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The Construction of Defense Department Contracts in Thin Markets

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Panel 9. Contract Design for Successful Public–Private Partnerships

Wednesday, May 14, 2014	
3:30 p.m. – 5:00 p.m.	**Chair: Fred Thompson,** Professor, Atkinson Graduate School of Management, Willamette University ***A New "Availability-Payment" Model for Pricing Performance-Based Logistics Contracts*** Amir KashaniPour, University of Maryland Xinyan Zhu, University of Maryland Peter Sandborn, University of Maryland Qingbin Cui, University of Maryland ***System Dynamics and Management Science Approaches Toward Increasing Acquisition Process Efficiency*** Joachim Block, UniBwM Heinrich Buch, UniBwM Bo Hu, UniBwM Armin Leopold, UniBwM Stefan Pickl, UniBwM ***The Construction of Defense Department Contracts in Thin Markets*** Trevor Brown, Ohio State University Yong Woon Kim, Ohio State University Alex Roberts, Ohio State University Daniel Albalate, University of Barcelona

The Construction of Defense Department Contracts in Thin Markets[1]

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Abstract

U.S. federal government agencies spend a lot of money through contracts. In Fiscal Year 2013 federal agencies spent $460 billion on contracts, over one third of all discretionary spending.[2] Some of these contracts are for simple products, like paper clips or grounds maintenance, but other contracts are for far more complex products, like advanced weapon systems or program management services. Given the significant amount of money spent on federal contracts annually and the importance of some of these contracts for agency operation, the way in which contracts are constructed impacts the ability of federal agencies to achieve their core missions and functions. This paper examines the impact of product characteristics and market conditions on the construction of contracts for products purchased by the Department of Defense. Analyses focus on contract type (fixed price versus cost reimbursement), contract length, and contract value.

Introduction

We draw five years of data (FY 2004–2008) from the Federal Procurement Data System (FPDS), the most comprehensive and largely untapped database on federal contracting practices, to examine contracts from the Department of Defense (DoD). We complement the contract data with data gathered from a survey of federal procurement professionals on the characteristics of different products. These data allow us to assess the impact of product characteristics and market conditions on contract type, length and value. The results indicate that product characteristics and market conditions are predictors of contract type, length and value. Fixed price contracts are the norm for simple products, while cost reimbursement contracts are often used for complex products. The results are inconclusive for contract length, but lower dollar value contracts characterize markets thick

[1] Draft—Not for citation without permission of the authors.
[2] See http://www.usaspending.gov. Accessed January 28, 2014.

with buyers and sellers, while contract value increases as markets thin with fewer buyers and sellers. Finally, as the percentage of an individual contract increases relative to the vendor's total revenues, the length and value of the contract increases.

Contract Construction—Product Characteristics and Market Characteristics

Government agencies face an implicit choice when it comes to production. A given product[3] can either be produced internally, with one's own resources, or it can be produced externally, through a contract with another organization. Contracting can bring with it a number of important benefits: efficiencies, cost savings, and innovation top the list (Kelman, 2002; Savas, 2005). These potential advantages help explain why many governments rely extensively on contracting. In the United States, in Fiscal Year 2013, the federal government acquired $460 billion of products through contracts, over one third of all discretionary spending.[4] Contracting also involves risks: cost overruns, delivery delays, and poor quality products. These risks can undermine contracting's ability to contribute to the achievement of agency missions and objectives. Harnessing the upside and mitigating the risks of contracting is increasingly an essential core management function.[5]

One of the primary sources of risk in contracting is the type of product to be acquired (Brown, Potoski, & Van Slyke, 2006). Some products, whether they be goods or services, are easy to describe and easy to make. That is, it is easy for the purchasing agency to describe the exact requirements of the product. This might mean specifying the inputs required to make the product (e.g., steel in the case of an aerial refueling tanker), what tasks and functions the product will perform (e.g., refueling other planes in the air), the outputs the product will generate (e.g., the number of additional gallons of fuel planes will be able to use during a flight), or the outcomes that will result from the product (e.g., the extended reach of the Air Force's planes). It is also easy for suppliers to develop the production process to create the product. That does not necessarily mean that it is cheap to produce. Some easy-to-make products—like airplane hangars—require expensive up-front fixed investments. Instead, it means that it is easy to figure out how to make the product, and it means that the investments required to make it can be relatively easily transferred to some other activity if the purchasing government stops buying the product. For example, if the U.S. Air Force stops buying airplane hangars, suppliers can retool their production process to make giant warehouses or garages for semi-trucks. These products are "simple."

"Complex" products, on the other hand, are difficult to describe and difficult to make. When government agencies buy a complex product, like an information technology system, it is difficult to describe everything the purchasing agency wants the product to do and how it should be made. This makes it difficult for the vendor to figure out how to make the product and consequently how much it will cost. Complex products often require investments in research and development to figure out how to design the production process to make the product. These investments are "specialized" to the extent that if the agency stops buying

[3] We use the generic term "product" to refer to both goods and services.
[4] See http://www.usaspending.gov. Accessed January 28, 2014.
[5] For example, the 2007 *Report of the Acquisition Advisory Panel to the Office of Federal Procurement Policy and the United States Congress* (https://acquisition.gov/comp/aap/24102_GSA.pdf) finds: "The federal acquisition workforce is an essential key to success in achieving the government's missions. Procurement is an increasingly central part of the government's activities" (p. 352).

the product, the supplier has limited alternatives to shop the product (and the accompanying production process) to another buyer. On the flip side, if the purchasing agency is dissatisfied with the chosen vendor, few if any other suppliers likely have made the required specialized investments to produce the product. This leads to what economists refer to as "lock in" or "hold up" (Tirole, 1999; Williamson, 1981, 1985). Once a buyer and a seller enter into an exchange for a complex product, it is very difficult for them to exit the exchange because alternatives are limited.

In comparison to simple products, the attributes and features of complex products create risks. Faced with uncertainty about what is required to make the product and how much it will cost, the risk of cost overruns, delivery delays, or an unsatisfactory product is high. These risks are lower, although still present, when purchasing simple products in part because buyers can turn to the market to replace poor performing sellers with relative ease. If a seller provides a product that costs more than the government agency anticipated, or delivers it late, or in shoddy condition, the agency is not forced to keep buying the product from the same vendor. It can find a vendor that better meets its need in the next round of purchasing. Exit is far more challenging when "locked in" to a vendor for a complex product.

There is a growing literature on managing contracts for complex products in thin markets (Amirkhanyan & Lambright, 2010; Girth et al., 2012; Johnston & Girth, 2012). In general, this literature focuses on managerial activities that occur after the contract has been let, ex post. The primary strategies focus on establishing rules and behavioral patterns of interaction that promote cooperation between the buyer and the seller since by entering into a contract for a complex product the two parties have essentially entered into an interdependent relationship rather than simply an exchange (Brown, Potoski, & Van Slyke, 2013). These management strategies require investments in contract management capacity and are worthy of pursuit, but their success is conditioned by the type of contract used to govern the relationship (Malatesta & Smith, 2013).

In an ideal world, external production would be governed by complete contracts. The purchaser would specify what he wanted from the vendor in exacting detail. The vendor would then provide accurate cost estimates, ultimately yielding a transparent and comprehensive agreement of what is to be produced and how much it will cost. Such a complete contract would guide both parties to a mutually beneficial outcome. There would be no surprises or substantial risk of harm to buyer or seller. But as scholars have long argued, human nature makes such complete contracts impossible (Coase, 1937). Because buyers and sellers are boundedly rational neither can know with exact certainty what future conditions will be like. Factors like the price of key inputs (e.g., steel) or how the product will be used in the future will have important implications for whether the buyer and the seller each receive value from the exchange, yet the ability of the two parties to forecast these types of changes is limited. This lack of knowledge means that parties do not necessarily know how to secure their interests ex ante. As a result, contracts often cannot be fully specified in advance, and the buyer and the seller will be exposed to risk. For the vendor, there is a chance that production costs will exceed what she expected. Profits may be reduced or losses incurred as a result. For the buyer, there is concern that the vendor will behave opportunistically by lowering service quality or running up charges to increase profits. Self-interested parties will—at least some of the time—behave contrary to the counterparty's interests (Williamson, 1981). The costs of writing a contract to cover all these contingencies are too high to warrant moving forward with the exchange. Instead, buyers and sellers have to rely on incomplete contracts that specify as much as reasonably possible about the product, but leave some aspects of the exchange unspecified.

Incomplete contracts create a zone of discretion where the decisions and actions of the buyer and the seller determine whether both receive value from the exchange. Here the best that can be done is to write contractual rules that guide the buyer and the seller towards actions that minimize the risks that one or both parties receive losing outcomes. One of the principal rules—a key contract design element—that conditions outcomes is the method of payment, the contract type. Broadly speaking, contracts come in two types. Fixed price contracts specify a final price for the good or service being purchased. This structure helps to shield the buyer from risk: Because the purchase price has been set ex ante, the vendor must bear any additional costs incurred over the course of production. Fixed price contracts therefore create an incentive for the vendor to determine product characteristics and costs at the outset. The other principal type of contract is the cost-reimbursement contract. Under this arrangement, allowable charges are specified at the outset but a final price is not set. A cost-reimbursement contract might state that the vendor can bill the buyer for all parts, labor, and fuel used in production. The final price will be a function of these factors rather than a fixed figure. This contract type shifts the risk of cost overruns onto the buyer because the vendor can pass on unexpected costs. The buyer faces an incentive to be as clear as possible about what he wants from the supplier and the means by which it should be produced.

Driven by the insight that fixed price contracts place the risk of cost overruns on the vendor, the Federal Acquisition Regulations (FAR)—the primary regulations governing contracting at the federal level in the United States—promote the use of fixed price contracts whenever possible.[6] The FAR's stated preference for fixed price contracts is premised on the acquisition of simple products, like commodities, because so much is known about the product ex ante and the risk of lock-in is low. Fixed price contracts are not appropriate for complex products, though, due to uncertainty about what it will take to produce the product. Because the development process for complex products is often iterative, it is challenging to identify performance measures for the purchasing agency to monitor over time. In the face of such heightened uncertainty we might expect the buyer to insist on a fixed price contract to defend against cost escalation. However, setting a payment cap ex ante might impose counterproductive constraints on production. The buyer could end up with an inadequate product, for example, a mediocre aerial refueling tanker, because the vendor is forced to cut corners under the fixed ceiling on costs. Alternatively, the vendor faces the acute risk of financial loss. She might not even be willing to enter into the exchange under a fixed price regime. In these cases a cost reimbursement contract is preferable. There is clearly still risk under this arrangement, but the buyer is now incented to work hard to specify as much as possible about what they want from the product and to invest in contract management capacity to coordinate and oversee the relationship with the vendor. The FAR allows for the use of cost reimbursement contracts in these circumstances. While relying on a fixed price contract for a complex product might seem advisable at the outset, it can also result in a dysfunctional relationship in which excessive risk is placed on the vendor, almost encouraging opportunistic behavior. The astute contract professional follows the FAR's guidance by matching the type of contract and the characteristics of the product to be acquired.

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[6] The FAR is a component of the Code of Federal Regulations, specifically *Title 48: Federal Acquisition Regulation System*.

When a buyer and a seller enter into an exchange, they each seek terms that will favor their interests. A buyer seeks a product at a price he can afford and a seller seeks payment above her costs of production. In some circumstances, the seller may find herself in an advantageous position relative to the buyer, for example, if she is the only provider of a product the buyer desires. In other cases, it may be the buyer that has the advantage, for example, if he is the only purchaser of a product in which there are multiple sellers. We make the simple assumption that when the buyer has the advantage he will prefer a fixed price contract with a long duration and a high value because he believes it will increase the chances of receiving a product at or close to the expected cost. Alternatively, when the seller has the advantage she will prefer a longer term cost reimbursement contract because it offers a greater opportunity to increase the product's price in comparison with a fixed price contract.[7]

In markets thick with sellers, any single buyer has relative freedom to enter into exchanges that best suit his or her interests. As markets become thinner, a buyer can become increasingly dependent on a single or limited set of providers of the resource they seek. Designing a contract in a thin market can mean settling for a contract that is less than ideal in order to secure necessary resources.[8] Sellers gain prospective bargaining power as there are fewer vendors which can offer the product the buyer desires (Bacharach & Lawler 1984; Root, 1988). The seller's bargaining power is prospective in the sense that no individual seller will actually demand a specific contract type—under federal contract practice this determination is made during the pre-award phase—but rather that market conditions may cause buyers to select a particular method of payment in the pre-award phase, before the Request for Proposal goes out, to ensure that sellers will be willing to bid and enter the exchange. As government procurement personnel scan the market in the pre-award phase, cost reimbursement contracts will be less likely in competitive markets with many sellers. In markets with few buyers, prospective sellers find themselves with limited alternatives for their products. In these circumstances, a seller may be more likely to bid on and enter into a contract where they bear the risk of cost overruns because they are dependent on the flow of financial resources (Salancik, 1979). Cost reimbursement contracts will be less likely in markets with few buyers than in markets thick with buyers.

Data and Methods

To examine the construction of contracts for different types of products we draw data from the most comprehensive data set of federal contract actions available to create a pooled sample of five years (2004–2008). This approach allows us to measure variables for product characteristics and market conditions for different products. We use logistic and ordinary least squares regression and accompanying interpretative tools to analyze our

[7] Obviously there will be circumstances when a buyer prefers a cost reimbursement contract and a seller a fixed cost contract, but all things being equal we assume that buyers are likely to select contract types that keep costs low and sellers are likely to select contract types that augment prices.

[8] Resource dependence theory makes powerful arguments about how the power of one organization over another in a relationship influences the structure of the relationship (Pfeffer & Salancik, 2003; Provan, 1993). We acknowledge this theory's insights but elect not to draw on it in crafting our framework given that resource dependency theory focuses on ongoing interdependent interactions between parties, whereas the contractual type decision we examine typically occurs before the exchange occurs and a relationship commenced. In instances where contractual exchanges become interdependent resource dependency theory offers a potential complement to transaction cost theory (Burt, 1983).

data. We conduct follow-on interviews with federal procurement officials to aid in interpretation.[9]

Research Design

We examine the contracting decisions of the DoD because it engages in a considerable amount of contracting across a broad range of products. Because we are interested in how different product characteristics influence contract type decisions, we select xx commonly procured product types. The unit of analysis is the initial contract agreement.[10]

Data

The data used in this paper are derived from the Federal Procurement Data System (FPDS), the Bureau of Economic Analysis' Benchmark Input–Output tables, Dun and Bradstreet's Million Dollar Database, and a survey of federal contract personnel of our own design. The FPDS catalogs all contract actions reported by 66 federal agencies (e.g., 5,614,758 contract actions were reported in the FPDS in FY 2009). We drew a stratified random sample from the FPDS of contracts for 29 product types in the DoD. To create our stratified random sample, we created lists for each of the selected the 29 product types of all contract actions signed from FY 2004 to FY 2008. Next we randomly drew 100 times from each of these lists to create our working sample. As noted earlier, a contract consists of either a base contract or a base contract plus modifications. For this reason, we provided random numbers only to initial contracts, not to all contract actions in our sample, so that the probability of being selected is the same across all contracts in the population. If we had provided random numbers to all contract actions on a list, contracts with more modifications would have been more likely to be selected.

The FPDS is the most comprehensive catalog of federal contracting actions available. Contract managers from across the federal government are required to input data on a standardized form about the contract actions they engage in with each contract they oversee. This provides a remarkable window into the contract type decisions of agencies. Like all datasets the FPDS has flaws. Most notably, there is no systematic way to monitor how contract managers actually input the data; as a result, many records are incomplete. In constructing our sample we took care to ensure that we only drew complete, comparable records. For this reason, the actual sample size for each service type of 29 services in an agency is typically less than 100 in most cases.[11]

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[9] Semi-structured interviews were conducted with seven current and former senior procurement personnel across a variety of federal agencies. All of those interviewed had served in a variety of acquisition positions in different agencies. Each interview followed the same semi-structured protocol, was recorded by hand, and then coded and scanned for key terms. Each interviewee was promised anonymity under a university Institutional Review Board process.

[10] Because contract managers can modify contracts through post-award negotiations with vendors, the initial contract does not always reflect the contract that ultimately governs the exchange. For this reason, in creating our sample we tracked both initial contract decisions and modified contract decisions. While contract managers in our sample often changed contract elements, like contract duration, we found no instances in which the type of contract—either cost reimbursement or fixed price—was changed after the initial agreement.

[11] The percentage of the incomplete FPDS records is 15.5% (269 of 1,734). The incomplete rate for the DoD is 15.2%.

Dependent Variables

To measure contract type, we use the contract type on the original base contract agreement. Following the FAR, the FPDS identifies 14 different types of contracts based on payment method, including five variations on cost reimbursement contracts, six variations on fixed price contracts, labor hour contracts, time and materials contracts, and order dependent contracts in which the payment method is determined separately for each acquisition off of a master contract (FPDS-NG, 2014). We combined all of the cost reimbursement contracts into a single cost reimbursement category. We did the same for all of the fixed price contracts. Both "time and materials" and "labor hour" contracts are variations on traditional cost reimbursement contracts because labor hours can be adjusted later if requirements and funding are uncertain. Like cost reimbursement contracts, these two contract types provide no positive profit incentive to the vendor for cost control or efficiency (GAO 2007, 2009a, 2009b). In addition, the Government Accountability Office classifies "order" contracts as partial cost reimbursement contracts, because they each lack clarity about the extent of cost reimbursement obligations (GAO 2009c). For these reasons we combined "time and materials," "labor hour," and "order" contracts into the cost reimbursement category. Our first dependent variable, *Contract Type*, is a dummy variable coded "1" for cost reimbursement contract types, and coded "0" for fixed price contract types.

To measure the length of contracts we pull two pieces of data from each FPDS record, the initial length of the contract at the time a vendor is selected and the ultimate length of the contract the final contract is signed. We label the first measure *Initial Contract Length* and the second measure *Ultimate Contract Length*. Both variables are measured in days.

To measure the value of contracts we pull two similar pieces of data, the initial value of the contract at the time of vendor selection and the ultimate value of the contract at final contract signature. We label the first measure *Initial Contract Value* and the second measure *Ultimate Contract Length*. Both variables are measured in dollars.

Independent Variables

To measure product characteristics, we include 29 different product types commonly purchased by the DoD. There are two standard classification codes to identify product types: North American Industry Classification System codes (NAICS) and Product Service Codes (PSC). Because both have different product classification schemes, NAICS and PSC codes do not always match for similar products. In our sample, we only looked at products that had the same NAICS and PSC codes. This means that there is industry agreement on the standardized classification of each of the products in our dataset. An appendix lists the NAICS and PSC codes for all 29 products.

We then conducted an original survey of federal procurement personnel which asked respondents to rate each of the 29 products on the two characteristics identified earlier—the ease or difficulty of specification and the degree to which specialized investments are required to make the product.[12] We surveyed members of the National Contract Management Association (NCMA), a membership organization of public procurement

[12] The survey was conducted with a protocol approved through a university Institutional Review Board.

personnel. We advertised the survey through NCMA's bi-weekly email newsletter, sending out a link in two successive email distributions. One hundred and twenty-nine active federal procurement personnel provided ratings. The response rate is low—less than 5% of the mailing list—but the respondents represent an array of federal procurement personnel with varying levels of education and experience. This effort to codify product characteristics at the federal level is the first we are aware of to tap the experience of those who do the actual purchasing of these types of products.[13]

Our measures of product characteristics are derivative of well-established measures in the extant literature (Brown & Potoski, 2005; Hefetz & Warner, 2012; Levin & Tadelis, 2010). We followed the measurement scheme of Brown and Potoski (2005) with some important improvements. To assess the ease or difficulty of specifying the product's attributes and requirements, survey respondents were asked to rate each product on a scale of 1 to 5, with 1 indicating that "requirements definition" was easy and 5 indicating that it was difficult. To assess the degree of specialized investments required to produce a product, survey respondents were asked to rate each product on a scale of 1 to 5, with 1 indicating a low level of specialized investments and 5 indicating a high level. In order to address instrumentation bias, respondents first rated the ease of requirements definition for all 29 products, followed by a series of questions about federal procurement practice, and then rated the degree of specialized investments for each product. The presentation of the 29 products was also randomized. An appendix reports the wording of the survey prompt for each of the two measures. Even with these steps to address instrumentation bias, in aggregate respondents rated the products similarly on both dimensions ($r^2 = .93$). To address colinearity in the measures, we combined the two scores into a single product characteristic score with a potential range from two to ten. This measurement schema aligns with our simple versus complex product conceptualization; products with low scores are simple and products with high scores are complex. We label this variable *Product Complexity.*

We measured market conditions in a variety of ways. First we measured whether agencies opted to go out for bids or sought a waiver from competitive bidding. The FAR permits government agencies to forgo competitive bidding when an agency can demonstrate that there is only one source that can satisfy the agency's requirements, the need is urgent, a statute or international agreement provides authorization, or for a series of other special purposes (FAR 6.302). This variable provides some insight into whether the purchasing government identifies multiple prospective sellers in the market. If the purchasing government opts to employ the competition procedure, it presumably anticipates receiving multiple bids. We label this dichotomous variable *Competition Procedure*, coded as "1" if the agency went out for competitive bids, else "0."

To assess the market power of the DoD, we include a measure of the percentage (ranging from 0 to 100) of total sales in each product category that are purchased by the DoD. This variable is not as precise as we might like since it measures DoD purchasing in aggregate rather than by each of its purchasing units. Still it provides some insight into the

[13] We pre-tested the survey instrument on a sample of 38 federal procurement personnel from a different professional association, the National Institute of Governmental Purchasing (NIGP). The pre-test provided useful feedback on ways to improve the validity of the survey items for the constructs we are interested in.

concentration of the market on the demand side. This variable is labeled *DoD Percentage of Sales.*

We draw data from the Bureau of Economic Analysis' Input/Output Tables to measure buyer scarcity; we use the data to calculate the total number of industries that purchase the product. A lower number of industries that purchase the product represents a scarcity of buyers and suggests that the purchasing agency will have a position of advantage in the market. We label this continuous variable as *Number of Purchasing Industries.*[14]

To assess market concentration on the seller side, we include a variable that measures when a single supplier provides the product for the DoD. This could be the result of the DoD opting to not use the competition procedure or when only one bid comes in when the DoD goes out for bids. We label this dichotomous variable *Single Supplier*, coded "1" if there is only one vendor, else "0."

Finally, to assess the value of the contract to the selected firm, we use Dun and Bradstreet's Million Dollar Database to construct a variable that measures the value in dollars of the contract over the total revenues in dollars for the firm in the year the contract was awarded. This variable is labeled *contract revenue/total revenue.*

Control Variables

We include a variety of control variables in our analyses. First, we include dummy variables for each of the five years of data in our sample, coded "1" for each year, else "0." In our empirical analysis, we use FY 2004 as the base year. Second, for our contract length analyses we include *contract type* as a control. Finally, for our contract value analyses we use include *contract type* and *contract length* as controls.

Table 1 reports the descriptive statistics for the all the dependent, independent and control variables in our analyses.

[14] In separate analyses we also include a variety of *ex post* measures of market competitiveness and concentration. These variables include the following: the total number of bids, whether there was a single offeror when agencies went out for competitive bids, and the percentage of the vendor's total revenue for a given year represented by the contract (this last measure is drawn from Dun and Bradstreet's Million Dollar Database). None of these measures are statistically significant or influence the results for the variables described above. We suspect that this is because all of these variables measure information revealed after contract type is set.

Table 1. Descriptive Statistics

	N	Min.	Max.	Mean	S.D.
Contract Type (1 = CR)	2,452	0	1	0.26	0.436
Initial Contract Length (days)	2,476	0	19,729	390.62	746.751
Ultimate Contract Length (days)	2,489	0	19,729	494.60	849.289
Initial Contract Value ($)	2,402	1	418,157,933	2,223,647.02	16,574,620
Ultimate Contract Value ($)	2,402	1	1,178,000,000	8,997,058.37	83,158,223
Product Complexity	2,553	3.078	9.011	5.93	2.005
Competition Procedure	2,551	0	1	0.65	0.477
Single Supplier	2,551	0	1	0.25	0.433
# of Purchasing Industries	2,553	4	425	303.10	168.687
DoD % of Sales	2,553	0.05	53.76	10.44	13.632
Contract Revenue /Total Revenue	1,615	0.000001	4139.926	3.66	104.975
FY 05	2,553	0	1	0.15	0.355
FY 06	2,553	0	1	0.16	0.365
FY 07	2,553	0	1	0.26	0.437
FY 08	2,553	0	1	0.22	0.414
Valid	1,496				

Findings

This section reports the results of our empirical analyses. The results provide evidence suggesting that product characteristics and market conditions are important predictors of contract type, length and value. At this early stage of inquiry, the results are preliminary. Our empirical strategy is to first examine simple Ordinary Least Squares regressions to determine whether relationships are present in the expected direction. Future analyses will employ more sophisticated analytical tools (e.g., logistic regression for the contract type analysis and censored regression for the contract length and value analyses) and interpret the effect size of independent variables.

Several of our key independent variables are correlated, namely *product complexity* and *DoD % of sales*. Consequently, we run three models for our contract type analysis: one model with the full slate of independent and control variables and two additional models which exclude each collinear variable. Table 2 reports the results of our contract type analysis.

Table 2. Regression Results of Impact of Independent Variables on Contract Type, 2004–2008

	Model A	Model B	Model C
Product Complexity	0.155****	0.129****	
Competition Procedure	0.034**	0.016	-0.014
DoD % of Sales	-0.007****		0.010****
# of Purchasing Industries	0.000****	0.001****	0.001****
FY 2005	-0.086***	-0.092****	-0.106****
FY 2006	-0.048**	-0.051**	-0.062**
FY 2007	-0.018	-0.007	0.001
FY 2008	-0.016	-0.002	-0.011
Constant	-0.732****	-0.708****	0.006
R^2	0.325	0.307	0.072
N	2420	2420	2420

Note. *P < .10; **P < .05; ***p < .01; ****p < .001

The coefficient for *product complexity* is statistically significant and positive in both models A and B, suggesting that cost reimbursement contracts are more likely as product complexity increases. The coefficient for *competition procedure* is significant and positive in model A, but not significant in the other two models. The coefficient for *DoD % of sales* is significant and positive in model C suggesting that as the DoD purchases a larger share of a particular product type the likelihood of a cost reimbursement contract increases. The coefficient for *# of purchasing industries* is significant and positive in all three models, but the effect size appears very small. Taken together the results suggest that the primary predictor of contract type is product complexity. This is not surprising given that the FAR guides agencies to make contract type decision *ex ante* when the product is known but market conditions are unclear.

Table 3 reports the results of our contract length analyses. Because of collinearity between *product complexity* and *DoD % of sales* we follow the same strategy of running three separate models. In each model, the left column reports the results for initial contract length and the right column reports the results for ultimate contract length. The coefficients for *product complexity* are statistically significant in both models A and B, but the signs flip. At this preliminary stage, these results are inconclusive. The coefficients for *competition procedure* are statistically significant and positive in all three models. Somewhat counter intuitively, when agencies opt to use the competition procedure, the result is longer contracts. It may be that when agencies forgo competition they are typically buying a product they can acquire quickly to meet their needs. On the supply side, the results are mixed. The coefficients for *DoD % of sales* and *# of purchasing industries* are statistically significant and positive in all three models. None of the coefficients for *single supplier* are statistically significant and the signs are inconsistent. As the DoD's share of the market increases, contract length increases. This may be because the types of products for which the DoD is the dominant purchaser tend to be highly complex (e.g., advanced weapon systems). The positive sign for the *product complexity* coefficient in model B supports this interpretation. The coefficient for *contract revenues/total revenues* is positive in all three models but only significant in ultimate contract length analyses. It may be that vendors that

are highly reliant on a single contract for their livelihood negotiate for longer contracts than initially anticipated. Finally, the control variable *contract type* is positive and significant suggesting cost reimbursement contracts are longer than fixed price contracts.

Table 3. Regression Results of Impact of Independent Variables on Contract Length, 2004–2008

	Model A		Model B		Model C	
	Initial	Ultimate	Initial	Ultimate	Initial	Ultimate
Product Complexity	-21.106**	-32.979***	32.094****	41.553****		
Competition Procedure	112.365****	86.149**	126.479****	109.634***	110.261****	83.498**
DoD % of Sales	7.799****	11.830****			5.743****	8.553****
# Purchasing Industries	0.298****	0.263**	0.150**	0.013	0.292****	0.242**
Single Supplier	-16.699	30.072	-41.743	-21.832	-20.025	25.712
CR/TR	0.088	0.547****	0.112	0.592****	0.091	0.552****
Contract Type	171.512****	209.987****			138.475****	155.783****
FY 2005	24.793	-19.540	2.035	-37.631	19.094	-28.644
FY 2006	11.150	-9.341	4.248	-2.984	8.988	-3.372
FY 2007	94.724***	-38.622	84.962***	-38.989	90.933***	-44.972
FY 2008	77.844**	-83.037*	61.191*	-93.820**	76.208**	-87.629
Constant	154.959***	370.189****	13.259	172.824**	66.195	234.985****
R^2	0.080	0.085	0.046	0.044	0.078	0.079
N	1496	1499	1561	1564	1521	1524

Note. *P < .10; **P < .05; ***p < .01; ****p < .001

Table 4 reports the results of our contract value analyses. Because of collinearity between *product complexity* and *DoD % of sales* we follow the same strategy of running three separate models. In each model, the left column reports the results for initial contract value and the right column reports the results for ultimate contract value. The coefficients for *product complexity* are only statistically significant in model B, when *DoD % of sales* is excluded. This suggests that high dollar contracts are associated with the acquisition of complex products. The coefficients for *competition procedure* are statistically significant and negative in all three models. When agencies opt not to use the competition procedure, the result is higher dollar contracts. This provides some evidence that competition leads to lower cost contracts. On the supply side the coefficients for *DoD % of sales* are statistically significant and positive in both models A and C. This suggests that increases in DoD market share are associated with higher dollar contracts. Again, this may be a reflection of the type of products the DoD tends to buy rather than a reflection of market power. The coefficients for *# of purchasing industries* are statistically significant and negative in all three models. This suggests that as markets thick with sellers are associated with lower dollar contracts. All of the coefficients for *single supplier* are statistically significant and positive suggesting that sole source contracts have high dollar values. The coefficient for *contract revenues/total revenues* is positive and significant in all three models suggesting that as vendors become highly reliant on a single contract they negotiate high value contracts. Finally, the control variable *contract length* is positive and significant suggesting longer contracts tend to be high dollar contracts.

Table 4. Regression Results of Impact of Independent Variables on Contract Value, 2004–2008

	Model A		Model B		Model C	
	Initial	Ultimate	Initial	Ultimate	Initial	Ultimate
Product Complexity	-492455	-693912	455227**	552428*		
Competition Procedure	-2292204**	-2852442**	-1800480*	-2115341*	-2227171**	-3138376**
DoD % of Sales	291086****	400774****			242797****	316603****
# Purchasing Industries	-5411*	-7461*	-14720****	-20366****	-5193*	-8486**
Single Supplier	3621185***	5404938****	3026011***	4709710****	3602287****	5310535****
CR/TR	66827****	60353****	68729****	62693****	66961****	59826****
Contract Type	-1668211	-2662430*			-2464639***	-3928052***
Contract Length	4741****	8315****	5250****	8966****	4823****	9575****
FY 2005	-958901	-1436021	-856897	-1269003	-1108486	-1595051
FY 2006	-2375843*	-3197912*	-2119419	-2913534	-2367899*	-2534378
FY 2007	-1182097	96759	-1679986	-617896	-1328860	-52701
FY 2008	367959	2083620	-439127	955744	118554	1919444
Constant	3435552	2526347	3101508	2292039	1144863	-407578
R^2	0.264	0.218	0.243	0.195	0.262	0.218
N	1496	1499	1561	1564	1521	1524

Note. *P < .10; **P < .05; ***p < .01; ****p < .001

Conclusion

Taken together the results of our analyses provide evidence that product characteristics and market conditions are predictors of contract type, length and value. Fixed price contracts are the norm for simple products, while cost reimbursement contracts are often used for complex products. While the evidence is inconclusive for contract length, lower dollar value contracts characterize markets thick with buyers and sellers, while contract value increases as markets thin with fewer buyers and sellers. Finally, as the percentage of an individual contract increases relative to the vendor's total revenues, the length and value of the contract increases. These results are preliminary and invite more sophisticated analyses and interpretation.

References

Amirkhanyan, A., Kim, H.J., & Lambright, K.T. (2010). Do Relationships Matter? Comparing the Performance of Relational and Classic Contracts. *Public Performance & Management Review, 34*(2), 189–220.

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

Blakey, M. (2011, August 2). The risks of fixed price contracts. Washington Business Journal. Retrieved from http://www.bizjournals.com/washington

Brown, T., & Potoski, M. (2005). Transaction costs and contracting: The practitioner perspective. *Public Performance and Management Review*, 28(3), 326–351.

Brown, T., Potoski, M., & Van Slyke, D.M. (2006). Managing public service contracts: Aligning values, institutions, and markets. *Public Administration Review*, 66(3), 323–331.

Brown, T., Potoski, M., & Van Slyke, D.M. (2013). Complex contracting: Government purchasing in the wake of the us coast guard's deepwater program. London, UK: Cambridge University Press.

Coase, R. (1937). The nature of the firm. *Economica*, 4(16), 386–405.

GAO. (2007). Defense contracting: Improved insight and controls needed over DoD's time-and-materials contracts. GAO-07-273.

GAO. (2009a). Contract management: Minimal compliance with new safeguards for time-and- materials contracts for commercial services and safeguards have not been applied to gsa schedules program. GAO-09-579.

GAO. (2009b). Defense acquisition: Actions needed to ensure value for service contracts. GAO-09-643T.

GAO. (2009c). Contract management: Extent of federal spending under cost-reimbursement contracts unclear and key controls not always used. GAO-09-92.

GAO. (2010). Joint strike fighter: Additional costs and delays risk not meeting warfighter requirements on time. GAO-10-382.

GAO. (2013). KC-46 tanker aircraft: Program generally stable but improvements in managing schedule are needed. GAO-13-258.

Girth, A.M., Hefetz, A., Johnston, J.M., & Warner, M.E. (2012). Outsourcing public service delivery: management responses in noncompetitive markets. *Public Administration Review,* 72(6), 887–900.

Hefetz, A., & Mildred, E.W. (2012). Contracting or public delivery? The importance of service, market and management characteristics. *Journal of Public Administration Research and Theory, 22*(2), 289–317.

Hehs, E. (2008, May 15). X to f: F-35 lightning II and its x-35 predecessors. *Code One Magazine*. Retrieved from http://www.codeonemagazine.com

Johnston, J.M., & Girth, A.M. (2012). Government contracts and 'managing the market:' 2012. The implications of strategic management responses to weak vendor competition. *Administration & Society*, 44(1), 3–29.

Kelman, S. (2002). Contracting. In L. Salamon (Ed.), *The Tools of Government: A Guide to the New Governance* (pp. 282–318). New York, NY: Oxford University Press.

Kendall, F. (2013). Use of fixed price incentive firm (FPIF) contracts in development and production. *Defense AT&L*, March–April, 2–4.

Levin, J. & Tadelis, S. (2010). Contracting for government services: Theory and evidence from u.s. cities. *The Journal of Industrial Economics*, 58(3), 507–541.

Majumdar, D. (2013, March 26). Outgoing F-35 programme boss shares hard won lessons. *Flight International*. Retrieved from http://www.flightglobal.com

Malatesta, Deanna and Craig R. Smith. 2013 Designing contracts for complex services. *Public Administration*.

Office of the Press Secretary, The White House. (2009, March 4). Memorandum for the heads of executive departments and agencies. Subject: Government contracting. Retrieved from http://www.whitehouse.gov/the_press_office/

Savas, E.S. (2005). *Privatization in the city: Successes, failures, lessons.* Washington, DC: CQ Press.

Tirole, J. (1999). Incomplete contracts: Where do we stand? *Econometrica*, *76*(4), 741–781.

Weisgerber, M. (2011, May 23). Supreme court overturns a-12 ruling against contractors. Defense News. Retrieved from http://www.defensenews.com.

Williamson, O. (1981). The economics of organization. *American Journal of Sociology, 87*(3), 548–577.

Williamson, O. (1985). *The economic institutions of capitalism: Firms, markets, relational contracting.* New York, NY: Free Press.

Appendix A: NAICS and PSC Categorizations for 29 Products

Service	NAICS	PSC	Service	NAICS	PSC
Advertising	541810	R701	Solid Waste Collection	562111	S205
Auditing	541211	R704	Warehousing and Storage	493110	S215
Computer Sys Development	541512	D302	Defense Aircraft – Basic Research	541710	AC11
Court Reporting	561492	R606	Defense Aircraft – Applied R&D	541710	AC12
Engineering	541330	R425	Defense Aircraft – Advanced Dev.	336411 336412 336413	AC13
Janitorial Service	561720	S201	Defense Aircraft – Engineering Dev.	541330	AC14
Landscaping	561730	S208	Weapons – Basic Research	541710	AC51
Laundry and Dry-Cleaning	812320	S209	Weapons – Applied R&D	541710	AC52
Legal Service	541110	R418	Weapons – Advanced Dev.	332992 332994	AC53
Logistics Support	541614	R706	Guns (30MM and Less)	332994	1005
Equipment Maintenance/Repair	811310	J099	Bombs	332993	1325
Professional and Mgmt Training	611430	U008	Guided Missiles	336414	1410
Program Management/Support	541611	R408	Aircraft, Fixed Wing	336411	1510
Program Review/Development	541611	R409	Submarines	336611	1904
Security Guard and Patrol	561612	S206			

Appendix B: Survey Prompts

Requirements Definition

Requirements definition involves specifying and describing the attributes and performance expectations of a good or service to be acquired.

At one end of the scale, a good or service has requirements that are EASY TO DEFINE if it is relatively straightforward to specify and describe the attributes and performance expectations of the good or service. For easy to define services, procurement professionals CAN easily write a contract that clearly specifies the good or service the

vendor should provide and performance metrics for assessing the quality of the good or service.

At the other end of the scale, a good or service has requirements that are DIFFICULT TO DEFINE if it is relatively hard to specify and describe the attributes and performance expectations of the good or service. For difficult to define services, procurement professionals CANNOT easily write a contract that clearly specifies the good or service the vendor should provide and performance metrics for assessing the quality of the good or service.

Degree of Specialized Investment

Degree of specialized investments refers to whether specialized investments are required to produce the good or service. Specialized investments apply to the production of one good or service but are very difficult to adapt for the production of other goods or services. These specialized investments include:

- the use of a specific a location that is only movable at a great cost;
- the use of highly specialized human skills that cannot be put to work for other purposes;
- the use of specialized tools or a complex system designed for a single purpose; or
- the requirement that the service reach the user within a relatively limited period of time or the quality of the service greatly diminishes.

At one end of the scale, a good or service requires a LOW DEGREE OF SPECIALIZED INVESTMENTS if no specialized investments are generally required to produce the good or service. An example of a good or service with a low degree of specialized investments is the production of simple writing pens. As a basic assembly line product needing few raw materials, pens can be produced in a diversity of locations, with few investments in either physical or human assets, and can be used effectively many years after they are produced. If the purchasing government finds that the pens it purchases do not meet its needs, then it can easily find another vendor.

At the other end of the scale, a good or service has a HIGH DEGREE OF SPECIALIZED INVESTMENTS if many specialized investments are generally required to produce the good or service. Such specific investments often mean that if a government decides to purchase such a good or service, it is more likely that only the selected vendor will be available in future rounds of contracting. An example of a good or service with a high degree of specialized investments is the production of flu vaccines. Producing flu vaccines requires a substantial investment in scientific research (a highly specialized human skill) and specialized laboratories and equipment. If the purchasing government finds that the flu vaccine it purchases does not meets its needs, then it cannot easily find another vendor.

Appendix C: Ease of Measurement and Specialized Investment Ratings

Product Category	Ease of Measurement			Specialized Investment			Combined
	Mean	*SD*	*N*	*Mean*	*SD*	*N*	*Mean*
Trash/Garbage Collection Services	1.73	1.02	84	1.35	0.61	71	3.08
Landscaping/Grounds Keeping Services	1.81	0.97	85	1.35	0.70	72	3.16
Laundry and Dry Cleaning Services	1.81	1.04	80	1.45	0.71	71	3.26
Custodial Janitorial Services	1.97	1.07	87	1.33	0.65	72	3.30
Court Reporting Services	1.92	0.90	75	1.59	0.93	68	3.51
Warehousing and Storage Services	1.92	0.95	83	1.70	0.88	69	3.61
Guard Services	2.27	1.06	86	1.51	0.88	71	3.77
Advertising Services	2.66	1.14	79	1.77	0.78	70	4.43
Auditing Services	2.73	1.00	85	2.04	0.96	71	4.77
Legal Services	2.87	1.21	79	2.10	1.10	71	4.97
Training/Curriculum Development	2.87	1.13	90	2.15	0.94	73	5.02
Maintenance and Equipment Repair	2.74	1.09	87	2.49	1.05	72	5.22
Program Management/Support Services	3.15	1.12	93	2.47	1.08	75	5.62
Logistics Support Services	3.01	1.07	82	2.62	1.09	71	5.63
Program Review/Development Service	3.41	1.14	87	2.46	1.10	70	5.87
Guns (30MM and less)	2.61	1.22	64	3.28	1.31	57	5.89
Engineering and Technical Services	3.77	1.11	88	2.99	1.18	71	6.76
Bombs	3.34	1.31	58	4.04	1.09	53	7.38
Systems Development Services	4.12	1.15	75	3.46	1.21	65	7.58
Weapons – Basic Research	3.88	1.23	67	3.72	1.11	57	7.60
Defense Aircraft – Basic Research	3.89	1.28	63	4.05	1.07	58	7.94
Aircraft, Fixed Wing	3.79	1.36	62	4.29	0.97	56	8.08
Defense Aircraft – Engineering Dev.	4.13	1.13	63	4.33	0.83	57	8.46
Weapons – Applied R&D	4.13	1.18	63	4.47	0.72	55	8.60
Defense Aircraft – Applied R&D	4.18	1.20	60	4.47	0.79	55	8.66
Guided Missiles	4.10	1.22	62	4.62	0.63	52	8.71
Weapons – Advanced Dev.	4.29	1.11	63	4.59	0.60	54	8.88
Defense Aircraft – Advanced Dev.	4.37	1.07	62	4.64	0.59	55	9.01
Submarines	4.21	1.21	57	4.80	0.56	55	9.01

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