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IMPACT OF PRODUCT CHARACTERISTICS AND MARKET CONDITIONS ON CONTRACT TYPE: USE OF FIXED-PRICE VERSUS COST-REIMBURSEMENT CONTRACTS IN THE U.S. DEPARTMENT OF DEFENSE

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ABSTRACT: *Transaction cost economics is used to produce a conceptual framework that helps explain public-sector contract decisions. When a 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 a product is difficult to produce, difficult to specify, and the market has few buyers and sellers, cost-reimbursement contracts are more likely. These arguments were tested with five years of data (FY 2004–2008) drawn from the Federal Procurement Data System (FPDS), the most comprehensive and largely untapped database on federal contracting practices. Over 2,000 Defense Department contracts were examined, charting contract type (i.e., fixed-price vs. cost-reimbursement) across simple and complex products. The results confirm conventional wisdom about public sector procurement practice, at least within the Defense Department: product characteristics and market conditions drive the use of fixed-price and cost-reimbursement contracts. This research lays the foundation for research on contract outcomes by identifying factors that drive the use of different contract types and producing unique measures of product characteristics that are not currently available in the literature.*

KEYWORDS: *cost-reimbursement contracts, fixed-price, market conditions, product characteristics.*

In 2011, the United States Air Force signed a contract with the Boeing Corporation, a major defense contractor, to produce a new aerial refueling plane. According to a 2014 GAO report, the program is the Air Force's highest acquisition priority (U.S. Government Accountability Office, 2014). Aerial refueling tankers increase the reach and carrying capacity of military aircraft, substantially magnifying U.S. air power capabilities. Boeing is expected to meet most contract schedule and budget targets—with one exception: development costs are projected to exceed the initial estimate of \$4.9 billion (U.S. Government Accountability Office, 2014). The extent of the overrun is a matter of debate, but because the contract has a fixed-price payment method, Boeing, and not U.S. taxpayers, will be on the hook for any overruns. Fixed-price contracts place the burden of any cost overrun on the vendor rather than the purchasing agency. The ability to shield the public purse from the risk of cost overruns has made fixed-priced contracting politically popular. In 2009, the Obama administration guided agencies to increase the use of fixed-price contracts relative to cost-reimbursement contracts (Office of the Press Secretary, The White House, 2009).

However, fixed-price contracts are not a cure-all for cost overruns and other contract performance issues. Consider the example of the Department of Defense (DoD) fixed-price contract in the late 1980s with defense contractor McDonnell Douglas for the A-12 Avenger II, a cutting-edge attack aircraft. When a series of technical challenges led to delays and cost overruns, the DoD terminated the program and accused McDonnell Douglas of violating contract terms. The company argued that the contract itself was the problem: Its fixed-price structure was inappropriate, given that the DoD had asked McDonnell Douglas to engage in unplanned research and development for an unproven aircraft. The dispute wound up costing both sides significant legal fees, further escalating overall costs, and the A-12 Avenger II was never delivered (Blakey, 2011).

These two examples highlight the impact of contract type on contract outcomes. 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.¹ 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.

The holy grail of research on government contracting is to understand the factors that deliver the win-win, a product that meets the needs of the purchasing government at a price it can afford and payment to the vendor that exceeds its production costs. Given the evidence on the importance of contract type for contract outcomes (U.S. Government Accountability Office, 2007, 2009a, 2009b, 2009c), a first step is to understand what drives the use of different types of contracts. On the one hand, this inquiry is pedestrian: Conventional wisdom among public procurement professionals suggests that government procurement officials select the type of contract that best matches the attributes of the product to be purchased. On the other hand, the function of systematic scholarship is to test conventional wisdom while simultaneously assessing the impact of other potential causal factors. The results of such an analysis provide the first-order conditions for understanding the conditions that promote contract success.

We draw from transaction cost economics to produce a conceptual framework that helps explain public-sector contract-type decisions. Transaction cost economics highlights the importance of product characteristics and market conditions, two sets of factors that are important guideposts in public procurement regulation and practice. Fixed-price contracts make the most sense to use when the product is easy to specify and easy to produce, like a paper clip or grounds maintenance. The vendor is content to accept the cost and performance risks because it knows what will be needed to produce the product. When the product is difficult to produce and difficult to specify, like an advanced weapon system or program-management services, cost-reimbursement contracts are more appropriate. Not knowing exactly what it will take to produce the product or how much it will cost, the vendor will be reluctant to enter into the transaction unless the purchasing agency bears a larger share of the risk. Turning to market conditions, when the purchasing agency is one of a small number of buyers of a product for which there are many vendors, the purchasing agency has greater freedom to set favorable contract terms. When the situation is reversed—buyers are many and vendors are few—vendors have more opportunities to enter into exchanges that advantage their interests.

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 2,000 DoD contracts. We select contracts from the DoD not because our interest is in defense acquisition, but because the DoD is the largest purchaser of the widest range of products in the federal government. This provides a baseline for future comparison to a wide range of other federal agencies. We complement the contract-design data with data gathered from an original survey of federal procurement professionals on the characteristics of 29 different products. We use

these data to chart contract type (i.e., fixed-price vs. cost-reimbursement) across simple and complex products. These data allow us to assess the impact of product characteristics and market conditions on the pattern of contract-type decisions.

The results of our analysis suggest that fixed-price contracts predominate when products are easy to specify and require few specialized investments, and that cost-reimbursement contracts are more common under the opposite conditions. The results also provide support for the impact of market conditions. In particular, as the Defense Department represents a larger share of the total sales of a product (i.e., its market power increases), the likelihood of a fixed-price contract increases. On the flipside, when the number of different industries purchasing a product increases (i.e., the market power of vendors increases), the likelihood of a cost-reimbursement contract increases. Taken together, our results confirm the 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.

Because our analysis validates conventional wisdom, our results are neither surprising nor novel. They are confirmatory. The value of our research is twofold. First, our analysis lays the foundation for research on contract outcomes by identifying factors that drive the use of different contract types. Future scholarship that seeks to understand the factors that give rise to cost overruns, poor-quality products, or delivery delays can use our model of contract-type decisions as a necessary building block. Second, we produce unique measures of product characteristics that are not currently available in the literature. Past research on product characteristics at the local level has proved useful to many scholars interested in the dynamics of local government contracting (e.g., Brown & Potoski, 2005; Hefetz & Warner, 2012; Lamothe & Lamothe, 2012; Levin & Tadelis, 2010). We provide measures that can be used by scholars undertaking similar research at the federal level.

This article is divided into six sections, including this introduction. In the second section, we lay out our theoretical argument. In the third section, we describe the data and methods used to conduct the analysis. In the fourth and fifth sections we report and discuss our results, respectively, highlighting the implications for practitioners. We conclude the article by summarizing our findings and offering pathways for future research.

Understanding Contract Types: The Impact of Product Characteristics and Market Conditions

Government agencies face an implicit choice when it comes to production. A given product either can be produced internally, with one's own resources, or it can be produced externally, through a contract with another organization. In the United States, in Fiscal Year 2014, the federal government acquired

\$445 billion of products through contracts, around one third of all discretionary spending.² The potential advantages of contracting—efficiencies, cost savings, and innovation—help to explain the heavy reliance on acquisition at the federal level (e.g., Kelman, 2002; Savas, 2005). Contracting also involves risks—cost overruns, delivery delays, and poor-quality products (e.g., Sclar, 2001). These risks can undermine contracting’s ability to contribute to the achievement of agency missions and objectives.

Extant research on the effects of contracting has produced mixed results (e.g., Fernandez, 2009; Hodge & Greve, 2007; O’Toole & Meier, 2004). Focusing on cost savings and overruns—the outcome that has received the most scrutiny in the literature—some studies find that competitive contracting results in cost savings (Dijkgraaf & Gradus, 2003; Hakim & Blackstone, 2013; Ivacko & Horner, 2014; Johnston & Seidenstat, 2007), while others find that contracting does not deliver cost savings (Bel & Warner, 2008), generates diminishing cost efficiencies over time (Dijkgraaf & Gradus, 2008), or leads to increased costs (Thompson, 2011). Making sense of these findings is complicated by variations across studies in terms of national context, level of government (i.e., local, regional, national), product (e.g., prison management, refuse collection, water treatment), and cost components (e.g., current payouts from contracting vs. total costs over time).

There is relative agreement that two interrelated sets of factors influence the likelihood of contract success or failure: product characteristics (e.g., Brown & Potoski, 2005; Brown, Potoski, & Van Slyke, 2010; Carr, LeRoux, & Shrestha, 2008; Levin & Tadelis, 2010) and market characteristics (Bel & Warner, 2008; Hefetz & Warner, 2012; Warner & Bel, 2008; Wassenaar, Groot, & Gradus 2013). Later in the article, we will unpack these factors and their impact on contract type—the focus of the study—but the basic finding from this raft of studies is that uncompetitive markets and products whose outcomes are difficult to specify and lend themselves to monopoly provision increase the likelihood of cost overruns, delivery delays, and poor product quality (e.g., Brown, Potoski, & Van Slyke, 2013). There is also relative agreement that various managerial strategies can be pursued to reduce the threat of undesirable contract outcomes posed by these characteristics. For example, one school of thought focuses on market characteristics and argues that a principal managerial responsibility is to “manage the market” to engender competition (e.g., Brown & Potoski, 2004; Girth, Hefetz, Johnston, & Warner, 2012; Johnston & Girth, 2012). A related school of thought encourages purchasing governments to engage in joint or mixed delivery to stimulate competition between public and private providers (Bel, Brown, & Warner 2014; Hefetz, Warner, & Vigoda-Gadot, 2014) or to encourage relational or collaborative partnerships between the two (Bel & Fageda, 2011; Bel, Hebdon, & Warner, 2007). A third variant recommends performance management and incentives as a managerial tool to encourage

successful contract outcomes (Brown et al., 2013; Girth, 2014; Hefetz & Warner, 2004). Taken together, these studies find that harnessing the upside and mitigating the risks of contracting is increasingly an essential core management function.³

In an ideal world, external production would be governed by complete contracts. The purchaser would specify what it 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. But as scholars have long argued, buyers and sellers are boundedly rational, and thus neither can know with exact certainty what future conditions will be (Coase, 1937). 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 receives 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 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 it expected. 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 (Tirole, 1999).

The best that can be done is to write contractual rules that guide the buyer and the seller toward actions that minimize the risks that one or both parties will receive a losing outcome. One of the most basic and important rules is contract type, which helps to structure the transaction by determining the method of payment. Broadly speaking, contracts come in two types—fixed-price and cost-reimbursement. Fixed-price contracts specify a final price for the product, shielding the buyer from risk because the vendor bears responsibility for any cost overruns. Fixed-price contracts create an incentive for the vendor to determine product characteristics and costs at the outset. Cost-reimbursement contracts specify allowable charges (e.g., parts, labor, fuel) rather than set a price *ex ante*. The final price is determined *ex post* when all allowable charges are tabulated. Cost-reimbursement contracts shift 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 it 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.⁴ The FAR allows for the use of various forms of cost-reimbursement contracts only in instances where the seller is unlikely to enter into the agreement without certainty that it will recoup its investment costs. These regulatory rules establish the framework for decision-making but they are not self-executing (Cooper, 2002). Procurement professionals have discretion to make choices about contract type. Two sets of factors are likely to influence the decision—product characteristics and market conditions.

PRODUCT CHARACTERISTICS

The field of transaction cost economics has identified various product characteristics that impact whether the buyer and the seller receive the outcomes they anticipated from an exchange. When these product characteristics are present, the buyer or the seller incurs “transaction costs” to mitigate the risks of a failed exchange (Coase, 1937; Commons, 1931). For example, if the product lends itself to monopoly provision, like electricity generation, the seller faces no market incentive to deliver high quality or keep costs low, and the buyer can anticipate devoting significant time and effort to monitoring and policing. As a result, the buyer is likely to include terms in the exchange agreement to ensure that such activities are contractually permissible. Two product characteristics have received considerable focus: the ease or difficulty of specifying the product’s details, and the degree to which specialized investments are required to produce the product (Brown & Potoski, 2004; Brown et al., 2010; Williamson, 1975, 2002). We explain how each of these characteristics can influence the contract-type decision.

Government agencies buy lots of products that are difficult to specify, including information technology systems, advanced weapons systems, and sophisticated program-management services (Lawther, 2002). When it is difficult to describe a product’s attributes or performance necessities (i.e., to define its requirements), the buyer faces the risk that the product it receives will fail to do what it hopes (Praeger, 1994). If the buyer cannot fully specify the product, the seller will have difficulty determining the exact cost of producing the product. The buyer and seller can reduce this problem by spending time and effort to research the product’s specifications before production commences, but such efforts are costly. For some products, the specification challenges are so great that the cost of figuring out all the details of the product *ex ante* is prohibitive (Masten, 1998). Thus decisions about the product’s details have to be made as the product is produced. In these circumstances, the buyer might prefer a fixed-price contract so that it can be certain of the price, but contracts for products that

are difficult to specify will be incomplete (Saussier, 2000). Instead, a seller is only likely to offer a bid if a cost-reimbursement contract is the selected payment method, since this design gives some assurance that it will recoup its costs. When a product is difficult to specify, a purchasing government will likely select a cost-reimbursement contract over a fixed-price contract.

Government agencies also buy many products that require specialized investments, including nuclear waste facilities, high-security prisons, and unique communication systems. When one or both parties have to make investments to produce a product that cannot easily be deployed to other activities, each will find it difficult to exit the exchange. The field of transaction cost economics refers to this as the “lock-in” or “hold up” problem (Tirole, 1986; Williamson, 1985). In such cases, the seller may have to develop a unique production process. If the buyer elects not to complete the transaction, the seller is stuck with a product that only one buyer wants and a production process that cannot be easily used to produce products for alternative buyers. The seller now faces the risk that the buyer may behave opportunistically and fail to fully compensate the seller. Once the seller has made the initial investment in the production process, the buyer has an advantage in subsequent rounds of contracting. The costs for others to enter the market will be much higher than for the seller that won the first contract. The buyer may find no alternatives beyond the originally selected seller. The risk is that once locked-in, the seller can behave opportunistically by raising the price or lowering the quality of the product in subsequent rounds of contracting (Brown & Potoski, 2005; Kelman, 1990). Generally speaking, buyers will prefer fixed-price contracts in these circumstances, to ensure that they do not overpay for the product, and sellers will prefer cost-reimbursement contracts, so that they can fully recoup the sunk costs of their specialized investments.

As we specify in Hypothesis 1, the use of cost-reimbursement contracts will be more likely for products that are difficult to specify and require specialized investments in comparison to those that do not.

H1: For exchanges between a purchasing government and private vendors, the probability of a cost-reimbursement contract governing the exchange will be greater for products that are difficult to specify and require specialized investments than for products that are easy to specify and do not require specialized investments.

MARKET CHARACTERISTICS

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 it can afford, and a seller seeks payment above its costs of production. In some circumstances, the seller

may find itself in an advantageous position relative to the buyer; for example, if it is the only provider of a product the buyer desires. In other cases, the buyer may have the advantage; for example, if it is the only purchaser of a product for which there are multiple sellers. We make the simple assumption that when the buyer has the advantage, it will prefer a fixed-price contract in the belief that it will increase the chances of receiving a product at or close to the expected cost. Alternatively, when the seller has the advantage, it will prefer a cost-reimbursement contract because it offers a greater opportunity to increase the product's price in comparison with a fixed-price contract.⁵

In markets thick with sellers, any single buyer has relative freedom to enter into exchanges that best suit its interests. As markets become thinner, a buyer can become increasingly dependent on a single or limited set of providers of the resource it seeks. Designing a contract in a thin market can mean settling for a contract type that is less than ideal in order to secure necessary resources.⁶ Sellers gain 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 under U.S. federal contracting practice, no individual seller can demand a specific contract type.⁷ Instead, market conditions may cause buyers to select a particular method of payment before going out to market in order to increase the odds that sellers will be willing to bid and enter the exchange. As we specify in Hypothesis 2, as government procurement personnel scan the market, cost-reimbursement contracts will be less likely in competitive markets with many sellers.

H2: For exchanges between purchasing governments and private vendors, the probability of a cost-reimbursement contract governing the exchange will decrease as the number of sellers of the product increases.

Alternatively, 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 it bears the risk of cost overruns because it is dependent on the flow of financial resources (Salancik, 1979). As we specify in Hypothesis 3, cost-reimbursement contracts will be less likely in markets with few buyers than in markets thick with buyers.

H3: For exchanges between purchasing governments and private vendors, the probability of a cost-reimbursement contract governing the exchange will decrease as the number of buyers of the product decreases.

In addition to the number of buyers and sellers in the market, the relative dependence of sellers on a given purchaser may impact contract type. Even in markets with multiple buyers, a single buyer or a small group of buyers may

dominate the market through their scale of purchasing (i.e., their market power), allowing them to set favorable terms in exchanges with sellers. It has been shown, for example, that health management organizations pay lower prices for certain hospital services as their footprints in the health market increase (Feldman & Wholey, 2001). Likewise, the purchasing power enjoyed by the military in some defense products markets allows it to exert a downward pressure on the prices it pays for such goods (Day, 2012). These patterns should extend to contract type as well. If sellers are relatively dependent on a single purchaser for sales of their products, and hence their revenue, that purchaser may have leverage to set contract terms. Sellers in a market with a dominant buyer may be more willing to accept the risk associated with a fixed-price contract. As we specify in Hypothesis 4, cost-reimbursement contracts are less likely in markets in which the government has significant market share.

H4: For exchanges between purchasing governments and private vendors, the probability of a cost-reimbursement contract governing the exchange will decrease as the purchasing government's market power increases.

EXPECTATIONS

Our conceptual framework identifies factors that will influence the type of contract to govern the exchange. We have explicitly designed our framework to be generic and applicable to purchasing governments in general. However, we draw data from the defense contracting arena and focus on a single government agency, the Department of Defense (DoD). While defense contracting involves unique challenges (e.g., warzone acquisitions) and is governed by the Defense Federal Acquisition Supplement (DFAS), the same basic dynamics present in government contracting in general are also present in defense contracting (e.g., U.S. Government Accountability Office, 2012). Furthermore, the basic product characteristics and market characteristics that influence contracting in general should have similar effects on contracting by the DoD (Harmon & Scot, 2013; McGowan & Venzryk, 2002; Rogerson, 1994; Williamson, 1967).

Recall that contracts between U.S. federal government agencies and vendors are governed by a set of regulations that promote, and in some cases mandate, the use of fixed-price contracts. Our initial expectation is that the use of cost-reimbursement contracts will be uncommon. However, the presence of conditions identified by our conceptual framework will increase the chance that a cost-reimbursement contract will be used. Specifically, when the product is difficult to describe and requires specialized investments, and there are few sellers but many buyers of the product, the use of cost-reimbursement contracts is likely to increase.

Data and Methods

We draw data from the Federal Procurement Data System (FPDS), the Benchmark Input-Output Tables of the Bureau of Economic Analysis, 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 to 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 catalogue 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 product type is less than 100 in most cases.¹⁰

VARIABLES

In this section, we describe the dependent, independent, and control variables used in our analysis.

Dependent Variable

To measure contract type, we use the contract type in 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 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. Time-and-materials contracts and labor-hour contracts are variations on the traditional cost-reimbursement contract 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, 2009b, 2009c). 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, 2009a). 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.

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 list of 29 products, 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 biweekly e-mail newsletter, sending out a link in two successive surveys. One-hundred and twenty-nine former and current federal procurement personnel began the survey, and 99 provided product ratings, for an effective sample size of $n = 99$. The response rate was 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. Table 1 provides information on the characteristics of respondents who provided background information. Approximately two thirds of the respondents worked in the public sector at the time of the survey. On average, respondents had 15 years of experience in public procurement.¹³ Half reported they were currently working for the DoD.¹⁴

Table 1. Characteristics of Respondents to 2013 Survey of National Contract Management Association Members

<i>Characteristic</i>	<i>Frequency (M)</i>	<i>Percent (SD)</i>	<i>Range</i>
Sector (<i>n</i> = 78)			
Public	52	66.7	—
Private	23	29.5	—
Nonprofit	3	03.8	—
Position (<i>n</i> = 79)			
Contract manager	24	30.4	—
Contract specialist	25	31.6	—
Procurement analyst	10	12.7	—
Supply-management specialist	1	01.3	—
Other	19	24.1	—
Highest Level of Education (<i>n</i> = 80)			
Some college	3	03.8	—
Associate's degree	4	05.0	—
Bachelor's degree	28	35.0	—
Graduate degree	45	56.3	—
Employed at DoD (<i>n</i> = 80)			
Years in public procurement (<i>n</i> = 77)	(15.0)	(11.0)	0–38
Years in private procurement (<i>n</i> = 78)	(07.5)	(10.1)	0–35

Notes: 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 & Potoski, 2005; Hefetz & Warner, 2012; Lamothe & Lamothe, 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.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 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.

Table 2. Descriptive Statistics for Defense Contracts Included in Study

<i>Variable</i>	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
Dependent variable				
Cost-reimbursement contract	0.26	0.44	0	1
Independent variables				
Product complexity	5.94	2.03	3.08	9.01
Competition procedure	0.64	0.48	0	1
DoD percentage of sales	10.66	13.90	0.48	53.76
Number of purchasing industries	302.63	168.73	4	425
FY 2005	0.14	0.35	0	1
FY 2006	0.16	0.37	0	1
FY 2007	0.27	0.44	0	1
FY 2008	0.23	0.42	0	1

Notes: $n = 2,420$. For *Competition Procedure*, a “1” indicates that an agency went out for competitive bids. *Product Complexity* scores are taken from a 2013 Survey of National Contract Management Association members; all other data are taken from the Federal Procurement Data System.

The fourth column reports the combined mean ease of measurement and specialized investments ratings.

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 the aggregate respondents rated the products similarly on both dimensions ($r^2 = 0.93$). To address the collinearity of the measures, we combined the two scores into a single product-characteristic score with a range from 2 to 10 (see the last column in Table 3). 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 (see Hypothesis 2), we measured whether agencies opted to go out for bids or sought a waiver from

Table 3. Ease of Measurement and Specialized Investment Ratings of 29 Products Commonly Purchased by DoD

<i>Product category</i>	<i>Ease of measurement</i>			<i>Specialized investment</i>			<i>Product complexity</i>
	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>Score</i>
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 (<30 mm)	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 development	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 development	4.29	1.11	63	4.59	0.60	54	8.88
Defense aircraft—advanced development	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

Notes: Data are from a 2013 Survey of National Contract Management Association members. The *Product Complexity* scores are simple sums of the ease of measurement and specialized investment scores.

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 its 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 (see Hypothesis 3); 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 (Hypothesis 4), 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 & Hefetz, 2003), ideally we would include measures of the location of the contract. Unfortunately, FPDS contract records do not consistently report this information.

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.

EMPIRICAL METHODS

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

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% of the DoD contracts in our sample were cost-reimbursement. This confirms our overall expectation that the fixed-price contract is the dominant contract type at the federal level. Table 4 reports the logistic regression results, including the coefficient, standard error, and odds ratio for the variables in our analysis. 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 Use of Cost-Reimbursement Contracts by DoD, 2004–2008

<i>Variables</i>	<i>b</i>	SE	Odds ratio
Product complexity	1.121****	0.053	3.068
Competition procedure	0.249*	0.139	1.283
DoD % of sales	−0.047****	0.007	0.954
No. of purchasing industries	0.003****	0.000	1.003
FY 2005	−0.630***	0.209	0.532
FY 2006	−0.347*	0.198	0.707
FY 2007	−0.012	0.168	0.989
FY 2008	0.110	0.176	1.116
Constant	−8.949****	0.405	0.000
χ^2			903.229****
Cox-Snell R^2			0.311

Notes: $n = 2,420$. For *Competition Procedure*, a “1” indicates that an agency went out for competitive bids. *Product Complexity* scores are taken from a 2013 Survey of National Contract Management Association members; all other data are taken from the Federal Procurement Data System. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$; **** $p < 0.001$.

PRODUCT CHARACTERISTICS

Consistent with Hypothesis 1, 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 coefficient for *Product Complexity* is positive and statistically significant at the 0.0001 level. Holding all other variables constant, a one-unit increase in *Product Complexity* increases the odds of a cost-reimbursement contract by 3.068 times.

MARKET CONDITIONS

When the other variables in our model are held at their means, the coefficient for the variable *Competition Procedure* is positive and statistically significant at the 0.1 level. Holding all other variables constant, 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 Hypothesis 2, which argues that as the number of vendors increases, the likelihood of a cost-reimbursement contract will decrease. We present a possible explanation for this apparently counterintuitive finding in the discussion section.

The results for the variables measuring market conditions—*Competition Procedure*, *DoD Percentage of Sales*, and *Number of Purchasing Industries*—provide support for Hypotheses 3 and 4. The coefficient for the variable *Number*

of *Purchasing Industries* is positive and significant ($p < 0.0001$). As this variable increases by one unit, the odds that an exchange will be governed by a cost-reimbursement contract increase by a factor of 1.003. While this odds ratio may appear small, it is important to remember that the range and standard deviation of the variable are substantial. This means that *Number of Purchasing Industries* has a significant impact on contract type across the services in our sample. More buyers increase the likelihood of a cost-reimbursement contract. This finding is consistent with our third hypothesis, which posits 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 ($p < 0.0001$). Holding all other variables constant, a one-unit increase in *DoD Percentage of Sales* decreases the odds of a cost-reimbursement contract by 0.954. This finding provides support for Hypothesis 4—the use of cost-reimbursement contracts declines as the DoD gains market power.

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 (all else equal).

Discussion

Federal regulatory policy and guidance promote, and sometimes mandate, the use of fixed-price contracts because this contract type is thought to lower the risk of cost overruns and receipt of a poor-quality product. The data we analyze suggest 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. We discuss product characteristics and market conditions below.

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 a lower risk 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 it 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 system 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 needed 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, it 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

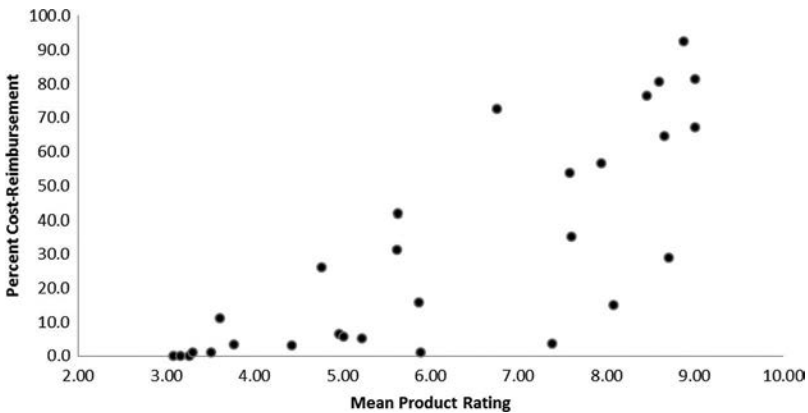


Figure 1. Use of Cost-Reimbursement Contracts by Mean Product Rating.

fixed-price contracts. Guided missiles, for example, have a mean product rating of 8.71, yet over 70% 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 article does a poorer job of explaining contracting decisions for complex products and signals a possible mismanagement 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.

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, & 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 its 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 the 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% of cases.²¹ This analysis provides evidence that a transaction cost framework that takes production stage into account 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.

MARKET CONDITIONS

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 flipside, 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, 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 has choices about who to sell products to, it can seek out exchange partners that offer 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 consistent explanation: when agencies opt to sole-source a contract, they are often buying simple products that are easily specified and 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.

Conclusion

The data and examples we present here illustrate the value of the transaction cost framework for explaining contract-type decisions. As the theory predicts, 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. Contrary to the implicit assumption of the Obama administration's 2009 guidance to agencies, the results presented here suggest that agencies have largely followed federal procurement regulations and contracting guidance. 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 product's attributes have been more precisely determined and more routine production processes developed.

Our results suggest that influencing *what* the government buys will likely have more impact on the use of cost-reimbursement contracts than further regulating *how* government agencies buy products. The agencies in our sample appear to be following existing regulatory guidance rather than flouting it. If legislative and executive overseers are driven to mitigate risk in contracting by reducing the number of cost-reimbursement contracts, their best strategy may be guiding agencies to buy more simple products and fewer complex products.

Our research affirms conventional contracting practice while controlling for other factors. 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. This sets the stage for future scholarly inquiry into the impact of contract type on contract outcomes. 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.

Like any investigation, our analysis is limited in some way. Many of our measures would benefit from increased precision, particularly our measures of market conditions. For example, we used national-level data on the number of industries that purchase the 29 products in our sample to gauge the size of the market for each. Ideally, market measures would be more closely tied to the particular locales in which the exchanges between the DoD and vendors are taking place (although the markets for some of the products included in this study are more or less national). Our study is also limited in reach in that we focus on contract-type decisions, and not on how these decisions impact outputs (e.g., whether the contract delivered the product at specifications, on time, and within budget) or outcomes (e.g., whether the product contributed positively to the pursuit of agency mission, goals, and objectives). The limitations of our measures invite improvements, whether in the acquisition of new data or better operationalizations with existing data. Ultimately, the value of this inquiry will be its contribution to future scholarship that will be able to tie variables like contract type to managerial outputs and outcomes (e.g., Lawther, 2002; Sclar, 2001). Our hope is that the research we have presented here will spark interest

among other public management scholars to focus on how contracts are constructed and the impact of different contract types on the managerial imperatives governing the transaction.

Notes

1. We use the generic term “product” to refer to both goods and services.
2. See <https://www.usaspending.gov>. Over the last decade, federal contract spending rose from \$346 billion in FY 2004 to a high of \$541 billion in FY 2008. Contract spending has averaged around \$450 billion over the last two fiscal years.
3. For example, the 2007 *Report of the Acquisition Advisory Panel to the Office of Federal Procurement Policy and the United States Congress* 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” (U.S. Acquisition Advisory Panel, 2007, p. 352).
4. The FAR is a component of the Code of Federal Regulations; specifically, Title 48: Federal Acquisition Regulation System.
5. 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.
6. Resource dependency 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 the 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 decisions we examine typically occur before the exchange occurs and a relationship commences. In instances where contractual exchanges become interdependent, resource dependency theory offers a potential complement to transaction cost theory (Burt, 1983).
7. Federal contracting practice requires the purchasing government to determine the contract type before going to market (Brown, 2013).
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, whether cost-reimbursement or fixed-price, was changed after the initial agreement.
10. The percentage of incomplete FPDS records is 15.5% (269 of 1,734). The incomplete rates for the DoD are on par with the overall rate of incompleteness at 15.2%.
11. The survey was conducted with a protocol approved through a university’s institutional review board.
12. We pretested the survey instrument on a sample of 38 federal procurement personnel from a different professional association, the National Institute of Governmental Purchasing (NIGP). The pretest provided useful feedback on ways to improve the validity of the survey items for the constructs we are interested in.
13. About 20% of respondents neglected to provide biographical information. We are unable to determine whether they differed from the respondents 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.

15. “Requirements definition” is a commonly accepted term in procurement, referring to the process of writing down a product’s attributes and capabilities.

16. Appendix 2 reports the wording of the survey prompt for each of the two measures.

17. There is a growing body of research on complex contracting (e.g., Malatesta & Smith, 2014) and product complexity in public sector procurement (e.g., Brown et al., 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 offer or 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 & Bradstreet’s Million Dollar Database). None of these measures is statistically significant or influenced the results for the variables described above. We suspect that this is because all of the variables measure information revealed after contract type is set.

19. Appendix 3 reports the mean product complexity rating and distribution of fixed-price and cost-reimbursement contracts for each product in our sample.

20. See <http://www.defense.gov/contracts/contract.aspx?contractid=3206> and <http://www.defense.gov/contracts/contract.aspx?contractid=5018> (accessed October 6, 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 0.05 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 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

<i>Service</i>	<i>NAICS</i>	<i>PSC</i>	<i>Service</i>	<i>NAICS</i>	<i>PSC</i>
Advertising	541810	R701	Solid-waste collection	562111	S205
Auditing	541211	R704	Warehousing and storage	493110	S215
Computer system 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 development	336411 336412 336413	AC13
Janitorial service	561720	S201	Defense aircraft—engineering development	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 development	332992 332994	AC53
Logistics support	541614	R706	Guns (30 mm and less)	332994	1005
Equipment maintenance/repair	811310	J099	Bombs	332993	1325
Professional and management 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.

Appendix 3. Contract Type by Product Complexity Score

<i>Product</i>	<i>Product complexity score</i>	<i>Contract type (%)</i>	
		<i>Fixed-price</i>	<i>Cost-reimbursement</i>
Trash/garbage collection services	3.08	100.0	0.0
Landscaping/grounds-keeping services	3.16	100.0	0.0
Laundry and dry-cleaning services	3.26	100.0	0.0
Custodial janitorial services	3.30	98.9	1.1
Court reporting services	3.51	99.0	1.0
Warehousing and storage services	3.61	89.0	11.0
Guard services	3.77	96.6	3.4
Advertising services	4.43	97.0	3.0
Auditing services	4.77	73.9	26.0
Legal services	4.97	93.6	6.4
Training/curriculum development	5.02	94.4	5.5
Maintenance and equipment repair	5.22	94.8	5.2
Program management/support services	5.62	68.9	31.1
Logistics support services	5.63	58.2	41.8
Program review/development service	5.87	84.2	15.8
Guns (≤ 30 mm)	5.89	99.0	1.0
Engineering and technical services	6.76	27.5	72.6
Bombs	7.38	96.5	3.6
Systems development services	7.58	46.4	53.6
Weapons—basic research	7.60	64.9	35.1
Defense aircraft—basic research	7.94	43.4	56.6
Aircraft, fixed-wing	8.08	85.0	15.0
Defense aircraft—engineering development	8.46	23.7	76.4
Weapons—applied R&D	8.60	19.6	80.5
Defense aircraft—applied R&D	8.66	35.4	64.5
Guided missiles	8.71	71.1	28.9
Weapons—advanced development	8.88	7.7	92.3
Defense aircraft—advanced development	9.01	18.8	81.3
Submarines	9.01	33.0	67.0

Note: $n = 2,420$ contracts.