Procurement, Incentives and Bargaining Friction: Evidence from Government Contracts

John Horton*

Abstract

A transaction cost theory of procurement developed by Bajari and Tadelis (2001) models the buyer's choice of incentive structure as endogenous, with buyers trading off the efficiency of high-powered incentives against the ex post bargaining friction these incentives can create. The source of the bargaining friction is assumed to be asymmetric information between the buyer and seller about the true costs of adapting the project to changed conditions. Using government contract data and an instrument based on contracting-office idiosyncratic variation in preference for various contractual forms, I estimate the effect of a buyer choosing a fixed-price (i.e., high-powered) contract on the probability that the contract will lead to litigation, which proxies for bargaining failure and friction. I find that (a) fixed-price contracts are far more likely to be litigated that cost-plus contracts and (b) the instrumental variables estimate of the effect of choosing a fixed-price structure is almost twice as larges as the biased, OLS estimate. These results are consistent with the main predictions of the Bajari and Tadelis model.

1 Introduction

The key insight from transaction cost economics (TCE) is that the governance structure that controls the relationship between a buyer and a seller can create incentives for parties to engage in surplus-dissipating ex post strategic behavior. When the parties have some control over that governance structure, they will rationally take steps ex ante to mitigate these costs, such as by vertically integrating or writing long-term contracts. Despite a large body of empirical evidence suggesting the relevance of transaction costs, the informality of most TCE models makes discriminating tests of the theory difficult (Whinston, 2001). For example, there are several competing theories of the firm, and not surprisingly, all make the prediction of vertical integration. Given the limited set of

*John F. Kennedy School of Government, Harvard University

observable characteristics normally available to the researcher, it is usually hard to rule out alternate theories as the cause of some governance structure, never mind determine (a) whether transactions costs are truly determining that structure or (b) which precise transaction costs that are most important. A novel contribution of this paper is the use an actual transaction cost — namely litigation — as the outcome of interest rather than a second-order effect of a transaction cost such as vertical integration. Facilitated by a formal theory that makes precise predictions, this innovation allows a much stronger test than past empirical investigations of TCE theories.

1.1 The Choice of Contract Structure

Although contract incentive schemes can be arbitrarily complex in principle, most real-world contracts are simple, with fixed-price or cost-plus being the dominant contractual forms (Eggleston et al., 2000). A fixed-price contract requires the seller to agree to perform some specific task in exchange for a predetermined lump-sum payment, while a cost-plus contract requires the seller to agree to an (approximately) undefined amount of work in exchange for reimbursement of costs plus a fee. In general, fixed-price contracts provide sellers with greater incentive to reduce costs than cost-plus contracts do, but they tend to be less flexible and more contentious. Table 1 highlights the key qualitative differences between cost-plus and fixed-price contracts.

The simplicity of real contracts is at odds with the thrust of modern procurement theory, as exemplified by Laffont and Tirole (1993). In these theories' models, the seller's private, ex ante information about production costs is assumed to be the primary obstacle to creating successful contractual relationships. The remedy to this asymmetry is a menu of complex contracts designed to screen sellers by type. Though these models are intended to be normative, even if buyers did offer menus of contracts (which, generally speaking, they do not), the limited repertoire of fixed-price and cost-plus contracts seems insufficient for the delicate task of screening sellers. Bajari and Tadelis and others have suggested that even if ex ante asymmetries do exist, the mechanism for addressing the problem is not the choice of incentive structure, but rather some combination of reputation, competitive bidding, and the use of sureties (Bajari and Tadelis, 2001; Banerjee and Duflo, 2000).

An alternative transaction cost procurement model developed by Bajari and Tadelis is more consistent with the stylized facts of contracting (Bajari and Tadelis, 2001). Their model assumes that buyers and sellers are restricted to choosing simple linear contracts and that both parties are equally ignorant ex ante about production costs, but that as work on a task progresses, the seller has better information about the costs of the contingencies that inevitably arise. With a cost-

plus contract, contingencies — i.e., states not considered by the parties beforehand — pose no real problem because the contract already specifies the correct action, namely, that the seller receives his or her costs. In contrast, with a fixed-price contract, unforeseen[1] contingencies force the buyer and seller to reach a new agreement about cost, but the seller's private information creates bargaining friction and ultimately litigation if terms cannot be reached. In their model, the fundamental problem of contracting is not ex ante information asymmetry, but ex post asymmetry about the costs of adaptation and the resulting bargaining friction.

One of the many merits of the Bajari and Tadelis model is that its formalism generates several clear, unambiguous predictions. Two predictions that are the focus on this paper are: (a) fixed-price contracts should lead more often to bargaining failure than cost-plus contracts do, and (b) fixed-price contracts will be used more frequently when the good or service is relatively simple and when the buyer's expectations are easy to specify. The first prediction is a direct implication of the ex post bargaining requirement of the fixed-price contract, which simply produces a greater flow of potentially litigated disputes. To understand the second prediction, note that a fixed-price contract induces the greatest effort by the seller to control costs, but to minimize back-end bargaining friction costs inherent with the fixed-price structure, more resources must be spent by the buyer up front to enumerate contingencies and write a careful contract. Goods and services for which the buyer can easily specify his or her expectations and likely contingencies will have lower front-end contract writing costs and hence, all else being equal, are the kinds of goods and services for which the fixed-price contract is most attractive.

This paper tests the Bajari and Tadelis model by estimating of the effect of contract structure on the probability of bargaining failure using government procurement data, with litigation between the government and the firm as a proxy for bargaining friction. Because the choice of structure is likely to be endogenous even without a theory whose key prediction is the endogeneity of incentive structure, to identify the effect I exploit idiosyncratic variation in how different government contracting offices procure identical goods. I find that the use of a fixed-price contract strongly increases the probability of bargaining failure as measured by contract litigation. I also find that the unbiased instrumental variables estimate of the effect is almost twice as large as the ordinary least-squares (OLS) estimate. The downward bias of the OLS estimate is consistent with the notion that fixed-price contracts are used to procure goods or services that can be easily specified and therefore simple and inherently less dispute-prone. These two findings are consistent with the main predictions of the Bajari and

[1] Unforeseen in the sense that the buyer and seller did not write contract actions for this contingency — this is not a bounded rationality assumption.

Tadelis model, though they do not exclude other possible causal mechanisms, which are discussed in Section 5.1.

2 Theory

2.1 Litigation as Bargaining Failure

Because litigation is a costly, negative-sum game, rational parties with symmetric information would presumably never litigate disputes. Instead, potential litigants could always reach some negotiated settlement that, in expectation, would make both parties better off (Spier, 2008). Litigation models explain this "paradox" of litigation by assuming some kind of asymmetry between the parties, either informational, such as in their respective estimates of the probability of a trial outcome, or in their valuation of outcomes.[2] There is an extensive theoretical and empirical literature on how disputes are selected for litigation, with some substantive disagreements about assumptions and implications, but the key insight of this literature relevant here is that litigated cases are not just random samples from all cases; rather, litigation comes from a failure to reach a settlement, and this failure can depend strongly on the characteristics of the situation (Priest and Klein, 1984; Bebchuk, 1984; Eisenberg, 1990; Hylton, 1993; Kessler et al., 1996; Shavell, 1996). In this example, the incentive structure is hypothesized to affect ex post bargaining, and to lead to disputes.

2.2 The Bajari and Tadelis Model

In the Bajari and Tadelis model, buyers are restricted to offering simple, linear incentive contracts of the form $\alpha + \beta c$, where c is the seller's actual total costs, which are assumed to be verifiable ex post in total but not in part.[3] If $\beta = 0$, the contract is a fixed-price contract, while $\beta \geq 1$ is a cost-plus contract.[4] The buyer has a project that gives him utility v if it is completed and 0 otherwise. The assumption on which the entire model hinges is that in any project, there are multiple contingencies that might arise once work begins that will affect the seller's realized cost, and these realized costs are the seller's *private* information. Examples of such states include design or regulatory changes,

[2]For example, a company facing a discrimination lawsuit might have a high incentive to settle all but the weakest cases because the reputational costs of losing at trial might greatly exceed the more modest stakes perceived by the defendant.

[3]This assumption allows cost contracts to be possible in that costs are at least partially verifiable, but it puts limitations on what is possible: for example, when adaptation must occur due to changed conditions, the buyer cannot fully determine the exact costs of the modification due to the sellers private information.

[4]Despite the great flexibility provided to the seller by allowing arbitrary choice of (α, β), cost-plus or fixed-price dominate. One possible reason for this regularity is that for any $\beta > 0$, the buyer must expend resources monitoring costs, no matter how small β. The fixed-cost of cost-plus probably introduces a non-convexity that pushes buyers and seller to boundary-point contracts.

adverse weather, technological changes, input price fluctuations, and so on. Assume that there are T possible contingencies for a particular project that can occur, and let π_t be the probability that state $t \in T$ occurs, with the states ordered such that $\pi_t \geq \pi_{t+1}$. The buyer's costs of specifying a contract action for a state is fixed at $k > 0$. The seller's actual costs for adapting the project to meet a contingency is a random variable m distributed according to the commonly known pdf f and cdf F on the support $[0, v - k]$.

Because m does not depend on the particular contingency, the buyer will enumerate states in order, from highest to lowest probability, $1, ...S$, with S being the total number of states enumerated. The buyer's problem is to choose S and (α, β). For simplicity, choosing the optimal S can be interpreted as choosing an optimal probability of not encountering an unenumerated contingency $\tau \in [0, 1]$, and then choosing the smallest S such that $\sum_{t=1}^{S} \pi_t \geq \tau$ as in Equation 1.

$$d(\tau, T) = \min_{S \in \{1,...,T\}} Sk \quad \text{subject to} \quad \sum_{t=1}^{S} \pi_t \geq \tau \tag{1}$$

Renegotiating the Fixed-Price Contract

With probability $1 - \tau$, some state arises that the buyer and seller did not write into the contract and therefore must renegotiate. If the buyer has the bargaining power, then they buyer makes an offer w that maximizes

$$F(w)(v - w) - k$$

where $F(w)$ is the probability that $w > m$, which is the probability that the seller accepts the buyer's offer. If $w < m$, then the seller will walk away from the project. The first-order condition for the seller's maximization problem is

$$w^* = v - \frac{F(w^*)}{f(w^*)} < v$$

For all log-concave density functions, $F(w)/f(w)$ is monotonically increasing, and hence $w^* < v$, which implies that negotiation will fail with positive probability, namely, when $m > w^*$ i.e. when the seller's actual costs are greater than what the buyer is offering. If the seller has the bargaining power, then the seller will simply request v to perform the change and the buyer will always accept the offer. Assuming that sellers do not always have the bargaining power, then some positive proportion of all fixed-price contracts should lead to negotiation failure i.e., litigation.

Renegotiating the Cost-Plus Contract

Under a cost-plus contract, if the buyer has the bargaining power, then the buyer cannot do better than to offer the seller the option to perform according to the unamended contract, but if the seller has the bargaining power, the optimal offer is to perform the work for $v - \mathbb{E}[m]$. In either case, there is no bargaining friction or possibility of negotiation failure, so long as total costs are measurable, even if the cost of modifications is not separately identifiable. One important difference between the two contractual forms is that in the cost-plus form, there is no right to demand contract changes when an unenumerated change occurs, the contract is clear: the seller performs the work at cost and the buyer must reimburse the seller for the realized costs. Bajari and Tadelis nicely summarize the the key difference between the contracts with respect to bargaining:

> In summary, there is a fundamental difference between having a fixed-price or cost-plus contract governing the relationship. A cost-plus contract is a well-defined compensation scheme for both the initial design and any modifications that are requested, so long as compensation is based on total costs. If a fixed-price contract was initially chosen, the compensation scheme is a specific performance compensation scheme and cannot account for modifications, resulting in ex post inefficient bargaining.

The model presented above is greatly simplified and does not include many of the technical points or motivations for the modeling assumptions. However, the two most salient implications from the model are that (a) fixed-price contracts are more likely to lead to bargaining failure, and (b) more complex projects require a larger S to achieve the same τ, all things being equal, and hence the greater design costs Sk of a complex project potentially outweigh the higher-powered incentive benefits of the fixed-price contract. These two testable implications are the focus of the rest of the paper.

3 Data

To create a suitable sample of contracts exhibiting both the fixed-price and the cost-plus structures, I selected contracts issued by the Department of Defense (DoD) during fiscal years 1993 —1996. The dependent variable measuring bargaining failure is an indicator for whether or not a particular contract led to the contract being docketed with the Armed Services Board of Contract Appeals (ASBCA). Using government procurement contracts raises questions about external validity because the government is a unique principal, with motivations, legal constraints, and legal prerogatives that

are different from those of an individual or firm. However, the essential principal-agent dynamic of misaligned interests and differing risk attitudes is maintained in government contracting situations. Once the contract is awarded, the government is concerned with cost and quality and faces the same difficulties in observing effort as a private sector principal.

3.1 Contracts

The Federal Procurement Data System (FPDS)[5] is an on-line database of all contracts issued by the federal government. The FPDS data contain information about the agency issuing the contract, the good or service being procured, the bidding process, the vendor performing the work, and a host of other variables, not all of which are available for every contract. Each observation in the database is a contract "action," such as the initial awarding of the contract, as well as subsequent modifications. Unfortunately, this "action" structure creates one of the greatest challenges in working with FPDS data because it makes it difficult to identify contracting relationships. A single contract might appear numerous times in the database because multiple contract actions might be made under the same contract. Another problem is that even though each contract is assigned a unique contract number, work is often broken up into several "contracts" even if there is only one vendor. Though there are technically multiple so-called contracts in these situations, there is only one contract both legally and in the economic sense of the term. Because the data set is too large for each contract to be investigated individually, some rules were used to infer contract relationships from contract actions, the details of which are in Appendix A and in the commented computer code generating the data set (available from the author's website) from the raw download from the FPDS website.

The population of contracts for this analysis is fully-competed[6] DoD contracts with awards or subsequent modifications greater than $250,000 (in 1996 USD) issued between September 1, 1992, and August 31, 1996, corresponding to fiscal years 1993 through 1996. Though contract data are available up to the present, a more recent time-frame cannot be used because of the slow rate at which disputes arise and are adjudicated. Contracting offices, of which there are several hundred across the Department of Defense, are service-specific (Army, Navy, Air Force, and so on), geographically based offices that actually prepare the contracts, solicit bids, and make awards. As will be discussed the later, the identification strategy relies upon having multiple contracts for the same good or service and multiple procurements across contracting offices. For this reason, the population consists only of contracts for which there were 200 or more procurement contracts for that type of good or service.

[5] https://www.fpds.gov/

[6] These are contracts awarded under an open-bidding process.

This 200 contract cut-off is somewhat arbitrary, so various levels are used in the section covering robustness checks. The results are insensitive to various levels (see Appendix B).

3.2 Disputes

To find which contracts from the population led to disputes, I used a comprehensive listing of the ASBCA's docket from January 1993 to September 2007 obtained through a Freedom of Information Act request. This listing contains all appeals by firms that were filed with the board, even if they were settled between the time of filing and the board hearing.[7] Contracts leading to a dispute have a dependent variable of $disp = 1$ while those that do not have $disp = 0$. Though I use only *disp* as the dependent variable in this analysis, it is possible to determine which of the disputed cases actually led to a board hearing. Contracts leading to a trial have $trial = 1$ while those that did not lead to a trial have $trial = 0$.[8]

Though I do not make use of the *trial* outcomes in this analysis, I do include them in the data set because they allow future researchers to explore the "selection hypothesis," i.e., cases leading to trial are different in important ways from those that settle. This analysis clearly shows that disputed contracts are not simply random samples from the population of all contracts, but the sub-sample of disputed contracts that actually go on to board hearings seems to be random. Figure 1 depicts the changes in means for various binary variables conditional upon whether the contract is from the population, the disputed sub-sample, or the trial sub-sub-sample. The data suggest that selection occurs in the first stage, when contracts lead to disputes, but not in the second, when the parties to disputed contracts decide whether to settle or litigate. Figure 1 also foreshadows the main empirical results: note that fixed-price contracts make up 73% of all contracts in the sample but 93% of disputed contracts.

3.3 Data Description

The most important feature of the contract data set is the type of contract chosen. While there are a wide variety of potential contractual forms available to contracting officers, there are two main types: fixed-price and cost-plus. The Federal Acquisition Regulations (FAR) does not mandate the

[7] One interesting feature of federal government contracting is that each contract includes a "finality clause" that reserves for the government the right to decide on all matters of fact. For this reason, in every case before the ASBCA, the appellant is a private firm (i.e., the seller), and the respondent is the government. For a detailed discussion of the ASBCA, as well as of the history and implications of the finality clause, see Shedd (1964).

[8] To determine which cases actually led to a hearing (which I refer to as a "trial" for simplicity), I used the text of the actual board decisions available from Lexis-Nexis covering the period of January 1, 1993, to the present. Unlike those of other courts, every ASBCA decision leads to a written decision, which allows the creation of a comprehensive listing of all heard cases from Lexis-Nexis data.

use of particular contract forms, but it does contain a discussion of the costs and benefits of different forms. This discussion does not directly present a transaction cost / hold-up argument, but the basic conventional wisdom about the incentivizing effects of fixed-price versus the potentially inefficiency when risks are great is made explicit (see FAR 16.104 - Selecting Contract Types).

For each contract, there is a product or service category code (PSC)[9] that is a fine-grained description of what the contract actually procured. The PSC is used to create an a comprehensive set of indexed dummy variables, *good*. The agency (i.e., Army, Navy, Air Force, and so on) procuring the contract is also represented by a set of indexed dummy variables, *agency*. Each contract issued by the DoD is classified as a definitive contract, a purchase order or a delivery order.[10] This categorical variable is represented by the indexed dummy variables, *type*. The log of the total recorded contract amount is *lamount*.

The good or service, agency, and type variables, along with the continuous contract amount variable, are the independent variables used in the estimating equation. The contract data set contains other variables that might impact ex post bargaining, such as the firm size, level of competition, and so on, but these variables are affected by the choice of $fixed$ and thus are not appropriate controls (nor are they necessary controls). However, some of these variables provide insight into the data and might have future value to other researchers, so I will briefly describe how they were created and what they measure.

I created variables that proxy for the level competition, the nature and cost of the work specified by the contract and various characteristics of the firm. Competitiveness is measured *mbids*, an indicator for whether the contract received two or more bids, and *fbo*, an indicator for whether the contract was listed as a "Federal Business Opportunity," a government effort to consolidate and publicize federal work on-line and through trade publications. Firm size is measured with an indicator variable *small*, which tells whether the vendor was classified as a small business according to the definition of the Federal Acquisition Regulations. The *special* variable indicates whether the firm was classified as being owned by a woman, veteran, or underrepresented minority. The variables and their definitions are summarized in Table 2. An auxilliary analysis of the effect of $fixed$ on these regressors is included in Appendix C.

[9] The PSC is hierarchical and appears to have a level of specificity similar to that of the NAIC.

[10] A definitive contract is written agreement specifying contingencies and what someone normally thinks of as a contract. A delivery order is a request for an unspecified amount of some good or service (though usually subject to some maximum or minimum amount), while a purchase order is an exact amount procured for an exact price.

3.4 Contract Amount

Figure 3 shows how various regressors change at different contract amount levels. Panel A shows that the proportion of disputed contracts rises with the contract amount, which is unsurprising given the greater stakes and greater potential for disagreement that come with larger contracts. In Panel B, the level of competition, as measured by multiple bids, is falling with larger contracts. This might be due to the small number of firms capable of bidding on the very largest contracts (which also might explain the Panel C results for small businesses), though the trend exists even for smaller contracts.

3.5 Characteristics by Type of Good or Service

Table 3 provides means for various binary regressors crossed with different groupings of good or service. Note that the good-and-service categories are not the exact controls used to create *good* — the categories displayed are aggregated categories, not the lowest level of the hierarchical PSC. One noteworthy feature of the data is that for some categories, all or almost all goods or services are procured with a fixed-price contract. An implication of this result is that one must be careful when inferring the causal effect of switching a contact from cost-plus to fixed-price for goods that, in the sample, were never procured with a cost-plus contract since the estimator only estimates a local average treatment effect.

While I wish to avoid an ad hoc, "just so" explanation from the pattern of results, Table 3 is intriguing: note that "R&D", "Guided Missiles" and "Professional, Administrative and Management Support Services" have the lowest rates of fixed-price contracts and comparatively low dispute rates. The kinds of goods having cost-plus contracts seems consistent with intuitions about the difficulty of writing contracts for certain kinds of tasks. By comparison, consider "subsistence" which is almost entirely procured using fixed-price contracts. The commodity nature subsistence, with its well-defined standards, non-specificity amd low risk make it an ideal cateteory of goods for fixed-price contracts. Perhaps unsurprisingly, no subsistence contracts were disputed in the sample.

4 Empirical Strategy

The empirical goal of this paper is to test the Bajari and Tadelis model by (a) identifying the causal effect of a fixed-price contract structure on the probability of bargaining failure, and (b) comparing that estimate to the naive, endogenous estimate of the effect of the fixed-price structure

on bargaining failure. The empirical strategy is to exploit idiosyncratic variation in how similar goods are procured in various contracting offices. This variation in procurement practices serves as the random assignment that provides the identification of the causal effect. The instrument for the endogenous $fixed$ is the proportion of all goods and services procured using fixed-price contracts by that office, *not including* that particular contract for which the instrument is calculated. This instrument is similar to the one used by Levitt and Snyder in their investigation of how federal spending in a district affects a member of congress's probability of reelection, where they used federal spending in nearby congressional districts as an instrument for spending within a district (Levitt and Snyder Jr, 1997).

4.1 The Reduced-Form Model

Equation (2) is a a reduced-form linear probability model (LPM) for the probability of dispute as a linear function of the characteristics of the contracting relationship, X_i.

$$P(disp_i = 1|X_i) = \beta_0 + \beta_1 lamount_i + \beta_2 fixed_i + \sum_l type_l + \sum_j good_j + \sum_k agency_k + \epsilon_i \qquad (2)$$

Given that *disp* is binary, using a linear probability model (LPM) might seem unattractive, because it can yield probability predictions outside of $[0, 1]$ and is inherently heteroscedastic.[11] However, with endogenous binary regressors, using the LPM is a relatively simple strategy with directly interpretable coefficients, and in practice the model seems to generate marginal effects estimates quite similar to those produced with more complex procedures (Angrist, 2001). Furthermore, because the main goal of this analysis is to identify marginal effects and not actual predicted probabilities, the possibility that the LPM will predict probabilities outside $[0, 1]$ is relatively unimportant.

The most important argument in favor the LPM in this particular application is the presence of a large number of group-indicating dummy variables. In a general linear model (GLM), the coefficients on dummy variables for groups that are homogeneous in their outcomes (i.e., all disputed or none disputed) are not identified (Caudill, 1987, 1988). Estimating GLMs like probit or logit with maximum likelihood methods will require an infinitely positive coefficient on "always" groups and an infinitely negative coefficient on "never" groups. Lastly, for rare-event data such as contract litigation, it is not clear that either probit or logit is a particularly good choice (King and Zeng, 2001).

[11] This difficulty can be easily corrected with the use of robust standard errors.

4.2 Identification Assumptions

Since $fixed$ is endogenous, β in Equation 2 is unidentified. I will present an instrumental variables approach that will allow identification, but before doing this, it is necessary to discuss the general assumptions that will provide identification of β in Equation 2:

1. The government's decision to procure the good or service and the specific agency procuring the good or service is exogenously determined. The basic contractual form (but not the incentive structure), such as whether the government procures the good with a delivery order, purchase order or a definitive contract, is also exogenous.

2. The contract amount, conditional upon the other regressors, is exogenous.

3. The contracting office has an impact on various contract characteristics but the contracting office has no direct impact on the probability of dispute or litigation, though I do allow and control for agency fixed-effects. This assumption is essentially the exclusion restriction for an instrumental variables estimator.

4. Unobserved contract characteristics are uncorrelated across contracts within a contracting office, conditional upon the good or service being procured and the approximate contract amount. This assumption must be strengthened to independence if $P(disp_i = 1|X_i)$ is modeled as some form of GLM, though this is not necessary in the LPM case.

4.3 Justification of the Assumptions

Exogeneity of Government Need and Contract Amount

I assume that the government requirement that generates the contracting relationship is exogenous and that any regressors that are determined by that need are as exogenous as well. This assumption is quite plausible because government needs are not determined or generated by contracting offices — they merely implement decisions made by other government bureaucracies. The assumption that recorded contract cost is an unbiased estimate of the true economic cost of a proposed project is controversial because the recorded contract amount is determined in part by the bidding firm. However, by design, every contract in the sample was awarded through a competitive process. Though the government might be expected to get a better or worse deal on any particular contract, it seems unlikely that the contract amount, conditional upon the other regressors, is chosen by anyone or is correlated with factors beyond simply what is being procured.

The Effect of the Contracting Office

Every government contract is issued under the authority of a single contracting officer, who is a warranted agent authorized to commit the government to a contract. Given the high potential for misconduct, contracting officers have fairly limited discretion and their decisions are subject to scrutiny by third parties. Despite these measures, contracting offices do exhibit idiosyncratic preferences and customs. The existence of these office effects seems to contradict the identification assumption that contracting offices have no direct impact on litigation except through their effect on contract structure. However, two stylized facts about federal procurement resolve this apparent violation of the exclusion restriction.

First, even though all contracts must be issued by a contracting office, the day-to-day management rarely comes from the contracting office; rather it comes from the agency that a contracting office serves. For example, a contracting office might prepare the written contract for the construction of new barracks at an Army base, but the day-to-day principal-agent interaction would come from the government's project manager, not from the contracting officer that drafted the contract. Because the dispute is likely to arise externally to the contracting office, the exclusion restriction assumption seems more plausible.

Second, the government's decisions regarding a contract reaching the ASBCA will almost certainly be made by government lawyers or higher-level executives and not by the contracting officer (and recall that the reduced-form equation includes controls for the agency providing the lawyers or making settlement decisions). Therefore, the ultimate decision on whether to accept or reject an offer is not made by the contracting office or the contracting officer responsible for the incentive structure of the contract: ex post negotiation and contract-drafting are compartmentalized in such a way that the contract writers have no direct effect on the probability of litigation once the project is underway.

4.4 Creating an Instrument from Idiosyncratic Contract Office Effects

If there are contract office customs that influence the decision to prefer one contract form over another, then a natural instrument for $fixed$ would be some measure of how that office procured similar goods or services in other contracting situations. If it is assumed that unobserved contract characteristics are independent within an office, then any instrument generated from other contracts procured by that office should also be uncorrelated with the error term for any particular contracting situation.

To demonstrate more precisely the problematic endogeneity of $fixed$, consider some contract i of good-and-service category k (such that $good_k = 1$), with a value within some specified range, issued by some particular contracting office. For argument's sake, assume that the contracting officer's decision about which structure to choose for each contract can be modeled with a simple LPM such as Equation 3, where α_g captures the office and good-and-service fixed effects and ν_i is a composite error term capturing all unobserved effects on the choice for $fixed_i$.

$$P(fixed_i = 1) = \alpha_g + \nu_i \tag{3}$$

By construction, $\mathbb{E}[\nu_i] = 0$ and $\mathbb{E}[\alpha_g \nu_i] = 0$. The unobserved component ν_i might include the unobserved task complexity, and presumably this task complexity also can affect $P(disp_i = 1|X_i)$ directly. Hence, $\mathbb{E}[\epsilon_i' \nu_i] \neq 0$ and therefore $\mathbb{E}[fixed_i' \epsilon_i] \neq 0$. The exogeneity assumption for OLS is thus violated and therefore the effect of $fixed$ on $P(disp_i = 1|X_i)$ is unidentified. The problem of endogeneity is a direct implication of the Bajari and Tadelis model: the complexity that reduces the the contracting officer's incentive to use a fixed-price contract *comes* from the fact that this complexity will increase transaction costs because unanticipated ex post changes will be more likely. The contracting officer can partially address the ex post bargaining problem by writing a more complete contract, but ceteris paribus, the fixed-price contract is relatively less desirable. One method of solving this problem is to find an instrumental variable that is correlated with $fixed$ but uncorrelated with ν and uncorrelated with ϵ.

Returning to the hypothetical grouping of contracts that generated the example of endogeneity, consider Equation 4, which is the proportion of fixed-price contracts in some group (with all contracts having the same *good* and $office$ values), not including the ith contract itself. This z_i will serve as the instrument for the ith contract.

$$z_i = \frac{1}{m-1} \sum_{j=1|j\neq i}^{m} fixed_i \tag{4}$$

Using the Equation 3, z_i can be represented as:

$$z_i = \alpha_g + \frac{1}{m-1} \sum_{j=1|j\neq i}^{m} \nu_j$$

The first requirement of the instrument is that $\text{corr}[fixed_i' z_i] \neq 0$, which can be verified with the first-stage of our two-stage least squares. The second requirement is that the instrument is uncorrelated

with our two unobserved error components ν and ϵ. For ν, note that:

$$\mathbb{E}[z_i \nu_i] = \mathbb{E}\left[\sum_{j=1|j\neq i}^{m} (\alpha_g + \nu_j)\nu_i\right] = \sum_{j=1|j\neq i}^{m} \mathbb{E}[\nu_j \nu_i]$$

By our assumption that that unobserved characteristics are not correlated across contracts within a specified grouping, $\mathbb{E}[\nu_j \nu_i] = 0$ and hence $\mathbb{E}[z_i \nu_i] = 0$.

For ϵ, by our assumption that there are no contracting office effects and the inclusion of goods-and-services controls in LPM for $P(disp_i = 1|X_i)$, $\mathbb{E}[\alpha_g' \epsilon] = 0$ for all g since α_g is not correlated with any unobserved effects. Our assumption that unobserved contract characteristics are not correlated even within a grouping g also implies that ϵ_i is not correlated with ν_j, where ν_j is the unobserved characteristics in some other random contract from the grouping, or:

$$\mathbb{E}[z_i \epsilon_i] = \mathbb{E}\left[\sum_{j=1|j\neq i}^{m} (\alpha_0 + \nu_j)\epsilon_i\right] = \sum_{j=1|j\neq i}^{m} \mathbb{E}[\nu_j \epsilon_i] = 0$$

To put things more succinctly, by the exclusion restriction assumption, we have $\mathbb{E}[z_i \epsilon_i] = 0$.

To provide some intuition for the instrument, consider that z_i is the empirically determined probability that a given contract in the specified grouping will be selected for $fixed = 1$, but this estimate is not based on unobserved characteristics that might affect the decision in the ith particular contracting situation. The peculiarities of the contracting office, as measured by this instrument, are serving to randomly assign some contracts fixed-price structures, while other offices are assigning comparable contracts cost-plus contracts, but without that office having an independent impact on the probability of a dispute, thus allowing the causal effect of that structure to be identified.

One important point is that this grouping is not necessarily *all* contracts issued by the office: we can further restrict this grouping based on other factors. In all the regressions, I sub-divide contracts based on the median amount for all contracts in the sample. The purpose of this further refinement is that even with controls for the contract amount in the first-stage, there might be fundamental differences between the largest and smallest contracts issued by an office not captured by *lamount*. Obviously, there is a trade-off between making ever smaller groups (and thus hopefully reducing bias or the possibility of mis-specificaton) and eventually creating too many useless singleton groups.

Causal IV Assumptions

A key contention of this paper is that the choice of contract structure has a causal effect on the probability of a dispute arising. For a causal interpretation to be plausible in an IV context, there are several assumptions that must be met, most of which map directly from our standard identification assumptions. Angrist et al. (1996) lay out the necessary assumptions using the potential outcomes framework for causal IV interpretations:

1. *Stable Unit Treatment Value Assumption (SUTVA):* Potential outcomes for each contract i are unrelated to how other contracts are procured. This assumption is almost certainly satisfied, because it seems very unlikely that a firm's decision on whether or not to appeal a contracting officer's decision (and hence set $disp = 1$) depends at all on how any other contracts are procured or on their litigation outcomes (especially considering the often decades-long lag between disputes and board hearings).

2. *Ignorable Treatment Assignment:* The ignorable treatment assumption is clearly not met with a simple OLS approach: presumably those contracts that are selected for a fixed-price contract are selected on the basis of other unobserved (from our perspective) characteristics as well as unobserved characteristics. The purpose of the instrument and the TSLS estimation is to provide the exogenous variation in $fixed$ that replicates the logic of a true experiment when treatment assignment is, by design, random or at least ignorable.

3. *Exclusion Restriction:* The effect of z_i on $disp$ occurs only by affecting $fixed$. This assumption is equivalent to the assumption made here that contracting offices have no direct effect on the probability of litigation, *except* through their effect on $fixed$ (and any effect that change in $fixed$ might have on other covariates). Unfortunately, this is not a testable assumption, but for the peculiar structural reasons discussed earlier (and the use of agency dummies), it is likely met.

4. *Non-Zero Average Causal Effect* This is simply the requirement that the instrument is sufficiently correlated with the endogenous regressor, which is shown convincingly with the first stage of the TSLS regression.

5. *Monotonicity:* This assumption requires only that z_i have a monotonic effect on $fixed$. In other words, having a large number of "neighboring" contracts procured in a similar manner does not make it less likely that the contract in question will also be procured with this method,

which, given the context, seems fairly innocuous. From a bureaucratic perspective, it is almost certainly easier to procure all items with an identical contract because re-using contracts is far cheaper than creating new contracts "from scratch" which makes the monotonicity assumption even more plausible.

5 Results

Table 4 shows the OLS and TSLS, including the first stage. Unsurprisingly, the contract amount has a strong, positive affect on the probability of dispute. Larger contracts simply have greater stakes for the parties and usually are more complex and hence provide more opportunities for disputes. Both the OLS and TSLS estimates have very low R^2 values, which is expected given the fairly small number of disputed contracts and the general nature of the regressors. The first stage of the TSLS shows that our instrument is highly correlated with $fixed$ and that the F-statistic for this first stage is very high.

In the TSLS estimate, using a fixed-price contract causes an increase in the probability of a dispute. The TSLS estimate of the coefficient of $fixed$ is almost twice as large as the OLS estimate. If the Bajari and Tadelis model is correct, the unobserved characteristics that are biasing downward the OLS results are unobserved characteristics such as the cost of writing the contract, the completeness of the design and probability of important changes. While the results do show that a forward-looking appraisal of likely transaction costs do influence the choice of structure, the results do not conclusively show that asymmetry about adaptation costs are the prime reason for ex post bargaining friction.

5.1 Alternative TCE Mechanisms

The Bajari and Tadelis model explicitly argues that it is ex post asymmetry of information about adaptation costs are the cause of bargaining friction. It is possible that the fixed-price structure causes more bargaining friction for non-adaption costs reasons and hence other theories could explain the empirical results without the Bajari and Tadelis model being valid. I have identified four possible ways in which the incentive structure could increase ex post transaction costs unique from the Bajari and Tadelis model:

1. The incentive structure can encourage parties to take unilaterally self-benefiting actions detrimental to the other party. For example, a fixed-price contract creates an incentive for the

seller to reduce costs by shading on quality, while a cost-plus contract creates an incentive to inflate costs. Under this scenario, the fixed-price contract simply creates more violations of the contract terms and hence more litigation results.

2. If the contract allocates greater financial risk to one party, then that party will have an incentive to seek a legal pretext for nullifying the contract when some adverse state of the world is revealed. For example, insurers have an incentive to find policy-voiding errors when the policy holder seeks a payout, but not before the loss-causing contingency occurs. Under this scenario, one or both parties would have to find contract nullification more attractive when the relationship is governed by a fixed-price contract.

3. If a certain incentive structure increases the variance in one party's estimate of the other party's effort, cost reduction or compliance with contract terms or any other salient feature that might be relevant to the court, this greater uncertainty might manifest itself in higher dispute rates. For example, a long, confusing contract with multiple terms is likely to be misinterpreted and hence likely to lead to more error in each parties subjective perception of the other sides compliance with the contract. Under this scenario, the fixed-price contract would have to generate more confusion among the parties about each sides' compliance with the contract terms.

5.2 Evaluation

The first mechanism — more cheating or self-dealing with fixed-price contracts— seems unlikely to be the cause of greater fixed-price litigation because the cost-plus contract is probably more conducive to cheating. First, profit increases and cost padding (i.e. over-reporting costs) are not just correlated in the cost-plus case: they are co-linear. Every dollar padded is a dollar earned and further, such padding poses little risk because the worst-case scenario (absent punitive damages or some kind of fraud liability) is that the seller must give the buyer a rebate. In contrast, shading on effort in a fixed-price contract is only correlated with profit, can lead to long-term, lingering liabilities if quality defects are detected later and can have severe reputation repercussions. Of course, cost-padding also hurts a firms reputation, but most firms firms would rather be known as "good but expensive" than "shoddy but cheap" because presumably a reputation for bad quality is far stickier than an easily-alterable reputation for high pricing.

The second mechanism — more risk in a fixed-price contract — is an unsatisfying explanation because all projects have risk: the contractual form just specifies which party is bearing the prepon-

derance of that risk. No matter which state of the world is revealed, one party or the other has an incentive to obtain better terms. If the project turns out to be difficult and costly, the buyer wishes there had been a fixed-price contract and the seller wishes there had been a cost-plus contract; if the project is easy and not costly, then each side wishes the opposite. This risk-symmetry suggests that greater litigation in the fixed-price case for risk-sharing reasons is not very plausible.

The third mechanism — greater uncertainty regarding performance in a fixed-price contract — seems plausible because detecting fixed-price quality shading is probably harder than detecting cost-plus padding. It may take years for quality problems with some goods to become fully apparent. Even if it is assumed that courts will punish sellers for quality problems (which may have a large stochastic component), this task is daunting in the fixed-price scenario because it requires assessment of the likelihood of both what occurred and what did not occur. By contrast, in a cost-plus situation the problem is comparatively simple: everyone knows what work was done and the reported cost of that work (and unlike in the fixed-price scenario, there is no presumption that the seller might have shaded on quality, because the seller has no incentive to do so). It might be the case that there is simply a greater perceived uncertainty in fixed-price contracts and hence greater divergence in each side's perceived expectation, which in turn decreases the probability of successful bargaining. This question seems interesting and cannot be answered without further study.

5.3 Content Analysis of Legal Decisions

The preceding argument is rather unsatisfying as it appeals to (informal) theory to answer questions that are, at least in principle, empirically answerable. A better approach would be a careful case study of a large number of disputes to see whether bargaining over adaptation costs was the dominant source of friction. Although this may be a fruitful topic for future research, obtaining a sufficient sample size would require a serious effort and is beyond the scope of this paper.

A partial substitute for a case study is a content analysis of the ASBCA Judge's written decisions. If we continually find references to certain keywords indicating haggling over adaptation costs in the text of the decision, it might indicate the flavor of dispute between the government and the firm. Of course, the frequency with which a "bargaining word" appears in the corpus of decisions must be compared to some other body of similar text to determine whether or not a particular word is appearing more or less frequently that we would expect. This method of course does not definitively answer anything and is merely suggestive, it does potentially provide some insight in into the nature of the disputes that might otherwise be completely obscure.

For this analysis, I used all the written decisions of the ASBCA from 1993 to the present as my corpus. For a "control" corpus, I use the text of decisions by the Occupational Safety & Health Review Commission Administrative Law Judge from January 1993 to February 1993.[12] I chose this corpus because it has some similarities to the ASBCA text. Like the ASBCA decisions, the written decisions from the OSHR tend be fact-oriented, with a focus on whether a firm was in violation of some particular OSHA regulation. If we imagine that most contract disputes are not about adaptation costs but rather the firm's compliance with an as-if complete contract, then the two court's tasks, and hence decisions, might be similar.

Figure 5.4 shows a log-log plot of word frequencies in the ASBCA decision corpus (y-axis) and the OSHR decision corpus (x-axis). A selection from the one-hundred most frequent English words were used as well as a small number of "bargaining words" such as "offer" and "reject" and "adaptation words" such as "design", "delays", "changes" etc. Words above the 45 degree line in Figure 5.4 are found more frequently in the ASBCA corpus, while those on the line are roughly equi-probable. Notice that "changes" occurs approximately eight times more frequently in the ASBCA corpus, "modifications" almost twice as often and "design" six times as often. The bargaining words — "reject" and "offer" also appear far more frequently in the ASBCA corpus. While these results are strongly caveated, they are suggestive and a further analysis seems likely to confirm the essentials of the Bajari and Tadelis argument about the nature of the disputes.

5.4 Conclusion

The main empirical finding of this paper is that the use of a fixed-price contract increases, on average, the probability of bargaining friction and subsequent litigation. The paper also suggests that contracting officers are aware of the trade-offs between the incentives for cost reduction with the fixed-price contract and the ex post bargaining friction of such contracts. A content analysis of the appearance of certain words in the text of ASBCA decisions compared to a control corpus suggests that bargaining and adaptation are at the heart of most contract disputes. The empirical results and the content analysis are consistent with the procurement model put forth by Bajari and Tadelis and suggests that ex post renegotiation and transaction costs are a significant feature of the contracting problem.

[12] Even with this much smaller time frame, the OSHR corpus provides over 600,000 words - far more than the ASBCA sample of 200,000 words.

Table 1: Comparing Fixed-Price and Cost-Plus Contracts

Features	Fixed-Price	Cost-Plus
Risk allocation mainly on	Seller	Buyer
Incentives for quality	Less	More
Buyer administration	Less	More
Good to minimize	Costs	Schedule
Documentation efforts	More	Less
Flexibility for change	Less	More
Adversarial Relationship	More	Less

* Reproduced from Bajari and Tadelis (2001)

Table 2: Some Key Contract Variables

Name	Description
$l/amount$	log / contract amount
$good$	controls for good/service being procured
$fixed$	indicator for fixed-price (not cost)
$mbids$	indicator for # bids ≥ 2
$small$	indicator small business
$special$	indicator for woman or minority-owned

Table 3: Contract Characteristics by Type of Good or Service

Good	N	disp	fixedprice	small	special	mbids	fbo	avg. amt
All	40417	0.02	0.73	0.46	0.03	0.3	0.7	4.04
ADP EQUIPMENT, SOFTWARE, SUPPLIES AND SUPPORT EQUIPMENT	1645	0.03	0.941	0.47	0.046	0.332	0.595	1.84
AIRCRAFT AND AIRFRAME STRUCTURAL COMPONENTS	793	0.02	0.878	0.311	0.004	0.564	0.753	30.65
AIRCRAFT COMPONENTS AND ACCESSORIES	337	0.006	0.899	0.291	0.006	0.665	0.792	5.68
AMMUNITION AND EXPLOSIVES	267	0.011	0.82	0.217	0	0.539	0.757	0.69
ARCHITECT AND ENGINEERING SERVICES - CONSTRUCTION	1395	0.009	0.884	0.238	0.011	0.091	0.939	2.56
AUTOMATIC DATA PROCESSING AND TELECOMMUNICATION SERVICES	1368	0.007	0.513	0.45	0.072	0.482	0.614	5.42
CLOTHING, INDIVIDUAL EQUIPMENT, AND INSIGNIA	315	0.006	0.902	0.46	0	0.324	0.508	3.37
COMMUNICATION, DETECTION, AND COHERENT RADIATION EQUIPMENT	978	0.016	0.817	0.232	0.006	0.517	0.71	6.21
CONSTRUCTION OF STRUCTURES AND FACILITIES	4119	0.039	0.976	0.511	0.028	0.092	0.806	3.12
EDUCATION AND TRAINING SERVICES	367	0	0.992	0.008	0	0.826	0.016	0.67
ELECTRICAL AND ELECTRONIC EQUIPMENT COMPONENTS	550	0.007	0.898	0.171	0.007	0.665	0.82	2.3
ENGINES, TURBINES, AND COMPONENTS	910	0.007	0.945	0.335	0	0.405	0.766	8.18
FUELS, LUBRICANTS, OILS, AND WAXES	1456	0.004	0.994	0.527	0.012	0.152	0.944	11.07
FURNITURE	370	0	0.786	0.143	0.003	0.032	0.408	0.45
GUIDED MISSILES	198	0	0.495	0.045	0	0.611	0.672	14.61
INSTRUMENTS AND LABORATORY EQUIPMENT	399	0.003	0.935	0.316	0.005	0.424	0.82	1.48
MAINTENANCE AND REPAIR SHOP EQUIPMENT	193	0.016	0.839	0.415	0	0.575	0.751	2.31
MAINTENANCE, REPAIR, AND REBUILDING OF EQUIPMENT	1461	0.023	0.772	0.346	0.027	0.344	0.737	5.57
MAINTENANCE, REPAIR OR ALTERATION OF REAL PROPERTY	8331	0.031	0.985	0.706	0.042	0.131	0.761	1.41
MISCELLANEOUS	149	0.007	0.537	0.463	0.027	0.57	0.356	5.46
PROFESSIONAL, ADMINISTRATIVE AND MANAGEMENT SUPPORT SERVICES	3348	0.008	0.24	0.352	0.036	0.465	0.728	5.61
R&D	6436	0.003	0.089	0.41	0.01	0.3	0.813	3.43
SUBSISTENCE	2222	0	0.999	0.404	0.014	0.588	0.178	1.42
TRANSPORTATION, TRAVEL AND RELOCATION SERVICES	338	0.009	1	0.216	0.003	0.071	0.325	9.95
UTILITIES AND HOUSEKEEPING SERVICES	2472	0.028	0.958	0.523	0.089	0.343	0.409	2.28

Notes: ADP: Automatic Data Processing disp: fraction of contracts disputed
fixedprice: fraction that are fixed-price
fbo: fraction awarded through the Federal Business Opportunities program
small: fraction that are small businesses
special: fraction of contracts awarded to woman, minority or veteran-owned businesses
avg. amount: average contract amount, in millions of 1996 USD.

Table 4: Effects of Contract Characteristics on Probability of Dispute

Variables	OLS	First Stage	TSLS
Log Amount	0.00509	-0.00937	0.00528
	(0.00064)	(0.00114)	(0.00065)
Fixed-Price	0.0129		0.02188
	(0.00197)		(0.00458)
Fixed-Price Instrument		0.69445	
		(0.01099)	
N	40417	40417	40417
R-Squared	0.0255	0.7339	0.0253
F-statistic	9.4215	992.4058	9.34

Notes — The dependent variable is $P(disp_i = 1|X_i)$. The standard errors are robust. Both regressions include fixed effects for the agency, good or service and sub-contract plan. The two-stage least-squares (TSLS) estimate includes a single instrument, z_i, for the endogenous binary regressor $fixed$.

Figure 1: Comparison of Population, Disputed and Litigated Contracts

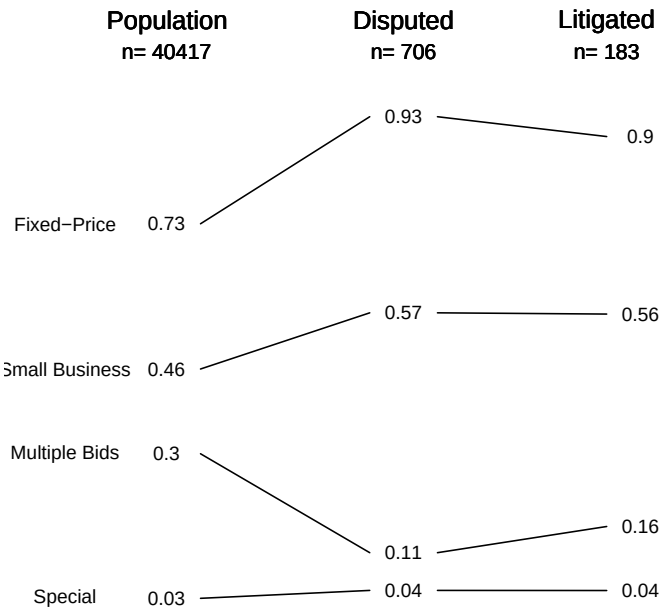


Figure 2: Trends in various Regressors and Outcomes vs. Contract Amount

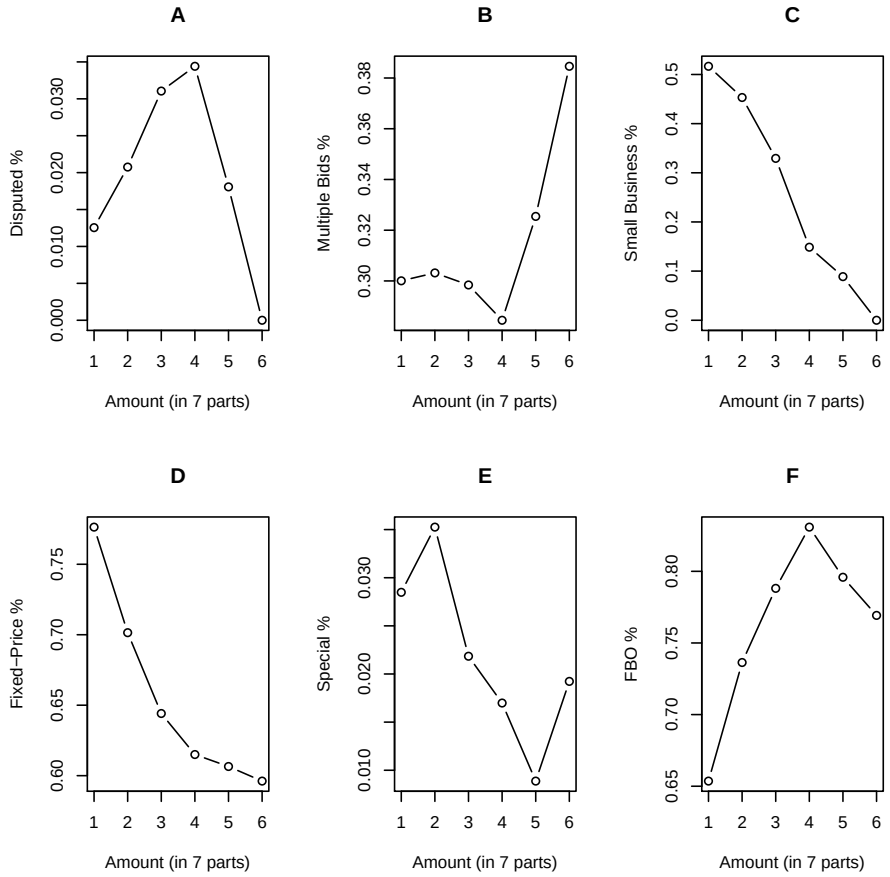
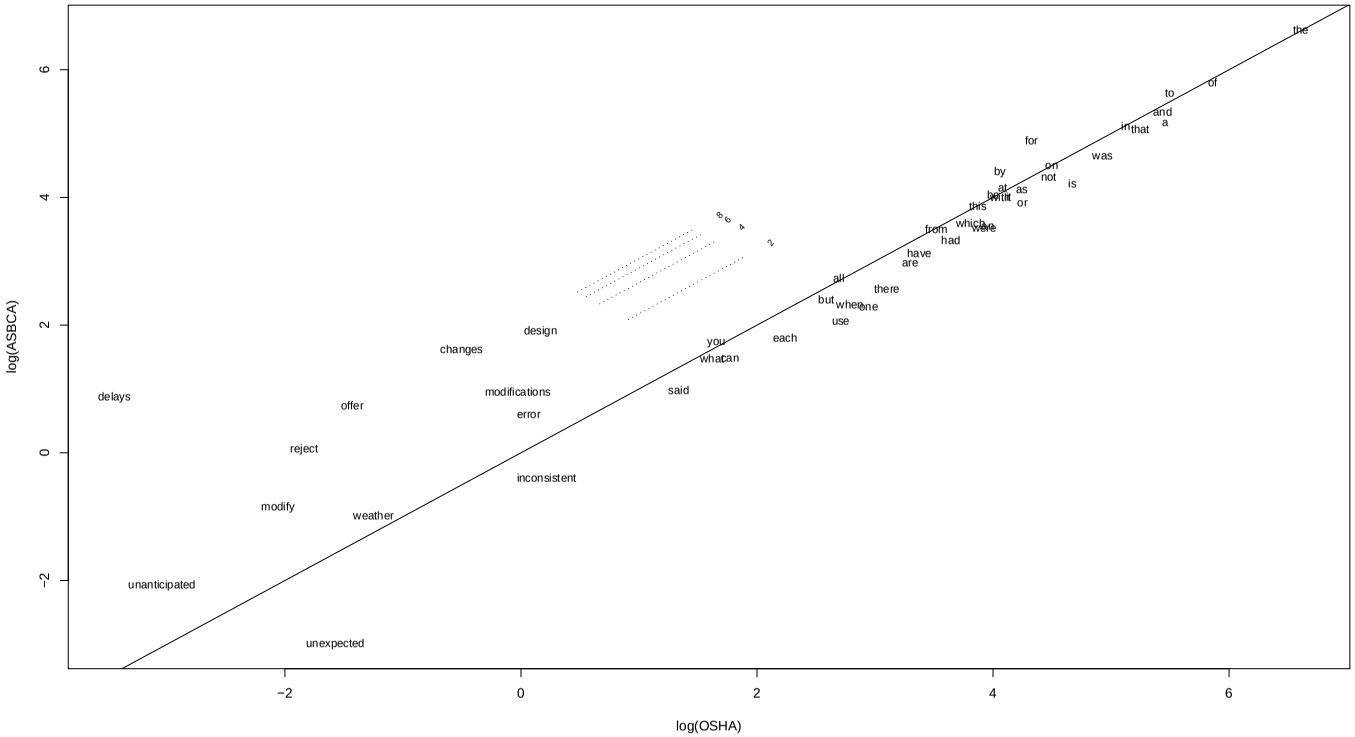


Figure 3: Comparison of Word Frequencies in ASBCA Decisions versus OSHA Decisions



This plot compares the log of word frequencies (appearances / 10,000 words) for the OSHA corpus on the x-axis and for the ASBCA corpus on the y-axis. The exact point on the plot is centered in each word, both in word length and font height. The dashed lines indicate iso-multiple lines: for example, words on the dashed line labeled 2 (above the 45 degree solid line) appear twice as frequently in the ASBCA corpus as in the OSHA corpus. Note the much higher frequency of "bargaining words" or "adaptation words", which is evidence in favor the Bajari and Tadelis mechanism.

References

Angrist, J., G. Imbens, and D. Rubin (1996). Identification of Causal Effects Using Instrumental Variables. *Journal of the American Statistical Association 91*(434).

Angrist, J. D. (2001, jan). Estimation of limited dependent variable models with dummy endogenous regressors: Simple strategies for empirical practice. *Journal of Business and Economic Statistics 19*(1), 2–16.

Bajari, P. and S. Tadelis (2001). Incentives versus transaction costs: A theory of procurement contracts. *The RAND Journal of Economics 32*(3), 387–407.

Banerjee, A. V. and E. Duflo (2000, aug). Reputation effects and the limits of contracting: A study of the Indian software industry. *The Quarterly Journal of Economics 115*(3), 989–1017.

Bebchuk, L. A. (1984). Litigation and settlement under imperfect information. *The RAND Journal of Economics 15*(3), 404–415.

Caudill, S. B. (1987). Dichotomous choice models and dummy variables. *The Statistician 36*(4), 381–383.

Caudill, S. B. (1988). An advantage of the linear probability model over probit or logit. *Oxford Bulletin of Economics and Statistics 50*(4), p425 – 427.

Eggleston, K., E. Posner, and R. Zeckhauser (2000). The design and interpretation of contracts: Why complexity matters. *Northwestern University Law Review 95*(1), 91–132.

Eisenberg, T. (1990, jun). Testing the selection effect: A new theoretical framework with empirical tests. *The Journal of Legal Studies 19*(2), 337–358.

Hylton, K. N. (1993, jan). Asymmetric information and the selection of disputes for litigation. *The Journal of Legal Studies 22*(1), 187–210.

Kessler, D., T. Meites, and G. Miller (1996, jan). Explaining deviations from the fifty-percent rule: A multimodal approach to the selection of cases for litigation. *The Journal of Legal Studies 25*(1), 233–259.

King, G. and L. Zeng (2001). Logistic Regression in Rare Events Data. *Political Analysis 9*(2), 137.

Laffont, J. and J. Tirole (1993). *A Theory of Incentives in Procurement and Regulation*. MIT Press.

Levitt, S. and J. Snyder Jr (1997). The Impact of Federal Spending on House Election Outcomes. *The Journal of Political Economy 105*(1), 30–53.

Priest, G. and B. Klein (1984, jan). The selection of disputes for litigation. *The Journal of Legal Studies 13*(1), 1–55.

Shavell, S. (1996, jun). Any frequency of plaintiff victory at trial is possible. *The Journal of Legal Studies 25*(2), 493–501.

Shedd, J. P. J. (1964). Disputes and appeals: The armed services board of contract appeals. *Law and Contemporary Problems 29*(1), 39–86.

Spier, K. E. (2008). Economics of litigation. In S. Durlauf and L. Blume (Eds.), *The New Palgrave Dictionary of Economics (forthcoming)* (2 ed.). Palgrave Macmillian.

Whinston, M. (2001). Assessing the Property Rights and Transaction-Cost Theories of Firm Scope. *The American Economic Review 91*(2), 184–188.

A Data Generation

As noted in Section 3, one of the difficulties of working with FPDS data is that contracts are stored as "actions," where an action might include both the original awarding of the contract as well as subsequent modifications. And additional complication is that some very large projects are broken into several contracts, though for the purposes of this paper, all these sub-contracts are really part of one contracting relationship. Identifying these relationships is a challenge and requires some inferences and imputations. The actual raw data and the code used to generate the data set are available on the author's website, but for clarity, the process by which the data was constructed and shaped is outlined here. Starting with the raw set of contracts:

1. Contracts with identical contract numbers issued by the same contract office are treated as one contract.

2. If there is any disagreement among the categorical covariates (i.e. one action records a fixed-price contract while another records a cost-contract), options are weighted by the contract amount and the option with the largest share of the total contract amount is recorded as the actual covariate for the amalgamated contract.

3. Contracts with missing contract numbers, contract offices and goods and service categories are dropped from the sample.

B Robustness

Given that the data set is somewhat unusual, with a large sample size but exceedingly small response rate, there might be concerns that the estimation strategy is incapable of recovering the LATE or that standard error approximations are incorrect. Further, as with almost all instrumental variables estimation strategies, there might be concern about the strength of the instrument and whether the exclusion restriction truly holds. Lastly, there might be concern that the pattern of results — never-mind the parameter estimates and standard errors — are sensitive to the functional form or the necessary but somewhat arbitrary decisions about which observations to include in the sample. Although some of the underlying assumptions are ultimately untestable, others can be made more plausible by subjecting them to appropriate falsification tests.

B.1 Alternate Specifications, Alternate Instrument Formulations

The paucity of non-dummy exogenous variables makes it difficult to develop meaningful alternate specifications: too many dummy variable interaction terms and the covariate space quickly becomes partitioned into spaces of perfect prediction. One fairly simple check is to use levels instead of logs for the contract amount. Table 5 shows the results from Table 4, but with levels instead of logs. Notice that the basic pattern of results does not change, though the magnitudes are decreased somewhat comapred to the log case.

B.2 Pseudo-Instruments & Pseudo-outcomes

The identification strategy depends critically on contract offices exerting an influence on the choice of contract structure, but not directly on the probability of litigation. While we cannot test this assumption directly, we can investigate several counter-factuals that might illuminate whether the office is truly having an effect on $fixed$. One method for investigating this assumption is use a a pseudo-instrument, z_i^p, based on the randomization of contracting office assignment. If there is no persistent contracting office effect on $fixed$, the pseudo-instrument, while still correlated with $fixed$, should have an uninformative, "weak instrument" first stage with a statistically insignificant coefficient on the predicted $fixed$ in the second stage. If we obtain the same results with the pseudo-instrument as with the real-instrument, we have found a serious problem: some kind of

Table 5: Effects of Contract Characteristics on Probability of Dispute - Levels instead of Logs

Variables	OLS	First Stage	TSLS
Amount (10 millions)	0	-0.00144	1e-05
	(1e-04)	(0.00063)	(1e-04)
Fixed-Price	0.01069		0.01653
	(0.00193)		(0.00447)
Fixed-Price Instrument		0.70063	
		(0.01095)	
N	40417	40417	40417
R-Squared	0.0234	0.7334	0.0232
F-statistic	8.6173	989.8286	8.5435

Notes: The dependent variable is $P(disp_i = 1|X_i)$. The standard errors are robust. Both regressions include fixed effects for the agency, good or service type and contract type (i.e., delivery order, puchase order or definitive contract). The two-stage least-squares (TSLS) estimate includes a single instrument, z_i, for the endogenous binary regressor $fixed$. This table shows that the basic pattern of results does not change when the regression is done in contract amount levels intead of in logs.

mechanical correlation or mis-specification is driving the TSLS results rather than the proposed causal mechanism.

Table 6 replicates Table 4 but using a pseudo-instrument generated from randomly assigning contracts within a good or service category to different offices. From the first-stage it is obvious that this instrument has a serious weak instruments problem and the TSLS estimate, as expected, gives non-sensical results.

B.3 Variations on Quasi-Arbitrary Cut-offs

In the results presented in the main body of the paper, only contracts for which there were 200 individual contracts for that item were included in the analysis. Furthermore, only those contracting offices with at least 15 procurements in the sampled period were included in the sample. Table 7 shows TSLS results with various contract number cut-offs but still with 15 required contracts per office, while Table 8 shows results with a minimum of 30 contracts per office. While the estimated LATE is sensitive to the choice of cut-offs, the basic pattern of results is maintained, with a positive sign on $fixed$ and a downward bias in the OLS estimate.

Table 6: Replication of Table 4 with Pseudo-Instrument

Variables	OLS	First Stage	TSLS
Log Amount	0.00509	-0.02104	0.01758
	(0.00064)	(0.00134)	(0.00955)
Fixed-Price	0.0129		0.60621
	(0.00197)		(0.45339)
Fixed-Price Instrument		-0.00363	
		(0.00323)	
N	40417	40417	40417
R-Squared	0.0255	0.6523	0.0249
F-statistic	9.4215	675.112	9.1883

Notes: The dependent variable is $P(disp_i = 1|X_i)$. The standard errors are robust. Both regressions include fixed effects for the agency, good or service and sub-contract plan. The two-stage least-squares (TSLS) uses single instrument for $fixed$, z_i^p, a pseudo-instrument generated by randomizing contract office assignments.

Table 7: Fixed-Price Effects with Variation in Contract Cut-off Amounts: 15 Contracts Per Office Minimum

V1	100	250	300
OLS	0.01396	0.01299	0.01285
	(0.00174)	(0.00194)	(0.00206)
TSLS	0.02229	0.02153	0.02127
	(0.00416)	(0.00461)	(0.00489)

Notes: The dependent variable is $P(disp_i = 1|X_i)$. The standard errors are robust. All regressions include fixed effects for the agency, good or service type and contract type (i.e., delivery order, puchase order or definitive contract). The two-stage least-squares (TSLS) estimate includes a single instrument, z_i, for the endogenous binary regressor $fixed$.

Table 8: Fixed-Price Effects with Variation in Contract Cut-off Amounts: 30 Contracts Per Office Minimum

V1	100	250	300
OLS	0.01481	0.0141	0.01417
	(0.00183)	(0.00209)	(0.00221)
TSLS	0.02635	0.02556	0.02521
	(0.00445)	(0.005)	(0.00523)

Notes: The dependent variable is $P(disp_i = 1|X_i)$. The standard errors are robust. Both regressions include fixed effects for the agency, good or service type and contract type (i.e., delivery order, puchase order or definitive contract). The two-stage least-squares (TSLS) estimate includes a single instrument, z_i, for the endogenous binary regressor $fixed$.

C Other Outcomes

Equation 2 did not include many observed variables available from FPDS because they clearly are not exogenous. For example, the firm size is recorded for each seller, but because small firms might choose whether or not to bid on work based on the incentive structure, a small business indicator is really an outcome variable, not an independent, explanatory variable.

Table 9 shows the average causal effect of $fixed$ on the probability of the contract (a) being awarded to small business (b) receiving multiple bids (c) being awarded to a woman, minority of veteran-owned business and d) being awarded to a firm that had multiple contracts with the government during the sampled period. These results are generally consistent with economic intuition: smaller firms are less likely to bid on the largest projects, which explains the negative sign on $lamount$, and are probably less capable of bearing the risk associated with fixed-price contracts. A similar line of reasoning can explain the pattern of results for the "special", (c) regression. The effect of fixed-price on receiving multiple bids is most likely a result of the government rationally attempting to publicize fixed-price contract opportunities and increase the number of bidders, because having a large bidding pool is likely to reduce costs in a fixed-price setting. That $fixed$ decreases bidding by firms with multiple government contracts might be a residual effect of $fixed$ increasing the number of bids and thus attracting a more heterogeneous group of firms.

Table 9: Effects of Contract Characteristics on Other Outcomes (TSLS)

Variables	Small Business	Multiple Bids	Special
Log Amount	-0.05617	-0.00652	-0.00125
	(0.0018)	(0.00177)	(0.00065)
Fixed-Price	0.06908	-0.03143	-0.01723
	(0.0177)	(0.01901)	(0.00612)
N	40417	40417	40417
R-Squared	0.1877	0.1872	0.0306
F-statistic	83.143	82.8713	11.3706

Notes — The dependent variable is is the percentage of contracts of that type. The standard errors are robust. All regressions are two-stage least-squares with fixed effects for the agency, good or service and type. The first stage for the TSLS is identical to first-stage shown in the the main table for $P(disp_i = 1|X_i)$.