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Department of Economics

Working Paper 89-12

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June 1989

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We would like to thank the participants at the Summer 1989 Econometric Society Meetings in Ann Arbor and at the 1989 Economic Science Association Meetings in Orlando for their helpful comments. We also thank John Van Huyck for comments on an earlier draft. Financial assistance from the National Science Foundation and the Center For Energy and Mineral Resources at Texas A&M University is gratefully acknowledged, as is support for Wiggins' research through the Institute for Innovation and Design In Engineering at Texas A&M. The order of names is random.

Abstract

This study examines the choice between relational contracts and firms in an experimental market setting. The study uses a theoretical operationalization of Williamson's arguments that markets (contracts) feature 'high-powered' incentives, while firms offer better communication. The paper investigates the types of information flows that can sustain relational contracts, and how this influences the choice between contractual and firm allocation. Specifically, when information flows are good, buyers can identify cost distortions by sellers and reallocate business to sellers who do not extract rents through cost distortions. The equilibrium result is then a contract similar in spirit to Williamsonian 'relational contracts.' These contracts sustain low cost adjustment to cost shocks while preserving the strong incentives of residual claims compensation. The analysis shows that surprisingly weak information flows can sustain such relational contracting. When information flows become sufficiently weak, reputational incentives deteriorate, and firms are chosen over contracts.

An unexpected result is that the analysis identifies an important Keynesian average opinion problem in institutional choice. Specifically, subjects' prior beliefs about optimal reporting behavior, and beliefs about beliefs and so on, play an essential role in the equilibrium. These beliefs determine subjects' initial choices of institutional form when information treatments are changed. These beliefs can differ, and updates depend on the past history of the individual subjects. The result is heterogeneity in institutional choice that can persist as a market equilibrium. Hence the experimental results suggest that existing treatments of institutional choice, which typically ignore this potentially important problem may be seriously incomplete.

There has been a recent burgeoning of interest in the economic forces that mold institutional choice.[1] This paper offers two contributions to this literature. The first contribution is to apply laboratory experimental methods as a way of testing theories of institutional choice.[2] The specific choice we examine is that between a Williamsonian 'relational' contract and firm allocation. The study shows how information flows affect the incentives of sellers to develop reputations for honest cost reporting under contracts, and how these reputational incentives in turn feed into the choice between these stylized 'relational' contracts and firm allocation.

The second contribution of the study is to identify an important strategic interdependence problem in institutional choice. Such interdependence is an issue because equilibrium depends on the beliefs of buyers regarding the beliefs of sellers, the beliefs of sellers regarding buyer beliefs, and so on. Since optimizing generally depends on the strategic choices of other agents, beliefs about those choices can have an important influence on the final equilibrium. Since beliefs about strategic choices can differ there can be heterogeneous choices of institutions and reporting behavior. Without reasonably strong information flows this heterogeneity can persist in equilibrium.

The analysis considers the institutional governance of a vertical relationship between the buyer and seller of an input. The study follows Wiggins (1988a) by operationalizing a contract as an arrangement where the seller is compensated as a residual claimant of the upstream stage. This compensation arrangement creates a strong incentive for effort, but also creates an incentive to distort cost shocks to reallocate profits from the downstream buyer to the upstream seller. In contrast, vertically integrated production is defined as an arrangement where the upstream manager is compensated through a fixed wage. Such a wage surmounts the incentive to distort the shock, but only at the cost of reduced incentives for effort. The

theoretical prediction is that when distortion of cost shocks is an important problem, there will be an incentive for subjects to choose firms over contracts. When such distortions are less important, parties will wish to avoid the weak incentives provided by a wage, and will use long term contracts.

This paper experimentally examines reporting behavior under contracts and firms, and then analyzes how this affects the choice between these two institutions. Specifically, sellers compete in a market for institutional choice by offering to supply under contract, where they are compensated as a residual claimant, or as an employee where compensation is through fixed wage. Buyers then choose among sellers and the various compensation arrangements they offer, enter into a supply agreement, and then there is a conceptual investment in a specific asset. After this investment a cost shock is realized, which sellers report to buyers. Hence there is a competitive ex ante market for institutional form, and this results in a long term relationship, which here lasts a "period." During this period there is a need to adjust to shocks, and the study investigates the reporting performance of agents compensated as they are in stylized firms, and under residual claims compensation associated with relational contracts. The analysis then shows how this affects institutional choice.

A key element of the competitive strategy space of sellers is their reporting behavior. Under contracts, sellers have an incentive to over-report costs because of the short term gains from a higher transfer price. The disadvantage of such over-reporting is that it reduces the profits of buyers, distorts output, and reduces overall surplus. Hence it creates a particular form of rent dissipation, and this means buyers have an incentive to contract with sellers who report costs accurately. The implication is that sellers face a standard reputational tradeoff where they are tempted to cheat to raise short run profits, but face a countervailing potential loss of future business.

Information flows affect this process because they determine how easy it is for buyers to identify honest reporting, and to allocate business accordingly. When information flows are good, buyers can identify and contract with sellers who report honestly, creating a strong incentive for honest reporting; the result is a Williamsonian type relational contract where prices can be efficiently adjusted ex post in response to shocks. When information flows are poor, however, buyers cannot identify sellers who over-report, undermining the reputational equilibrium. The resulting cost distortions under contract create an incentive for buyers to opt for firm allocation.

The key issue then is to identify the types of information flows that are sufficient to sustain relational contracting, and show how these flows influence the choice between contracts and firms. The results show that information flows affect reputation formation, in the expected way, and that surprisingly weak information flows sustain relational contracting. The implication is that relational contracting, and reputation formation work for an extremely wide range of information conditions. Still, there are some conditions where information flows are quite weak, and then subjects choose firm allocation over contract.

An important, unexpected result is the key role played by heterogeneous subject beliefs in the final equilibrium. The results show clearly that various buyers and sellers begin new information conditions holding different subjective prior probabilities regarding the incentives of sellers to report honestly under contract. These heterogeneous priors affect buyers' calculation of expected profits in a new treatment, and lead to variation in the calculation of expected profits. These variations lead to differing initial choices of institutional form.

As buyers experience seller reporting behavior in a new information condition, they then update their initial expectations. When buyers commonly observe the reporting

behavior of all sellers, there is both a strong incentive for sellers to report honestly, and good information that they are doing so. In this case, the equilibrium converges to truthful reporting under contract, and any initial variation in perceptions is transitory. When buyers are restricted to only observing information about reporting behavior in their own contracts, however, there is less incentive for sellers to be honest--because fewer buyers observe the cost report--and buyers do not learn about the reporting behavior of other sellers in contracts. The result is that initially sellers often adopt heterogeneous cost reporting strategies, and these heterogeneous strategies can persist. This means buyers who sample contracts may experience different histories. These heterogeneous priors and differing experiences lead to variation in choices of institutions. When information flows are private, moreover, there is no general assurance that parties will converge to a common posterior; heterogeneities in institutional choice can persist in equilibrium.

To our knowledge this is the first work to identify the possibility of such heterogeneity in institutional choice. Hence the experimental results raise a new and potentially important set of issues in the general economic analysis of equilibrium institutional choice.

The remainder of the paper is organized as follows. Section 1 provides a conceptual background beginning with the existing theory of institutional choice, and then investigates the nature of the sequential reporting equilibrium. Section 2 incorporates this into an experimental design, and Section 3 presents the results.

Section 1. Conceptual Background

1.A. The Static Williamsonian Tradeoff

The theoretical model investigated provides a simple, rigorous operationalization of Williamson's (1985, 1988) tradeoff between the 'high-powered' incentives of markets, with greater flexibility and communication under firm allocation.[3]

To see the general set-up, consider a vertical production process that consists of two stages. For example, one might think of automobile manufacture, and consider the upstream stage of tire production.[4] Following the early literature, assume there is a specific asset that rules out spot exchange, and creates an incentive for a long term relationship, though here this long term relationship will be collapsed into a single "production" stage. The central question is when agents will choose to vertically Integrate tire-making into the auto firm (or vice versa), and when will they choose instead to use a long term contract.

The analysis here operationalizes the Williamsonian tradeoff through differences in the compensation structures found under contracts and firms.[5] Under a (long term) contract there are two distinct firms, and the interests of the manager of each stage are wed to his own firm. This is operationalized by having the manager of each stage of production be compensated out of the residual of that particular stage. The advantage of such an arrangement is that the upstream unit fully internalizes the returns to cost reduction, and so will produce at minimum cost. The disadvantage is that because the upstream monitor is compensated out of upstream earnings, there is an incentive to rent seek by reallocating revenues between the stages; the Independence of the two firms creates an implicit competition between the two states. In particular, when there are cost shocks upstream there Is an incentive to distort the adjustment process to reallocate profits upstream, as in a cost-plus contract.

Figure 1 illustrates. Assume that a contract consists of a (possibly nonlinear) price schedule $P'(\cdot)$ that defines a payment made from the downstream firm to the upstream firm for inputs, and that under the contract the downstream firm sets output by "ordering" units. The transfer price determines payments between the two stages, and implicitly determines the level of output the downstream firm will set. When there are cost shocks and parties attempt to adjust the transfer pricing rule and output, the upstream manager has an incentive to claim high costs to reallocate profits upstream.

Such misreporting inhibits adjustment of the transfer pricing rule, and undermines low cost output adjustment in response to the shocks. For example, the upstream monitor who observes cost level $C_0'(\cdot)$ in Figure 1 will have an incentive to report the higher level of costs $C_1'(\cdot)$ $(= P_1'(\cdot))$, which will reallocate the shaded area of profits from the downstream stage to the upstream stage. This inhibits adjustment because the overstated transfer price distorts output and reduces overall surplus. Hence contracts create strong incentives that lead to minimum cost production, but also leads to costly distortions of contractual adjustment processes.[5]

The lower cost adjustment to changing conditions ascribed by Williamson to internal (integrated) allocation is achieved here theoretically by compensation arrangements that attenuate the competition between the two stages found under contractual compensation. This attenuation of competition improves information flows and lowers adjustment costs. The simplest example of such an arrangement is a predetermined wage, or a wage plus a bonus tied to the overall integrated firm's performance.[7] A manager so compensated has no incentive to reallocate profits between stages, because such reallocation will increase neither a fixed wage nor a bonus tied to integrated profits. Hence firm compensation attenuates incentives to reallocate profits between the stages.

The advantage of such an arrangement is lower cost adjustment to shocks. Specifically, when cost shocks occur the employee-manager does not have an over-riding incentive to claim costs are high as under contract.[8] This lowers the cost of adjusting both transfer prices and quantities in response to shocks. The result is better communication within the firm, à la Williamson, and more flexibility. The disadvantage of firm incentives is that they generally provide less incentives for effort in equilibrium, as for example under a fixed wage.

The net result is a simple static tradeoff. With contracts there is an incentive for minimum cost production, but imperfect adjustment to shocks. With firms there is lower cost adjustment to shocks, but a failure to achieve minimum cost production.

l.B. Repeated Dealing, Reputation, and Relational Contracting

This tradeoff becomes richer in a dynamic context because reputation provides an additional means to discipline parties. Of particular interest in the experimental analysis below is the possibility that reputations can surmount the incentive for over-reporting under contract, leading to 'relational' contracts. A key feature of such contracting, according to Williamson (1979), MacNeil (1974, 1978), and Goldberg (1976), is that contracts are essentially incomplete at the time of the initial agreement. Instead, parties adjust the terms of such contracts over time as new information arrives.

One key ingredient of low cost relational adjustments of contract terms will be the ability of reputational incentives to discourage parties from distorting the adjustment process for their own benefit. Reputation can deter over-reporting if the current trading partner becomes reluctant to renew the contract, or if others become reluctant to enter new agreements. This means that a seller who considers over-reporting must trade off the immediate gains against the longer-term possible loss of future business.

Hence there emerges a standard reputational tradeoff of current gains versus future losses.

An essential element of such reputational incentives will be the size of potential losses of future business from over-reporting. When such losses are large, reputational incentives will be strong, and ex post adjustment to new information will be effective and low cost. As potential losses become small, however, reputational incentives will break down, and contractual adjustment becomes costly and imperfect.

To see agents' incentives and the reputational tradeoffs more clearly, consider buyers and sellers who will enter a series of contracts similar to the one described in Figure 1. A seller who over-reports receives in the short run the shaded area as described above. The opportunity cost of such over-reporting is the potential loss of future business. These losses consist of a possible termination of the existing contract together with a loss of potential future business. A simple way to capture this loss of business is to consider a simple necessary condition. Specifically, for a reputational equilibrium to be viable the instantaneous gains to over-reporting must be smaller than the largest possible loss of business that could result from over-reporting. This formal necessary condition is:[9]

$$(1)\quad [R_i^{\omega}(t_o) - R_i^{H}(t_o)] \leq E\{\Sigma_{t\epsilon(t_o,\tilde{T}]}\ [\delta_i(\omega|I)]\cdot R_i(t) + \Sigma_{j\neq i}\ \Sigma_{t\epsilon(t_o,\tilde{T}]}[S_j(\omega|I)]\cdot R_j(t)\},$$

where E is the expectation operator. The LHS represents the instantaneous returns from over-reporting, where R(t) is period t net returns under a contract, w signifies the over-report, and H signifies honest reporting. The first term on the RHS represents expected losses of earnings should this contract be terminated, where 5(1) is the probability that over-reporting will be detected by seller i, I represents the information flow about reporting behavior and $\tilde{T}$ is the (random) termination period for

the treatment.[10] The second term represents the lost potential earnings from new business when the seller over-reports, where the probability $S_j(\cdot)$ is the probability that contract j will not be reallocated because of an over-report.

The characterization in (1) highlights two key hypotheses that set the stage for experimental testing. The first hypothesis is that as information flows improve, the current contracting partner becomes better able to detect over-reporting, and this raises the expected losses from possible termination of the current trading relationship.[11] Hence, improved information flows increase reputational incentives because they increase the likelihood that cheating will be detected, and result in termination of the trading relationship. As market-wide information flows improve, moreover, reporting behavior can also be observed by other buyers. Such observation raises the opportunity cost of over-reporting because market-wide information flows mean that reporting behavior is commonly observed and affects the likelihood of attracting business from other buyers. Hence information flows are a key determinant of the incentives of sellers to form reputations, and of the viability of low cost adjustment under 'relational' contracting.

The key hypotheses to be tested experimentally are then as follows. When information flows are sufficiently poor, reputations will not sustain low cost output adjustment under contract, and firm allocation will be chosen. As information flows improve, sellers will report more honestly under contracts, and the efficiency of contract will rise. When the expected efficiency of contract exceeds that of firms, then subjects will choose contracts over firms.

1.C. Beliefs and Equilibria

Before proceeding, it is also important to touch briefly on the role played by subjects' beliefs about strategies, and how these affect the nature of the equilibrium.

To see this, note that each seller will have subjective beliefs regarding the probabilities of termination, new business, and earnings: $\delta^P(\cdot)$, $S^P(\cdot)$, and R_i^P. To illustrate, one can simply rewrite equation (1) in terms of subjective beliefs:

$$(2)\quad [R_i^{\omega}(t_o) - R_i^{H}(t_o)] \leq E_S\{\Sigma_{t\epsilon(t_o,\bar{T}]}\ \delta(\omega|I)\cdot R_i^P(t) + \Sigma_{j\neq i}\ \Sigma_{t\epsilon(t_o,\bar{T}]}[\partial S_j^P(\omega|I)/\partial\omega]\cdot R_j^P(t)\},$$

where E_S represents subject expectations of the various relevant factors. These expectations can vary across sellers because they cannot know a priori how buyers will respond to various reporting strategies, and because both buyers and sellers will generally have heterogeneous beliefs and experience.

An "average opinion" problem emerges because buyers must form subjective estimates of seller beliefs regarding the tradeoffs in equation (2), because sellers must also forecast buyer beliefs about seller behavior, and so on. Specifically, before buyers can know whether to choose contracts or firms, they must determine seller expectations regarding equation (2). In other words, buyers must determine a priori whether sellers believe the penalties of over-reporting will be sufficiently severe to make it unattractive.[12]

If a buyer's subjective prior suggests sellers will cheat, then that buyer will not accept seller offers of contracts. On the other hand, buyers may accept contracts, but do so with significant worries about over-reporting. Such a "skittish" buyer will then opt out of contract at the first relatively high cost report, which makes the reputational horizon short. Finally buyers may have a firm belief that sellers will be honest, providing a long reputational future, and substantial returns to honest reporting. Regardless of which strategies are actually followed, then, optimal behavior depends on beliefs, on beliefs about beliefs, and so on; the game is an average opinion game as in Keynes' beauty contest.

One interesting feature of this problem is that symmetrically endowed people may behave asymmetrically by choosing heterogeneous institutions to govern a given allocation. Such variation in choices will occur either if various buyers have differing subjective priors regarding seller reporting behavior, or if they have experienced different reporting histories when information flows are weak.

With strong information flows, one would expect such heterogeneities to break down over time. When information flows are weak, however, heterogeneities can persist in equilibrium. To see why, note that buyers who believe sellers will cheat under contracts have an incentive to choose firm allocation, and so they gain no new experience with reporting behavior under contracts; their beliefs persist. If sellers appear to report honestly under contracts, buyers in contracts will continue to use contracts. Meanwhile, buyers choosing firms will also continue if they do not have access to information regarding reporting behavior in other trading relationships. Hence there is a true equilibrium with persistent heterogeneities in institutional choice.

The erosion of such heterogeneities requires some degree of market information flows. Such flows could include actual reporting behavior under contracts, or perhaps could be as weak as simple market share data regarding equilibrium institutional choices. In any event some level of market information flows are necessary, and the precise level required is an empirical question to be examined in the course of the experiment.

We now turn to the experimental design.

Section 2 Implemented Theory and Experimental Design

The design consists of two basic sets of issues. The first issue is the operationalization of the technology, compensation arrangements, and information flows

defined in Section 1. The second set of issues regards the creation of a laboratory-experimental market where subjects can choose between firms and contracts in the ways described. We now examine these issues in order.

Section 2.A. Contracts and Firms in the Laboratory Microeconomy

The first step in the experimental design was to create experimentally the basic model described in Section 1. Formally, assume there are buyers and sellers trading fictitious units of an input X, and the production cost is

$$(3) \quad C(X;\epsilon) = \tilde{\alpha} + \beta X + \epsilon = \alpha + \beta X,$$

where X is output, ϵ is a stochastic cost shock with finite variance, $\alpha = \tilde{\alpha} + \epsilon$. Similarly, the downstream firm's revenue function is

$$(4) \quad R(X) = \delta - \theta X.$$

The desire to contract or enter into a firm is motivated in the theory by investment in a set of specific assets that link together the buyer and the seller before production, but these assets are not modeled explicitly.[13]

The time line of the game is illustrated in Figure 2. Buyers and sellers agree ex ante to terms of trade in either a contract or a firm. They then make a hypothetical investment in a specific asset that lasts for a generic production period and enables production. After investment, cost shocks are realized and privately revealed to the seller who then reports cost to the buyer through a transfer pricing schedule. This transfer price determines the marginal cost of the input to the buyer, and after the report, quantity is set to maximize the buyer's residual surplus.

Under contract the seller is compensated out of the residual of the upstream "firm." This residual consists of a lump sum payment from the buyer, together with the

difference between the marginal reported cost (transfer price) and actual marginal cost. To simplify the design, the slope of the transfer price schedule was set exogenously, so that sellers cost reports consisted of reporting an intercept of the cost schedule. Figure 3 illustrates. Marginal cost is given by $C'(X;\epsilon_o)$ with an intercept α_o $(= \bar{\alpha} + \epsilon_o)$, and the cost report made by the seller is $\hat{\alpha}$ $(= \bar{\alpha} + \hat{\epsilon})$. The seller then receives the area between reported marginal cost and actual marginal cost, shaded area B in the figure, plus a lump sum transfer. Algebraically, this becomes:

$$(5) \quad \int_{\hat{X}} [\hat{\alpha} - \alpha_o]\, dX + L_c,$$

where α_o is the actual cost intercept, $\hat{\alpha}$ is the reported intercept, which becomes the intercept of the marginal transfer price, and L_c is the lump sum transfer under contract. After the cost report, the buyer sets output to maximize profits given the transfer price. When unconstrained by reputational incentives, the seller will report cost, $\hat{\alpha}$, to maximize area B, much as a monopolist optimally sets price. Just as with monopoly, however, this over-reporting leads to a standard deadweight loss, illustrated as Area C in Figure 3.

Under contract the buyer is compensated out of the downstream residual which is the difference between marginal revenue and the marginal transfer price, area A in Figure 3, minus the lump sum transfer. Algebraically this is

$$(6) \quad \int_{\hat{X}} [(\delta - \hat{\alpha}) - (\beta + \Theta)X]dX - L_c$$

Under firm allocation (vertical integration), in contrast, the employee-seller is compensated through a fixed wage, W. Under a firm the buyer is assumed to be the overall residual claimant in a firm, and receives compensation of

$$(7) \quad \int_{\hat{X}} [(\delta - \hat{\alpha}) - (\beta + \Theta)X]dX - W.$$

The differential reporting incentives under contracts and firms emerges clearly from the differing compensation arrangements. The compensation arrangements under contract create two conceptually distinct firms. When the supplier over-reports costs under contract, the residual claims compensation imply that the supplier retains the difference between actual and reported cost, and this incentive is operationalized in the laboratory compensation schedules. In contrast, an employee manager of an upstream plant is generally compensated out of a fixed wage, and cannot appropriate differences between actual and reported costs; this fixed wage gives the seller a (weak) incentive to report actual cost to the seller.

In the process of implementing the model, control required that this weak incentive to report truthfully be strengthened. To do so a small auditing parameter was added to the laboratory model. This parameter consisted of a probability that over-reporting of costs would be detected in an 'audit,' and penalties levied. Following Grossman and Hart (1986), however, it is important to treat auditing in contracts and firms symmetrically. Accordingly, this auditing parameter was added to compensation arrangements under both firms and contracts. Operationally, auditing consisted of a one-third chance that a cost over-report would be detected, and when detection occurred a penalty of $0.75 was levied.[14]

The focus of the laboratory experiments is on the information flows necessary to generate efficient relational contracts, and whether subjects will then choose contracts and firms efficiently given these information flows. In contrast, the present analysis does not deal directly with the deficient incentives for effort under a fixed wage. Accordingly, it was decided to parameterize the underprovision of effort associated with a fixed wage as an exogenous twenty five percent reduction in the

maximum available joint surplus under firms compared to that available under contract.[15] Conceptually, this amounts to an upward shift in the upstream cost curve due to shirking behavior.

The central issue then regards when sellers will have sufficient incentives to develop reputations for honest reporting under contract, and two key experimental variables affect these reputational incentives. These incentives, which are formally described in equation (1), are i) the likelihood that over-reporting (or honest reporting) will be detected, and ii) a loss of earnings to sellers who are identified as over-reporting.

The first step in creating such reputational incentives in an experimental environment is to ensure that when sellers lose business through over-reporting this leads to a significant loss in earnings in future periods; otherwise reputational incentives will fail uniformly. The experimental design created the potential for lost earnings by using an unbalanced market design; there was excess seller capacity in the market to form contracts and firms.[16] Specifically, there were six buyers and six sellers in the market, but each buyer was allowed to form only one contract, while each seller could form six. This imbalance means that each seller has enough capacity slots to serve all buyers. The implication is that when a seller loses a contract due to overreporting, she can easily lose the earnings of the associated "capacity slot" for the remaining horizon. Equally important, when buyers commonly observe all cost reports as "market information," a seller making a low cost report can attract contracts from other buyers, creating powerful reputational incentives. Hence, when buyers have sufficient information to ascertain reporting behavior, they will have an incentive to allocate business to sellers who report honestly, creating one important underpinning for a reputational equilibrium.

The problem created by an unbalanced market is that under such designs the resulting competition often bids marginal seller earnings to zero.[17] The reason is that the associated excess capacity creates an incentive for Bertrand competition in which sellers continually undercut each other's offers to attract buyer acceptances. Without additional constraints, this undercutting frequently will drive seller returns to zero.[18] With zero returns for sellers, however, saliency is lost because all seller strategies result in equivalent (zero) returns. If bidding requires effort (disutility), sellers will either not bid, or will bid randomly.

To ensure that sellers receive strictly positive earnings from both contracting and firm allocation, rules were built into the design to prevent sellers from bidding away all of their earnings. Specifically, the design included a minimum lump sum transfer rule, a rule preventing sellers from reporting cost <u>below</u> actual cost, and a small capital payment made to sellers each period.[19] The implication of this set-up is that sellers earn positive returns from each contractual and firm relationship.

These minimum payments, together with the returns sellers earn from over-reporting, are a key element of the experimental design. To see their important role, consider the special case of equation (1) that focuses solely on a single contractual relationship (i.e. honesty cannot attract business from other buyers). Accordingly, reputational incentives will discipline sellers when

$$(8) \quad [R_i^{\omega}(t_o) - R_i^{H}(t_o)] \leq E\{\Sigma_{t\epsilon(t_o,\tilde{T}]} \; [\delta(\omega|I)]^t \cdot R_i(t).$$

Letting $R_i(t)$ be constant over time, one can factor R, and divide through to get:

$$(9) \quad \{[R_i^{\omega}(t_o) - R_i^{H}(t_o)]/R_i(t)\} \leq E\{\Sigma_{t\epsilon(t_o,\tilde{T}]} \; \delta(\omega|I)$$

Holding the likelihood of detection and the expected length of the future constant, then, the viability of a reputational equilibrium turns critically on the immediate returns to cheating compared to the per period returns from honesty.[20]

The design parameters were chosen to focus attention on the role of information flows in sustaining a reputational equilibrium. Consequently it was important to ensure that R_i was sufficiently large that if buyers detected cheating, and if they chose to reallocate business, then the losses to sellers would outweigh the gains to cheating; otherwise a reputational equilibrium is simply not viable. With these considerations in mind, the parameters were chosen so that if sellers bid the lump sum transfer to the boundary, which they generally did, the expected returns to contract under honest reporting were $.60.[21] The marginal returns to over-reporting varied with the cost state, but the expected returns to cheating were $.77. With these parameter values the costs of being detected cheating become large, even when there is a relatively short expected future. The implication is that the effectiveness of reputational incentives will be determined by the likelihood of detecting over-reporting, which will then determine the choice between contracts and firms.[22] The key element, then, is the flow of buyer information regarding seller reporting behavior.

Section 2.B. Information Flows and Relational Contracts

There are different kinds of information conceptually available to buyers attempting to assess seller cost reports. One kind of information that buyers of inputs will frequently have is reasonable forecasts about the distribution of possible costs, and so this cost information was provided to subjects as common knowledge throughout the experiment.[23]

In addition, there are a variety of other types of information buyers may have in particular market settings, but not in others. These variations in market information

form the conceptual underpinnings of the differing information conditions used in various treatments in the experiment.

In some settings it is reasonable to suppose that buyers have reasonably good cost information about all sellers in a market. The value of this information, however, will vary according to the underlying cost structure, and three different treatments were used to capture these differences. In treatment A buyers know the cost reports of all sellers, as well as the actual cost state; this very powerful set of information should be thought of as a baseline in which buyers are (ex post) perfectly informed. Treatment B backs off of this baseline in that buyers are not provided with actual cost. Treatment C backs off further by allowing sellers to have independent cost shocks, so that buyers cannot learn about the honesty of their own seller by observing the cost reports of other sellers.

Together these treatments provide a comparatively rich characterization of the various market environments in which buyers have relatively comprehensive access to the costs of various sellers. In A buyers know actual cost and all reports, in B costs are perfectly correlated, and since buyers see all sellers' cost reports, cost is likely to be effectively revealed. In C there is market information, but it is less useful because each trading relationship is idiosyncratic and specialized. The experimental question then is how well reputations will work with market level information, and whether the independence of cost shocks in treatment C will have a material affect on reporting behavior and the choice of institutional form.

In other market settings buyers have more limited information. Specifically, as exchange becomes more idiosyncratic, market level information will be unavailable, or not a reliable indicator of cost conditions in a particular exchange. This setting provides the strongest test of "relational" contracts because of the limited nature of buyer information. These sorts of information were examined experimentally in

Treatments D, E, and F. In treatment D sellers were identified, but subjects only saw the cost reports for their own agreements; buyers could maintain a cost reporting history for sellers in their own agreements. Treatment E breaks down information flows further by obscuring seller IDs, so that buyers could only keep track of a seller so long as their relationship continued. This effectively means that buyers can only reward honest cost reports by continued dealing. Treatment F suppressed seller ID's and agreements were terminated exogenously each period; the lack of a mechanism conveying information across time was expected to effectively break down reputational incentives. These three treatments then form a reasonable coverage of the kinds of information flows one might have when exchange is highly idiosyncratic so that cost conditions across exchanges are essentially noncomparable.

Overall, then, the six treatments summarized in Table 1 span a large portion of the space of potential information flows. The key questions then are what kinds of information flows can sustain relational contracting. When information flows are sufficient to sustain such contracting through reputational incentives, then it is hypothesized that contracts will be chosen over firms. As information flows weaken, reputational incentives should weaken and the efficiency of contract is expected to deteriorate. When this efficiency declines sufficiently, firm allocation is expected to supplant contracts.

Section 2.C. Technical Implementation

The design used in this study creates a market for institutional form, similar to the one used in Hackett, Battalio, and Wiggins (1988).[24] The market for contractual form, subject's incentive structures, and environments are illustrated in Table 2. The payoff information was summarized for subjects in the form of payoff tables, which are illustrated as the top two panels, A and B.[25] In these panels column outcomes

correspond to realized cost while row outcomes correspond to the cost reports made by sellers to buyers. Accordingly, elements along the diagonal correspond to honest reporting, and cost over-reporting corresponds to reporting a row number greater than the column number.

The essential differences between contracts and firms are incorporated in these payoff tables. Specifically, Panel A shows that over-reporting increases profits for sellers under contract, while Panel B shows that such reporting does not raise compensation under firm allocation. Buyer payoffs, however, depend on cost reports, under both firm and contract because such reports determine the effective transfer price and output. As one can see, high cost reports reduce buyer payoffs. Finally the payoff tables operationalize the weaker incentives under firms in that for any given cost report, buyer payoffs are less under firms than under contracts.

To facilitate subject learning, these compensation structures were common knowledge, and were available to subjects on their computer screens and in printed form throughout the experiment.[26] While common knowledge of payoffs facilitates learning, Smith (1982) has pointed out that it can lead to interpersonal utility comparisons, which may upset otherwise well-defined induced valuations. Accordingly, we adopt the widespread convention of conveying qualitative incentives through common knowledge payoff tables, but then limit interpersonal comparisons by denominating payoffs in experimental 'francs,' and by then keeping subjects' exchange rates of francs to dollars private information.[27]

Recalling Figure 2, the first step in the market period is an auction of institutional form, and this auction was run as a computerized, improving offer auction in (approximately) continuous time. During a market period, sellers could tender offers for forming contracts and firms. These offers consist of a fixed payment, which

corresponds to the lump sum transfer under a contract or the fixed wage under firm allocation.

Panel C of Figure 4 illustrates how these offers were made by presenting a simulated market environment as it appeared on buyer and seller computer screens in the course of the experiment. Sellers would enter a fixed payment and an institutional type--a contract (an "X" agreement) or a firm (a "Y" agreement), and this would appear on all buyer and seller screens. Buyers could observe both the amount of the offer, and the identity of the seller, and they were free to accept any offer on the floor.[28] After an agreement was formed it automatically continued until subjects chose to terminate it, which could be done either before or after forming a new agreement.[29] This endogenous termination allowed subjects to determine the effective life of a trading relationship.[30]

After the market for institutions closed, there was a cost shock privately revealed to sellers as the time line in Figure 2 illustrates. The cost shock was represented as one of seven equally likely column numbers in the payoff tables in Table 2.A. or 2.B., and corresponds to one of seven possible intercepts of a marginal cost curve. After the cost shock, sellers reported costs to buyers in the form of a row choice. After the cost reports, the computer set the profit maximizing quantity for the buyer, and payoffs were realized.

The final implementation issue regards the experience level of subjects. To familiarize the subjects with the experimental procedures, initial trainer experiments were run without institutional choice. In these trainers, subjects operated under information conditions A and B, but were restricted to either contracts or firms. Afterwards, the actual experiments involving institutional choice used only experienced subjects.[31]

Section 3. Analysis of Results

The experimental results address three important sets of issues. The first result addresses the primary motivation for the experiments, which is the endogenous choice between contracts and firms. The second set of results regards the kinds of information flows necessary to sustain 'relational' contracting. The final issue, which emerged in the course of the experiments, is the key role played by subject beliefs in equilibrium.

Section 3.A. The Choice Between Firms and Contracts

The central hypothesis is that when information flows are high, sellers will have an incentive to form reputations for honest reporting under contract; in this case contracts will be highly efficient and will be chosen over firms in equilibrium. When information flows are poor, sellers will not develop honest reputations under contract, and firm allocation will be chosen.

The market results for institutional choice and efficiency are given in Table 3, and these results provide strong overall support for the central hypothesis. The first column of the table shows the information condition, and these are arranged from the strongest information flows (at the top), to the weakest. The third column shows the percentage of contracts in the entire treatment, and the fourth that same percentage in the last period. Under the relatively powerful information treatments at the top, treatments A, B, and C, contractual allocation dominates throughout the treatment, and such allocation is the unique choice of all subjects in the last period.

The third column shows that contract works because the information flows are sufficiently strong to suppress over-reporting. In treatment A there is no over-reporting, and only in the first repetition of B is there any meaningful over-reporting. In treatment C there is some over-reporting, but it remains quite small.

The last column in the Table shows mean market efficiency, and shows that reputational incentives are sufficient in these treatments to permit allocations to be 95% efficient. Hence when information flows are good, reputational incentives lead to highly efficient 'relational' contracts. When reputational incentives support the low-cost adaptation of relational contracts, the superior incentive properties of such contracts make them superior to firms, and they become the equilibrium choice of institution. The experimental results then confirm this basic tenet of the theory.

The analysis also shows the key role played by reputational incentives in efficient relational contracting. When information flows become weak, reputations break down. This breakdown undermines low cost contractual adjustment and firms are chosen over contracts. This result is illustrated in the Treatment F, which is reported at the bottom of Table 3. Recall that in treatment F information flows are weak because history is destroyed each period. The data show that the resulting lack of reputational incentives leads to substantial over-reporting, as reported in column (5) of the Table. This over-reporting drives the efficiency of contract quite low.[32] The net result is that firm allocation is generally chosen over contracts, and firms become the equilibrium choice of institution. Specifically, firm allocation generally dominates throughout Treatment F, and firm allocation is the unique choice in the final period of both replications.

These results then provide a simple test of the central hypothesis of the paper, and generally confirm the underlying theory. When information flows are good sellers will have an incentive to develop reputations for honest reporting, and Williamsonian relational contracts will be chosen over firms. As information flows deteriorate, incentives for reputation and the relative efficiency of contract fall, and firm allocation eventually supplants relational contracting. We now turn to a more detailed

examination of the forces that mold reputational contracting and institutional choice.

Section 3.B. Information Flows. Reputation, and Relational Contracting

Treatments D and E were designed to investigate further the information flows capable of sustaining a reputations, and to provide balance in the design. To sever all information flows in treatment F it was necessary to terminate all agreements each period, since otherwise there is the information of continued dealing. Such termination, however, may also introduce a spurious pure termination effect. Treatment D controls for this effect by maintaining seller IDs, which preserves information about past reporting behavior, but then terminating agreements each period. Hence if simple termination per se interrupts the market and reputation formation, treatment D will account for these effects.

Treatment D also provided an intermediate level of information, which provides important information regarding the kinds of information flows capable of sustaining relational contracts. Specifically, treatment D has purely private cost reports, but seller IDs were used so that a buyer could keep track of seller reporting behavior over time. This treatment corresponds fairly closely to Williamson's "idiosyncratic exchange" where exchanges are sufficiently specialized that there is essentially no market information.

Treatment D, then, together with treatments B and C provide a reasonable continuum of the kinds of information flows that one might generally expect to be present in actual markets. Private reporting of cost under treatment D corresponds to settings where costs differ materially across economic trading relationships, so that cost reports by other sellers are not a very useful guide to one's own idiosyncratic cost conditions. Treatment C's public cost reports of independent shocks is similar to a setting where there are some cost differences, but there is useful public level of

information about the cost structures of various agents. Treatment B's common cost shocks correspond much more closely to a neoclassical setting.

The results show that there are effective reputation incentives in all of these treatments, and that these incentives permit low-cost contractual adjustment and relational contracting is highly viable in all of these information treatments. And while there are some differences in reporting behavior between treatment B, and treatments C and D, reputations were strong enough to generate contracts that were more than 93 percent efficient in all of these treatments. Hence reputational incentives appear to be a potentially powerful force in generating efficient relational contracting, even when information flows are relatively weak. The implication is a relatively strong confirmation of the incentive properties of relational contracting.

Given the powerful performance of reputations in Treatments C and D, Treatment E was designed to further explore the viability of low cost contractual adjustment. In particular, it was decided to pursue in Treatment E an extreme case to see how weak one could make information flows, and still maintain reputations. Accordingly, seller IDs were suppressed, and cost reports were purely private information. With private cost reports buyers only gain information about the reporting behavior of the seller in their own contractual agreement, and without seller ID's, even this information is lost upon termination. Hence information flows are extremely weak.

Suppressing seller IDs in this way leads to a large drop in information, and the results show a corresponding decline in the reputational incentives under contract. Sellers over-report costs in treatment E by an average of 1.28, compared to an average over-report of less than 0.4 in higher information treatments. These over-reports are sufficient to drop the efficiency of contract to roughly eighty percent of the total available surplus. This drop in contractual efficiency leads in turn to a large increase in the choice of firms as an allocational device. More precisely, in

treatment D contract was used instead of firms roughly eighty percent of the time, while in treatment E it was chosen about half as often, roughly forty percent of the time.[33] The general result, then, is that as information flows weaken, relational contracting deteriorates, which leads to a reduction in market efficiency (measured against the maximum possible joint payoffs), and more firms are chosen in equilibrium.

Table 3 summarizes this result in column (5) as the increasing difference between the mean cost report relative to the mean cost state as one moves down the table to weaker information flows. As these flows become sufficiently weak, firm allocation becomes attractive, and the choice of firm allocation puts a lower bound on the degree of inefficiency, at least in this design. Hence market efficiency is inextricably linked to the reliability of information flows that discipline seller cost reports in relational contracts.

These results then lend broad support to the theory developed in Section 1. Information flows do affect reputation formation as hypothesized, and this feeds into the efficiency of relational contracting, and finally into institutional choice. Hence the experiments lend broad support to emerging theories of institutional choice. In addition to these important results, however, the data also raise the apparently new question of the role played by subject beliefs in institutional choice, to which we now turn.

Section 3.C. Subject Beliefs and Multiple Equilibria

The data in Treatment E exhibit a great deal of heterogeneity in choices of institutional form, and as one looks further, in the reporting behavior of sellers. In order to understand these differences more completely it is important to return to the issue of strategic uncertainty, and the important role played by subject beliefs.

Subject beliefs, and beliefs about beliefs, play an essential role in the equilibrium because these beliefs form the analytical underpinnings to the calculation of expected profits in equation (10):

$$(10)\quad \{[R_i^{\omega}(t_o) - R_i^{H}(t_o)]/R_i(t)\} \leq E\{\Sigma_{t\epsilon(t_o,\bar{T}]}\ \delta(\omega|I)$$

Beliefs are important because buyers and sellers must forecast each other's beliefs about $\delta(\cdot)$, since these beliefs determine the profitability of various reporting strategies. Specifically, such forecasts are essential because they determine the present value of the returns to honest reporting, and hence are an integral part of sellers' expected profit calculations. These beliefs, however, feed in turn into buyer calculations, and so on.

In general, there are numerous punishment strategies that can support a variety of equilibria, and sellers must forecast the strategy that buyers will follow.[34] For example, if buyers believe sellers are pessimistic about retaining contracts because they expect quick buyer termination, then sellers will discount the future and over-report. As a result, buyers will terminate contracts and choose firms. Hence pure beliefs can become self-fulfilling, and so the problem is a special case of standard average opinion problems pioneered by Keynes, and studied extensively in the macroeconomics literature.[35] Surprisingly, at least to us, this problem of strategic interdependence exists in institutional choice, and can lead to inefficient choices based on self-fulfilling "bad" beliefs.

The problem here, moreover, is in some ways richer than the problem typically studied in the macro literature. The reason is that more than one belief can persist in the final equilibrium. Specifically, for an equilibrium it is only important that the buyer and seller in a particular trading relationship share beliefs about reputational incentives under contract. Trading partners in other relationships may

have different self-fulfilling beliefs, and so a homogeneous market-wide belief may not emerge. Without market-wide beliefs, of course, there are likely to be heterogenous choices of institutions, but this creates no particular theoretical problems per se; the result is simply heterogenous choices. The results show that such heterogeneities did emerge, and seem to persist.

Subject behavior in Treatment E generally resulted in three equilibria in the reporting game, each corresponding to a particular structure of beliefs regarding equation (10).[36] Two of the equilibria involve seller beliefs that buyers will be "skittish," and bolt if they believe sellers are cheating. When buyers are highly skittish the future represented by the RHS of (10) becomes very short and sellers respond by cheating completely; they report nines every period, which consists of reports along the lower row of Table 2. When buyers are moderately skittish sellers can report honestly, and then hope for a long enough initial run of favorable draws to convince a buyer that he is better off under a contract; this equilibrium consists of reports down the diagonal of Table 2.

When buyers are confident (not skittish), sellers recognize that they can cheat some. The reason is that marginal cheating under contracts still results in higher payoffs for buyers because of superior effort incentives under contracts, and so sellers can cheat at the margin and still generate more total surplus. On the other hand, too much cheating will lead the buyer to sever relations and either try another seller or move into contracts. Hence, in this equilibrium there will be modest amounts of over-reporting.

Buyer behavior can also be generally organized as a Nash best response to perceived seller beliefs. If buyers know they are perceived as highly skittish, they expect to be cheated every period under contract, and so they will opt for firm allocation instead of contract. If buyers believe they are perceived as moderately skittish or

not skittish, then they will forecast that sellers will follow a reporting that makes both parties weakly better off under contract. These buyers will adopt contractual allocation.

Buyer and seller beliefs at the start of a new treatment contain a deductive component based on the common knowledge description of the game. These beliefs are then updated as information emerges, and such information can be the result of a particular agent's individual experience, or of market wide information flows. When information flows are based on individual experience, ex ante differences in perceptions can persist and grow larger, resulting in heterogeneities in choices. On the other hand, when there are strong market wide information flows, ex ante differences are not expected to persist, and parties will converge to a unique choice of institutional form.

Figure 4 shows how subjects choose institutions, how these choices depend on perceptions in various information conditions, and then shows how these choices vary over time. Consider, for example, experiments five and six. In both experiments subjects were initially constrained to use contracts to gain experience with treatment D. After ten periods conditions were switched to allow choice between contracts and firms. Immediately at the switch-over, half of the buyers opt out of contracts and into firms, apparently because the description of the information condition lead them to believe that there will be too much cheating to make contracts viable.

Over time, however, buyers who are in contracts generally experience favorable reporting behavior, as shown in Table 3. Specifically, the underlying mean cost state is six, and actual reports were 6.13 in experiment five and 5.64 in experiment six; the suggestion is one of minimal cheating by sellers. Subsequently, more buyers sampled contractual allocation, and had favorable experiences so that the market share of contracts gradually rose. Still, one buyer in experiment 6 never tried contracts,

and another buyer tried contracts for a short time, experienced high mean cost reports--a seven was the mean report--and then opted for firm allocation. The result was that two buyers were using firm allocation at the end of the treatment.

While there are modest heterogeneities in beliefs in Treatment D, the heterogeneities in Treatment E are quite sharp. As in Treatment D, there were heterogeneous initial buyer perceptions of reporting behavior, as reflected in initial institutional choices. Moving from one hundred percent contracts in either an A or a B treatment, numerous buyers immediately opted for firm allocation in the first period of Treatment E, and this decision was based on their deductive perceptions of the game. The far right-hand column of Table 4, moreover, shows that some buyers beliefs were so strong that they never tried contracts. These included one buyer in experiments 1 and 2, and two buyers each in experiments 3 and 4. Hence initial deductive perceptions play an important role in the resulting equilibrium.

Equally important, buyers who actually tried contracts experienced substantial heterogeneities in reporting behavior. These differences led to differences in updating, and ultimately to variation in institutional choices. A simple way to see this variation is through the market level data illustrated in Figure 4. The figure shows that over time some buyers switching out of contracts into firms, while others do the reverse. Some of this variation is random experimentation as buyers seek better information about the market, but there is also a highly systematic component that has an important impact on final choices of institutional forms.

The systematic component in these choices is highlighted by the data reported in Table 4. The left half of the Table chronicles the reporting experience of buyers who used contracts in the last period, while the right half reports the experience of buyers who used firms in the last period.

The data show that buyers who chose contracts in the last period of the treatment had generally experienced much more favorable reporting behavior than buyers who ended up in firms. Specifically, in all replications of treatment E the mean cost report experienced by buyers who ended up in firms was 8.00 or greater, and the average for all replications was about 8.4. In contrast, the mean cost report of buyers who ended up using contracts was less than 7.5 in all replications, and less than 6.9 in three of the four replications. The general implication is that buyers who linked up with sellers who reported reasonably honestly, continued in contracts. In contrast those buyers who sampled contracts and found sellers who greatly over-reported, subsequently opted for firms.

The efficiency results are striking. When buyers sampled reporting behavior "honest enough" for them to conclude that they (as well as sellers) were better off in contracts, it was chosen. On the other hand, when buyers sampled reporting behavior sufficiently dishonest, firm allocation became relatively more attractive, and buyers opted out of contracts into firms.[37] The implication is a relatively strong confirmation that when information flows are weak, heterogeneities in beliefs can apparently persist.

These results are of potentially major significance. The general theory of institutional choice has, monopoly reasons aside, generally focused on economic efficiency driving choices. The general argument is that natural selection mechanisms weed out inefficient institutions over time. The findings here qualify this result in important ways. Heterogeneities can emerge solely because of differences in beliefs about beliefs, and these differences can cause symmetrically endowed agents to behave asymmetrically. The result is substantial variation in choices in apparently similar circumstances.

To the extent that such heterogeneities can persist, the analysis provides one possible explanation for why symmetrically endowed sellers and buyers choose substantially different institutions for apparently similar relationships. These findings provide at least one way of organizing the large heterogeneities in private institutional choices observed across cultures. And while it is too soon to suggest how powerful this explanation will prove, it is at least one possible step along the path toward explanation.

Section 4 Conclusion

This study has provided several contributions to the theoretical and empirical analysis between long term 'relational' contracts and firm allocation. The first contribution of the analysis has been to bring laboratory experimental methods to bear on this important issue. Experimentally, the paper provides the first development of a methodology to allow competitive forces to determine the choice between contracts and firms in a laboratory environment. Buyers in the experiment chose between contracts and firms in a competitive market for institutional form. This is an important contribution because experimental methods have shown that institutional environments are important, but such institutions have been generally treated as exogenous.[38] Hence the paper has provided an important new methodology to experimental economics.

The results also provide important contributions to the analysis of institutional choice. Specifically, the analysis examines the effectiveness of reputation in ensuring low cost adjustment under 'relational' contracts, how information flows affect reputational incentives, and how these incentives then affect the choice between contracts and firms. The broad result is that when there are reliable market-wide information flows regarding cost reporting behavior, reputational incentives are quite

strong. These strong reputational incentives result in highly efficient contractual adjustment under relational contracts. Such efficient adjustment means subjects choose contracts over firm allocation. The general result, then, is that when information flows are strong, contracts emerge as the equilibrium institutional choice.

As information flows weaken, the strength of reputational incentives steadily declines, undermining low cost contractual adjustment. As these incentives become weak and contractual adjustment becomes correspondingly imperfect, firm allocation replaces relational contracting. Hence the results provide broad support for existing theories of institutional choice, as pioneered by Williamson and others.

Finally, the experimental analysis has identified a major new theoretical problem in the economic analysis of institutional form. The experimental results point strongly to a Keynesian 'average opinion' problem in institutional choice. An important result is that this problem can lead to asymmetric institutional choices by symmetrically endowed agents.

The average opinion problem emerges because subjects' optimizing strategies, regarding both reporting behavior and institutional choice, depend on each other's beliefs regarding likely strategies. The data show that beliefs differ markedly even when subjects face the same common knowledge description of the experiments. These differences in beliefs lead subjects to make different choices in their initial choices of institutional forms. When there are reasonably strong market-wide information flows, these differences are transitory, but when information flows are weak, differences can persist. When differences can persist, the typical theoretical prediction that optimizing agents will converge to a unique choice of institution is not supported by the data. Hence pure beliefs can differ, and they can matter in the final choice of institutional form.

Appendix

Keyboard Entries Required in the Experimental Market

For agreements to be formed, sellers had to make offers for buyers to accept. An offer is composed of an institutional form (X or Y), and the amount of the lump sum transfer paid to the seller. To make an offer, sellers entered OX to make a contracting (X) offer, or OY to make a firm (Y) offer. Following this entry, sellers were asked to enter the value of the offer they wished to make (the amount of lump sum transfer desired). After entering the offer they desire, sellers were shown their selection and asked to confirm it or abort. If they confirmed, the offer would then be checked by the computer to see if it was between 60 and 999, and that it was an improving offer.

To accept an outstanding offer, buyers had to enter AX to accept a contracting offer, or AY to accept a firm offer. If the treatment identified sellers, buyers were next asked to enter the ID number of the seller they want to accept, and then were asked to confirm. Following a confirmation, the acceptance was checked to see if the acceptor has capacity to form an additional agreement, and that the seller had made an offer that could be accepted. If the acceptance went through, then all market participants became aware of the institutional form and the offer for seller payment that was accepted. The computer did not maintain a queue of offers greater than the outstanding offer, so after an offer was taken off the floor, the next offer tendered became the outstanding offer until an improving offer was made.

Subjects could see buyer and seller payoff tables on their computer screen for any lump sum transfer offer on the floor. Hence buyers and sellers could see the possible payoffs associated with accepting, or having a particular offer accepted. To make a payoff table inquiry on the computer, a subject entered IX to see payoff tables for a contract offer, or IY for a firm offer. If sellers are identified, the subject also entered the ID of the seller who tendered the offer in question.

Subjects could terminate any agreements formed in past market periods. To terminate, subjects entered T, and then entered the serial number identifying the agreement they wanted to terminate. Buyers could also terminate after forming a new agreement. This was provided so that buyers could accept very quickly. After forming the new agreement, the buyer had to terminate within a 30 second interval, or have $0.50 deducted from their balance. If the first 30 second interval elapsed without a termination, the subject would remain in the forced termination mode and face a $0.75 penalty every 30 seconds until the old agreement was terminated.

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Endnotes

1. See, e.g., the important work of Williamson (1975), Goldberg (1976), and Klein, Crawford, and Alchian (1978), who argue that the key feature distinguishing simple market (spot) exchange from longer term economic relationships is the existence of transaction specific assets. For more recent theoretical work, see Grossman and Hart (1986), Riordan and Sappington (1987), and Wiggins (1988a, 1988b).

2. See also our earlier work, Hackett, Battalio, and Wiggins (1988), and the important contemporaneous work by Berg, Coursey, and Dickaut (1988), who have contemporaneously developed similar methods. The key methodological difference between their work and ours is that they have monopolistic market "mediators," who do not themselves directly participate in the institutions, imposing the choice of institution. In our set-up, buyers and sellers are free to competitively offer the choice of institution during the actual market period. This permits an analysis of the role played by competition among buyers and sellers in molding institutional choice.

3. A more complete version of the basic model is Wiggins (1988a). See also the important parallel treatment of this tradeoff in Riordan (1989).

4. It is convenient to assume fixed proportions between stages, though this assumption only applies to the input in question.

5. The full model in Wiggins (1988a) is a double moral hazard, double adverse selection model between the two stages. He shows that there are simple allocation arrangements that solve any three of these four problems--e.g. special cases of contracts solve a version of the model with double moral hazard, and one form of adverse selection, etc. Rogerson (1988) analyzes a similar model, and shows that there exists a mechanism that will solve both moral hazard and adverse selection problems simultaneously. This is an important result, but the mechanism in Rogerson is fairly complicated, and does not appear to correspond closely to observed arrangements. In contrast, the schemes in Wiggins are more restrictive, but are simpler and correspond more closely to empirically observed compensation arrangements. To the extent that Wiggins approach characterizes the tradeoffs between these institutions, it leaves unanswered why we do not observe the more complex schemes derived in Rogerson's analysis. This question is left for later research.

6. See Wiggins (1988a) for a more complete treatment of this result and the other basic theoretical results in this section.

7. More generally the central results carry through when managers are compensated through efficiency wages, bonuses tied to overall firm performance, and tournaments where rewards are promotions.

8. This argument is somewhat overstated in that reports may make the manager "look good" and so forth. The central argument is not that there is no incentive to distort in firms, only that it is weaker.

9. The necessity of (1) is easy to see. The LHS represents the immediate returns to cheating. If the possible future losses from over-reporting are smaller than this immediate return, then individual rationality requires over-reporting. Sufficient conditions are much more difficult to obtain because of the complexity of potential cheating and repentance strategies. Fortunately, following Wiggins (1988b), a great deal of insight can be obtained by simply relying on the simple necessary condition in (1).

10. In laboratory implementation subjects know that no outcomes of $\tilde{T}$ will be infinitely large. Nevertheless, in the laboratory design used in this study the finite nature of the treatment endpoints does <u>not</u> necessarily imply that the reputation equilibrium will backward-unravel. The reason is that buyers can choose firms in the last sequence of periods in a treatment. Further, if buyers use honest reports under contracts in the early periods to allocate business near the end, then the associated quasi-rents maintain the reputational equilibrium at the end; backward unraveling need not occur.

11. Specifically, for any given termination strategy that buyers might follow, an increase in the likelihood of detection raises the expected losses from over-reporting.

12. As with any strategic interdependence problem there is an infinite regress of expectations on expectations, which we ignore in the text.

13. One can also think of the investments as being long-lived, but then letting these long lives be collapsed into a single "period." Detailed examination of the role of specific investments is an important issue in our future research agenda.

14. This parameter choice was expected to make unbiased cost reporting salient in firms, and still maintain the single period profitability of sellers over-reporting cost in contracts. Of the 516 integrated firm agreements observed in this study, 509 of them were characterized by sellers reporting actual cost to buyers.

15. Twenty five percent was chosen to ensure saliency in the choice between contracts and firms. Specifically, subjects must prefer the higher available earnings under contract sufficiently that they will bear the opportunity cost of thinking through the problem of how to achieve those returns. The twenty five percent differential translated into an expected twenty five cent differential in earnings per period.

16. Miller and Plott (1985) is the first study we are aware of to experimentally investigate information and market share as a reputation device. They used an unbalanced market to allow market share to be endogenous.

17. Prior work suggests that the exact degree of imbalance is qualitatively less important than the imbalance itself. Hence the ability of one seller to corner the market is not nearly as important as the fact that sellers have net excess capacity. The exact degree of excess capacity necessary for the results, however, remains an important question for future research.

18. It is important to note that existing evidence suggests that sellers will not just bid the lump sum transfer to zero. Instead they are likely to bid the transfer price into the negative range, if this will enable them to reap positive returns by over-reporting cost. Hence without further constraints the unique equilibrium under contracts is likely to be one where sellers over-report costs, and then bid a transfer price sufficiently negative to ensure zero net returns. See for example Miller and Plott (1985), and Lynch, Miller, Plott, and Porter (1986).

19. Miller and Plott (1985) used a similar unbalanced market as a component of their reputation mechanism, and also included a capital transfer to sellers in their design.

20. See Wiggins (1988b) for a more complete treatment of the forces that affect the viability of reputational enforcement of contracts.

21. The $.60 minimum lump sum transfer also creates general saliency in seller decisions in that it creates an incentive for sellers to choose their offers carefully. For reasons of symmetry the minimum wage under firm allocation was also chosen to be $.60. The experimental sessions lasted 3.5 hours and generated approximately 28 complete periods, giving sellers an average earnings of $4.80 per hour.

22. The parallel question, that is when information flows within the firm will permit complete detection of shirking, is an important question left for future research.

23. There are settings such as weapons procurement, where this assumption might be violated. The impact of relaxing this assumption is left for future research.

24. That study created a market for contractual form, by allowing buyers and sellers to compete over the form of contract to be used in a problem similar to the one used here. The key differences between that study and the present one is that transfer prices were determined in the bidding process, so that there was no ex post communication, and there was no option for buyers and sellers to use firm-type compensation.

25. The following parameter values were used to generate these payoff tables. Marginal revenue = $16.00 - 0.1066Q, and marginal cost = a + 0.1066Q, where a could take on values between $3.00 and $9.00 with equal likelihood. Raw payoffs are transformed by multiplying them by 0.01. Finally, buyers faced a capital cost of $0.50 on payoffs from every agreement to reduce the cost of the experiment. Shirking on monitoring effort reduces raw payoffs in a firm by 25 percent in expectation. The distribution of possible cost intercepts were normalized to 1 through 7 for subjects.

26. On-line computer payoff tables were provided for both institutional forms, and for any lump sum transfer, possible cost state, and cost report. Printed payoff tables had to be condensed to a manageable size, and so they were printed for the minimum lump sum transfer equal to 60. Subjects were then told that for lump sum transfers greater than 60 they should directly add the marginal increase to all possible seller payoffs, and subtract it from all possible buyer payoffs.

27. To help control for interpersonal utility effects, all payoffs were denominated in an experimental currency called francs. Subjects were told that all exchange rates were positive, but the actual redemption value of francs for buyers and sellers was private information. A franc was worth $0.01 for all subjects. Subjects were told that if they were called back, subjects who formerly had been buyers would be sellers in future experiments with a different group of subjects. By switching roles, subjects who may have felt shorted in one role had an opportunity to take on the more favorable role next time. Switching also helped subjects become quite familiar with the experiment.

28. When information flows did not include seller identities, then the only outstanding offers on the floor are the lowest seller contract and firm offers out of the offers made by all sellers.

29. Since each "period" corresponds to the productive life of a set of specific investments, continuing agreements correspond conceptually to renewed investments in such assets. The detailed mechanics of termination are discussed in the appendix.

30. The only restriction was that subjects could not terminate an agreement in the same market period it was formed. Confirmations of keyboard entries greatly reduced the problem of errors in offers and acceptances. An implication was that each agreement formed would have an actual and reported cost associated with it. Hence buyer terminations provide some indication of buyer beliefs regarding biased cost reporting. The restriction forced subjects to only offer the terms of trade they would find acceptable in an agreement.

31. Subjects had the following experience levels. Naive subjects first experienced information conditions A or B in contracts alone for ten periods, followed by firms alone for ten periods. On the next evening as experienced subjects they participated in treatment A or B for ten periods, followed by treatment E for ten periods. In the second evening they could choose institutional form endogenously. From this pool of 48 experienced subjects, participants for treatments C, D, and F were drawn. Hence subjects had common experience in E and in either A or B.

32. In the second replication it took subjects a number of periods to converge to firm allocation--and full convergence was only achieved in the last period. This slow convergence appears to have occurred because of less over-reporting on the part of sellers. The full dynamics of this replication are illustrated more fully below, when we discuss histories and induction.

33. The heterogeneity in behavior in treatment E is quite remarkable, and is dealt with in Section 3.C. below.

34. Given the dynamic set-up, the Folk Theorem of repeated games ensures that there are a large number of equilibrium strategies that buyers and sellers could follow. The essential question confronting sellers is which of these equilibria will be 'focal' for buyers.

35. See Van Huyck, Battalio, and Beil (1988, 1989), Cooper and John (1988), and Keynes (1964).

36. The coordination problem described here emerged in the course of the experiments, and so the experiments were not designed to explicitly distinguish between various strategies that subjects might follow out-of-equilibrium. This important issue is left for later work.

37. The two buyers in treatment E with cost reports of 9 did not try contracts until late in the treatment and had few periods in contracts. It is likely that with a continuing experience of gross over-reporting these two buyers would soon switch to firms.

38. This paper is part of a recent set of investigations examining institutional choice in laboratory environments. These papers include Hackett, Battalio, and Wiggins (1988), and the important work of Berg, Coursey, and Dickaut (1988). The primary differences between these lines of work is that ours concentrates on the choice between various forms of contracts and firms, while the highly complementary work of Berg, et. al., focuses on the choice between bargaining and auctions as alternative allocation devices.

Table 1--Treatment Design

	Conditions present by treatment					
conditions	A	B	C	D	E	F
1. Cost Conditions: identical shocks	y	y		*	*	*
2. Information:** buyers see actual cost shock	y					
buyers see all cost reports and market shares	y	y	y			
sellers identified	y	y	y	y		
3. Terminations endogenous	y	y	y		y	
A. Range of Experience in the study	1	1	1-3	1-2	1	1-2
B. # Replications	1	3	2	2	4	2
C. Experiment Numbers	1	2-4	7-8	5-6	1-4	5-6

* In experiments D, E, and F independence of shocks is immaterial since buyers see only reports in their own agreements

** In all treatments buyers saw cost reports in their own agreements

Table 2.A.
Possible payoffs from forming a contract-an "X" Agreement with lump sum payment = 60 francs

Seller payoffs in francs*								Buyer payoffs in francs	
actual number / reported number	3	4	5	6	7	8	9	reported number	payoff
3	60							3	286
4	116	60						4	227
5	163	111	60					5	173
6	200	153	106	60				6	124
7	228	185	144	102	60			7	79
8	247	210	172	135	97	60		8	40
9	256	224	191	158	125	92	60	9	4

* Sellers are subject to a 1 in 3 chance of incurring a $0.75 auditing penalty when reports are greater than actual (all off-diagonal outcomes).

Table 2.B.
Possible payoffs from forming a firm-a "Y" Agreement with wage payment = 60 francs

Seller payoffs in francs*								Buyer payoffs in francs	
actual number / reported number	3	4	5	6	7	8	9	reported number	payoff
3	60							3	207
4	60	60						4	180
5	60	60	60					5	117
6	60	60	60	60				6	77
7	60	60	60	60	60			7	41
8	60	60	60	60	60	60		8	10
9	60	60	60	60	60	60	60	9	-18

* Sellers are subject to a 1 in 3 chance of incurring a $0.75 auditing penalty when reports are greater than actual (all off-diagonal outcomes).

Table 2.C.
Market With Sellers Identified

Lowest Seller Offers						
ID ⇒	7	8	9	10	11	12
X	675	75	***	99	221	60
Y	91	409	82	64	***	998

Table 3--Aggregate Results

Information condition	Rep	Frequency of contracts out of total agreements	Frequency of contracts in the last period of the treatment	Mean Cost Over-Report Under Contract**	mean market efficiency
A: Common Cost Shocks, Public Cost Reports, Actual Cost Revealed (Maintain Seller ID's-Histories)	1	100%	100%	0.00	100%
B: Common Cost Shocks and Public Cost Reports (Maintain Seller ID's-Histories	1	95.00%	100%	0.20	97.00%
	2	98.33%	100%	0.09	99.00%
	3	98.31%	100%	0.03	99.00%
	avg*	97.00%	100%	0.10	98.00%
C: Independent Cost Shocks and Public Cost Reports (Maintain Seller ID's-Histories	1	89.47%	100%	0.28	95.00%
	2	94.74%	100%	0.44	95.00%
	avg	92.00%	100%	0.37	95.00%
D: Private Cost Reports (Maintain Seller ID's-Histories)	1	83.33%	100%	0.31	96.00%
	2	66.67%	67.00%	0.25	91.00%
	avg	75.00%	83.00%	0.29	93.00%
E: Private Cost Reports Suppress Seller ID's. Histories present only with continued dealing.	1	31.67%	33.00%	1.63	74.00%
	2	40.00%	33.00%	1.41	80.00%
	3	46.67%	50.00%	0.67	84.00%
	4	56.67%	50.00%	1.47	81.00%
	avg	44.00%	42.00%	1.28	80.00%
F: -No seller ID's -No Individual History -Exogenous Termination Each Period	1	6.67%	0.00%	4.50	70.00%
	2	25.93%	0.00%	1.43	78.00%
	avg	16.00%	0.00%	2.12	74.00%

* average market efficiency in an information treatment
** Mean cost over-report in firms was zero in all treatments

Table 4--Buyer Histories And Institutional Choice

Treatment and Replication	Buyers who were in CONTRACTS at the end of the treatment: Number of buyers (out of 6 possible) who were in CONTRACTS at the end of the treatment	Buyers who were in CONTRACTS at the end of the treatment: Mean cost report experienced by these buyers (high & low buyer means in parentheses)	Buyers who were in FIRMS at the end of the treatment: Number of buyers (out of 6 possible) who were in FIRMS at the end of the treatment	Buyers who were in FIRMS at the end of the treatment: Mean cost report experienced by these buyers (high & low buyer means in parentheses)	Buyers who were in FIRMS at the end of the treatment: Number of buyers (out of 6 possible) who never tried a contract
treat. D rep. 1	6	6.13 (6.0, 6.3)	0	---	0
	4	5.64 (5.4, 5.9)	2	7.00 (-)	1
treat. E	2	7.45 (6.6, 9.0)	4	8.50 (8.2, 9.0)	1
rep. 2	2	6.50 (6.0, 9.0)	4	8.67 (8.6, 8.8)	1
rep. 3	3	6.74 (6.4, 7.0)	3	8.00 (8.0, 8.0)	2
rep. 4	3	6.88 (6.4, 7.1)	3	8.56 (8.3, 9.0)	2
treat. F rep. 1	0	---	6	9.00 (9.0, 9.0)	3
rep. 2	0	---	6	7.79 (7.4, 9.0)	0

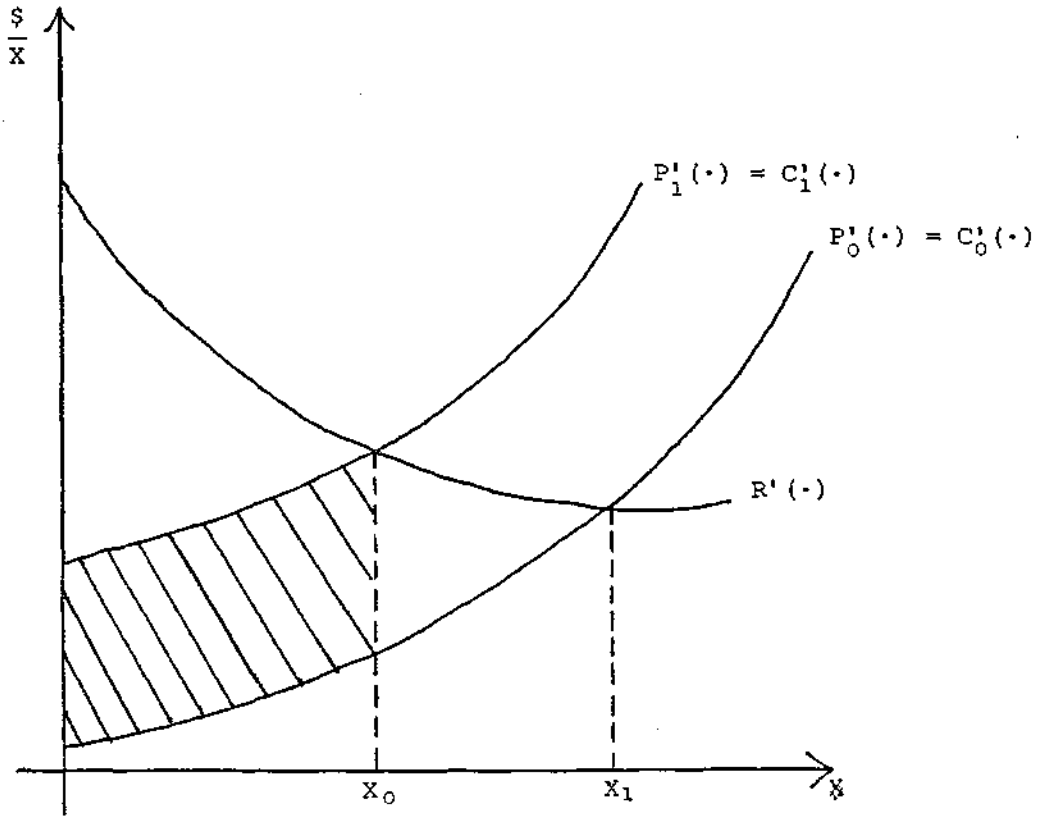
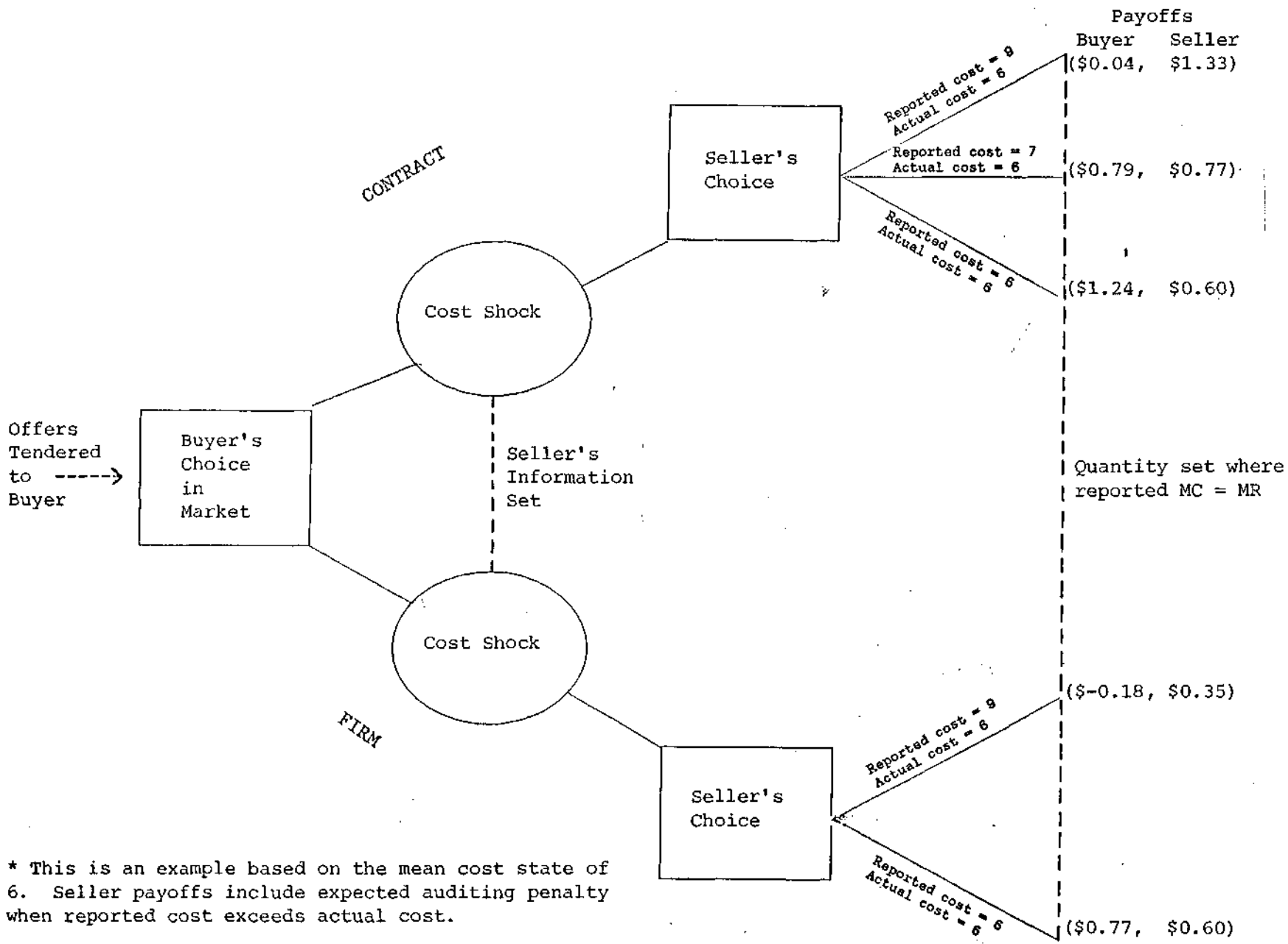


Figure 1

Over-Reporting Incentives Under Contract

Figure 2--Order of Events*



* This is an example based on the mean cost state of 6. Seller payoffs include expected auditing penalty when reported cost exceeds actual cost.

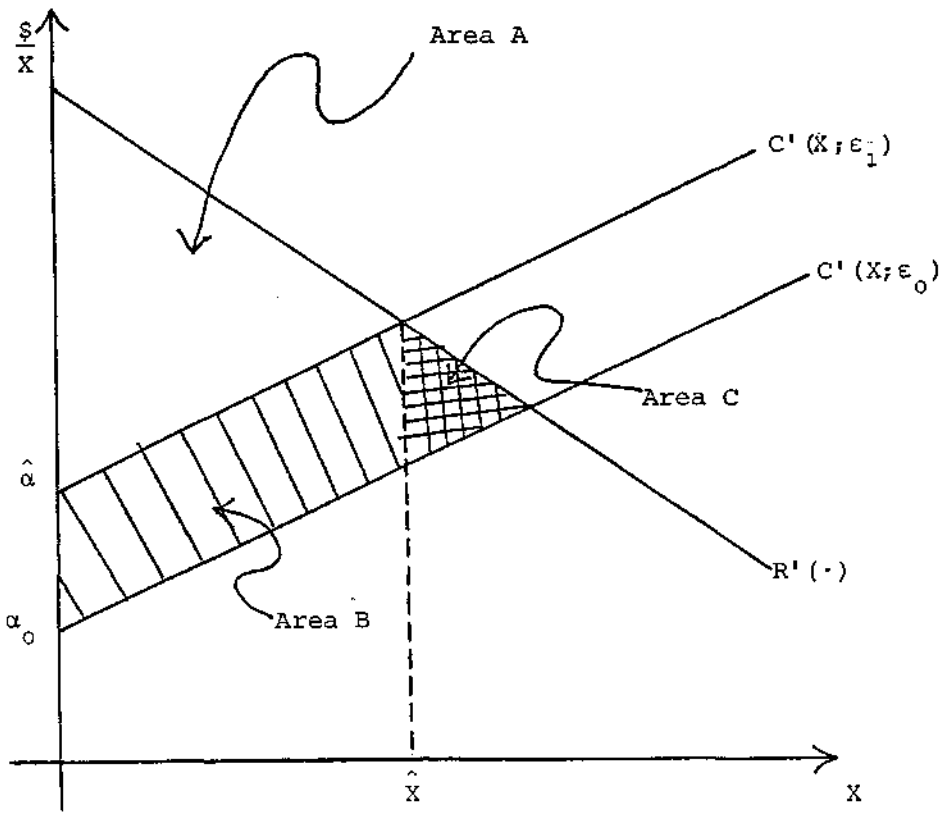


Figure 3

Experimental Implementation
of Contractual Reporting Incentives

Figure 4

Plots of Institutional Choice by Treatment and Period