# Contracting Officer Workload, Incomplete Contracting, and Contractual Terms: Theory and Evidence

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## Abstract

This paper examines the effects of an exogenous shift in the cost of contractual completeness induced by workload spikes on the endogenous selection of procurement terms. I build a model of the contracting process and conduct an instrumental-variable estimation of the causal effect of workload on contracting. In a sample of $140-$thousand contracts from 85 civilian procurement offices over 11 years, exogenous shocks that increase the cost of writing complete contracts, such as increases in contracting officer workload, lead to decreased reliance on competitive acquisition procedures, decreased reliance on firm-fixed-price contracts, increased risk of renegotiation, and higher total costs of procurement. These estimates are extremely policy-relevant, since the U.S. federal government has experienced exceptional growth in the level of acquisitions contracting over the past decade, but relatively limited growth in acquisitions manpower. The economic consequences of this state of affairs are not well understood, and this paper provides some of the facts necessary to evaluate them.

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*Keywords:* Workload, Contracting, Procurement

"A man who is very busy seldom changes his opinions." -Friedrich Nietzsche

# 1    Introduction

Composing a carefully constructed and detailed contract takes time, both in planning and execution. A contracting officer who has a limited time budget must divide his time among the contracting tasks at hand. If the number of tasks increases, less time will necessarily be devoted to each, often leaving some contingencies unaddressed. The choice to leave contracts less and less complete may also affect other procurement terms: pricing structure, extent to which the contract is competed, and even the final price paid. This paper examines the effects of an exogenous shift in the cost of contractual completeness induced by shocks to workload, both on completeness itself and on other related procurement features.

After briefly outlining the procurement process in the U.S. federal government, I build a model that extends a simple version of Bajari and Tadelis (2001) to understand the choice of contractual completeness and contractual terms in the presence of varying workload. This model predicts that busier contracting officers choose to write less complete contracts, leading to more renegotiations as unspecified eventualities arrive. Anticipating these costly renegotiations, the officers decrease their use of fixed-price contracts, which are more difficult to renegotiate than cost-plus contracts. Since the specified features of the contract form the basis for competition, less complete contracts decrease the benefits of competition, so busier contracting officers use less competitive procurement mechanisms. Finally, busier contracting officers end up paying more for a given project, in expectation, because renegotiation is costly, cost-plus contracts give little incentive for cost-saving effort, and less competitive acquisition procedures lead to less efficient selection of contractors.

With this model to structure the investigation, I analyze a sample of 140−thousand contracts from a panel of 85 civilian federal procurement offices over 11 years. Exogenous shocks that increase the cost of writing complete contracts, such as increases in contracting officer workload, decrease the use of competitive acquisition procedures, decrease the use of firm-fixed-price contracts, increase the risk of renegotiation, and lead to higher total costs of procurement. Each of these results is consistent with the predictions of the model.

These results shed new light on a number of important questions about the causes and effects of incomplete contracting. Most extant studies, summarized in section 1.1, either take the degree of completeness as exogenous or look for differences in completeness induced by the underlying complexity of the project. Since the variation in completeness here is induced by a completely different source (workload), the set of potential confounders is quite different,

so the broad consistency of the results here with that earlier literature should reassure. Furthermore, I provide a comprehensive framework for understanding the codetermination of contractual completeness and many contractual/procurement terms. This framework can unify the constellation of disparate results in the literature that look at the effects of completeness on one particular contractual feature at a time.

In addition to contributing to the academic literature on the causes and effects of incomplete contracting, this paper also addresses a pressing policy question. The U.S. federal government, over the past decade, has been faced with exactly this situation. From FY2000 to FY2010, the total spending on U.S. Federal procurement contracts grew from just over $200 (B)illion to over $500B.[1] After accounting for inflation, this growth represents more than a doubling of real contractual expenditures. In this same period, the relative importance of procurement in the total Federal budget has also grown. In FY2000, contracting made up 12 percent of total Federal expenditures; while by FY2010 it had risen to 22 percent.[2]

Despite the dramatic growth in procurement contracting, there has been no concomitant growth in the number of contracting personnel. In FY2000, there were 26,588 contracting officers (occupational designation GS-1102) government-wide. By FY2010, the workforce had increased to 35,707, an increase of only 34 percent. Over the same period, the number of procurement assistants (GS-1106) actually fell, from 3,635 to 1,664.[34]

Concern about the strain of increased contracting in an environment of relatively fixed contracting capacity has been present within the acquisitions community for some time.[5] Potential negative consequences include fraud vulnerability, insufficient oversight, problems with cost or quality certification, dependence on excessively simplistic or boiler-plate contracts, weak bargaining in negotiated contracts, and excessive dependence on private contractors to perform contracting functions. This concern has some anecdotal support at the level of individual investigations and surveys of acquisitions professionals.[6] But the magni-

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[1]FPDS-NG, available at www.usaspending.gov

[2]Consolidated Federal Funds Reports, U.S. Census Bureau, http://www.census.gov/govs/cffr/

[3]OPM Fedscope (www.fedscope.opm.gov)

[4]See Gates, Keating, Jewell, Daugherty, Tysinger, Robbert and Masi (2008) for a very careful and complete analysis of these trends in the context of the Department of Defense

[5]See *Report of the Acquisition Advisory Panel to The Office of Federal Procurement Policy and The United States Congress* (2007), Chptr. 5, for an overview, as well as a large body of work by the GAO: High-Risk Series: An Update, GAO-05-207 (Jan. 2005); DoD Acquisitions: Contracting for Better Outcomes, GAO-06-800T (Sept. 2006); Contract Management: DoD Vulnerabilities to Contracting Fraud, Waste and Abuse, GAO-06-838R (Jul. 2006); Defense Acquisitions: Assessments of Selected Major Weapon Programs, GAO-06-391 (Mar. 2006); Defense Acquisitions: DoD Has Paid Billions in Award and Incentive Fees Regardless of Acquisition Outcomes, GAO-06-66 (Dec. 2005); Defense Management: DoD Needs to Demonstrate that Performance-Based Logistics Contracts are Achieving Expected Benefits, GAO-05-966 (Sept. 2005).

[6]See, e.g., Rau and Stambersky (2009), who find that less than 15 percent of senior contracting officers surveyed at the Army Contracting Command felt that there were an adequate number of acquisition man-

tude and direction of any effect of binding contracting capacity on contractual outcomes has not been subject to rigorous theoretical and statistical investigation. This is the first such evaluation.

In the rest of this section, I put the paper in context, both in terms of the existing literature and the policy environment. In section 2, I build a model of the effects of workload on contractual completeness and contract/procurement terms and derive some testable implications. Section 3 discusses the data and the empirical approach. Section 4 presents the empirical results, and section 5 briefly concludes.

## 1.1 Determinants of Procurement Terms

The economics literature on the determinants of contractual form is quite robust and mature. For a summary, see Lafontaine and Slade (forthcoming). In the particular case of procurement contracts, several papers have investigated the determinants of the specific features examined here. I review those results below. The overarching approach taken in this paper, where contractual completeness is endogenously determined and, in turn, affects the other contractual provisions, was pioneered by Goldberg (1977) and formalized by Bajari and Tadelis (2001).

This framework has been used to investigate the decision to open a contract to competition, often couched in terms of "auctions versus negotiations." In the context of private construction contracts, Bajari, McMillan and Tadelis (2008) find that more complex projects are procured less competitively and, holding complexity fixed, competitive procurements are more likely to be renegotiated. Gil and Oudot (2008) find similar results in the context of French Defense Procurements, at least within a given buyer-seller relationship, as does Leffler, Rucker and Munn (2007), in the context of private timber sales. All these papers look at how the use of competitive procurement methods is affected by differences in completeness driven by the underlying difficulty of the project. My approach is different, because I look for differences in completeness induced by exogenous variation in the opportunity cost of the contracting officer's time due to changes in workload. Nevertheless, the results are quite consistent with the existing literature.

Parallel to the literature on "auctions versus negotiations" is the literature on pricing terms, often characterized as "fixed-price versus cost-plus." In the context of timber auctions, Leffler and Rucker (1991) find that simpler-to-specify tracts are more likely to be sold at fixed prices. Kalnins and Mayer (2004) find that when quality is difficult to measure, so

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agement positions in their installation. Furthermore, only 23 percent felt that service contracts were afforded the proper level of oversight to monitor contractor performance.

difficult to contract on, the IT services industry uses more cost-plus contracts. Corts and Singh (2004) find that oil exploration companies increase their use of cost-plus contract for drilling contractors as their experience with those contractors grows, and posit that this change occurs because opportunities for repeat business strengthen the incentives for efficiency more than they reduce the costs of specifying complete contracts. Crocker and Reynolds (1993) find the opposite pattern, in the context of Air Force engine procurement, and argue that as the buyer gains more information over time it becomes easier to write complete contingent contracts. The approach in Crocker and Reynolds (1993) is closest to this paper, in that they identify how changes in the contracting agencies' ease of writing complete contracts affect the pricing methods chosen. They focus on a single agency and a very specific type of contract, but the results from my broader panel IV approach are quite similar.

Finally, a very few studies have directly targeted the question of the costs and incidence of renegotiation and contractual incompleteness, independent of the contractual terms outlined above. Guasch, Laffont and Straub (2008) find that concession contracts in Latin America are more likely to be renegotiated if the firm is not regulated or if the quality of the bureaucracy that oversees the concession is low. Patrick Bajari, Houghton and Tadelis (2010) use a structural approach to analyze a set of California Highway Procurement auctions, and find that the ex-post adaptation costs make up between 7 and 13 percent of the winning bid. Consistent with these results, I find that decreasing workload leads to less renegotiation and lower prices.

By contrast to the extensive research on contractual incompleteness and procurement terms, the formal literature on the effects of workload specifically is sparse. A large literature exists on the measurement of workload, which I reference below when discussing my own approach. There has been some work on the role of contracting capacity in the context of the local and municipal governments in the public administration literature, but this literature has concerned itself primarily with the determinants of contracting capacity rather than its effects and has been mostly qualitative in nature. See, for example Brown and Potoski (2003) and Yang, Hsieh and Li (2009).

In summary, this paper sits squarely in the broad literature that examines the causes and effects of incomplete contracts. It uses a novel source of identification, workload, which may be of independent interest, and it relies on uniquely extensive set of contracts. The results fit nicely with the existing literature, simultaneously confirming many of the general findings about the effects of incomplete contracting on contractual and procurement terms, under different identification conditions, while bringing them into a common framework.

## 1.2 The Procurement Process

The U.S. federal government's procurement process progresses in three stages. It begins with the identification of a need and a contract planning process. It continues with the solicitation and award stage, and ends with the contract management and closeout stage.[7]

In the first stage, the agency determines it has some need to perform its mission that it cannot fulfil with its current resources. If an analysis of this need determines that a procurement is the appropriate response, the procurement process begins. A contracting officer (or his delegate) designs a procurement strategy in light of authorizing legislation, the agency's needs, market conditions, and the dictates of the Federal Acquisition Regulation (FAR) and agency-specific acquisition regulations. At this point, the agency decides the degree and method by which the contract will be competed, the form of pricing appropriate to the contract, and whether the contract will be for a definitive quantity or some indefinite-delivery vehicle.

Once it is determined which contractual forms and procurement mechanisms are appropriate, the agency moves to the second stage of the process. If the contract is expected to be above $25,000, the agency solicits offers through various channels, including the Federal Business Opportunities website. The solicitation outlines, at least, a description of the agency's needs, the format that offers should take, who is allowed to make an offer, and the method by which those offers will be evaluated. Offerers respond to this description as appropriate. Responses may be a simple price bid, a more complicated proposal, or even entering into a bilateral or multilateral negotiation including exchanges of proposals and responses with the agency. These offers are evaluated in accord with the provisions outlined in the original solicitation and an award is made.

Once the contract is awarded, the agency moves into the third stage of the process, contract management. The contractor begins work on the project, and the agency oversees this effort as appropriate. This oversight may include inspection for quality, adherence to specifications, and auditing of costs. It is at this stage, as well, that unanticipated problems may arise, leading to modifications of the original contract. Depending on the degree and reason for the modifications, they may be simple unilateral modifications or bilateral agreements that require some equitable adjustment to pricing. Finally, the contract will come to an end, and the relationship between the contractor or agency will be complete. This can occur either because the terms were satisfied or because contract was terminated

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[7]Adapted from: Contracting Officers Technical Representative (COTR) Training Blueprint (formerly called the Contracting Officers Representative (COR) Workbook), Federal Acquisition Institute, Office of Governmentwide Policy, General Services Administration, November 2003, pg. 27-30.

by the agency for any number of reasons, including convenience or misconduct.

Throughout this entire process, the government's primary representatives are civil service employees in the occupational series GS-1102, broadly referred to as contracting officers. The Position Classification Standard for the Contracting Series describes their role as follows:

> This series includes positions that manage, supervise, perform, or develop policies and procedures for professional work involving the procurement of supplies, services, construction, or research and development using formal advertising or negotiation procedures; the evaluation of contract price proposals; and the administration or termination and close out of contracts. The work requires knowledge of the legislation, regulations, and methods used in contracting; and knowledge of business and industry practices, sources of supply, cost factors, and requirements characteristics.

These agents are assisted in their task by a number of support personnel, including Purchasing Officers (GS-1105s, who concentrate on simplified acquisitions), Procurement Clerical and Assistance Series (GS-1106s, who provide clerical support), and Contracting Officer Representatives and Contracting Officer Technical Representatives (various series, who develop the contracts technical requirements and determine if a contractor meets them). I will use *ceteris paribus* variation in the number of the (GS-1102) contracting officers to measure changes in workload.

In the next section, I construct a formal model that includes the key features of this formal procurement process in order to trace the effects of a shock to workload on the procurement and contracting decisions.

# 2    Modeling the Procurement Process

To structure the investigation of the effects of contracting-officer workload, I present here a model of the procurement process with endogenous contractual design. This model builds on the analysis in Bajari and Tadelis (2001) of the choice between fixed-price and cost-plus contracts. Consistent with that model, I focus on the trade-off between cost-saving effort with fixed-price contracts and ease of renegotiation with cost-plus contracts and on how this tradeoff is affected by the endogenous choice of contractual completeness. But rather than derive the trade-off from first principles, I include a simplified version of this finding as an assumption in the model, below, and leave the interested reader to follow up on the micro-foundations in the original. Instead, I broaden the analysis to also investigate the choice

between competitive procurements and limited-source negotiations. In this second dimension, the trade-off is slightly different, between the cost of implementing and documenting a competitive procurement and the benefit of selecting the ex-ante lowest-cost producer. Again, the endogenous choice of contractual completeness will interact with this trade-off, since finding the lowest-cost producer of the specified product is only useful if the product is correctly specified.

## 2.1   Primitives

**Players and Payoffs**   The central actor in the model is the contracting officer. The total payoff of the contracting officer depends on three elements: the value they receive from the product or service, net of payments to the contractor; the cost of specifying contractual contingencies; and the cost of running a procurement competition.[8] Assume that the product or service is valued by the contracting officer at some dollar value $v > 0$. If the final outlay for the contract is $p$, his net value is given by $v - p$. The cost of writing a contract that explicitly specifies the contractor's obligations under all possible contingencies would be prohibitive. Instead, the contracting officer will choose a level of contractual completeness $t \in [0, 1)$, where the contract covers all circumstances that actually arise with probability $t$, and with probability $1 - t$ some unanticipated event occurs which will require some off-contract performance in order for the agency to receive that value $v$. The cost of preparing such a contract, in terms of the contracting officer's time and effort is given by $wd(t)$, where $d(0) = 0$, $d'(0) = 0$, $d''(t) > 0$, and $\lim_{t \to 1} d(t) = \infty$. Here, $w$ measures the workload borne by the contracting officer on other projects, so the opportunity cost of his time is higher when workload is higher.[9] Finally, I assume that there is some additional cost of running a competitive procurement $m$, where the cost comes in soliciting and analyzing competitive bids completely and documenting the process carefully.[10] To summarize, the utility of a contracting officer with workload $w$, expecting to pay price $p$ is given by

$$U(t, compete) = v - p - wd(t) - m * compete.$$

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[8] In reality, the contracting officer is an agent in a bureaucracy, so will not be residual claimant. For simplicity, I ignore this complication and simply assume he is facing some set of incentives that leads him to value saving time and money on the project and on its procurement. Having him only receive a fraction of the net benefit of the project has no effect on the signs of the comparative statics.

[9] I model the effects of workload as a change in an exogenous parameter for simplicity, but it would be easy to provide microfoundations with a model of time allocation among more and more contracts, a fixed time budget, and decreasing marginal value of effort on an outside project.

[10] The real possibility of a bid protest makes the documentation effort especially salient. See, e.g., Maser, Subbotin and Thompson (2011)

The other participants in the model are the contracting firms. I assume there are $N > 2$ potential bidders, indexed by $i$, and they have initial costs of production $c_i$ drawn from a common distribution $F()$, which is bounded below by zero and above by $\bar{c}$ with expected value $E[c]$. If an unanticipated eventuality arises, the cost of providing the contracted good or service may change. I assume this alternative cost, $k$, is independently drawn from a distribution, $G()$, bounded below by zero and above by $\bar{k} > \bar{c}$, with expected value $E[k] > E[c]$. I assume that it remains efficient to complete the contract, so $\bar{k} < v$, but on average modifications will be more costly than non-modifications, since some costs will be nonrecoverable. Finally, whichever cost is realized, the contractor can reduce that cost by putting forth unobservable effort $e$ at effort cost $g(e)$, so if the applicable cost draw is $c$, the final real cost is $c - e + g(e)$, while the accounting cost is $c - e$. I assume that the costs are such that even efficient effort will never make the expected costs negative. Formally, define $e_{fp}$ by $g'(e_{fp}) = 1$, and let $f \equiv e_{fp} - g(e_{fp})$ represent the net cost savings of this efficient effort. Fixed-price contracts will induce this efficient effort, and I assume that $f < E[c]$.

**Timing, Negotiation, and Renegotiation**  The timing of the model is as follows:

1. The contracting officer decides whether to issue a fixed-price or cost-plus contract, whether to run a competition, and how completely to specify the contract.

2. Bidders make offers as allowed by the procurement provisions, and a winner is selected.

3. Unanticipated contingencies may arise, which lead to renegotiation.

4. The winning bidder makes cost-saving efforts.

5. Final production occurs, and contracts are paid.

Given a contractual form and specification, I assume that competition always takes the form of a second-price or second-cost auction.[11] For a fixed-price contract, this means the lowest bidder wins and is paid the second-lowest bid. For a cost-plus contract, this means that the firm with the lowest cost wins and is awarded a cost-plus contract in which they are fully compensated for all realized costs, plus they are paid a fixed difference between their cost and the second-lowest cost. Absent any changes, this contract would pay them exactly the second-lowest cost. Of course, if actual costs are higher than expected they are paid more and if they are lower than expected, they are paid less. So, for example, if the

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[11]This assumption is simply to make the calculation very transparent. First-price auctions would yield identical comparative statics, since (by the revenue equivalence theorem) they yield the same expected cost.

lowest initial cost was 5 and the second lowest was 7, the lowest bidder would be awarded a contract paying $2 + C$, where $C$ is whatever the final costs of production are.

For negotiations, the buyer is vested with a very extreme form of bargaining power, throughout. This assumption simplifies the analysis and allows us to concentrate on comparative statics with respect to workload. I assume that when negotiation or renegotiation occurs, the buyer will always make a take-it or leave-it offer. I assume that the buyer knows all relevant cost information when making this offer. These assumptions make negotiation/renegotiation more attractive than they are, in practice, but should not affect the change in their relative attractiveness as the workload changes.

Consistent with the results of Bajari and Tadelis (2001), I assume there are some frictions in the renegotiation of fixed-price contracts, so an offer of $\overline{P}$ to the seller actually costs the buyer $(1 + \delta)\overline{P}$, with $\delta > 0$ measuring the friction.[12] Cost-plus contracts, by contrast, are assumed to be completely flexible. If the cost of production goes up or down with a modification so will the payment, one-for-one.

## 2.2    The Costs and Benefits of Contractual Completeness

Our interest here is understanding the effects of increasing workload on contractual completeness, contract pricing, the decision to compete the contract, and the price paid. Workload only appears one place in the model, in the marginal cost of contractual completeness. Since contractual completeness is set optimally, an increase in its marginal cost will obviously tend to decrease the equilibrium level of completeness. The effects of workload on all the other contractual choices arise due to the adjustment in optimal completeness.

Compare, first, the payoffs to fixed-price versus cost-plus contracts. The advantage of fixed-price contracts is the efficient provision of cost-reducing effort by the contractor, since the contractor is residual claimant on any cost savings. The advantage of cost-plus contracts is the ease of renegotiation, by assumption. If there were no chance of unforeseen contingencies, fixed-price contracts would unambiguously dominate, but, as contracts become less and less complete, cost-plus contracts may become optimal. Since increasing workload leads the contracting officer to decrease completeness, cost-plus contracts become attractive as workload increases.

Compare, next, competition versus negotiation. The advantage of negotiation is that the

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[12]Perhaps information is not fully available, so there is some monopsonistic inefficiency in the take-it or leave-it offer, whereby inefficiently little trade occurs. Perhaps the processes of rewriting a fixed-price contract, itself, involves some extra contracting costs. Different micro-foundations are possible. I simply take this as a working assumption.

contracting official can forgo the time and cost of conducting a full-and-open competitive procurement. The advantage of competition is that an ex-ante more efficient producer is selected. But this efficiency advantage only occurs in the absence of modification. If modification is certain, negotiation unambiguously dominates since a cost advantage with respect to the initial project $c$ tells us nothing about the final costs $k$. As workload lightens, officers choose more complete contracts, and competition may become optimal if the cost advantage is important enough, relative to the costs of running the competition. .

Furthermore, both the initial winning bid and final expected payment made by the contracting officer should be increasing in workload. The change in initial bid occurs due to the decreasing use of competition and fixed-price contracts. The effect on final expected payment is even more direct. The reason you write more complete contracts is to decrease the expected amount paid. If less completeness actually led to lower expected payments, the contracting officer should move to those less complete contracts even absent a push from workload. Since completeness declines in workload, expected cost should increase.

The following proposition formalizes these intuitions.

**Proposition 1** *Let $t^*(w, \delta, N)$ represent the equilibrium level of contractual completeness. Let $x^*(w, \delta, N)$ represent the equilibrium decision to use a fixed-price contract (where $x = 1$ means using a fixed-price contract and $x = 0$ means using a cost-plus contract). Let $y^*(w, \delta, N)$ represent the equilibrium decision to run a procurement competition (where $y = 1$ means using a competitive procurement and $y = 0$ means single-source negotiating). As workload ($w$) increases, all three equilibrium choices weakly decrease and expected winning bid and final expected costs increase.*

**Proof.** Appendix ∎

In the empirical analysis below I will investigate all four predictions, and find evidence for each.

# 3    Data and Methodology

I construct measures of workload and contractual/procurement terms from a large public database of government contracts. The contract data consist of every transaction above a reporting threshold from FY2000 to FY2010 for 85 civilian agencies, about 4 million actions in all.[13] Gathered from the Federal Procurement Data System, through usaspending.gov,

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[13]This consists of every civilian agency/sub-agency that reports non-zero GS-1102s to the OPM and more than 500 contractual action to the FPDS-NG, with a few exceptions. The following agencies are

the contract data include procurement contract transactions reported directly through the contract writing systems of the constituent agencies. Each initial government obligation above a reporting threshold ($25,000 before 2005 and $3000 after) appears exactly one time, as does every modification of a reported contract. Each element includes a broad range of information about the contracting parties, the contractual terms, and the method of procurement. The particular provisions that form the basis for the analysis are discussed in detail below.

I measure the number of contracting officers in an agency by counting the number of GS-1102s. The data on the GS-1102 employment in each contracting agency in each fiscal year comes from the Office of Personnel Management's Central Personnel Data File. It reports the number of contracting officers in each agency at the end of each fiscal year, by years of experience in that agency, as well as the number of such officers leaving the federal service by reason of departure.

I choose to focus on civilian agencies for three reasons, despite the fact the Defense agencies make up the majority of procurement spending. First, there are many more civilian agencies, allowing for greater variation in workload. Second, all contracting officers in civilian agencies are GS-1102s, while in military contracting offices the procurement work may be shared with career military officers. Finally, there may be differential reporting in defense agencies, where a greater fraction of contracts are classified for reasons of national security. Although I have no reason to believe that the results here would not extend to defense agencies, care should be taken in applying them.

Finally, there are a few cases of agencies moving among departments, passing out of existence, or merging. The most important of these was the formation of the Department of Homeland Security in 2003, and the 2005 merger of the Federal Supply Service with the Federal Technology Service. In all cases, the original and transformed agencies are coded separately, since they may change in unobservable ways as a result of their reorganization.

dropped for irregular reporting with many missing observations. From the DHHS: Program Support Center. From the DoT: Federal Aviation Administration and the Surface Transportation Board. From the GSA: Office of Chief Person Officer, Office of the Inspector General, and Office of Governmentwide Policy. From USDA: Departmental Administration and Agricultural Marketing Service. From Treasury: Secret Service, Federal Law Enforcement Training Center, and Alcohoal and Tobacco Tax and Trade Bureau. From Labor: Employment Standards Administration and OSHA. From DoJ: Immigration and Naturalization. Finally, a few agencies enter the sample after the beginning: From USDA, Rural Housing Service in 2003, Natural Resource Conservation Service in 2003, and Office of Chief Financial Services in 2003; from DoJ, ATF in 2003; from Homeland Security, Headquarters in 2005; and from DoT, Pipeline and Hazardous Materials Safety Administration in 2005.

## 3.1 Contractual Types and Terms

Even within a single agency, contracts vary enormously. I analyze the effects of workload on four endogenous aspects of contracts: competition, pricing terms, modification, and final outlays. Of course, the effects of workload may go beyond these simple factors, but I limit my attention to these factors for a first look into the problem. In addition to these endogenous factors, contracts also vary in their exogenous underlying characteristics. It is important for inference to control for these factors as well. I will discuss two important exogenous factors first and then turn to the endogenous outcomes.

The first exogenous dimension along which contracts vary is the product or service class of the procurement. The General Services Administration divides every product or service purchased by the U.S. Federal government into one of 24 broad services classes or one of 90 broad product classes.[14] Each contract indicates the primary product/service class of the acquisition. Within civilian agencies some of these classes, such as Nuclear Ordinance, are not represented or very small, so I collapse them into neighboring categories. After these combinations, there are 55 broad product/service categories.[15]

The second exogenous dimension along which contracts vary is the mix of *award types*. Awards are first divided by whether they specify a fixed quantity (Definitive Contract) or leave some quantities unspecified (Indefinite Delivery Vehicle). Very small awards (currently below $3000) are known as "micropurchases," and are exempted from a number of competition and reporting requirements. Compared to other features of the contract, the contracting agency has little discretion over the product class and award type, as they are primarily dictated by the nature of the good or service to be acquired. I take the mix of award types as exogenously given, and ignore the possibility that the mix may respond (on the margin) to workload.

For this paper, I limit my investigation to the effects of workload on the contractual terms of consummated original definitive contracts above the original $25,000 reporting threshold. This winnows the sample enormously, from over 4 million total contractual actions to only about about 150 thousand qualifying contracts. I limit the sample in this way for a number of reasons. First, modifications are problematic because of the way they depend on some already-extant contract. Which workload do we think would affect the terms of the modification, the original or the workload at the time of the modification? Also, the existence of a modification is, itself, an outcome that might be affected by workload, so we may particularly worry about sample-selection issues when looking at modifications. Calls

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[14]For definitions, see http://www.acquisition.gov/service_product_codes.pdf

[15]Details of matches available by request.

Table 1: Summary Statistics by Subsample

| Variable | Full Mean | s.d. | Analysis Mean | s.d. | Services Mean | s.d. |
|---|---|---|---|---|---|---|
| Definitive | 0.14 | 0.35 | 1 | 0 | 1 | 0 |
| Modification | 0.61 | 0.29 | 0 | 0 | 0 | 0 |
| Measures Of Competition | | | | | | |
| Competed | 0.61 | 0.49 | 0.43 | 0.50 | 0.40 | 0.49 |
| Exclusion | 0.10 | 0.28 | 0.15 | 0.36 | 0.16 | 0.36 |
| Not Competed | 0.13 | 0.32 | 0.15 | 0.35 | 0.14 | 0.35 |
| Contractual Pricing Form | | | | | | |
| Firm Fixed | 0.65 | 0.48 | 0.85 | 0.36 | 0.83 | 0.38 |
| Substantive Changes (Pre-2009) | | | | | | |
| Any Mods | n.a. | n.a. | 0.37 | 0.48 | 0.43 | 0.49 |
| Termination | n.a. | n.a. | 0.01 | 0.08 | 0.01 | 0.08 |
| # Mods | n.a. | n.a. | 1.33 | 5.30 | 1.54 | 5.73 |
| Obligations ($M2009) | | | | | | |
| Final Obligation | n.a. | n.a. | 2.45 | 74.5 | 2.63 | 81.1 |
| Initial Obligation | 0.30 | 7.10 | 0.85 | 17.4 | 0.87 | 19.0 |
| Agency Characteristics (Weighted by Sample Sizes) | | | | | | |
| Any Retire | 0.90 | 0.30 | 0.94 | 0.24 | 0.93 | 0.25 |
| Pct. Retire | 0.03 | 0.03 | 0.04 | 0.03 | 0.03 | 0.02 |
| Pct. 10-20 | 0.25 | 0.10 | 0.26 | 0.10 | 0.27 | 0.09 |
| Pct. 20+ | 0.48 | 0.11 | 0.51 | 0.11 | 0.50 | 0.11 |
| C. Officers | 387 | 359 | 444 | 421 | 464 | 421 |
| n | 4.3M | | 149k | | 121k | |

**Notes** Full sample includes all contractual action for 85 civilian contracting offices, over 11 years (2000-2010). Analysis sub-sample is limited to original definitive contracts. The Services subsample is further limited to only the service contracts in the Analysis subsample.

on indefinite contracts suffer from many of the same problems as modifications. Finally, I only look at contracts above the original $25,000 reporting threshold. Some contacts below this threshold are reported, but since the reporting is not obligatory, reporting rates may adjust with workload.

The first endogenous dimension along which contracts vary is the *pricing structure*. For modeling purposes, I divide simply between fixed-price and cost-plus contracts. In reality, they are much more finely delineated, including: firm-fixed-price; fixed-price with various price adjustments, effort requirements, and incentive payments; cost-plus fixed fee; cost-plus various incentive fees; time-and-materials; and various hybrid forms. In the sample of original definitive contracts, firm-fixed-price contracts make up 85 percent of all contracts. According to the FAR, fixed-price contracts should be used when the contract risk is relatively low, or defined within acceptable limits, and the contractor and the government can reasonably agree on a maximum price. Official government policy is to prefer firm-fixed-price contracts when possible (especially recently, with a order from the Office of Federal Procurement Policy).

The second endogenous dimension along which contracts vary is the degree to which they are competed. The most open form of competition is termed "Full and Open Competition," which refers to any competitive method in which all responsible sources are permitted to compete. It includes sealed bids, competitive proposals, and combinations of competitive procedures. A more limited level of competition is "Full and Open Competition after Exclusion of Sources," in which some number of otherwise qualified bidders are excluded from the competition. Such exclusions are primarily set asides for preferred bidders, such as small businesses, Historically Underutilized Business Zone (HUBZone) businesses, or service-disabled veteran-owned businesses, but they can also be used if the use would reduce overall costs without harming competition, benefit national defense, ensure a reliable source, or satisfy a critical need. Finally, a contract may not be competed at all, either because its awarding procedure was explicitly specified by statute (Not Available for Competition) or because only one source was solicited for reasons authorized by regulation and justified by the contracting officer (Not Competed). The most common justifications are: there is only one responsible source and no other suppliers will satisfy agency requirements, unusual and compelling urgency, and industrial mobilization.

The third endogenous characteristic of original contracts I consider is that some are modified over time and some are not. The reasons for modification vary substantially. About half are strictly administrative, a funding only action or a close out of a completed contract. But about forty-five percent of modifications are some type of real change in the way the contract will be carried out: unilateral requests for additional work, change orders, the exercise of options, and bilateral supplemental agreements. The remaining five percent are

a collection of cancelations, terminations, and movements between definitive and indefinite contracts.

Finally, contracts differ endogenously with respect to size of the government's financial obligation. Every original contract has an initial level of expected obligation, and that obligation can be altered by subsequent modification. I look at both initial and final obligation, individually, since the model predicts effects on each.

Table 1 presents the summary statistics for each of the characteristics for the full sample of contractual actions and for the Analysis subsample of original definitive contracts that will form the basis for the regressions below, and for the subset of the Analysis which are service contracts. Since services may be particularly difficult to fully specify, they may by particularly responsive to workload. Consistent with this idea, service contracts are about 6 percentage points more likely to be modified eventually. I also consider a "Big Agencies" subsample consisting of the 39 agencies that had more than 500 original definitive contracts over the sample period; they are listed individually in Table 7. Since the "Big Agency" sample includes 140k of the 149k qualifying contracts; the summary statistics for it are nearly identical to the Analysis sample, so they are not presented separately here.

## 3.2   Econometric Specification of Workload

Constructing some consistent measure of workload across agencies and time is a particularly difficult task. The problems of using naive measures such as contracts per officer or dollars obligated per officer are well documented (Black 1995, Reed 2010) and are present here as well. Some contracts are much more complex than others, and simply adding up the number of contracts or dollars would overstate the load on those agencies who have relatively simple tasks to perform and understate the load on those with complex tasks. Since the difficulty of the tasks themselves might also directly influence the structure of the procurement terms, any results derived from such a biased measure of workload would be *a priori* suspect. Instead of trying to measure work per officer directly, I instead concentrate on the effects of increasing or decreasing the number of contracting officers in an agency, while controlling for the number and mix of purchases that the officers need to manage.

The mix of procurement problems varies enormously across agencies and over time, so some consistent method of measurement must be adduced. Most extant measures use some sort of ex-ante weighting scheme among contracts. The most well known of these is the Air Force manpower standard for operational contracting (AFMS) (AFIMA 2001). AFMS counts up contractual actions, giving fixed extra weights to actions with certain characteristics, including: actions over $100,000, actions during expeditionary deployments, and certain

oversight activities. In all, there are around 200 individually specified weights. No weight is given to modifications or orders off centralized contracts. Other agencies have broadly similar methods of calculating workload (for a detailed summary, see Reed (2010)), but implementing such a method is not feasible in the present study for two reasons. First, any ex-ante weighting system derived without cross-agency measures of time use would be extremely ad hoc. Second, all the extant schemes that could be applied in a cross-agency framework have workload weights that depend on the very outcomes we are interested in exploring: solicitation procedure, dollars obligated, and extent competed. Since those choices are equilibrium outcomes, including them in the workload measure will lead to biased results.

Given the problems with these ex-ante workload weights, I will instead take a relatively agnostic approach and try to let the data tell me how work-intensive various contracting actions are. For each agency-year, in every regression, I will include (the log of) the number of contracting officers. I categorize each original action according to which of 55 major product/service codes is the primary object of the action. For each product/service class, I count the (log of) the number of original contracts for each agency/year combination and include these as 55 separate controls, indexed by $j$. Finally, every regression will include measures of contracting-officer experience, including the fraction with 10-20 years of experience and the fraction with over 20 years of experience, agency fixed effects, year fixed effects, and product/service fixed effects.

Intuitively, we want to compare the outcomes for an agency in years when it has more contracting officers than we would predict given its contract load, mix, and experience to that same agency in years when it has fewer officers, all the while adjusting for year-specific factors that are common to all agencies and product/service-specific factors. Formally, I will estimate the following Fixed-Effects OLS (FE-OLS) equation for contract $i$ in product class $p$ in agency $s$ in year $t$.

$$(1) \qquad y_{ipst} = \beta \, officers_{st} + \gamma' \mathbf{E_{st}} + \sum_{j=1}^{55} (\alpha_j X_{jst}) + \gamma_{\mathbf{pst}} + \epsilon_{ipst},$$

where employment ($officers$) and contract counts ($X$) are measured in logs, $\mathbf{E}$ is the vector of experience controls, $\gamma_{\mathbf{pst}}$ is the combination of three fixed effects (agency, year, and product class), and $y$ is the outcome of interest. Across various contracting outcomes, our interest is in estimating $\beta$, the effect of expanding the contracting workforce on that outcome. Since the variable of interest varies at the agency-year level only, standard errors are clustered at that level.

## 3.3 Instrumental-Variable Estimation

The approach above has an advantage over a naive regression of outcomes on contracts per GS-1102 because it adjusts for observable predetermined differences in work mix. If the naive measure was biased because offices that handled simple products/services hired fewer GS-1102s per contract, the problem is solved. There can still be a lot of variation in complexity within an agency; this sort of variation would not bias the estimates of $\beta$ unless the unobservable complexity varies over time within an agency and is correlated with both employment and contractual outcomes.

If there are unobservable changes in complexity that occur *within* agency and those changes are correlated with contracting officer employment in the agency, the estimates of $\beta$ are still biased. Imagine, for example, that the mission of the agency changes slightly over time, and they have to write more complicated contracts without any significant change to the product mix. To respond to this increased complexity, they may hire more contracting officers and start writing in different contractual terms. In that case, the FE-OLS estimates might find a relationship between contracting officer employment and contractual terms, but that relationship would not be causal. In fact, some third factor (mission complexity) is driving both.

To get around this problem, we need to find some intervening variable that leads to a shift in the employment of contracting officers that is independent of other factors that might affect contractual mix, an instrumental variable. My approach will be to use retirements by contracting officers as an instrument for employment.

For this approach to be successful, two conditions must be satisfied. First, variation in contracting-officer retirement rates over time within an agency must have some power in explaining variation in employment. Second, conditional on other covariates, retirement rates must only relate to contractual form due to its correlation with employment. To return to the example above, if retirement rates suddenly jump or fall because of the change in agency mission, this assumption would not be satisfied. Given the structure of the civil service retirement system, retirement seems to be driven, in large part, by the threshold rules that govern pension obligations. Retirement rates spike dramatically as employees qualify for full benefits at certain age thresholds, which depend on their years of service (Asch, Haider and Zissimopoulos 2005). As long as this effect is the primary determinant of retirement, the instrument will be valid.

To check the first assumption, that retirement rates are related to employment, I estimate

Table 2: The Relationship between Retirements, Employment, and Contracts

| | Full Sample | Big Agencies | Services |
|---|---|---|---|
| *Panel A (First Stage): Predicting Employment* | | | |
| Pct. Retire | −0.06*** | −0.06*** | −0.07*** |
| | (0.01) | (0.01) | (0.01) |
| Any Retire | −0.16*** | −0.13*** | −0.15*** |
| | (0.03) | (0.04) | (0.04) |
| Pct. 10-20 | −1.25*** | −1.60*** | −0.95*** |
| | (0.21) | (0.27) | (0.22) |
| Pct. 20+ | −1.55*** | −1.66*** | −1.39*** |
| | (0.25) | (0.33) | (0.29) |
| *Joint Test of Retirement Variables* | | | |
| F-Stat | 16.6 | 13.0 | 13.0 |
| p-value | 0.00 | 0.00 | 0.00 |
| *Panel B (Exogeneity): Predicting Number of Contracts* | | | |
| Pct. Retire | −0.06* | −0.06* | −0.04 |
| | (0.03) | (0.03) | (0.03) |
| Any Retire | −0.11 | −0.07 | −0.03 |
| | (0.12) | (0.15) | (0.13) |
| C. Officers | 0.31 | 0.32 | 0.36 |
| | (0.21) | (0.28) | (0.24) |
| Pct. 10-20 | −0.60 | −0.74 | −0.31 |
| | (0.53) | (0.71) | (0.61) |
| Pct. 20+ | −1.01 | −1.13 | −0.89 |
| | (0.75) | (0.97) | (0.80) |
| *Joint Test of Retirement Variables* | | | |
| F-Stat | 2.0 | 2.2 | 1.1 |
| p-value | 0.14 | 0.13 | 0.33 |
| n | 828 | 400 | 828 |

**Notes** Panel A Dependent Variable: The log of the number of contracting officers. Panel B Dependent Variable: The log of the number of original contracts. The unit of observation is the agency-year, and regressions are weighted by the number of original definitive contracts. In addition to the tabulated regressors, the first stage includes the log of the number of original contacts in 55 product/service groups and the log of the number of modifications in that agency-year, agency fixed effects, and year fixed effects. The second panel does not include contract workload controls. The full sample includes contracts from 85 agencies over approximately 11 years (2000-2010). Standard errors, in parenthesis, are clustered by agency. *,**,*** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

the following regression.

$$(2) \qquad officers_{st} = \beta_1 anyretire_{st} + \beta_2 pctretire_{st} + \gamma' \mathbf{E_{st}} + \sum_{j=1}^{55}(\alpha_j X_{jst}) + \gamma_{\mathbf{st}} + \epsilon_{st},$$

where $anyretire_{st}$ is a dummy for whether there are any retirements in agency $s$ in fiscal year $t$, and $pctretire_{st}$ is the log of the percent of GS-1102s who retire. Since our interest is in using this relationship to explain variation in contract-level outcomes, I weight this first-stage regression by the number of original definitive contracts in each agency-year. Panel A of Table 2 displays the results of these estimations, for the full sample, the big-agency subsample, and the services subsample. In all three cases there is a strong and robust relationship between retirements and employment. The joint hypothesis that both retirement variables are equal to zero is rejected with $p < 0.005$.

To investigate the exclusion restriction, I check in Panel B of Table 2 for one obvious sort of reverse causality, that big changes in workload push people to either retire or stay around. To test this, I repeat the estimation in equation (2), with two differences. I replace the dependent variable with the log of the total number of contracts in the agency-year and replace the controls for product/service mix with the log of contracting officer employment, as a time-varying measure of size. Since product counts will be collinear with the new dependent variable, they must be dropped, but some measure of scale must be included. In all three samples, retirement rates are only weakly related to the number of contractual actions. Since the regression includes agency and year fixed effects, the retirement rate in years with higher than expected numbers of contractual actions are no different from those with lower than expected numbers. If there is any relationship, it is negative, so people are *less* likely to retire when the agency is busy. Such a relationship would tend to bias toward finding no effect of workload on contracting, since the endogenous positive shocks to workload would occur when workload is low. Some unobserved change in a qualitative factor of the contracts may still driving retirements, and thereby undermining the identification, but we cannot detect much for observable factors.

# 4 Results

## 4.1 Degree of Competition

Table 3 outlines the estimated effects of decreasing workload on the decision to award a contract by competitive mechanisms. For all samples, the OLS results would suggest that having

Table 3: The Effect of Workload on Competition

| | OLS | IV | OLS-Big | IV-Big | OLS-Serv | IV-Serv |
|---|---|---|---|---|---|---|
| | Panel A: Full and Open Competition | | | | | |
| C. Officers | 0.04 | 0.39** | 0.04 | 0.41** | 0.03 | 0.26 |
| | (0.04) | (0.18) | (0.05) | (0.21) | (0.04) | (0.19) |
| Pct. 10-20 | −0.12 | 0.34 | −0.18 | 0.41 | −0.15 | 0.11 |
| | (0.10) | (0.25) | (0.14) | (0.35) | (0.11) | (0.24) |
| Pct. 20+ | 0.14 | 0.69** | 0.11 | 0.70** | 0.06 | 0.38 |
| | (0.11) | (0.30) | (0.15) | (0.35) | (0.12) | (0.28) |
| | Panel B: Competition with Exclusion | | | | | |
| C. Officers | 0.02 | −0.51*** | 0.03 | −0.59*** | 0.01 | −0.37** |
| | (0.03) | (0.17) | (0.05) | (0.20) | (0.03) | (0.16) |
| Pct. 10-20 | 0.18** | −0.49** | 0.23* | −0.78** | 0.22*** | −0.22 |
| | (0.08) | (0.24) | (0.12) | (0.34) | (0.09) | (0.20) |
| Pct. 20+ | −0.16* | −0.97*** | −0.21 | −1.20*** | −0.06 | −0.60** |
| | (0.09) | (0.28) | (0.13) | (0.35) | (0.10) | (0.25) |
| | Panel C: Not Competed | | | | | |
| C. Officers | −0.03 | −0.07 | −0.01 | −0.04 | −0.03 | −0.06 |
| | (0.03) | (0.12) | (0.03) | (0.13) | (0.03) | (0.14) |
| Pct. 10-20 | 0.11 | 0.06 | 0.18 | 0.12 | 0.15* | 0.12 |
| | (0.08) | (0.16) | (0.11) | (0.21) | (0.09) | (0.16) |
| Pct. 20+ | 0.12 | 0.06 | 0.11 | 0.06 | 0.17** | 0.14 |
| | (0.09) | (0.20) | (0.12) | (0.22) | (0.09) | (0.20) |
| n | 148,591 | | 139,936 | | 121,012 | |

**Notes** Dependent variable: Indicator of use of given level competition. Not available for competition is the excluded class. Regressions include original definitive contracts, limited to 39 large agencies in specifications 3 and 4, and to service contracts in specifications 5 and 6. In addition to the tabulated regressors, each specification includes the log of the number of original contacts in 55 product/service groups and the log of the number of modifications in that agency-year, product/service fixed effects, agency fixed effects, and year fixed effects. The full sample includes contracts from 85 agencies over up to 11 years (2000-2010). Standard errors, in parenthesis, are clustered by agency-year. *,**,*** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

more contracting officers is associated with negligible differences in the use of competitive contracting mechanisms. Agencies that have more contracting officers than we would expect, given their mix of contracts, are no more or less likely to use full-and-open competition or to exclude sources.

The IV results, however, suggest that these OLS results are likely misleading. When we consider exogenous changes in the number of contracting officers, the results are dramatically different. Increasing the number contracting officers actually *increases* the use of competitive procurement mechanisms. In particular, increasing the number of contracting officers by 10 percent increases the probability of full and open competition by about 4 percentage points, decreases the use of competition with excluded sources by about 5 percentage points, and decreases the probability that a contract is not competed at all by about 1 percentage point. To give a sense of magnitudes, about 40 percent of contracts are full and openly competed, while about 15 percent are competed after exclusion. The relationship may be slightly weaker for service contracts, although the difference is not significant.

The most plausible reason for the difference between IV and OLS results is that the FE-OLS approach has not succeeded in controlling for the differences in contract mix within an agency over time. More difficult procurements will both require more officers and will be less likely to be fully competed, and we are seeing this correlation when agencies respond to a change in the mix of procurement problems they face by adjusting their employment of contracting officers. Even if the adjustment is imperfect, the correlation could still move in the observed direction. Only when armed with a shock to employment such as a spate of retirements can the true effect of exogenous changes in the number of contracting officers be uncovered.

## 4.2   Pricing Structure

Table 4 outlines the estimated effects of decreasing workload on the pricing structure chosen by the contracting officer. For both samples, the OLS results would suggest that having more contracting officers is actually associated with more fixed-price contracting. Agencies that have more contracting officers than we would expect, given their mix of contracts, are more likely to use firm-fixed-price contracts

The IV results, in this case, suggest that these OLS results are correct in sign, but perhaps slightly biased downward. When we consider exogenous changes in the number of contracting officers, the results are qualitatively quite similar to the OLS results, for the most part. Increasing the number contracting officers increases the use of fixed-price contracts. In particular, increasing the number of contracting officers by 10 percent, increases the

Table 4: The Effect of Workload on Contract Pricing

| | OLS | IV | OLS-Big | IV-Big | OLS-Serv | IV-Serv |
|---|---|---|---|---|---|---|
| | Use of Firm Fixed-Price Contracts | | | | | |
| C. Officers | 0.07*** | 0.11 | 0.13*** | 0.16* | 0.07** | 0.05 |
| | (0.03) | (0.09) | (0.03) | (0.10) | (0.03) | (0.09) |
| Pct. 10-20 | 0.15* | 0.19 | 0.36*** | 0.43** | 0.10 | 0.07 |
| | (0.08) | (0.13) | (0.10) | (0.19) | (0.08) | (0.14) |
| Pct. 20+ | 0.22*** | 0.28** | 0.41*** | 0.47*** | 0.15** | 0.12 |
| | (0.07) | (0.14) | (0.09) | (0.17) | (0.08) | (0.14) |
| n | 148,456 | | 121,851 | | 120,957 | |

**Notes** Dependent variable: Indicator of use of firm-fixed-price contract. Regressions include original definitive contracts, limited to 39 large agencies in specifications 3 and 4, and to service contracts in specifications 5 and 6. In addition to the tabulated regressors, each specification includes the log of the number of original contacts in 55 product/service groups and the log of the number of modifications in that agency-year, product/service fixed effects, agency fixed effects, and year fixed effects. The full sample includes contracts from 85 agencies over up to 11 years (2000-2010). Standard errors, in parenthesis, are clustered by agency-year. *,**,*** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

probability of using a firm fixed-price contract by about 1 percentage point. On average, about 85 percent of contracts in the sample are firm-fixed-price contracts.

There is little evidence for a difference between IV and OLS results. If it exists at all, the bias seems less extreme than in the case of the determination of competition. Perhaps agencies are not as responsive to employment needs that result in changes in pricing terms as they are in responding to employment needs would result in changes in the use of competitive procurement practices.

## 4.3 Obligations

Table 5 outlines the estimated effects of decreasing workload on the initial and final amount obligated on the contract, where final obligations take into account all later adjustments due to modification. The OLS results suggest that having more contracting officers is associated with lower initial and final obligations, on average. The IV results, in this case, again suggest that these OLS results are approximately correct. Increasing the number contracting officers lowers the initial and final dollar cost of the contract. In particular, increasing the number of contracting officers by 10 percent lowers the expected final obligation by between 2 and 4 percent. The effect on initial obligations are in the same direction about about half the size.

Table 5: The Effect of Workload on Obligations

|  | OLS | IV | OLS-Big | IV-Big | OLS-Serv | IV-Serv |
|---|---|---|---|---|---|---|
| Panel A: Total Dollars Obligated | | | | | | |
| C. Officers | −0.28*** | −0.31 | −0.42*** | −0.36 | −0.19** | −0.22 |
|  | (0.08) | (0.35) | (0.11) | (0.38) | (0.08) | (0.35) |
| Pct. 10-20 | −0.39 | −0.43 | −0.79** | −0.69 | −0.60** | −0.64 |
|  | (0.24) | (0.52) | (0.33) | (0.71) | (0.25) | (0.48) |
| Pct. 20+ | −0.37 | −0.42 | −0.68** | −0.59 | −0.51** | −0.56 |
|  | (0.23) | (0.60) | (0.29) | (0.70) | (0.24) | (0.56) |
| Panel B: Initial Dollars Obligated | | | | | | |
| C. Officers | −0.14** | −0.26 | −0.28*** | −0.21 | −0.05 | −0.15 |
|  | (0.07) | (0.29) | (0.09) | (0.32) | (0.06) | (0.28) |
| Pct. 10-20 | −0.09 | −0.23 | −0.42 | −0.30 | −0.24 | −0.35 |
|  | (0.20) | (0.43) | (0.28) | (0.59) | (0.20) | (0.38) |
| Pct. 20+ | −0.01 | −0.18 | −0.13 | −0.02 | −0.13 | −0.26 |
|  | (0.19) | (0.50) | (0.24) | (0.57) | (0.19) | (0.44) |
| n | 148,644 | | 139,979 | | 121,052 | |

**Notes** Dependent variable: The natural log of the cost of obligations, measured in real 2009 dollars. Regressions include original definitive contracts, limited to 39 large agencies in specifications 3 and 4, and to service contracts in specifications 5 and 6. In addition to the tabulated regressors, each specification includes the log of the number of original contacts in 55 product/service groups and the log of the number of modifications in that agency-year, product/service fixed effects, agency fixed effects, and year fixed effects. The full sample includes contracts from 85 agencies over approximately 11 years (2000-2010). Standard errors, in parenthesis, are clustered by agency-year. *,**,*** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

This could involve a lot of money. Take the smallest estimate, with an elasticity of about $-0.2$. Weighting by contracts, the average agency has about 444 contracting officers and handled about $1,752$ original definitive contracts over the sample period with an average final obligation of about \$M 2.45 in 2009 dollars. If they had increased their workforce to 488 officers, the total obligations would have fallen to about \$2.4M per contract, a savings of about \$87.5 million over the eleven year period. A rough estimate of \$150,000 per contracting officer per year implies a net savings of about \$15 million dollars per agency on original definitive contracts. Note, this calculation excludes any concomitant effects on obligations for other contract types, but I have no reason to suspect they would move in the opposite direction.

## 4.4  Modifications

Table 6 outlines the estimated effects of decreasing workload on the presence and number of substantive modifications or terminations. For this analysis, alone, I limit the sample to contracts written before 2009, since enough time must pass to observe any modifications. For all three samples, the OLS results would suggest that having more contracting officers is not robustly associated with ex-post changes at all, or else the effect is very small.

The IV results, by contrast, show significant effects of workload on contract terminations, in all three samples. Increasing the number of contracting officers by about 10 percent when the original contract is signed decreases the probability that the contract is later terminated by about 0.4 percentage points, on a mean of about 1 percent.

The IV results for modifications are more mixed. For service contracts, more contracting officers leads to fewer modification, along both the extensive and intensive margins. Specifically, increasing the number of contracting officers by 10 percent, decreases the probability of modification by about 2 percentage points, and decreases the expected number of modifications by about 3.5 percent. To judge the size of these effects, about 43 percent of service contracts in the sample are modified at some point, and the average service contract has about 1.5 modifications. The sign of the IV estimates in the other subsamples are also negative, but they are not statistically different from zero.

Consistent with the predictions of the model, less busy agencies do a better job at foreseeing contingencies in the original contract and thereby limiting the need for ex-post renegotiation or termination. This relationship is especially apparent in the case of service contracts, for which the costs of contractual completeness may be particularly high.

Table 6: The Effect of Workload on Substantive Modifications

| | OLS | IV | OLS-Big | IV-Big | OLS-Serv | IV-Serv |
|---|---|---|---|---|---|---|
| Panel A: Any Substantive Modifications | | | | | | |
| C. Officers | −0.02 | −0.12 | 0.03 | −0.08 | −0.06* | −0.24* |
| | (0.03) | (0.14) | (0.04) | (0.18) | (0.03) | (0.13) |
| Pct. 10-20 | −0.20** | −0.31* | −0.12 | −0.27 | −0.21* | −0.39** |
| | (0.10) | (0.18) | (0.15) | (0.28) | (0.11) | (0.17) |
| Pct. 20+ | −0.17 | −0.28 | −0.09 | −0.22 | −0.21* | −0.40** |
| | (0.10) | (0.20) | (0.13) | (0.25) | (0.11) | (0.19) |
| Panel B: Termination | | | | | | |
| C. Officers | −0.00 | −0.04** | −0.01* | −0.04* | −0.00 | −0.04** |
| | (0.00) | (0.02) | (0.00) | (0.02) | (0.00) | (0.02) |
| Pct. 10-20 | −0.03** | −0.06*** | −0.04*** | −0.08** | −0.03*** | −0.07*** |
| | (0.01) | (0.03) | (0.02) | (0.04) | (0.01) | (0.03) |
| Pct. 20+ | −0.01 | −0.05** | −0.03*** | −0.06** | −0.02 | −0.06** |
| | (0.01) | (0.02) | (0.01) | (0.03) | (0.01) | (0.02) |
| Panel C: Number of Substantive Modifications | | | | | | |
| C. Officers | −0.04 | −0.23 | 0.00 | −0.17 | −0.09** | −0.37* |
| | (0.04) | (0.21) | (0.06) | (0.27) | (0.05) | (0.21) |
| Pct. 10-20 | −0.23 | −0.44* | −0.18 | −0.42 | −0.24 | −0.50* |
| | (0.15) | (0.27) | (0.22) | (0.42) | (0.17) | (0.26) |
| Pct. 20+ | −0.02 | −0.25 | 0.07 | −0.14 | −0.00 | −0.29 |
| | (0.14) | (0.29) | (0.18) | (0.37) | (0.16) | (0.28) |
| n | 117,426 | | 110,921 | | 95,632 | |

**Notes** Panel A Dependent Variable: Indicator of a subsequent substantive modification. Panel B Dependent Variable: Indicator of a contractual termination. Panel C Dependent Variable: the log of one plus the number of substantive modifications. Regressions include original definitive contracts, limited to 39 large agencies in specifications 3 and 4, and to service contracts in specifications 5 and 6. In addition to the tabulated regressors, each specification includes the log of the number of original contacts in 55 product/service groups and the log of the number of modifications in that agency-year, product/service fixed effects, agency fixed effects, and year fixed effects. The full sample includes contracts from 85 agencies over up to 9 years (2000-2008). Standard errors, in parenthesis, are clustered by agency-year. *,**,*** represent significance at the 0.10, 0.05, and 0.01 levels, respectively.

# 5  Conclusion

This paper explored one driver of incomplete contracting, workload, and the numerous effects of incomplete contracting on other contracting and procurement provisions. As workload increases, contracting officers will optimally write less complete contracts. Recognizing that renegotiation is more likely with less complete contracts, they will also alter the method of competition and pricing structure. In particular, they will lean away from full-and-open competition and away from firm-fixed-price contracts. They will also end up obligating more money, in expectation.

Although this is not the first paper to identify similar effects of contractual incompleteness on contracting and procurement terms, it is unique in its scope and method of identification. Most papers have focussed on a single industry and identified variation in completeness by looking for differences in underlying complexity. I instead control for complexity and industry and look at variation in completeness induced by exogenous differences in contracting-officer workload. Despite this very different approach, my results are quite consistent with the literature. This consistency is important, since the potential biases are very different in the two approaches. For the extant literature, we worry that complexity may have impacts on contactual forms that are not mediated by incompleteness; for this paper, we worry that workload may have impacts of contractual form that are not mediated by incompleteness. But unless these biases are coincidentally in the same direction for each contractual term, in both approaches, the consistent findings should make us feel more confident about both.

Although a lot is known about the determination of contractual forms, in general, very little work has looked into the effects of workload. Given the dramatic changes in the amount of contracting the federal government has done over the last decade, and the relatively small change in the contracting workforce, understanding these effects is a pressing policy question. In this paper, we have seen that an incomplete-contracting framework is a useful way to thinking about the effects of workload. Furthermore, we quantified some of the benefits of increasing the number of contracting officers (decreasing workload).

These results are relevant beyond their importance for procurement policy. In a private firm, we would probably expect that contracting managers are aware of the trade-off identified above and choose the size of the contracting to maximize expected profits. But experienced contracting officers are probably a fixed resource in the short run, so we might expect there to be important short-run consequences of unexpected shocks to contracting workload. If the economic forces identified here apply in that circumstance too, then firms should respond to sudden increases in procurement needs by increasing their reliance of cost-plus and negotiated contracts, in the short run. Of course, over time they will appropriate

re-balance their contracting workforce.

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# 6   Appendix (Proof)

Let $P_{x,y}$ and $R_{x,y}$ represent the expected prices paid under contract form $x$ and competition choice $y$, for the original contract and in a renegotiation, respectively. Given choices $(x, y, t)$, the expected utility of the contracting officer is given by

$$U(x,y,t) = v - wd(t) - x\Big[y(tP_{11} + (1-t)R_{11} + m) + (1-y)(tP_{10} + (1-t)R_{10})\Big] -$$

(3)
$$(1-x)\Big[y(tP_{01} + (1-t)R_{01} + m) + (1-y)(tP_{00} + (1-t)R_{00})\Big]$$

Start by deriving the prices. In the last stage of the game, contractors make effort decisions. Under a cost-plus contract, they have no incentive to put forth effort, since any cost reductions will be directly subtracted from their payments, so $e_{cp} = 0$. Under a fixed-price contract, contractors are residual claimants of any cost-reductions, so they will set effort to satisfy $g'(e_{fp}) = 1$. Let $f \equiv e_{fp} - g(e_{fp})$ represent the net real cost savings of this efficient effort.

By assumption, in the renegotiation stage, the contractor will be pushed to zero-profits by a take-it or leave-it offer from the contracting officer. In a cost-plus contract, this just amounts to offering no additional "plus" and simply reimbursing costs, so the expected price is simply $E[k]$, whether or not the initial contract was competed (so $R_{0,1} = R_{0,0} = E[k]$). Here, the competitive contractor has lost the "plus" part of his cost-plus contract, due to the extreme bargaining power I assumed. The results are unaffected if we instead assume he keeps that portion. In a fixed-price contract, the contracting officer and contractor anticipate the cost-saving effort by the contractor and so the expected total cost is $E[k] - f$, which requires a payment of $R_{1,1} = R_{1,0} = (1 + \delta)(E[k] - f)$.

Moving back to the original pricing stage, expected payments under negotiation are straightforward from the zero-profit condition. The difference between fixed-price and cost-plus are similar to above, where total cost is reduced by non-contractible effort, so $P_{1,0} = E[c] - f$ and $P_{0,0} = E[c]$. I assumed that competition results in the lowest-cost producer producing at the second-lowest "bid". Immediately $P_{1,1} = E[c_2] - f$ and $P_{0,1} = E[c_2]$, where $c_2$ is the second-lowest cost. With these prices in hand, I first show that $t^*$ decreases in $w$ and then that $x^*$ and $y^*$ increase in $t$ while $w$ has no direct effect, so they decrease in $w$,

overall.

Consider some set of strategies $(x, y, t_1)$ and some alternative set $(x, y, t_2)$, where $t_1 > t_2$. We can write the difference in the contracting officer's expected utility using these two sets of strategies as follows,

$$U(x, y, t_1) - U(x, y, t_2) = A(x, y, t_1, t_2) - w(d(t_1) - d(t_2)),$$

where $A(\cdot)$ is independent of $w$, since $w$ only appears in the cost of contractual completeness. By the assumption that $d()$ is increasing, it follows immediately that this difference strictly increases in $-w$, so the contracting officer expected utility has strictly increasing differences in $(-w, t)$.

Consider some set of strategies $(1, y, t)$ and some alternative set $(0, y, t)$. We can write the difference in the contracting-agent's expected utility using these two sets of strategies as follows,

$$U(1, y, t) - U(0, y, t) = -t(P_{1,y} - P_{0,y}) - (1 - t)(R_{1,y} - R_{0,y}).$$

Replacing for the prices derived above, this difference becomes

$$U(1, y, t) - U(0, y, t) = f - (1 - t)\delta[Ek - f],$$

which is strictly increasing in $t$ and independent of $w$ and $y$.

Finally, consider some set of strategies $(x, 1, t)$ and some alternative set $(x, 0, t)$. We can write again the difference in the contracting officer's expected utility using these two sets of strategies as follows,

$$U(x, 1, t) - U(x, 0, t) = -t(P_{x,1} - P_{x,0}) - (1 - t)(R_{x,1} - R_{x,0}) - m.$$

Replacing for the prices derived above, this difference becomes

$$U(x, 1, t) - U(x, 0, t) = t[E[c] - E[c_2]] - m,$$

which is strictly increasing in $t$ and independent of $w$ and $x$.

Taken together, I have shown that the contracting officer's objective function has increasing differences in $x$,$y$,$t$, and $-w$, and the increases with respect to $t$ are all strict. By the results of Topkis (1998), this suffices to show that $t^*$, $x^*$, and $y^*$ weakly increase in $-w$, so weakly decrease in $w$.

Table 7: Average Total Contract Load, GS-1102 Employment, and Initial Obligation ($2009) for Big Agencies

| Agency | GS-1102s | Contracts | Avg. Obligation ($M2009) |
|---|---|---|---|
| Dept. Veterans Affairs | 1001 | 39692 | 0.53 |
| FSS + FTS (Joint) | 762 | 966 | 0.64 |
| NASA | 724 | 7859 | 7.72 |
| Fed. Supply Service (Pre-merger) | 588 | 914 | 0.26 |
| Public Buildings Service | 575 | 9946 | 2.47 |
| Dept. of Energy | 519 | 2080 | 47.4 |
| Bureau of Prisons | 328 | 2799 | 2.66 |
| NIH | 322 | 3517 | 6.47 |
| Coast Guard | 304 | 3849 | 0.89 |
| IRS | 285 | 729 | 1.32 |
| Forest Service | 274 | 14410 | 0.31 |
| National Park Service | 215 | 5128 | 0.76 |
| Fed. Tech Service (Pre-Merger) | 181 | 1345 | 1.16 |
| State Department | 134 | 5787 | 2.74 |
| Interior- OPMB | 117 | 2374 | 1.12 |
| US Customs Service | 121 | 538 | 4.38 |
| FEMA | 99 | 557 | 5.19 |
| Bureau of Reclamation | 93 | 1210 | 1.79 |
| Dept of HUD | 93 | 1511 | 4.13 |
| NOAA | 92 | 2289 | 1.06 |
| Social Security Admin. | 92 | 542 | 2.37 |
| CDC | 90 | 1878 | 10.0 |
| Natural Resources Conservation Service | 87 | 1228 | 0.43 |
| Bureau of Land Management | 72 | 2197 | 0.42 |
| Fish and Wildlife | 70 | 2147 | 0.50 |
| FBI | 70 | 1066 | 0.97 |
| Dept. of Education | 60 | 533 | 9.38 |
| Farm Service Agency | 59 | 8539 | 1.00 |
| Agricultural Research Serv. | 56 | 1192 | 0.83 |
| Indian Affairs | 54 | 1263 | 0.88 |
| Geological Survey | 54 | 631 | 1.18 |
| FDA | 54 | 950 | 0.66 |
| DOJ- Offices, Boards, and Divisions | 40 | 6116 | 0.37 |
| Minerals Management Serv. | 37 | 568 | 0.92 |
| Fed. Highway Admin. | 36 | 1192 | 4.26 |
| NIST | 31 | 616 | 1.25 |
| Labor- ETA | 24 | 661 | 10.8 |
| OPM | 18 | 710 | 1.39 |
| Surface Mining and Reclamation | 8 | 799 | 0.14 |

**Notes** Agencies with at least 500 original definitive contracts. GS-1102 is the average stock of contracting officers at the start of the fiscal year. Contracts is the total number of original definitive contracts in the sample. Obligation is the average obligation for original definitive contracts.