{2} & V \geq c, \\ 0 & v < c, \end{cases} \tag{3.2}$$

$$\phi_S = \begin{cases} \frac{(v+c)}{2} & V \geq c, \\ 0 & v < c, \end{cases} \tag{3.3}$$

Suppose that the parties are risk neutral, so that, for a given pair of strategies,  $\beta$  and  $\gamma$ , 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 (1.1) - (1.3) 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 ( $r_1 = r_2 = 1.0$ ) defined over the closed interval  $[0, 100]$ , 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:

$$v = \begin{cases} V & V < 25, \\ \frac{25}{3} + \frac{2}{3}V & V \geq 25 \end{cases}$$

$$c = \begin{cases} C & C > 75, \\ 25 + \frac{2}{3}C & C \leq 75, \end{cases}$$

At the equilibrium, the buyer bids his value for all realizations less than 25, but under-bids for all realizations above that value, while the seller bids his cost for all realizations greater than 75, and overbids for all realizations below that value.

Myerson and Satterthwaite [1983] have demonstrated that this particular equilibrium has a very strong welfare property: It maximizes the ex ante gains from trade that can be achieved at any Bayesian-

Nash equilibrium of any individually rational bargaining mechanism employed in this environment, in which what the seller received equals what the buyer pays.

There are other equilibria to this mechanism as Leininger, Linhart, and Radner [1989] and Satterthwaite and Williams [1989] have shown. In fact there are an infinite number of other such equilibria, some of which involve continuous but non-linear bid functions and some of which involve discontinuous step-functions.

In the theory of bargaining under incomplete information quite a bit of attention has been focused on the sealed-bid mechanism mostly because of the Myerson-Satterthwaite result that the linear equilibrium of this mechanism is the only equilibrium of any mechanism capable of achieving second-best welfare results.

In a set of experiments, Radner and Schotter (1989) test the sealed bid mechanism and found that, at least in the laboratory, it performed as well or in some cases even better than the theoretical prediction. (This result was replicated by Rapoport and Fuller (1992) in a slightly different design.) More precisely, they found that subjects did, in fact, tend to use linear bidding strategies and as a result were capable of achieving efficiencies that were at least equal to second-best optimal efficiencies.

Since theory tells us that the linear equilibrium of the sealed-bid mechanism is the only one capable of achieving these efficiencies and laboratory experience supports this contention, it would appear that our search for an optimal way to structure bargaining is over. Ironically, however, simple unstructured face-to-face bargaining does even better. That is, for bargaining situations the mechanism in which people simply sit face to face and bargain with each other in an unstructured manner appears capable of achieving almost first-best gain from trade. Evidence for this laboratory stylized fact is born out by experiments on Coasian bargaining performed by Hoffman and Spitzer (1982) and others, in a complete information context, and by the face-to-face bargaining experiments of Radner and Schotter (1989) where face-to-face bargaining seemed to be remarkably efficient in attaining first-best gains from

trade in incomplete information bargaining situations. Anonymous procedures like those of Roth and Mordigham (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 a 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)).

From the description of these results it is obvious that we have a mechanism selection problem here since we are faced with a problem (how to structure bargaining within an organization) and two competing mechanisms that can be used to solve it -- the sealed bid mechanism and the face-to-face bargaining mechanism. Which one should we choose? It is at this point that the criteria which we specified in Section 2 come into play. On many of the criteria there are no real differences between these two mechanisms. For example, both are easily understandable and fair in the sense that the rules treat each agent in a strategically symmetrical manner. As we will see later when we review the Linhart, Radner, Schotter (1993) paper, on both a theoretical and an empirical level the sealed-bid mechanism is strategically robust in the sense that its efficiencies are relatively high and invariant to considerable deviations of the bidding strategies of subjects away from truth-telling. From the small face-to-face bargaining experiment run by Radner and Schotter (1989) face-to-face bargaining also seems to be a robust mechanism in that it almost always leads to efficiencies close to the first best levels. Theoretically it is, of course, not possible to say anything about unstructured face-to-face bargaining since one can not write down the game form describing it. The big differences between the mechanisms pertains to the efficiency and personality robustness criteria.

On efficiency grounds face-to-face bargaining seems to dominate the sealed bid mechanism. To illustrate this point let us look at Table 1.

Table 1  
Disagreement and Inefficiency Rates

Experiment Type	Number of Observations	Disagreement Rate (%)			Inefficiency Rate (%)		
		1st 7 rounds	Last 8 rounds	Total	1st 7 rounds	Last 8 rounds	Total
Face-to-Face	150	6	6	6	1	1	1
Sealed Bid Bargaining	150	25	32	30	13	14	13

In this table we assess and compare the performance of the sealed-bid and face-to-face bargaining mechanisms using various measurements of **inefficiency**, or the failure to realize potential gains from trade when these potential gains are positive.<sup>1</sup> 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. As we see from Table 1, both in terms of inefficiency and disagreement rates, face-to-face bargaining outperformed the sealed-bid mechanism. While the sealed-bid mechanism was able to capture 87% of the first-best gains from trade, face-to-face bargaining captured nearly 99%

Where the face-to-face mechanism failed is in the variance of the payoffs to the players and the prices formed. The face-to-face mechanism determined payoffs which varied greatly across experimental bargaining pairs as did the prices formed. For example, while the mean payoff to a buyer (seller) in the

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<sup>1</sup> In both experiments the prior distribution had coefficients  $r_1 = 0.4$  and  $r_2 = 0.4$ .

face-to-face experiment was 30.53 (28.88), the variance around those means was 502.93 (561.33) respectively. For the sealed bid mechanism the mean payoffs were 32.49 (35.79) respectively for buyers and sellers while the variance around these means were 270.45 (352.27). In short the variability of payoffs and prices was around 30% smaller in the sealed-bid mechanism when compared to the face-to-face mechanism. The histograms of these payoffs are presented in Figures 1a and 1b.

#### Figures 1a and 1b

Note that the distribution of buyer and seller payoffs are far more spread out in the face-to-face bargaining experiment than they are in the sealed-bid mechanism. A similar result can be seen in the price data as portrayed in Figure 2.

#### Figure 2

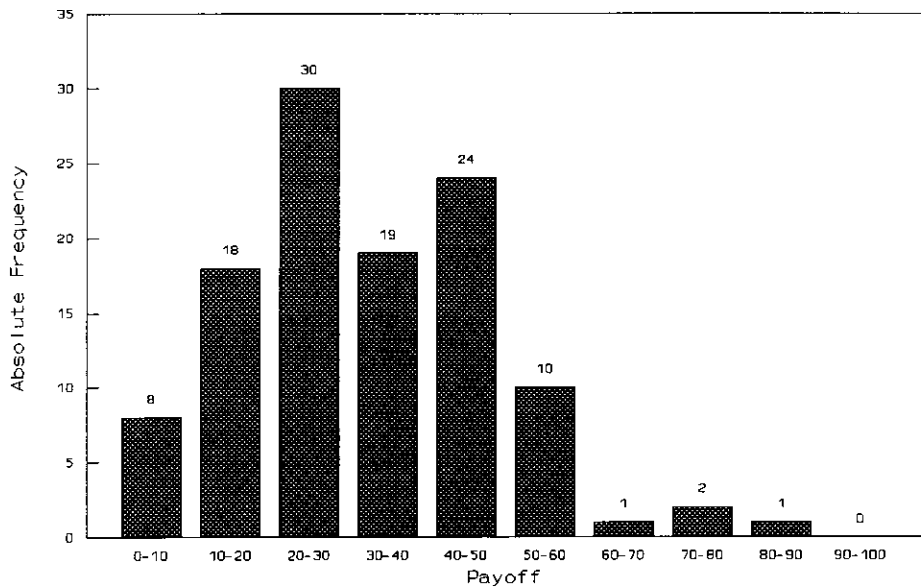
From this data we conclude that while both mechanisms may be robust in the strategic sense, the face-to-face bargaining mechanism is not robust to the personalities using it. What this means is that when two people face each other in face-to-face bargaining, while the outcome is likely to be efficient, the distribution of gains to trade and the prices formed are likely to be widely dispersed and dependent on the personalities of the people doing the bargaining. This has a number of consequences. First, it implies that for reasons of risk aversion, the sealed-bid mechanism may be preferable to the face-to-face mechanism since although it has a lower mean efficiency, the payoff to any one side using the mechanism has a smaller variability. Second, since bargaining in the future is likely to be done by agents unknown to today's principals, decision makers may want to opt for the security of a mechanism that protects them from the variability introduced by not knowing what agents will use the mechanism in the future. This

Figure 1

(A)

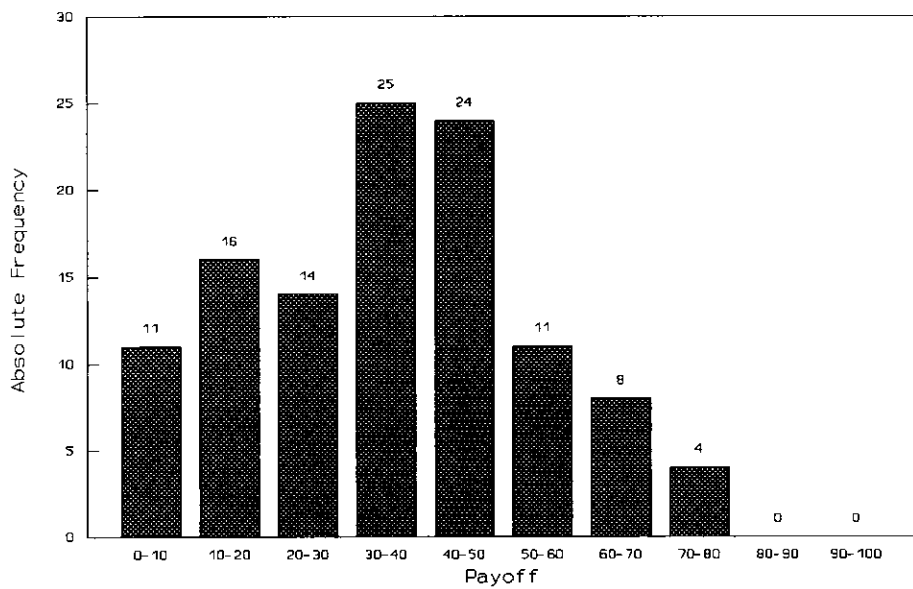
### Histogram For Buyers' Payoffs

Sealed-Bid Bargaining



### Histogram For Sellers' Payoffs

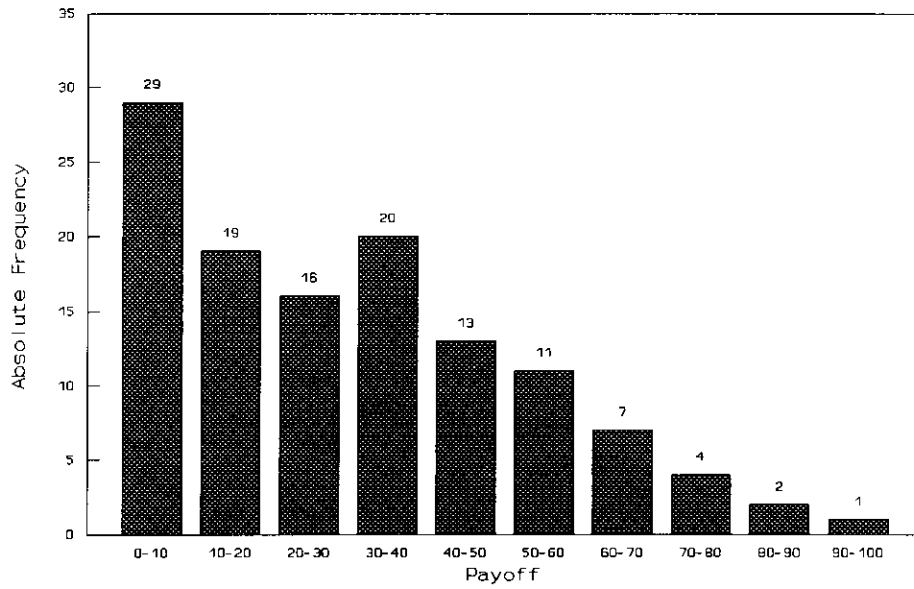
Sealed-Bid Bargaining



(B)

### Histogram For Buyers' Payoffs

Direct Face-to-Face Bargaining



### Histogram For Sellers' Payoffs

Direct Face-to-Face Bargaining

