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Product Characteristics, Market Conditions and Contract Type: U.S. Department of Defense Use of Fixed-Price and Cost Reimbursement Contracts

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EXECUTIVE SUMMARY

This report examines the impact of product characteristics and market conditions on the use of fixed-price and cost reimbursement contracts by the Department of Defense. When the product is easy to specify, easy to produce, and there is a thick market of buyers and sellers, fixed-price contracts are more likely. When the product is difficult to produce, difficult to specify, and a market with few buyers and sellers, cost-reimbursement contracts are more likely. To test these arguments, 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 the contract type of over 2000 DOD contracts. We use these data to chart contract type (i.e. fixed-price versus cost-reimbursement) across simple and complex products. The results of our analysis results confirm conventional wisdom about public sector procurement practice, at least within the DOD: product characteristics and market conditions drive the use of fixed-price versus cost-reimbursement contracts. We draw three key findings from our analysis.

- Federal regulatory policy is effective in promoting the use of fixed-price contracts
- Following federal regulatory policy, DOD procurement personnel match contract type to product characteristics
- Competitive markets promote the use of fixed price contracts

The value of our research is two-fold. First, our analysis lays the foundation for research on contract outcomes by identifying factors that drive the use of different contract types. Second, we produce unique measures of product characteristics that are not currently available in the literature.

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I. RESEARCH QUESTION

In Fiscal Year 2013 federal agencies spent $460 billion on contracts, over one-third of all discretionary spending.[1] Some of these contracts are for simple products, like report 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 assembled impacts the ability of federal agencies to achieve their core missions and functions. In an effort to secure best value for purchasing agencies, federal policy and regulatory guidance in the United States promote the use of fixed-price contracts. Cost-reimbursement contracts are to be used only in those instances in which there is uncertainty about what is required to produce a product.[2] Vendors are unlikely to enter into a contract without some certainty that they will recoup their research and development costs. While cost-reimbursement and other contracts that put cost overrun risks on the purchasing government are allowable, policy and regulatory guidance discourages agencies from buying products they cannot specify at the point of purchase. This report examines the impact of product characteristics and market conditions on the variable use of these two predominant types of contracts for products purchased by the Department of Defense.

II. LITERATURE REVIEW AND PRIOR RESEARCH

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. 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. [4]

One of the primary sources of risk in contracting is the type of product to be acquired (Brown, Potoski and 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

[1] See http://www.usaspending.gov. Accessed January 28, 2014.
[2] We use the generic term "product" to refer to both goods and services.
[3] We use the generic term "product" to refer to both goods and services.
[4] 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)."

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 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 and Lambright, 2010; Girth et al, 2012; Johnston and 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, and 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 and 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.[5]

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

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, e.g. 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.

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.[6]

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.[7] Sellers gain prospective bargaining power as there are fewer vendors

[6] 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.

[7] 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 and 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

which can offer the product the buyer desires (Bacharach and 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 RFP 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 competitive markets.

III. RESEARCH METHODS

We draw data from the Federal Procurement Data System (FPDS), the Bureau of Economic Analysis' Benchmark Input-Output tables, 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). To construct a database of contracts, we selected the DOD as the focus of the study. We selected the DOD because it is the largest purchaser in the federal government, buying large volumes of simple products that are easy to describe and easy to make, such as landscaping and laundry services, and complex products that are difficult to describe and difficult to make, such as program management services and guided missiles. This allows us to control for agency level factors that might influence contract design decisions and focus instead on product characteristics and market conditions. We then identified 29 products commonly purchased by the DOD. Federal agencies buy products under two industry standard product categorization schemes – the North American Industry Classification System (NAICS) and the Product Services Code (PSC) system. We selected products that had uniform NAICS and PSC categorizations. Appendix 1 reports the NAICS and PSC categorizations for the 29 products in our sample. We then drew a stratified random sample from all contract actions for each product category from FY2004 to FY 2008. [8] The unit of analysis is the initial contract agreement.[9] To create our stratified random sample, we created lists of all contract actions signed from FY 2004 to FY 2008 for the 29 product types.

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

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contractual exchanges become interdependent resource dependency theory offers a potential complement to transaction cost theory (Burt 1983).

[8] 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.

[9] 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.

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 product type is typically less than 100 in most cases.[10]

A. Variables

i. Dependent Variable

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. 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 (U.S. Government Accountability Office, 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 (U.S. Government Accountability Office, 2009c). For these reasons we combined "time and materials", "labor hour", and "order" contracts into the cost-reimbursement category. Our dependent variable, *Cost-Reimbursement Contract*, is a dummy variable coded "1" for cost-reimbursement contract types, and coded "0" for fixed-price contract types.

ii. Independent Variables

To measure product characteristics, we conducted an original survey of federal procurement personnel which asked respondents to rate each of the 29 products in our sample 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.[11] 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.

With this product list, we surveyed members of the National Contract Management Association (NCMA), a membership organization of public procurement personnel.[12] We administered the survey through NCMA's bi-weekly email newsletter, sending out a link in two successive surveys. One-hundred and twenty-nine former and current federal procurement personnel began

[10] The percentage of the incomplete FPDS records is 15.5% (269 of 1,734). The incomplete rates for the DOD is on par with the overall rate of incompletion at 15.2%.

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

[12] We pre-tested the survey instrument on a sample of thirty-eight 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.

the survey and 99 provided product ratings. While the response rate is low (less than 5%), respondents represent an array of federal procurement personnel with varying levels of education and experience. Table 1 reports respondent characteristics. Approximately two-thirds of the respondents worked in the public sector at the time of the survey. On average, respondents had 15 years of public procurement experience.[13] Half were currently with the DOD.[14]

Table 1 – NCMA 2013 Survey Respondent Characteristics

Characteristic	Valid N	N (Mean)	% (S.D.)	Range
Sector				
Public	78	52	66.7	--
Private	78	23	29.5	--
Nonprofit	78	3	03.8	--
Position				
Contract Manager	79	24	30.4	--
Contract Specialist	79	25	31.6	--
Procurement Analyst	79	10	12.7	--
Supply Management Specialist	79	1	01.3	--
Other	79	19	24.1	--
Highest Level of Education				
Some College	80	3	03.8	--
Associate's Degree	80	4	05.0	--
Bachelor's Degree	80	28	35.0	--
Graduate Degree	80	45	56.3	--
Employed at DOD	80	40	50.0	--
Years in Public Procurement	77	(15.0)	(11.0)	0 – 38
Years in Private Procurement	78	(07.5)	(10.1)	0 – 35

Notes: N = number of observations (total N = 80); means and standard deviations are reported in parentheses for continuous variables.

Our measures of product characteristics are derivative of well-established measures in the extant literature (Brown and Potoski 2005; Hefetz and Warner 2012; Lamothe and Lamothe 2012; Levin and 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

[13] About 20% of respondents neglected to provide biographical information. We are unable to determine whether those individuals differed from those who did provide information but have no reason to think that they would differ in any systematic way.

[14] Non-DOD respondents tended to rate products higher on the scales we describe below but the differences were not statistically significant.

difficult.[15] 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. As another check on instrumentation bias, for each respondent, the presentation of the 29 products was randomized for each characteristic.[16] Table 2 reports the mean ratings, standard deviations, and the number of valid responses for each product. The first column reports the product category. The second and third columns report the ease of measurement and specialized investment ratings, respectively. The fourth column reports the combined mean ease of measurement and specialized investments ratings.

[15] "Requirements definition" is a commonly accepted term in procurement referring to the process of writing down a product's attributes and capabilities.
[16] An appendix reports the wording of the survey prompt for each of the two measures.

Table 2 – 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

The ratings of the 29 products vary significantly. Landscaping, janitorial, laundry, and trash collection services all have ease of measurement and specialized investment scores between 1 and 2. The more defense-specific services, meanwhile, almost uniformly score very highly on the two characteristics. The ease of measurement and specialization scores for the aircraft and weapons development services, for example, are all above 4 – indicating that these services are difficult to specify in a contract and require specialized investments that cannot easily be transferred. Table 2 also indicates that the DOD purchases a number of products with moderate complexity scores, including logistics support, program review and management, legal services, and program development. Even with steps to address instrumentation bias, in aggregate respondents rated the products similarly on both dimensions (r^2 = .93). To address the collinearity of the measures, we combined the two scores into a single product characteristic

score with a range from two to ten (see the fourth column in Table 2). Products with low scores are simple – easy to specify and easy to make – and products with high scores are complex – difficult to specify and difficult to make. We label this variable *Product Complexity.*[17]

We measured market characteristics in a variety of ways. First, in order to gauge the number of sellers of a particular product 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."

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.*[18]

Finally, to assess the DOD's market power, we include a measure of the percentage (ranging from 0 to 100) of total sales in each product category that the agency purchases. This variable is labeled *DOD Percentage of Sales*.

Given research that shows that markets vary across urban, suburban and rural locations (e.g. Warner and Hefetz 2003) ideally we would include measures of the location of the contract. Unfortunately, FPDS contract records do not consistently report this information.

iii. Control Variables

We include one set of control variables in our analysis. 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.

[17] There is a growing body of research on complex contracting (e.g., Malatesta and Smith, 2014) and product complexity in public sector procurement (e.g., Brown, Potoski, and Van Slyke, 2010, 2013).

[18] In separate analyses we also include a variety of *ex post* measures of market competitiveness and concentration. These variables include: 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.

B. Empirical Methods

Because our dependent variable is dichotomous, we use logistic regression to analyze the data. All estimation was done in SPSS v. 17.0. Table 3 below provides the basic descriptive statistics for the variables in our analysis.

Table 3 – Descriptive Statistics

Variable	N	Mean	S. D.	Min	Max
Dependent Variables					
Cost-Reimbursement Contract	2452	.26	0.44	0	1
Independent Variables					
Product Complexity	2522	5.93	2.00	3.08	9.01
Competition procedure	2551	0.65	0.48	0	1
DoD Percentage of Sales	2553	10.44	3.63	0.48	53.76
Number of Purchasing Industries	2553	303.10	168.69	4	425
FY 2005	2553	0.15	0.36	0	1
FY 2006	2553	0.16	0.37	0	1
FY 2007	2553	0.26	0.44	0	1
FY 2008	2553	0.22	0.41	0	1
Valid N	2420				

Notes: N = number of observations; S.D. = standard deviation; Min = minimum; Max = maximum

IV. RESULTS

This section presents the results of our analysis. Before turning to the logistic regression results that inform the hypotheses of this study, we note that 26 percent of DOD contracts in our sample were cost-reimbursement. This confirms our overall expectation that the fixed-price contract is the dominant contract type at federal level. Table 4 below reports the logistic regression results including the coefficient, standard error, and odds ratio for the variables in our analysis. As we discuss below, because the variables *Product Complexity* and *DOD Percentage of Sales* are highly collinear, we report three models: Model A includes both variables and Models B and C include one variable but not the other. The results of the logistic regression analysis provide consistent support for our hypotheses about product characteristics and inconclusive results for our hypotheses about market conditions.

Table 4: Logistic Regression Results of Impact of Independent Variables on the Use of Cost-Reimbursement Contracts by the Department of Defense, 2004-2008

Variables	Model A			Model B			Model C		
	B	S.E.	Odds Ratio	B	S.E.	Odds Ratio	B	S.E.	Odds Ratio
Product Complexity	1.121****	0.053	3.068	0.936****	0.042	2.551			
Competition Procedure	0.249*	0.139	1.283	0.038	0.131	1.038	-0.093	0.106	0.911
DoD % of Sales	-0.047****	0.007	0.954				0.054****	0.004	1.055
# of Purchasing Industries	0.003****	0.000	1.003	0.005****	0.000	1.005	0.004****	0.000	1.004
FY 2005	-0.630***	0.209	0.532	-0.720****	0.205	0.487	-0.619****	0.174	0.538
FY 2006	-0.347*	0.198	0.707	-0.387**	0.195	0.679	-0.343**	0.161	0.710
FY 2007	-0.012	0.168	0.989	0.025	0.165	1.026	0.015	0.138	1.015
FY 2008	0.110	0.176	1.116	0.189	0.171	1.208	-0.032	0.146	0.968
Constant	-8.949****	0.405	0.000	-8.596****	0.388	0.000	-2.627****	0.201	0.072
N			2420			2420			2451
χ^2			903.229****			855.278****			177.825****
Cox and Snell R^2			0.311			0.298			0.070

Note: Standard errors in parentheses. *P < .10; **p<.05; ***p<.01; ****p<.001

A. Product Characteristics

The results indicate that cost-reimbursement contracts were more likely when contracting for complex products, those that are difficult to specify and require specialized investments. In Table 4, the coefficients for *Product Complexity* are positive and statistically significant at the .0001 level in both Model A and Model B. Holding all other variables constant in Model A, a one unit increase in *Product Complexity* increases the odds of a cost-reimbursement contract by 3.068 times.

B. Market Conditions

The results for the variables measuring market conditions – *Competition Procedure*, *DOD Percentage of Sales*, and *Number of Purchasing Industries* – provide some support for our arguments about competitive markets. Interpreting the results is complicated by the high degree of collinearity between *DOD Percentage of Sales* and *Product Complexity* (r^2=.71). We use the three models in an effort to provide some insight into the independent impact of the two variables. The sign, coefficient, and statistical significance for *Product Complexity* is consistent across Models A and B, whereas the sign, coefficient, and statistical significance of *DOD*

Percentage of Sales changes across Models A and C. We report the differences in this section and discuss possible interpretations of these differences in the discussion section.

The coefficients for the variable *Competition Procedure* are positive and statistically significant at the .1 level in Model A, but insignificant in Models B and C. Holding all other variables constant in Model A, when the DOD opted to go out for competitive bids during the time period of our analysis, it was 1.283 times more likely to use a cost-reimbursement contract than a fixed-price contract. This runs counter to the argument that as the number of vendors increases the likelihood of a cost-reimbursement contract will decrease.

The coefficients for the variable *Number of Purchasing Industries* are positive and significant ($p<.0001$) in all three models. A one unit increase in the variable leads to 1.003 to 1.005 increase in the odds of a cost-reimbursement contract, depending on the model. While these are small odds ratios, the range and standard deviation of the variable is large enough that sizable increases in the number of industries purchasing a particular product leads to substantive changes in the likelihood of one contract type over another. More buyers increase the likelihood of a cost-reimbursement contract. This finding is consistent with the argument that purchasers – in this case the DOD – will demand fixed-price contracts from vendors when the number of purchasers is relatively low.

Finally, the coefficient for the variable *DOD Percentage of Sales* is negative and significant ($p<.0001$) in Model A, but positive and significant ($p<.0001$) in Model C when *Product Complexity* is not included. In Model A, holding all other variables constant, a one unit increase in *DOD Percentage of Sales* decreases the odds of a cost-reimbursement contract by .954, whereas in Model C, holding all other variables constant, a one unit increase in *DOD Percentage of Sales* increases the odds of a cost-reimbursement contract by 1.055. The Model A results provide support for the argument that the use of cost-reimbursement contracts declines as the DOD gains market power, while the Model C results run counter to this argument. We focus on the Model A results because this model controls for *Product Complexity*. In Model C we think *DOD Percentage of Sales* is serving as a proxy for *Product Complexity* given the high degree of correlation between these variables ($r=.71$).

C. Control Variables

The logistic regression results in Table 4 show that the coefficients on all four time variables vary in sign and significance, with the negative and significant coefficients for the first two years – FY 2005 and FY 2006. This suggests that the likelihood of using a cost-reimbursement contract decreased for these two years relative to FY 2004.

V. FINDINGS

A. Federal regulatory policy is effective in promoting the use of fixed-price contracts

Federal regulatory policy and guidance promotes, and sometimes mandates, the use of fixed-price contracts because this contract type is thought to lower the risks of cost overruns and receipt of a poor quality product. The data we analyze suggests that the FAR has largely succeeded in promoting this contract type – three-quarters of the contracts in our sample were fixed-price. We assessed the impact of two categories of variables – product characteristics and market conditions – on the variable use of these two contract types. Our results strongly support conventional wisdom: product characteristics and market conditions drive contract type decisions.

B. Following federal regulatory policy, DOD procurement personnel match contract type to product characteristics

The results of our empirical analysis provide strong evidence that contract type is driven by the characteristics of the product to be acquired. When products are easy to specify and do not require specialized investments, the DOD is likely to offer a fixed-price contract when it goes out for bid and vendors are willing to accept these terms. For example, in our sample, 100% of contracts for landscaping, a simple product, are fixed-price.[19] This is consistent with expectations. When neither party faces the risk of becoming locked in to the exchange, and the government agency can specify in clear detail what it wants before production commences, the vendor faces lower risks of cost overruns. In fact, agreeing to a fixed-price contract may incentivize the vendor to find ways to deliver the specified product at a lower cost because she pockets the difference.

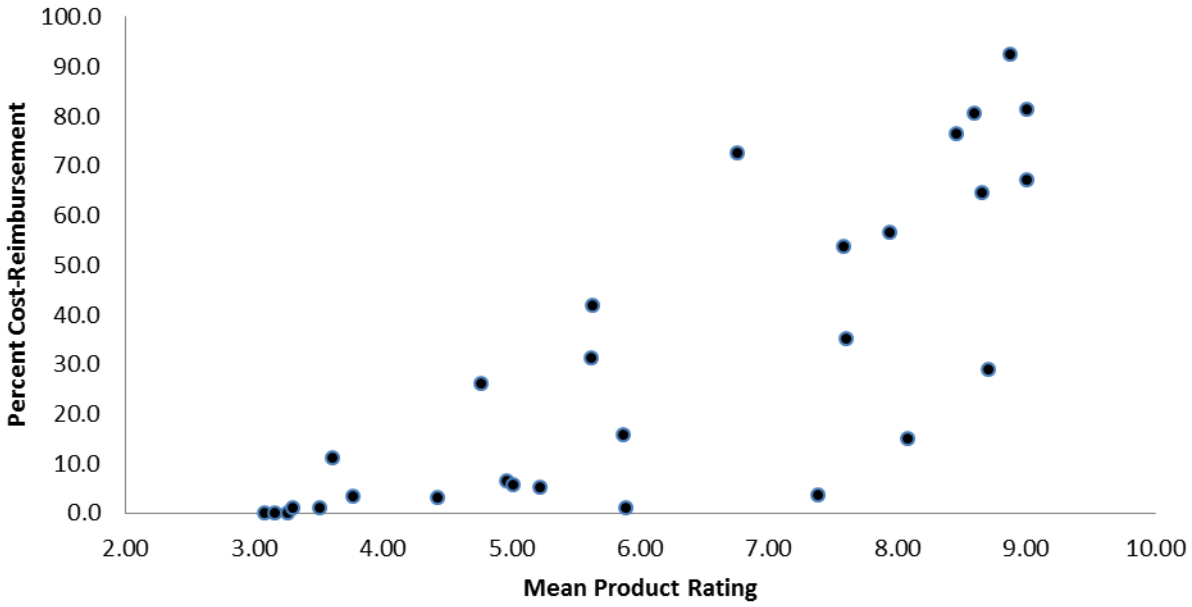
Alternatively when products are difficult to specify and require specialized investments, the likelihood of a cost-reimbursement contract increases. For example, in our sample, 54% of contracts for computer systems development, a complex product, are cost-reimbursement. The vendor is unlikely to agree to a fixed-price contract *ex ante* if much is unknown about the steps it will take to produce the product and how much it will cost. The risk of losing out financially increases if the product requires specialized investments since the vendor and the purchasing agency are likely to become locked in to the exchange. Under these circumstances, if the purchasing agency wants the product, they may have no choice but to offer a cost-reimbursement contract, even though there is a risk that the vendor will "gold plate" the product by adding expensive options that the purchasing agency does not need.

Figure 1 reports the percentage of cost-reimbursement contracts in our sample along the y-axis by the variable *product complexity* on the x-axis. This isolated examination of the impact of the variable *product complexity* is consistent with the logistic regression results. In general, as product complexity increases, the use of cost-reimbursement contracts increases. Yet, there are some products with high ratings of product complexity that also show notable reliance on fixed-

[19] An appendix reports the mean product complexity rating and distribution of fixed price and cost reimbursement contracts for each product in our sample.

price contracts. Guided missiles, for example, have a mean product rating of 8.71, yet over 70 percent of the contracts in our sample are fixed-price, an apparent "mismatch." One interpretation of this result is that the transaction cost framework we have outlined in this report does a poorer job explaining contracting decisions for complex products and signals a possible mismanagement of risk by the DOD. By making vendors responsible for unexpected costs, the DOD may be exposing them to excessive financial strain and constraining production in ways that are ultimately self-defeating.

Figure 1. Use of Cost-Reimbursement Contracts by Mean Product Rating



There are reasons to believe that this interpretation may not be accurate. With complex products, the risk of negative contract outcomes is often most acute in the early stages of development and production (e.g., Brown, Potoski and Van Slyke 2015). It is then that product requirements and possibilities will be most uncertain; and it is then that the vendor will actually be making the bulk of her specialized investments. Once a product has been developed, tested and evaluated, both parties are likely to have a solid understanding of its specifications and costs, and the vendor should have begun to recoup the cost of her specialized investments. It will then become more feasible to use to a fixed-price contract. When complex products reach the stage of regular production, fixed-price arrangements should become more common. This logic may help explain the pattern observed in Figure 1. By and large, the complex products with high levels of cost-reimbursement contracting – weapons advanced development (92%), for example – are potential *early-stage* activities. Those with higher levels of fixed-price contracting appear to be products that have moved beyond the research and development phase. Certain categories of products with high complexity scores – guns, bombs, fixed-wing aircraft, and guided missiles – may have moved into more routine and standardized production. An illustrative example of such

a product is the Joint Direct Attack Munition (JDAM), the kit that converts conventional "dumb bombs" into GPS-guided missiles. Once a revolutionary, cutting-edge product, JDAMs are now purchased in bulk by the DOD with fixed-price contracts.[20] This is why the details of any exchange matter. Here an apparent mismatch may not signal an increased level of risk or the weakness of the framework.

To further test this argument, we performed a supplementary analysis that examined how much of the variation in contract type could be explained by our measure of product complexity *and* an additional dummy variable specifying categories of complex products that are likely to involve routine and standardized production. This model correctly predicted contract type in 82 percent of cases.[21] This analysis provides evidence that a transaction cost framework that takes into account production stage provides a robust explanation of contract type decisions. It also suggests that DOD acquisition practices are sensitive to the unique risks associated with the products it purchases.

C. Competitive markets promote the use of fixed price contracts

Our results also provide support for the impact of market conditions on contract type decisions. In theory, if the market for a product is thick with buyers, vendors are in a better position to set favorable terms, in this case a cost-reimbursement contract. Markets with fewer buyers present less of an advantage to vendors and the likelihood of a cost-reimbursement contract for the product should diminish. On the flip side a thicker market of vendors should provide purchasing agencies an advantage: if one vendor does not agree to terms, the purchasing government can select another vendor. Two of the variables in our analysis provide support for these arguments. On the demand side, when controlling for product complexity in Model A, as the DOD's percentage of market share increases, the likelihood of a fixed-price contract increases. This suggests that the DOD is able to exercise its market power to set more favorable contract terms. On the supply side, as the number of purchasing industries increases, the likelihood of a cost-reimbursement contract increases. This result suggests that in those instances when the vendor is able to exercise more market power it can set more favorable contract terms. At face value, the results for the use of the competition procedure provide contrary evidence. Notably when purchasing agencies go out for bid they are more likely to rely on cost-reimbursement contracts than when they sole source a contract. To explain this contrary finding we interviewed a handful of federal procurement professionals.[22] The federal procurement professionals all offered a

[20] See http://www.defense.gov/contracts/contract.aspx?contractid=3206 and http://www.defense.gov/contracts/contract.aspx?contractid=5018 (accessed 6/10/2013)

[21] This analysis is based on a logistic regression that added the production stage dummy variable to our original model. The dummy variable is statistically significant and positive and the results for the other independent variables remain largely unchanged – the magnitude of the coefficients decreases slightly and the competition variable is no longer significant at the .05 level. We opt to incorporate this analysis in the discussion rather than in our core theoretical argument because our proxy for stage of development – the dummy variable – is crude. The coding of the dummy variable is based on NAISC product categories rather than detailed contractual information on whether the purchase is for development of the product or routine production of the product.

[22] 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

consistent explanation: when agencies opt to sole source a contract they often buy simple products, those they can easily specify and are easy for the firm to produce. In this way, the variable *Competition Procedure* is less of a proxy for supply side market conditions than for the type of products agencies purchase.

VI. CONCLUSION

The results demonstrate that cost-reimbursement contracts are commonly used for complex products in thin markets, and fixed-price contracts tend to predominate for simple products in thick markets and proven complex products that have moved beyond research and development into the production phase. Of the 29 products in our sample, there is a clear alignment between product characteristics and contract type in the vast majority of cases. In those few instances in which there is an apparent mismatch between product characteristics and contract type, government agencies are likely using cost-reimbursement contracts in the product development phase and then switching to fixed-price contracts once the products' attributes have been more precisely determined and more routine production processes developed. The results presented here suggest that policy makers and overseers concerned about the rise of cost-reimbursement contracts should focus on what the government buys instead of how it buys the products.

Our research provides confirmatory evidence for conventional wisdom within the public sector contracting community. The value of our research is that it confirms this conventional wisdom while controlling for other factors. In addition, a primary contribution of our research is that it provides a foundational set of conditions for modeling contract outcomes such as cost overruns, delivery delays, and poor quality products. Finally we have generated novel measures of important characteristics of 29 different products. Some of these products are unique to the DOD (e.g. guided missiles), but other products in our sample are purchased widely across government agencies (e.g. laundry and refuse collection). Other scholars and analysts of procurement and acquisition can apply these measures to the contracting practices of other agencies. Specifically, future research can examine whether these primary product characteristics influence the use of different contract types – fixed-price versus cost-reimbursement – as our data suggest.

scanned for key terms. Each interviewee was promised anonymity under a university Institutional Review Board process.

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Appendix 1: 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 2 – 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.

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