Auctions Versus Negotiations in Procurement: An Empirical Analysis

Author(s): Patrick Bajari, Robert McMillan and Steven Tadelis

Source: *Journal of Law, Economics, & Organization*, Oct., 2009, Vol. 25, No. 2 (Oct., 2009), pp. 372-399

Published by: Oxford University Press

Stable URL: https://www.jstor.org/stable/25620037

Auctions Versus Negotiations in Procurement: An Empirical Analysis

Patrick Bajari*
University of Minnesota and NBER

Robert McMillan**
Federal Trade Commission

Steven Tadelis***
University of California, Berkeley

Should the buyer of a customized good use competitive bidding or negotiation to select a contractor? To shed light on this question, we consider several possible determinants that may influence the choice of auctions versus negotiations. We then examine a comprehensive data set of private sector building contracts awarded in Northern California during the years 1995–2000. The analysis suggests a number of possible limitations to the use of auctions. Auctions may perform poorly when projects are complex, contractual design is incomplete, and there are few available bidders. Furthermore, auctions may stifle communication between buyers and sellers, preventing the buyer from utilizing the contractor's expertise when designing the project. Some implications of these results for procurement in the public sector are discussed (*JEL* D23, D82, H57, L14, L22, L74).

1. Introduction

Manufactured goods, such as computers, washing machines, and DVD players, are mass produced, have standardized characteristics, and are typically purchased at list price. Other goods, such as new buildings, fighter jets, or consulting services, are tailored to fit a buyer's needs. To procure these customized

*Department of Economics, University of Minnesota and NBER, 1035 Heller Hall, 271 19th Avenue South, Minneapolis, MN 55455, USA. Email: bajari@econ.umn.edu

**Federal Trade Commission, 600 Pennsylvania Avenue, NW Washington, DC 20580. Email: rob.mcmillan@gmail.com

***Haas School of Business, University of California, Berkeley, 545 Student Services Building, CA 94720-1900, USA. Email: stadelis@haas.berkeley.edu

We thank Susan Athey, Tim Bresnahan, Jeremy Bulow, Igal Hendel, Matt Kahn, Pueo Keffer, Jon Levin, Scott Masten, John McMillan, Paul Milgrom, Aviv Nevo, Peter Reiss, Ilya Segal, Pablo Spiller, Bob Tatum, and Oliver Williamson for helpful discussions. An editor and two anonymous referees offered excellent comments. This research has been supported by the National Science Foundation, grants SES0112106 and SES0122747 (Patrick Bajari), and SES0079876 (Steven Tadelis), and by the Stanford Institute for Economic Policy Research.

The Journal of Law, Economics, & Organization, Vol. 25, No. 2,
doi:10.1093/jleo/ewn002
Advance Access publication May 7, 2008

goods, the buyer hires a contractor who supplies the good according to a set of desired specifications.

In this context, a buyer faces two important questions before entering into a contract with a contractor. First, what kind of specifications and payment structures should the contract offer? Second, should he award the procurement contract by using an auction or by negotiating with a potential seller? Much of the procurement literature in economics deals with the form of contracts (see, e.g., Laffont and Tirole, 1993) offering some insights into the first question. In contrast, the second question received considerably less attention. Bulow and Klemperer (1996) emphasize the benefits of competitive auctions as sale or procurement mechanisms. Twenty years earlier, however, Goldberg (1977) argued that for nonstandard complex transactions, the use of auctions may prevent the exchange of important precontract information, thus favoring negotiations. The main contribution of this article is to shed light on the broad use of both auctions and negotiations and to explore some possible determinants behind a buyer's decision of how to award a contract.

Federal Acquisition Regulations (FAR) that strongly favor the use of auctions in public sector procurements have been justified using arguments for competitiveness, equal opportunity, and corruption prevention. Interestingly, there is widespread use of *both* auctions and negotiations in the private sector where buyers have considerably more freedom in choosing how to purchase goods. For example, from 1995 to 2000, almost half of private sector nonresidential building construction projects in Northern California were procured using negotiations, whereas the rest were procured with some form of competitive bidding. Only 18% were procured using unrestricted open-competitive bidding, which is what FAR dictates for the public sector.

To try and test for the determinants of choosing award mechanisms, we draw on insights from the existing theoretical literature and thus contribute to a small but growing empirical literature that is attempting to understand the broad issues concerning the interplay of contracts and award mechanisms and the transactional characteristics that determine these. The theories we draw upon are discussed carefully in Section 3, and here we outline our three main hypotheses.

Our first hypothesis argues that more complex projects—for which ex ante design is hard to complete and ex post adaptations are expected—are more likely to be negotiated, whereas simpler projects will be awarded through competitive bidding. Two theoretical arguments imply this hypothesis. First, as argued by Goldberg (1977) and consistent with conventional wisdom from the engineering management literature, sealed-bid auctions stifle communication between the buyer and the contractor. In a sealed-bid auction, the principle piece of information that the buyer receives from the sellers is the bid. In negotiations, however, the buyer usually discusses the project in detail with the seller before the contract is signed. Sellers may have important information about appropriate construction practices and current materials' prices that buyers can use when drafting the plans and specifications. For complex projects that are difficult to specify in advance, communication and coordination between the buyer and seller will be even more important, thus implying a positive correlation between complex projects and the use of negotiations.

Another reason for this correlation to be observed follows from the work of Bajari and Tadelis (2001). Their model argues that more complex transactions will likely be plagued by ex post adaptations, and these are best administered with cost-plus contracts. In contrast, simple transactions are best served by fixed-price contracts, which induce strong cost-reducing incentives. Though Bajari and Tadelis (2001) focus the analysis on the type of contract awarded, there are reasons for the choice of contract form to influence the choice of award mechanism. In particular, since the only relevant information in a fixed-price contract is the price, it is easy to devise an auction to use the market mechanism. However, if a cost-plus contract is used, using the market mechanism becomes more difficult since the costs will not be reflected by bids in any meaningful way. Indeed, the construction management literature suggests that there is a strong correlation between the use of cost-plus contracts and the use of negotiations, whereas fixed-price contracts are primarily awarded by auctions.

Our second hypothesis follows directly from standard auction theory: more potential bidders increase the benefits of using an auction. If contractors have more idle capacity, implying that there are more contractors available to bid, then the benefits of an auction increase. On the other hand, during construction booms it may be difficult to find a contractor, lowering the benefits to auctions.

Our third hypothesis follows indirectly from the choice of award mechanisms and echoes the conventional wisdom of industry that buyers should rely on past performance and reputation to select a contractor for negotiations. If, as our first hypothesis argues, it is the complexity of the transaction that dictates the optimal award mechanism, then when complex projects are procured, the experience and know-how of the contractor are especially important (unlike for simple projects, where work is more straightforward and a smooth ride is expected.) This in turn implies that negotiated contracts are more likely to be allocated to more reputable and experienced sellers.

The hypotheses are tested using a data set of contracts awarded in the building construction industry in Northern California from 1995 to 2001. The empirical analysis appears to be consistent with the hypotheses. First, more complex projects are more likely to be awarded by negotiation than by auction. Second, the use of auctions is counter-cyclical, consistent with the increased benefits of auctions when more contractors are available. Third, negotiated projects tend to be awarded to larger, more experienced contractors, consistent with the reputation hypothesis.

As mentioned earlier, theoretical research on the choice of award mechanisms is also somewhat scant. Goldberg's (1977) important article seems to have been primarily overlooked by the more technical contributions that employ the mechanism design framework. Bulow and Klemperer (1996) use a standard auction model to show that in most cases a seller should prefer using a simple (no reserve price) auction to the best possible negotiation with one less buyer. Manelli and Vincent (1995) develop an alternative framework in which the buyer of a good cares both about quality and costs. In this two-dimensional framework, they show that when quality concerns become strong enough, sequential offers, which they call negotiations, are better than an auction.

Recent empirical work on the choice of contractual form, such as Crocker and Reynolds (1993), Corts and Singh (2004), and Hendel and Lizzeri (2003), study the determinants of contractual form. None of these articles, however, link project characteristics to the choice of award mechanisms. In a recent study that is very much related to ours, Leffler et al. (2007) gather data from private sales of timber tracts in North Carolina. They find that about half of the 360 contracts they analyze are auctioned and the other half are negotiated, similar to the distribution of award mechanisms in our data. They also refer to the Goldberg (1977) and to the Bajari and Tadelis (2001) predictions on the effects of complexity and show a positive relationship between their measures of complexity and the use of negotiated contracts, consistent with our results. They also show that more available buyers (the analog to sellers in our data) make the use of auctions more likely, consistent with our results as well. Their data allows them to offer some interesting tests of common value versus private value auction predictions, which we are unable to address with ours.

In complementary work that builds on the theoretical work of Manelli and Vincent (1995), Bonaccorsi et al. (2003) offer an empirical analysis of auctions versus bargaining as alternative procurement mechanisms using data on the procurement of medical devices by Italian hospitals. They directly test the hypothesis that quality concerns will affect the choice of award mechanisms and do this by considering variation in which part of the hospital is directly in charge of procuring the devices: administrators, who are more concerned with costs, or medical personnel, who are more concerned with quality. They confirm this hypothesis in their analysis.[1]

Due to the nature of our data, our empirical analysis has some limitations as discussed in Section 6.1. At a minimum, however, we provide a set of basic stylized facts on the choice of auctions versus negotiations. We believe that some of our stylized facts, particularly the positive correlation between auctions and measures of complexity, challenge the conventional view about the widespread benefits of auctions.

Although the analysis is motivated by practices in the private sector, it may offer some thoughts on implications for the public sector. Public sector statutes that govern procurement, typically based on FARs, strongly favor the use of competitive bidding. In the data, for instance, 97% of public sector building construction projects in Northern California are procured using competitive

1. Cameron (2000) considers a different variant of analyzing award mechanisms by focusing on whether rigid rules for awarding contracts have different consequences than flexible rules, the latter often followed by renegotiations of the contract terms. Her empirical investigation of power purchase contracts shows that rigid rules result in lower ex ante prices but a higher likelihood of ex post breach. Arguably, complexity may be a significant reason not to use rigid rules that later hamper adaptation and renegotiation.

bidding. Although competitive bidding does have the advantage of unbiased awarding of projects, it may come at a cost of both losing valuable information ex ante, and if fixed-price contacts are used, then ex post adaptation may be insufficient. This suggests that public procurement of complex projects may suffer from efficiency losses, and further analysis is warranted to consider other mechanisms that safeguard against corruption, while allowing for some flexibility in the contract and award mechanisms.

2. The Building Construction Industry

2.1 Overview

In 1992, there were 2 million establishments in the US construction industry that completed $528 billion dollars of work. These firms directly employed 4.7 million workers and had a payroll of $118 billion dollars (Census 1992a, 1992b, 1992c). In 1997, the construction industry accounted for 8% of US GDP and worldwide was a 3.2 trillion dollar market (Engineering News-Record 1998).

In the industry, there is typically a division of labor between creating the designs for the project and the actual construction. The buyer first hires an architectural firm to design the project and monitor the contractor during construction, whereas the contractor is liable to the buyer for project completion and directs the work of subcontractors.[2]

Since every construction project is unique, the plans and specifications included in the contract may fail in the field and are therefore subject to change. If the plans and specifications are significantly altered, then the contract will be amended by filing a change order. Change is the source of acrimonious disputes. The buyer wishes to minimize the cost due to the change and may believe that the changes are due to inadequate workmanship by the contractor. The contractor, on the other hand, may believe that the changes are due the buyer's poor planning and incomplete specifications. In the engineering and construction management literature, coping with change plays a key role in selecting appropriate contract award procedures.

2.2 Construction Contracts

The contracts used in private sector building construction are frequently standardized and typically contain six major parts: bidding documents, general conditions of the contract, supplementary conditions of the contract, specifications, and drawings and reports of investigations of physical site conditions.

The specifications and drawings contain detailed engineering information about exactly how the project is to be completed. They are meant to be

2. Other possible organizational forms include design-and-build contracts, force accounting, and construction management among others. For general descriptions of the industry, contracting practices, and project management, see Bartholomew (1998), Clough and Sears (1994), and Hinze (1993).

a sufficiently clear description of how the project is to be built so that the contractor may estimate costs in order to bid. Substantial deviations from the specifications and drawings will result in change orders to the project.

The general conditions of the contract define, in general terms, the participants in the contract—that is, owner (buyer), general contractor, engineer, subcontractors, etc.—and their roles, the process for amending the contract with change orders, the contractor's liability for on-time completion of the contract and procedures for extending the completion date, terms describing how payments will be made, and conditions under which the contract may be terminated. In many cases, the general conditions are a "boilerplate" that is similar from contract to contract.

The standard form of contracts published by the American Institute of Architects and the Associated General Contractors are used in many building projects.[3] Because these contracts are widely used, the central clauses are well understood in industry and there exists a significant body of case law on interpreting these contracts. Although there are many forms of alternative contractual arrangements, cost-plus (referred to as cost-plus a stipulated fee) and fixed-price contracts appear to be the most commonly used. In a fixed-price contract, the compensation for the contractor is agreed to in advance. In a cost-plus contract, the general contractor is paid a fee and reimbursed for the costs incurred to complete the project.

2.3 Change Orders

The courts have recognized that contractors are entitled to compensation for changes to the plans and specifications in a fixed-price contract (for a discussion of this, see Sweet, 1994). Therefore, in a fixed-price contract, the general contractor will not be willing to perform duties beyond those to which he is contractually bound without additional compensation. Two contractual procedures used to adjust compensation in fixed-price contracts are called *change orders* and *change directives*.

A change order is a written amendment to the contract that describes additional work the contractor must undertake and the compensation he will receive. The work and the conditions in a change order are generally determined by bargaining between the buyer, contractor, and architect.[4]

The effects of changes are not trivial. Hester et al. (1991) summarize the results of six studies (reports) of procurement contracting in the construction management literature. In all these studies, less than half of the projects are completed with changes of <2%. Although changes of 5% or more are not the

3. According to the industry sources we have spoken with, these standard forms of contracts are more common among less experienced buyers. Very large and experienced buyers may design their own standard forms of contract for building construction.

4. If the parties are unable to reach an agreement, in many contracts the architect has the power to issue a change directive. See Bajari and Tadelis (2001) for more on change orders and change directives and the references therein.

norm, they do occur regularly. The most common sources of changes are defective plans and specifications, changes in project scope, and differing site conditions.

Ibbs et al. (1986) quantify the impact of 96 different contract clauses on project performance. Their study consisted of a survey of buyers and contractors for 36 building construction projects. They claim to verify some conventional wisdoms about cost-plus and fixed-price contracting, emphasizing that changes are more easily agreed upon under cost-plus contracting and that fixed-price contracts require the buyer to invest more in design and specification.[5] Bajari and Tadelis (2001) develop a theoretical model that offers an explanation for these facts.

2.4 Award Mechanisms

Four award mechanisms are used to select contractors. The first is *open competitive bidding* in which, following a broad advertisement of the project, any contractor who is bonded is allowed to submit a bid. Such bonds seriously reduce both adverse selection and moral hazard, which to some extent question the applicability of the mechanism design approach to procurement.[6] The second, *invited bidders*, is like open bidding except that only invited bidders are given contract information and are allowed to bid. The buyer generally makes sure that an invited bidder is in a sound financial position so that it has sufficient resources to pay subcontractors and material suppliers during construction and therefore will not file for bankruptcy while construction is taking place. Furthermore, the buyer verifies that the contractor has sufficient experience and free capacity to complete the project in a timely manner. The third, *pre-qualified bidders*, which "is not a common practice" (Hinze 1993: 95), is like open bidding with an initial qualification stage. For this procedure, firms that wish to compete must submit specific information about their experience, financial stability, and other characteristics before the buyer qualifies them as viable bidders. Finally, in *negotiations*, the buyer decides to forgo the bidding process altogether and picks a contractor directly.

5. They also mention that fixed-price contracts offer good cost incentives (which is no surprise); that the allocation of risk differs and that quality may be jeopardized with fixed-price contracts. A multitask model can explain how cost-reducing incentives adversely affect quality (see Holmstrom and Milgrom 1991).

6. Three types of bonds are typically required by most owners. The first is a bid bond that is typically equal to 10% of the bid. The surety, or bonding company, is liable for this amount if the contractor reneges on its bid after it is awarded the contract. The second is a performance bond, typically equal to the amount of the bid. The surety is liable up to this amount if the contractor fails to build according to the plans and specifications. Finally, there is a payment bond, typically equal to the amount of the bid, which guarantees that all subcontractors and material suppliers will be paid. If a contractor is grossly negligent in performing its work, it will be very difficult for it to be bonded for future contracts, effectively shutting the contractor out of business. See Clough and Sears (1994, chapter 7) and Hinze (1993, chapter 8) for a more detailed discussion of bonding.

3. Auctions Versus Negotiations: Theoretical Concerns

This section lays out some insights based on the theoretical literature related to the choice of award mechanisms. In an important article, Goldberg (1977) recognized that "competitive bidding is one of several devices for transmitting information between organizations. As such it is both a substitute and complement for alternative devices such as negotiated contracts . . ." (p. 250). Furthermore, as Goldberg explains, the information transmitted by an auction is primarily restricted to price, and when projects are complex, the relative significance of price may be dwarfed by other considerations, such as how to deal with adaptation due to unforeseen events and problems. Indeed, it is widely believed that when competitive bidding is used to award what is typically a fixed-price or unit-price contract,[7] the contractors strategically read the plans and specifications to determine where they will fail.

To see this, consider a contractor who sees a flaw in the plans. He can use this information to submit a low bid and recover significant profits when necessary changes are implemented. Thus, competitive bidding may lead to adverse selection, which is more problematic when projects are complex. This disadvantage of auctions has been recognized by Goldberg (1977) who writes that "in competitive bidding for complex contracts, conveyance of information at the precontract stage is likely to be a substantial problem" (p. 254). The industry literature (see, e.g., Sweet 1994) suggests that one merit of negotiations is that buyers and contractors spend more time discussing the project and ironing out possible pitfalls before work begins and that complementing this with cost-plus contracts will allow for the needed flexibility of adapting work for complex projects.

This argument offers our first hypothesis: more complex projects are more likely to be negotiated, and as such, we expect to see a positive correlation between project complexity and the choice of negotiations.

A more recent article by Bajari and Tadelis (2001) explores the effects of complexity on contractual choice, not award mechanisms. They show that fixed-price contracts provide good ex ante cost incentives but impose high frictions when ex post adaptations are needed. Cost-plus contracts, on the other hand, better accommodate ex post adaptation but suffer from the lack of ex ante cost incentives. They conclude that fixed-price contracts perform well for simple projects with few anticipated changes, whereas cost-plus contracts are better suited for more complex projects, for which many changes are anticipated.[8]

Our first hypothesis that is a consequence of Goldberg's arguments can also indirectly follow from the analysis of Bajari and Tadelis (2001) if there is a strong positive correlation between fixed-price contracts and competitive

7. For a discussions and analysis of unit-price auctions in construction, see Bajari (2007).

8. The Bajari and Tadelis (2001) analysis offers some foundations to an argument in Williamson (1985) who suggested that the ease with which adaptations are adopted will depend on the contract employed. In particular, a cost-plus contract easily adapts to cover additional changes, whereas renegotiating a fixed-price contract generally involves more haggling and friction.

bidding, and between cost-plus contracts and negotiations. As most practitioners agree, "[a] cost-plus contract does not lend itself well to competitive bidding" (Hinze 1993: 144). Indeed, "[m]ost negotiated contracts are of the cost-plus-fee type" (Clough and Sears 1994: 10.) On the other hand, once a set of blueprints is in place for a fixed-price contract, it is rather straightforward to request fixed-price bids and adopt an auction. It is easy to see how a fixed-price contract should indeed be awarded by an auction: if the buyer has decided that given a design he wishes to use a fixed price, then by using an auction he will generate competitive bidding and allocate the project to the lowest, most efficient bidder. If, however, the project's complexity warrants a cost-plus contract to accommodate ex post changes, then it is not possible to associate ex post costs with any meaningful ex ante bidding. Hence, if contracts dictate constraints on the award mechanism, then the comparative statics derived in Bajari and Tadelis (2001) on contract choice will pass through to award mechanisms, offering another reason to find the positive correlation between contract complexity and the use of negotiations.

Our second hypothesis is a rather straightforward implication of auction theory. It is well known that increasing the number of bidders in an auction will reduce the expected winning bid.[9] Therefore, in a situation in which there are few bidders available to participate in an auction, the gains from holding the auction will be relatively low, and, in turn, negotiations will more likely be seen as the chosen mechanism. Thus, our second hypothesis is that in environments where there are more available bidders, the likelihood of choosing auctions will increase.

The arguments above imply a causal relationship between project characteristics (complexity) and award mechanisms and environmental characteristics (degree of competition) and award mechanisms, though given the nature of our data we will only be able to demonstrate correlations. However, a third hypothesis is implied from our first hypothesis, though the causal relationship may be less clear. When negotiation is considered "[i]t is common practice for a private owner to forgo the competitive bidding process entirely and to hand-pick a contractor on the basis of reputation and overall qualifications to do the job" (Clough and Sears 1994: 10). This is consistent with an argument that more expertise is needed to complete complex projects, and such expertise is part of a contractor's reputation. Thus, we would expect more reputable contractors to be selected when negotiations are used. This argument assumes that the choice of award mechanism is independent of the set of available contractors and that, therefore, the choice is sequential: first an award mechanism is chosen and then the buyer searches for a reputable and competent contractor. One might argue that the mere existence of reputable contractors may make negotiations with such a contractor more attractive, causing the buyer to forgo competition. This is less likely to be beneficial if the project is simple since

9. In an independent private values setting, this can be easily shown for a second-price auction since the second-order statistic is decreasing in N. In this environment with risk neutral bidders, there is a revenue equivalence theorem. See, for example, McAfee and McMillan (1987).

reputation for competency may not and should not imply that the contractor will offer attractive cost bids. Hence, if competence concerns are not an issue, even the availability of a reputable contractor should not induce a buyer to forego competition. Nevertheless, this reverse causality cannot be refuted, but the empirical hypothesis is the same: more reputable and experience contractors should be selected when negotiations are used.

4. The Data

4.1 General Description

Our data includes nonresidential building construction projects in Northern California during the period 1995–2000. The data were purchased from Construction Market Data (CMD) Group, a firm that sells information about upcoming projects to contractors through periodicals, its Web site, and access to local CMD reporters and plan rooms. For many contractors, CMD is a primary source of information for learning about construction projects.[10] The data consist of approximately 25,600 projects of which roughly 4100 were awarded in the private sector. We focus on the private sector jobs since most public sector projects are required by statute to use open competitive bidding.

The unit of observation in our data set is a nonresidential building construction project. Each observation includes project characteristics such as the location of the project site, a detailed description of the work to be done, the estimated project value (an engineering cost estimate), the award mechanism (auction or negotiation), the number of bidders, the date that bids were due, and bonding information. The data does not include any information on project outcomes or the form of contract that is used. However, as we argued earlier, industry sources have documented that most of the negotiated contracts are cost-plus, whereas practically all the auctioned contracts are fixed price. In addition to the project characteristics, the data include unique id numbers for the firms involved in the project (the buyer, the bidders, and all the other major roles), as well as their identity, allowing us to examine the dynamics of relationships between firms and how frequently certain firms are active, as well as other tests that we describe below.

4.2 Summary Statistics

In what follows, we begin by summarizing some key statistics in our data. Table 1 summarizes the size, value, and other characteristics of the buildings in our data set. The project value is an architect's or engineer's estimate of the total project cost. Before construction begins, it is typical for the architectural firm that designs the plans and specifications to compute an estimated cost.

10. CMD estimates that their coverage is approximately 85%–90% of all projects in the building construction market during this period. According to CMD, the missing projects are usually those that are too small or projects that the buyer does not want publicized.

Table 1. Summary Statistics

Variable	Number of observation	Mean	Standard deviation	1%	99%
Project value	4085	9,506,236	3.60×10^7	50,000	148,000,000
Floor area (square feet)	3030	187,894	2,750,522	1,098	1,000,000
Number of divisions	758	5.6	2.78	1	12
Floors above ground	4086	1.77	3.4	0.00	18.00
Parking spaces	4087	18.67	129.0	0.00	500

Table 1 demonstrates that there is a great deal of heterogeneity in project size. The average project value is approximately 9.5 million dollars with a standard deviation of 36 million dollars. The smallest project is near $10,000 in cost, whereas the largest project is close to $800 million in cost. The variation in other project characteristics, such as floor area, number of divisions, floors above ground, and parking spaces, also demonstrates that our data set contains a diverse set of projects (see the Appendix for a more detailed description of the divisions).

Table 2 summarizes the distribution of award mechanisms. Nearly half of the jobs are negotiated. Open competitive bidding is used for only 18% of the jobs, whereas invited bidders is used for 37% of these projects. Since buyers use invited bidders twice as often as open competitive bidding, it appears that buyers frequently prefer to *restrict* the set of firms allowed to bid.[11]

Table 3 summarizes the distribution of the number of jobs done by each firm in our data set. The construction industry is extremely competitive with high entry and exit rates that are commonly attributed to the low entry costs in construction, as compared with other industries. Nearly 60% of the firms in our data set only complete one job as a prime contractor.[12] Many of these small firms in the Northern California building construction industry work as subcontractors on other construction projects, work on smaller projects not contained in our data set, or have a short life span.

5. Auctions Versus Negotiations: Evidence

We evaluate the hypotheses discussed in Section 3 using a discrete choice econometric model. Most of the analysis consists of logistic specifications that regress the choice of award mechanism on possible explanatory variables such

11. Ye (2007) develops a model in which it is costly for bidders to learn their valuations, and in his setting, it is typically optimal for the auctioneer to restrict entry into the auctions. Since it is far from trivial for contractors to discover their costs for a specific project, this may be a reason for the prevalence of invited bidder auctions. A concern for quality may also explain the prevalence of these auctions.

12. This is consistent with findings about the size distribution of firms in other branches of the construction industry. Bajari and Ye (2003) report that in the highway construction industry, about half of the firms who bid never win a single large contract.

Table 2. Breakdown of Award Methods

Variable	Number of observations (private sector)	Percentage (private sector)	Number of observations (public sector)	Percentage (public sector)
Invited bidders	1,522	37.2	42	0.2
Prequalified bids	44	1.1	394	1.8
Open bidding	752	18.4	20,865	97
Negotiated	1,769	43.3	210	1
Total	4,087	100	21,511	100

as project complexity, the number of available contractors, and buyer characteristics. We also test for correlations between the choice to negotiate a contract and the reputation of the selected contractor.

We proxy for complexity using three project characteristics: the (*log*) *value* of the project, the (*log*) *square feet* of the project, and the *number of divisions*. The value of the project is a reasonable proxy for complexity since the number of hours to completely document the plans and specifications is generally higher for projects with large estimated values. Furthermore, projects that are more complex are typically more costly to construct. The log square feet of the building is a reasonable proxy for complexity by analogous arguments. The number of divisions indicates the number of subcategories of work, as defined by CMD that are required to complete the project (such as electrical wiring, plumbing, dry walling, etc., which are shown in great detail in the Appendix.) In general, the complexity of the plans and specifications is also positively correlated with the number of divisions.

Industry specialists argue that competitive bidding will be used more often by buyers who are more experienced and build frequently. We wish to control for this and proxy for the buyer's experience with three variables. First, we use a "cumulative owner experience" variable that is the log of the number of times a buyer has appeared in our data set.[13] Second, we supplement our CMD data with credit data from Reference USA, a web-based firm whose rating considers a business' number of employees, years in business, industry stability, census data, pay history, etc.[14] This data include credit rating of a buyer (0–7) and a size measure of buyer (number of employees). We assume that these measures are positively correlated with a buyer's experience.

Our second hypothesis argues that the choice between auctions and negotiations will also depend on the number of available contractors. In the late

13. We considered other specifications, including a dummy for whether the buyer appears more than once, and the significance and sign of the correlations are robust to these specifications.

14. Reference USA information is compiled from public sources such as Yellow Pages, annual reports, 10-Ks, and other SEC information, government data, Chamber of Commerce information, leading business magazines, trade publications, newsletters, major newspapers, industry and specialty directories and postal service information. There ratings are indicators of the financial strength of the business.

Table 3. Distribution of Firms by Number of Jobs Done, All Jobs

Number of jobs done by firm	Number of firms	Frequency %	Cumulative %
1	757	59.3	59.3
2–5	387	30.3	89.6
6–10	83	6.5	96.1
11–20	37	2.9	99.0
>20	13	1.0	100

1990s, there was considerable fluctuation in local construction activity that arose from the varying fortunes of high technology companies. We control for this by including the 6-month percentage change in the total volume of work awarded in the project's county. Since the construction industry is highly spatial, the majority of work performed by a contractor will be close to a contractor's headquarters. Since the number of local contractors will not adjust instantaneously to local, short-run demand shocks, we believe that our control reasonably proxies for the number of available contractors.[15]

Our third hypothesis suggested that negotiations will be awarded to more reputable contractors. We proxy for a contractor's reputation using similar experience measures that we use for buyer experience. Given the high turnover of firms in the industry, we believe that these are reasonable proxies for contractor reputation.

5.1 Choosing the Award Mechanism

5.1.1 Complexity.

In this section, we estimate both binomial and ordered categorical versions of the model. The former is summarized in Table 4, which reports estimates from a series of logit specifications where $y_i = 1$, if the project is negotiated, and $y_i = 0$, if the project is competitively bid. We define a project as "competitively bid" if it is awarded using invited bidders, prequalified bidders or open competitive bidding. In all our specifications, we observe a positive and statistically significant relationship between our three measures of complexity and the use of negotiations. The standard errors (here, and in Tables 5.2 and 5.5) are clustered by owner to account for potential correlation among the error terms.

15. Some large firms operated on much larger geographical scales. To control for potential differences across projects in the impact of regional project activity levels on award mechanism, we tried interacting the "6 month change in county work volume" variable with a number of functions controlling for project complexity. Regardless of the specification, the effect of the "6 month change in county work volume" did not vary (either economically or statistically) significantly with project complexity.

Table 4. Logistic Regressions of Award Mechanism (Negotiation = 1) on Project and Owner (Buyer) Characteristics

	1	2	3	4	5
Log project value	0.1481**	0.2637*	0.2640*	0.1604	0.2503*
	(0.0564)	(0.1030)	(0.1038)	(0.1221)	(0.1047)
Log floor area	0.2014**	0.4193**	0.4286**	0.6702**	0.4495**
	(0.0631)	(0.1251)	(0.1286)	(0.1593)	(0.1314)
Number of divisions		0.0880*	0.0893*	0.1076*	0.0821*
		(0.0376)	(0.0376)	(0.0439)	(0.0400)
Cumulative owner experience	−0.2465*	−0.7130**	−0.6878**	−0.5321**	−0.7648**
	(0.0960)	(0.1572)	(0.1572)	(0.1631)	(0.1711)
Owner credit			−0.0693	−0.2983**	−0.0397
			(0.0495)	(0.0733)	(0.0513)
Owner size				−0.0013	
				(0.0007)	
6 month change in county work volume					0.0473
					(0.0242)
Constant	−3.960**	−7.928**	−7.853**	−8.290**	−7.864**
	(0.5445)	(1.297)	(1.289)	(1.578)	(1.338)
Sample size	2589	597	597	439	557

Standard errors in parentheses.
*Significant at 5%, **significant at 1%.

The specification in column 1 only includes log-project value and log-floor area but does not include the number of divisions. This allows us a sample size of 2589 projects, and the effects of complexity are significant when controlling for the cumulative experience of the owner/buyer. In all the other specifications in Table 4 (columns 2–5), we add our third proxy for complexity, the number of divisions, which reduces the maximum sample size to 597 projects. Controlling for buyer characteristics and for change in the 6-month county volume of work still results in significance of our proxies of complexity. In the specification of column 4, the addition of the owner's size measure causes the sample to drop to 439 projects, resulting in different estimates and loss of significance for log project value. It turns out that controlling for owner size is not responsible for these changes, and they occur due to the sample selected for this specification.[16]

16. We ran the specifications of columns 2 and 3 on the sample of column 4, and the results for these two regressions yielded very similar estimates and standard errors as those that appear in column 4. Thus, the unique results in column 4 are due to the sample restricted by the inclusion of owner size. Similarly, the subsample of projects for which we observe the number of divisions does appear to be somewhat different than the whole sample. The projects tend to be smaller in project value and in floor area. There do not appear to be noticeable differences in the aggregate choice of award mechanism, however, and the differences in specifications in Tables 5.1, 5.2, and 5.5 do appear to stem primarily from the sample selection issue rather than from the effect of controlling for the number of divisions. This was confirmed when the same regression as the first column was performed on the smaller sample of projects that include the number of divisions.

To check our results, Table 5 reports estimates from an ordered logit where the dependent variable is $y_i = 3$, if the project is negotiated, $y_i = 2$, if invited bidders are used, and $y_i = 1$, if open competitive bidding is used. We chose this ordering of the dependent variable because it seems reasonable to treat the invited bidder mechanism as something between open auctions, where everyone can participate, and negotiations, where a single contractor is selected.[17] To further justify this ordering, the following argument seems appealing. For projects that are complex, but not too complex, the buyer may wish to exploit the benefits of a competitive auction but is wary about the contractor's ability to perform the work and his reputation for performing such projects. Thus, as complexity increases, but is not too high, the buyer may wish to restrict the set of bidders to a sample of qualified and reputable contractors. When complexity increases further, the merits of negotiated contracts come into play.

The five columns of Table 4 are replicated with the ordered logit in Table 5 as described above, and two additional columns (2 and 3) provide further strength to the results. These results are consistent with our previous findings. We have found that this is robust to changes in our specification, such as restricting attention only to the choice between invited bidders and open competitive bidders.[18]

The results of Tables 4 and 5 are consistent with our hypothesis that suggests a positive correlation between negotiation and measures of complexity. From our conversations with industry sources and from reading the industry literature, it is our impression that both the motivations we discuss in Section 3 (from Goldberg [1977] and Bajari and Tadelis [2001]) for negotiating contracts are important in practice, but with our data, we cannot offer further tests to tease these apart. There are two alternative stories that we can distinguish from our theories, however.

First, since all three of our measures of complexity involve the scale, or size of the project, an alternative explanation for the positive relationship between our proxies for complexity and the use of negotiation would be a budget constraint argument: the larger a project, the fewer contractors there are who have deep enough pockets to compete for it. As a result, an auction may not induce sufficient competition, in turn making it less effective.

To test this alternative hypothesis against ours, we regress the number of bidders on project covariates. The "deep pocket" hypothesis implies that conditional on running an open auction, as the project becomes bigger there will be fewer bidders who can compete for it. This is particularly true since it is well known to contractors that preparing bids for larger projects is more costly than for smaller ones. In Table 6, we use a series of OLS specifications in which the

17. There are only 25 contracts with prequalified bidders as the designated award mechanism, and these were dropped. We ran a specification in which prequalification was lumped with invited bidders (one can think as the two sharing some similarities of being above a certain "bar"), and the results were almost identical.

18. If submitting bids is more costly for more complex projects, which seems to be the case, then there are advantages to restrict the number of bidders (see Ye, 2002).

Table 5. Ordered Logistic Regression for Award Mechanism (Open Bidding = 1, Invited Bidders = 2, Negotiation = 3)

	1	2	3	4	5	6	7
Log project value	0.1354* (0.555)	0.1350* (0.0554)	0.1442 (0.1053)	0.2067* (0.0908)	0.2050* (0.0913)	0.1864 (0.1031)	0.1847 (0.0955)
Log floor area	0.1950** (0.0595)	0.1958** (0.0594)	0.4099** (0.1051)	0.4504** (0.1055)	0.4647** (0.1092)	0.5870** (0.1220)	0.4947** (0.0991)
Number of divisions				0.0703* (0.0354)	0.0724* (0.0350)	0.0847* (0.0405)	0.0719 (0.0376)
Cumulative owner experience	−0.1338 (0.0718)	−0.0899 (0.0780)	−0.1964* (0.0820)	−0.4494** (0.0883)	−0.4200** (0.0932)	−0.3809** (0.0898)	−0.4947** (0.0898)
Owner credit		−0.0510* (0.0253)	−0.1370* (0.0537)		−0.0851 (0.0438)	−0.2570** (0.0696)	−0.0528 (0.0452)
Owner size			−0.0002 (0.0001)			−0.0001 (0.0001)	
6 month change in county work volume							0.0431* (0.0199)
Constant (cut 1)	1.507** (0.5192)	1.481** (0.5226)	2.487** (0.9492)	4.845** (0.9492)	4.730** (1.137)	4.961** (1.354)	4.688** (1.190)
Constant (cut 2)	3.854** (0.5302)	3.834** (0.5313)	5.700** (1.010)	7.678** (1.181)	7.587** (1.611)	7.868** (1.161)	7.668** (1.201)
Sample size	589	2589	937	597	597	439	557

Standard errors in parentheses.
*Significant at 5%, **significant at 1%.

dependent variable, the number of bidders, is regressed on log project value and on year dummies.[19] Our results in column 1 show that in contrast to the deep pocket hypothesis, the number of bidders *increases* with the value of the project, implying that the positive relationship between project value and the choice of negotiations does not appear to arise from a limited number of potential bidders. In column 2, we run a specification with dummies for low-, medium-, and high-value projects and verify that the positive relationship between project value and the number of bidders is maintained across all value ranges, implying that the deep pocket hypothesis is not born out in the data.

A concern from drawing conclusions based on private sector data is that OLS may be inappropriate because of selection: competitive bidding is more likely to be used the larger the number of potential bidders (as hypothesized and confirmed), and as such the projects let out to bid are not a random sample. To address this, we observe that the positive correlation between the number of bidders and the project value is also prominent in the public sector (columns 3 and 4) in which almost all the contracts are awarded through open competitive bidding by the directives of FAR.

A second alternative story consistent with our results is that auctions are not used in complex projects because buyers are more concerned about contractors not performing when complex projects are at stake and therefore will choose a reputable contractor through negotiations. Although contractors can shirk and be incompetent, this problem is severely limited by industry practices due to bonding requirements. When bidding on a fixed-price contract, the contractor must submit a performance bond obtained from a surety (a bonding company). The surety is liable up to the amount of the contractor's bid if the contractor fails to build the project to plans and specifications. The surety has no incentive to provide a low-priced bond to a contractor who has not proven that he poses little risk. Thus, the incentives of bonding firms to screen for competence is a possible remedy for adverse selection, and the hostages of a contractors assets and future reputation will mitigate moral hazard. This suggests that this alternative story is unlikely to be true.

5.1.2 Buyer Characteristics. Awarding a project through competitive bidding involves significant advertising, followed by contractors picking up the plans and specifications from the buyer and preparing cost estimates, and then submitting bids at the prespecified time and place. In contrast, when a project is negotiated, there is no need to advertise and consequently a contract can be signed with considerably less delay. Industry participants suggest that more experienced buyers should be more familiar with the bureaucratic procedures

19. The regression does not include projects that were bid in 2000 because we only observe the number of bidders on projects that were bid prior to December 11, 1999. We can verify that the post-12/10/99 projects were bid because we observe data on the top three bidders for these projects. The post-12/10/99 sample does not appear to be substantially different than the pre-12/10/99 sample.

Table 6. OLS Regression of Number of Bids Received on Project Value and Year Dummies

	Bids received (private sector)	Bids received (private sector)	Bids received (public sector)	Bids received (public sector)
Log project value	0.2103*		0.2805**	
	(0.0750)		(0.0294)	
1995 dummy	0.1815	−0.1191	1.306**	1.296**
	(0.2746)	(0.3364)	(0.3631)	(0.3621)
1996 dummy	1.142**	1.099**	0.6346**	0.6284**
	(0.3313)	(0.3390)	(0.0920)	(0.0926)
1997 dummy	−0.3671	0.3333	0.0079	0.0067
	(0.3081)	(0.3063)	(0.0803)	(0.0802)
1998 dummy	−0.0240	−0.0490	0.0973	0.0944
	(0.3220)	(0.3272)	(0.0782)	(0.0782)
Log project value				
Low dummy		0.4135**		0.3511**
		(0.1474)		(0.0327)
Medium dummy		0.3727**		0.3456**
		(0.1308)		(0.0280)
High dummy		0.3625**		0.3134**
		(0.1205)		(0.0306)
Constant	0.9928	−1.429	0.9623*	0.1258
	(1.066)	(1.853)	(0.3762)	(0.3993)
Sample size	304	304	10,693	10,693

Standard errors in parentheses.
*Significant at 5%, **significant at 1%.

associated with competitive bidding and use competitive bidding more frequently, all else held constant.[20]

Tables 4 and 5 demonstrate that more experienced buyers are more likely to use competitive bidding. All three proxies for buyer experience—cumulative owner experience, owner credit, and owner size—are negatively correlated with the choice of negotiations. This is consistent with the views of industry participants that more experienced buyers are likely to have lower administrative costs for awarding a contract by competitive bidding. This result is significant at conventional levels in all our specifications.[21]

20. Another drawback of open competitive bidding is that a complete set of the buyer's plans and specifications must be made available to all bidders. These plans may contain sensitive information about business strategy, such as markets in which the buyer wishes to expand. In such circumstances, the buyer will wish to maintain the privacy of these plans and specifications by using negotiation as the award mechanism. We cannot address this with our dataset.

21. We have no direct evidence about the influence of privacy concerns in the auction or negotiation choice. However, according to CMD, who has a large staff of reporters that search for upcoming jobs, buyers are often concerned about privacy. In the past, buyers got angry when CMD has advertised projects that they wished to keep secret. Buyers have an incentive to keep their plans and specifications a secret when a new technology is involved (e.g., when constructing a plant that will utilize a new manufacturing process) or when a buyer is expanding his business into a new territory.

5.1.3 The Number of Bidders. In Tables 4 and 5, we find that an increase in the 6-month county work volume leads to an increased use of negotiations. We interpret this result in the following way: When there is an increase in the amount of work done in a county, the local contractors are busier, leaving fewer contractors to bid on new work since construction is a rather local activity. This is consistent with the prediction that negotiations are more attractive when fewer bidders are available.

In Table 6, we find that the time dummies for 1995 and 1996 are statistically significant and decreasing over time, whereas the dummies for 1997 and 1998 are insignificant, implying that there are as many bidders as in the base year of 1999. The years 1997–1999 correspond to a period of robust economic growth in the bay area, brought on by a strong demand for high-technology products, and the creation of many new high-technology businesses. Overall, demand for building construction rose sharply in these years.

As a result, there was an average of 0.6 and 1.3 less contractors bidding on any given job in the public sector in 1997–1999 as compared to 1996 and 1995, respectively.[22] It is informative to consult Table 7, in which we see that auctions were used for about 60% of the projects in the years 1995–1997 and 2000–2001, as compared to 52% in 1999. Overall, the results indicate that the use of negotiations tended to be procyclical, whereas the use of auctions was counter-cyclical. This is consistent with our hypothesis that fewer available bidders, other things equal, make auctions a less attractive award mechanism.

5.2 Choosing the Contractor

To see if our data can shed light on the relationship between the contractor's reputation and the award mechanism, in Table 8 we report estimates from a series of logit specifications where the dependent variable is a proxy for contractor reputation and experience, regressed on project characteristics, owner characteristics as well as on dummies for the type of award mechanism treating open competitive bidding as the base-case. Note that this time we use our endogenous variable, award mechanism, as a right-hand-side variable. Recall from our discussion in Section 3 that this assumes that the choice of award mechanism is independent of the set of available contractors. Alternatively, this positive correlation of high reputation with the use of negotiations can be a consequence of having a reputable contractor to deal with. Hence, we cannot identify the mechanism through which such a correlation would occur, but we can verify whether it is there.

We conduct these regressions on our large sample without the number of divisions (columns 1 and 3) and on the smaller sample that includes the number of divisions. Also, we use two proxies for the contractor's reputation: for "experienced builder," $y_i = 1$, if the contractor appears more than once in our data, and for "cumulative builder experience," $y_i = 1$, if the contractor had appeared previously in our data. We see that for all four specifications, both

22. There are only 304 observations in the private sector for Table 6, and as such, the results of the public sector seem more robust. Still, the 1996 dummy in the private sector is significant with about 1 less bidder per contract.

Table 7. Award Method over Time (Private Sector Only)

Year	1995–1996	1997	1998	1999	2000–2001
Negotiated	39.6%	41.4%	46.3%	48.0%	40.0%
Invited bidders	47.5%	47.2%	43.1%	40.8%	41.4%
Open competitive bidding	11.8%	10.7%	9.1%	10.5%	16.6%
Prequalified bidders	1.1%	0.7%	1.5%	0.6%	2.0%
Number of observations	442	439	518	475	467

prequalification and invited bidders select for more reputable builders, and negotiations exhibit the same bias but significantly more pronounced. This finding is consistent with our discussion in Section 3 that more reputable contractors should be selected when awarding a negotiated contract.[23] These results are robust to controlling for project and owner characteristics.

On a separate note, it is often suggested in the construction management literature that fixed-price contractors aggressively seek change orders since their overall profit will depend on revenues derived from changes. In this highly competitive environment, firms who do not aggressively seek changes will quickly be driven out of business. As a result, fixed-price contractors and public sector contractors are perceived as more ruthless than firms who perform cost-plus contracts.

In Figure 1, we plot a histogram of the fraction of work that is done by a given firm in the private sector, and in Figure 2, we plot a histogram of the fraction of work done through negotiated contracts within the private sector (only for firms who complete more than one contract). These results suggest that firms tend to specialize in either public or private work and within the private sector in either negotiated or competitively bid work. According to industry sources, the most reputable contractors engage in cost-plus contracting, less reputable contractors are awarded fixed-price contracts in the private sector, and the least reputable are awarded contracts in the public sector. This is further evidence, consistent with our discussion in Section 3, that reputation plays a role in matching contractors to award mechanisms.[24]

23. Banerjee and Duflo (2000) also find a positive correlation between the reputation of software contractors and the use of cost-plus contracts. Their interpretation is that the choice of contract is influenced by the seller's reputation, which differs from our story. Using our data, it is hard to tease out the causal effects of reputation, but when we control for seller characteristics, both with and without spatial location as instruments, the significance of project and buyer characteristics shown in Tables 4 and 5 still hold strong.

24. Long-term relationship between a buyer and a contractor may imply the more frequent use of experienced contractors in negotiated projects. We found that pairings between the same buyer and contractor are very infrequent in the data. We also found that multiple pairings of the same contractor and architect are not very frequent. Thus, we cannot investigate the relationship between repeated interactions and the choice of award mechanism. (See Corts and Singh, 2004, for an analysis of this sort). That said, reputational incentives would prevail through word-of-mouth referrals, giving experience contractors an incentive to sustain their reputation.

Table 8. Logistic Regression of Builder Experience on Project Value and Award Dummies

	Builder experience	Builder experience	Cumulative builder experience	Cumulative builder experience
Log project value	0.0204	−0.2241*	0.0302	−0.2261*
	(0.0542)	(0.1116)	(0.0509)	(0.1132)
Log floor area	−0.0221	0.1955	−0.0145	0.2109
	(0.0673)	(0.1205)	(0.0645)	(0.1236)
Number of divisions		−0.0347		−0.0657
		(0.0368)		(0.0346)
Cumulative owner experience	0.1688	0.0579	0.3752**	0.1787
	(0.0858)	(0.1309)	(0.0895)	(0.1480)
Invited bids	1.195**	1.172**	0.9214**	1.026*
	(0.2244)	(0.3902)	(0.2295)	(0.4150)
Prequalified	1.337*	1.341	0.7891	
	(0.5670)	(0.9244)	(0.6625)	
Negotiation	2.256**	1.753**	1.999**	1.616**
	(0.2268)	(0.4086)	(0.2278)	(0.4310)
Sample size	2589	597	2589	592

Standard errors in parentheses.
*Significant at 5%, **significant at 1%.

6. Discussion

6.1 Limitations of the Empirical Analysis

There are at least three limitations to the empirical analysis above, the first two being common. First, many of the variables in our analysis are proxies of our independent variables, and as such, these are measured with error. Second, there are standard endogeneity problems. Given the lack of a general theoretic framework, it is difficult to assess what these omitted factors might be. From our conversations with industry participants, we believe that the error term can be best interpreted as buyer specific preferences for a particular award mechanism. For instance, some buyers are very "hands on" in their working relationship with contractors and therefore prefer cost-plus contracts which allow them more discretion. It seems unlikely, however, that buyer-specific preferences for auctions or negotiations would significantly bias our results. For instance, a buyer who needs to build a new business headquarters would probably not change the scale (and thus the complexity) of its headquarters because its head purchasing officer has a strong preference for awarding contracts by competitive bidding.

A third, related, potential problem is selection. We are not able to construct all our variables for all the projects in our data set. In particular, when projects are very incompletely specified, engineering cost estimates are not available—the architects/engineers simply lack the data to assess what will be done. As a result, we do not see how the award mechanism is determined on the full support of the data.

However, there is no natural exclusion restriction that would allow us to identify a separate selection equation. We interpret our results as

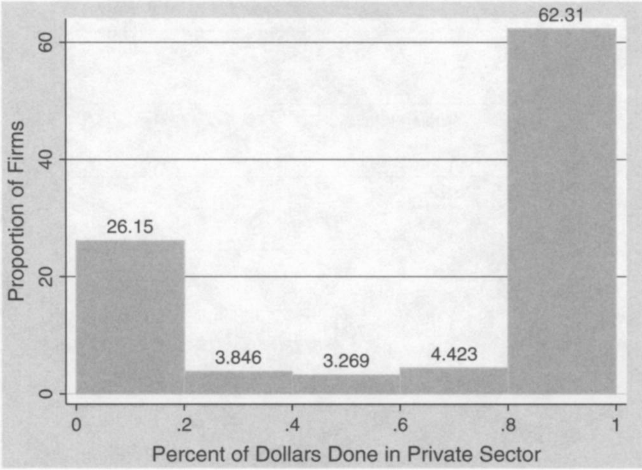

Figure 1. Fraction of Work (in dollar value) Done in the Private Sector for Firms with More than One Job.

valid on the part of the data where projects are sufficiently well specified in order for a cost estimate to be constructed. We therefore probably understate to some degree the importance of complexity in choosing the award mechanism.

6.2 Contractual Choice and Award Mechanisms

In their analysis of auctions versus negotiations, Bulow and Klemperer (1996) write that for the sale of a company, "a single extra bidder more than makes up for any diminution in negotiating power. This means that there is no merit in arguments that negotiation should be restricted to one or a few bidders to allow the seller to maintain more control of the negotiating process, or to credibly withdraw the company from the market" (p. 180). Though their main application is for the sale of a company, they also note that "in a procurement context, competitive bidding by suppliers will yield lower average prices than negotiating with a smaller number of suppliers."

We believe that their conclusions are insightful for applications where the item being bought or sold is well defined, and there is no ex post stage where the ex ante committed price needs to be renegotiated. Our analysis suggests that this is not the case for many procurement projects, for which ex ante information sharing is important and for which ex ante descriptions of the project may be incomplete, causing ex post adaptation to be an important feature of the transaction.

As we have argued, two channels can make negotiations more attractive than auctions. The first, which follows from Goldberg (1977), is the need for ex ante information in order to use the knowledge and experience of a contractor before the designs are complete and construction begins. If a project will be awarded using competitive bidding, then a contractor has an incentive

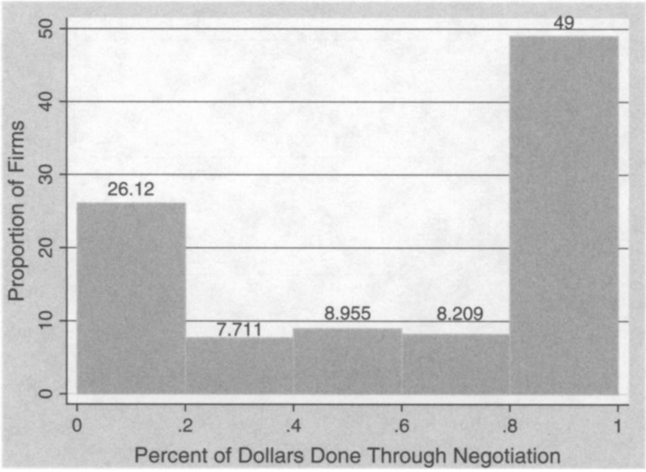

Figure 2. Fraction of Work (in dollar value) that is Negotiated in the Private Sector for Firms with More than One Job.

to hide information about possible design flaws, submit a low bid, and recoup profits when changes will be required. The second channel is the need to accommodate ex post adaptation for complex projects that are too costly to specify in advance. A response to this problem is choosing cost-plus contracts and, as argued by industry participants, these cannot easily be awarded through competitive bidding. As of yet, we cannot offer a comprehensive theoretical argument for the linkage of contractual form and award mechanism and believe that this is a potentially important issue to address in future work.

6.3 Implications for Public Sector Policy

In the public sector, statutes such as the FARs (and the many statutes that are modeled after the FARs) strongly favor the use of competitive bidding and, particularly, open competitive bidding when feasible. For instance, in our data set, 97% of the projects awarded in the public sector were awarded using open competitive bidding as compared to only 18% in the private sector.

Competitive bidding is perceived to select the lowest cost bidder, prevent corruption and favoritism that are opposed to efficiency, and it offers a clear yardstick with which to compare offers. According to an Ohio Court, competitive bidding "... gives everyone an equal chance to bid, eliminates collusion, and saves taxpayers' money .... It fosters honest competition in order to obtain the best work and supplies at the lowest possible price because taxpayers' money is being used. It is also necessary to guard against favoritism, impudence, extravagance, fraud and corruption" (see Sweet 1994: 379).

One recent case that caused a stir in California was a 95–126 million dollar no-bid contract that was awarded by California's department of information technology to Oracle for the long-term purchase of software database licenses. In a series of articles over the past 2 years in the San Jose Mercury News by Noam Levey, it was suggested that Oracle, through a series of contributions and lobbying efforts, had influenced the decision in their favor and that ex post the contract was not considered an attractive deal to the state of California. More recently, the award of "rebuilding Iraq" to Bechtel has also raised concern about the transparency of awarding a huge contract (up to $680 million in 2005) through a process other than open competitive bidding, concerns that were exacerbated due to Bechtel's connections with the republican administration.

Our results suggest that for complex projects, there may be a currently ignored downside to the use of fixed-price contracts awarded through competitive bidding. This downside of open competitive bidding can arise from a lack of input by contractors at the design stage, from the need to proceed quickly without the ability to complete detailed plans and specifications and from the expectations that ex post haggling and frictions might occur when changes are needed. An important practical question for public procurement is whether one can design a set of objective rules for awarding negotiated contracts that minimize transaction costs but that are not easily subject to manipulation, corruption, or blatant favoritism. We believe that investigating the costs of using competitive bidding is an important direction for future research that can shed light on important policy issues regarding public procurement.

6.4 Summary

This article offers one of the few empirical studies to examine the choice between auctions and negotiations in procurement. Our empirical analysis is primarily descriptive, but it sheds some light on what we believe is an important factor in procurement: the relationship between project complexity and contractual response.

We suggest some limitations of auctions, as compared to negotiations, that have not been emphasized in the literature. In procurement, the standard assumption of well-defined products, which is central to the mechanism design and auction literature, is questionable. When ex ante information is valuable and when ex post change is anticipated, the use of auctions, which often requires fixed-price contracts, may be inefficient.[25]

The analysis suggests some possible drawbacks of FARs that force public sector bureaucrats to award fixed-price contracts by competitive bidding. Our results suggest that there is room to consider alternative ways to prevent corruption, like more costly but effective monitoring, and then allow the public sector to award contracts with the flexibility and speed used by the private sector. Given the sheer volume of public sector procurement, it is clear that this approach begs for more serious research and evaluation.

25. Spulber (1990) shows that when ex post cost overruns can occur, and when contract enforcement is weak, then fixed-price contracts awarded through auctions will cause an adverse selection problem.

Appendix: Construction Divisions

We use the number of divisions as a proxy for complexity. Based on the tasks associated with each division, it is possible to broadly classify most of the divisions (although divisions 12 through 14 defy easy classification). This classification is seen in Table A1 below, which shows the percentage of projects (for which we observe the divisions used) that called for various pair-wise combinations of the divisions.

Although we do not have definitions of each division, we do have descriptions of the tasks associated with each division. We do see some overlapping of tasks across divisions (e.g., "HVAC" appears in both Divisions 15 and 16), but we interpret this as shorthand for tasks that are in fact different. Below, we list each of the tasks associated with each of the divisions. (Note: There is no Division 1.)

Division 2 (Demolition and Clearing): Asphalt Paving, Asphaltic Concrete Paving, Backfill, Backfilling and Compacting, Building Demolition, Clearing, Compaction, Dewatering, Excavation, Excavation and Backfill, Gas Distribution Systems, Grading, Hazardous Material Abatement, Hot Mixed Asphalt Paving, Irrigation, Landscape Irrigation System, Landscape Planting, Off-Site Improvements, Pavement Marking, Piles and Caissons, Portland Cement Concrete Paving, Railroad Work, Selective Demolition, Selective Demolition For Remodeling, Sewer and Drainage, Sewerage and Drainage, Shoring, Site Clearing, Site Concrete, Site Electrical Utilities, Site Masonry Work, Slope Protection and Control, Striping and Bumpers, Structural Excavation, Termite and Pest Control, Termite Control, Trenching, Unit Pavers, Utilities, Water System.

Division 3 (Concrete): Architectural Concrete, Architectural Precast Concrete, Cast-In-Place Concrete, Cementitious Deck, Cementitious Decks, Concrete, Concrete Curbs and Walks, Concrete Formwork, Concrete Reinforcement, Concrete Reinforcement and Formwork, Concrete Restoration and Cleaning, Concrete Work, Floor Sealer, Landscaping, Post-Tensioned Concrete, Reinforcing Steel, Shotcrete, Structural Concrete, Structural Precast Concrete, Tilt-Up Panels, Tilt-Up Precast Concrete.

Division 4 (Masonry): Cast Stone Masonry, Clay Unit, Clay Unit Masonry, Concrete, Concrete Masonry, Concrete Unit Masonry, Exterior Stone Cladding, Floor Sealer, Glass Block Masonry, Glass Unit Masonry, Granite, Marble, Masonry, Masonry Brick Veneer, Masonry Restoration and Cleaning, Mortar, Mortar and Grout, Stone, Unit Masonry.

Division 5 (Metalwork): Cold Formed Metal Framing, Expansion Joints, Landscaping, Metal Decking, Metal Fabrications, Metal Joists, Metal Railings, Metal Stairs, Metals, Miscellaneous Metal Fabrication, Ornamental Metals, Ornamental Stairs, Prefabricated Spiral Stairs, Steel Joists and Joist Girders, Structural Steel.

Division 6 (Carpentry): Architectural Woodwork, Cabinets and Finish Carpentry, Carpentry, Custom Casework Installation, Finish Carpentry, Finish Carpentry and Millwork, Finish Carpentry/Millwork, Glue Laminated Beams, Metal Railings, Miscellaneous Rough Carpentry, Open Web Truss, Plastic Fabrications, Plastic Laminate Casework, Plywood Wainscot, Prefabricated Structural Wood, Rough Carpentry, Stairwork and Handrails, Wood Timber, Wood Trusses.

Division 7 (Insulation and Waterproofing): Building Insulation, Built-Up Roofing, Caulking, Crystalline Waterproofing, Dampproofing, EIFS, Exterior Insulation, Exterior Insulation and Finish Systems, Finish Carpentry, Fireproofing, Firestopping, Flashing and Sheet Metal, Insulation, Joint Sealants, Manufactured Roofing, Manufactured Roofing and Siding, Membrane Roofing, Metal Framed Skylights, Metal Wall Panels, Roof Accessories, Roof Repairs, Roofing, Roofing Tiles, Sealants and Caulking, Sheet Metal Roofing, Shingles, Single-Ply Membrane Roofing, Skylights, Thermal and Moisture Protection, Waterproofing.

Division 8 (Doors and Windows): Accordion Folding Doors, Aluminum Entrances and Storefronts, Aluminum Storefronts, Automatic Entrance Doors, Coiling Doors, Coiling Doors and Grilles, Curtain Walls, Doors and Windows, Entrance and Storefront, Entrances, Finish Carpentry, Finish Hardware, Folding Doors and Grilles, Glass and Glazing, Glazing, Hardware, Hollow Metal Work, Metal Doors, Metal Windows, Overhead Doors, Plastic Windows, Sectional Overhead, Sectional Overhead Doors, Traffic Doors, Wood Doors, Wood Windows.

Division 9 (Floors and Ceilings): Acoustical Ceiling, Acoustical Walls, Acrylic Wall Panels, Carpeting, Ceiling Suspension Systems, Ceramic Tile, Drywall, Drywall/Gypsum, Epoxy Floor Toppings, Floor Covering, Glass and Glazing, Gypsum Board Systems, Gypsum Wallboard, Gypsum Wallboard System, Lath and Plaster, Marlite, Painting, Plaster, Plaster Patching, Plastic Panels, Resilient Flooring, Resilient Tile Flooring, Stone Flooring, Stucco, Terrazzo, Tile, Wall Coverings, Wood Flooring.

Table A1. Percentage of Projects that Call for Pairwise Combinations of Divisions

Division#	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	86														
3	67	73													
4	48	41	51												
5	77	64	46	87											
6	50	41	26	55	59										
7	28	22	13	34	33	38									
8	23	19	10	29	27	30	33								
9	22	19	11	28	26	28	31	32							
10	18	16	9	23	23	24	27	27	27						
11	4	4	2	5	5	5	6	6	5	6					
12	4	4	2	6	6	6	6	6	6	2	6				
13	3	2	1	4	4	4	5	5	5	1	2	5			
14	4	4	2	4	4	5	5	5	5	1	2	0	5		
15	16	14	6	22	19	22	23	24	20	4	4	5	2	25	
16	17	14	6	23	20	23	25	25	21	4	4	5	2	24	27

Division 10 (Cabinets and Partitions): Access Flooring, Compartments and Cubicles, Exterior Signs, Fire Extinguisher Cabinets and Accessories, Fire Extinguishers and Cabinets, Fireplaces and Stoves, Flagpoles, Folding Panel Partitions, Identifying Devices, Interior Signs, Lockers, Louvers and Vents, Operable Partitions, Painting, Partitions, Plastic Laminate Toilet Partitions, Postal Specialties, Protective Covers, Signage, Specialties, Storage Shelving, Telephone Specialties, Toilet and Bath Accessories, Toilet Accessories, Toilet Partitions, Toilet Partitions and Urinal Screens, Tub and Shower Doors, Visual Display Boards, Wall and Corner Guards.

Division 11 (Heavy Equipment Installation): Appliances, Athletic Equipment, Audio-Visual Equipment, Fluid Waste Treatment/Disposal Equipment, Food Service Equipment, Installation Of Food Service Equipment, Laboratory Equipment, Loading Dock Equipment, Parking Control Equipment, Toilet accessories, Waste Disposal Equipment, Water Supply/Treatment Equipment.

Division 12: Casework, Floor Mats, Furniture, Multiple Seating, Rugs and Mats, Toilet Accessories, Window Treatment.

Division 13: Building Automation Systems, Ground Storage Tanks, Hot Tubs/Pools, Pre-Engineered Structures, Radiation Protection, Sound, Swimming Pools, Vibration and Seismic Control.

Division 14: Appliances, Elevators, Material Handling Systems, Wheelchair/People Lifts.

Division 15 (HVAC): Air Handling, Boilers, Compressed Air System, Controls and Instrumentation, Cooling Towers, Ductwork, Evaporative Cooler, Fire Protection Systems, Fire Sprinklers, Fuel Fired Heaters, Furnaces, Heat Pumps, HVAC, HVAC Pumps, Hydronic Heat Pump, Hydronic Piping, Mechanical Insulation, Packaged A/C Units, Plumbing, Plumbing Fixtures, Plumbing Piping, Plumbing Pumps, Radiant Heat, Testing and Balancing, Toilet Accessories, Unit Heater, Water Chillers, Water Heaters.

Division 16 (Electrical): HVAC, Alarm and Detection Systems, Clock/Program Systems, Electrical, Electrical Controls, Emergency Lighting, Exterior Lighting, Interior Lighting, Public Address Systems, Service/Distribution, Service/Distribution, Standby Power Generator Systems, Television Systems, Transfer Switches, UPS Systems, Voice and Data Systems.

References

Bajari, Patrick, and Steven Tadelis. 2001. "Incentives Versus Transaction Costs: A Theory of Procurement Contracts," 32 *RAND Journal of Economics* 387–407.

Bajari, Patrick, Stephanie Houghton, and Steven Tadelis. 2007. "Bidding for Incomplete Contracts: An Empirical Analysis." NBER Working Paper No. W12051.

Bajari, Patrick, Lixin Ye. 2003. "Deciding Between Competition and Collusion," 85 *Review of Economics and Statistics* 971–89.

Banerjee, Abhijit V., and Esther Duflo. 2000. "Reputation Effects and the Limits of Contracting: A Study of the Indian Software Industry," 115 *Quarterly Journal of Economics* 989–1017.

Bartholomew, Stuart H. 1998. *Construction Contracting: Business and Legal Principles.* New York: Prentice-Hall, Inc.

Bonaccorsi, Andrea, Thomas P. Lyon, Fabio Pammolli, and Giuseppe Turchetti. 2003. "Auctions vs. Bargaining: An Empirical Analysis of Medical Device Procurement." Working Paper, Department of Economics, University of Washington.

Bulow, Jeremy, and Paul Klemperer. 1996. "Auctions vs. Negotiations," 86 *The American Economic Review* 180–94.

Cameron, Lisa J. 2000. "Limiting Buyer Discretion: Effects on Performance and Price in Long-Term Contracts," 90 *The American Economic Review* 265–81.

Clough, Richard, and Glenn Sears. 1994. *Construction Contracting.* New York: Wiley.

Corts, Kenneth, and Jasjit Singh. 2004. "The Effect of Repeated Interaction on Contract Choice: Evidence from Offshore Drilling," 20 *Journal of Law, Economics and Organizations* 230–60.

Crocker, Keith J., and Kenneth J. Reynolds. 1993. "The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement," 24 *Rand Journal of Economics* 126–46.

Engineering News-Record. 1998. "The World is a 3.2 Trillion Construction Market." *Engineering News-Record,* November 30,1998, 35–68.

Goldberg, Victor P. 1977. "Competitive Bidding and the Production of Precontract Information," 8 *Bell Journal of Economics* 250–61.

Hendel, Igal, and Alessandro Lizzeri. 2003. "The Role of Commitment in Dynamic Contracts: Evidence from Life Insurance," 118 *Quarterly Journal of Economics* 299–328.

Hester, Weston T., John A. Kuprenas, and T.C. Chang. 1991. "Construction Changes and Change Orders: Their Magnitude and Impact." Working Paper, The Construction Industry Institute, Austin, Texas.

Hinze, Jim. 1993. *Construction Contracts. McGraw-Hill Series in Construction Engineering and Project Management.* New York: Irwin/McGraw-Hill.

Holmstrom, Bengt, and Paul Milgrom. 1991. "Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership and Job Design," 7 *Journal of Law, Economics and Organization* 24–52.

Ibbs, C. W., Back, W. E., Kirn, J. J., Wall, D. E., De La Garza, J. M., Hassanein, M. A., Schran, S. M., and R. K., Twardock. 1986. "Determining The Impact of Various Construction Contract Types And Clauses On Project Performance: Volumes I and II." Working Paper, The Construction Industry Institute, Austin, Texas.

Laffont, Jean-Jacques, Jean Tirole. 1993. *A Theory of Incentives in Procurement and Regulation.* Cambridge: MIT Press.

Leffler, Keith B., Randal R. Rucker, and Ian Munn. 2007. "The Choice Among Sales Procedures: Auction vs. Negotiated Sales of Private Timber," unpublished manuscript, Dept. of Agricultural Economics and Economics, Montana State University, Bozeman, MT, January 2007.

Manelli, Alejandro, and Daniel Vincent. 1995. "Optimal Procurement Mechanisms," 63 *Econometrica* 591–620.

McAfee, R. Preston, and John McMillan. 1987. "Auctions and Bidding," 25 *Journal of Economic Literature* 699–738.

Spulber, Daniel F. 1990. "Auctions and Contract Enforcement," 6 *Journal of Law, Economics and Organizations* 325–44.

Sweet, J. 1994. *Legal Aspects of Architecture, Engineering and the Construction Process,* Minnesota: West Publishing Company.

U.S. Department of Commerce, Bureau of the Census. 1992a. *Census of Construction Industries. United States Summary. Establishments With and Without Payroll.* Washington DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1992b. *Census of Construction Industries. General Contractors-Residential Buildings, Other Than Single-Family Homes.* Washington DC: Government Printing Office.

U.S. Department of Commerce, Bureau of the Census. 1992c. *Census of Construction Industries. General Contractor-Nonresidential Buildings, Other Than Industrial Buildings and Warehouses.* Washington DC: Government Printing Office.

Williamson, Oliver E. 1985. *The Economic Institutions of Capitalism.* New York: Free Press.

Ye, Lixin. 2007. "Indicative Bidding and A Theory of Two-Stage Auctions," 58 *Games and Economic Behavior* 181–207.