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**Unintended Consequences of Advocating Use of Fixed-Price  
Contracts in Defense Acquisition Practice**

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## Preface & Acknowledgements

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During his internship with the Graduate School of Business & Public Policy in June 2010, U.S. Air Force Academy Cadet Chase Lane surveyed the activities of the Naval Postgraduate School's Acquisition Research Program in its first seven years. The sheer volume of research products—almost 600 published papers (e.g., technical reports, journal articles, theses)—indicates the extent to which the depth and breadth of acquisition research has increased during these years. Over 300 authors contributed to these works, which means that the pool of those who have had significant intellectual engagement with acquisition issues has increased substantially. The broad range of research topics includes acquisition reform, defense industry, fielding, contracting, interoperability, organizational behavior, risk management, cost estimating, and many others. Approaches range from conceptual and exploratory studies to develop propositions about various aspects of acquisition, to applied and statistical analyses to test specific hypotheses. Methodologies include case studies, modeling, surveys, and experiments. On the whole, such findings make us both grateful for the ARP's progress to date, and hopeful that this progress in research will lead to substantive improvements in the DoD's acquisition outcomes.

As pragmatists, we of course recognize that such change can only occur to the extent that the potential knowledge wrapped up in these products is put to use and tested to determine its value. We take seriously the pernicious effects of the so-called “theory–practice” gap, which would separate the acquisition scholar from the acquisition practitioner, and relegate the scholar's work to mere academic “shelfware.” Some design features of our program that we believe help avoid these effects include the following: connecting researchers with practitioners on specific projects; requiring researchers to brief sponsors on project findings as a condition of funding award; “pushing” potentially high-impact research reports (e.g., via overnight shipping) to selected practitioners and policy-makers; and most notably, sponsoring this symposium, which we craft intentionally as an opportunity for fruitful, lasting connections between scholars and practitioners.

A former Defense Acquisition Executive, responding to a comment that academic research was not generally useful in acquisition practice, opined, “That's not their [the academics'] problem—it's ours [the practitioners']. They can only perform research; it's up to us to use it.” While we certainly agree with this sentiment, we also recognize that any research, however theoretical, must point to some termination in action; academics have a responsibility to make their work intelligible to practitioners. Thus we continue to seek projects that both comport with solid standards of scholarship, and address relevant acquisition issues. These years of experience have shown us the difficulty in attempting to balance these two objectives, but we are convinced that the attempt is absolutely essential if any real improvement is to be realized.

We gratefully acknowledge the ongoing support and leadership of our sponsors, whose foresight and vision have assured the continuing success of the Acquisition Research Program:

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James B. Greene, Jr.  
Rear Admiral, U.S. Navy (Ret.)

Keith F. Snider, PhD  
Associate Professor



## Panel 5 – Contemporary Contracting Issues

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<b>Wednesday, May 11, 2011</b>	
<b>11:15 a.m. – 12:45 p.m.</b>	<p><b>Chair: Lenn Vincent</b>, RADM, USN, (Ret.), Industry Chair, Defense Acquisition University</p> <p><b><i>Unintended Consequences of Advocating Use of Fixed-Price Contracts in Defense Acquisition Practice</i></b> Chong Wang and Joseph San Miguel, NPS</p> <p><b><i>Why Didn't the DoD Defend Their FDO's Listed in GAO Report 06-66?</i></b> James Gill, Space &amp; Missile Systems Center</p> <p><b><i>Identifying Procurement Fraud in Defense Agencies: An Analysis of the Government Purchase Card Program</i></b> Juanita Rendon, NPS</p>

**RADM Lenn Vincent**—Industry Chair, Defense Acquisition University (DAU). An independent consultant, RADM Vincent uses his defense and industry experience, expertise, and perspective to advise the DAU management team, OSD, the uniformed services, and industry on matters relative to contracting, program management, logistics, and supply chain management. As a professor at the DAU, he presents views to foster a more viable and effective defense acquisition management system. An international educator, consultant, dynamic speaker, and respected government and industry leader, he has taught and/or consulted in contract management, capture management, project management, supply chain management, and leadership.

As a vice president at American Management Systems and CACI International, RADM Vincent was responsible for working with senior Department of Defense and industry leaders to build long-term business relationships and to help identify solutions to acquisition, logistics, and financial management challenges. His strategic focus was an initiative to create an integrated digital environment that would extend the DoD's automated procurement systems into industry and into the DoD program management offices, in addition to implementation and training strategies for new products and service.

Prior to entering civilian life, RADM Vincent completed a distinguished career in the United States Navy, serving at both sea and ashore. He has over 30 years of broad based and in-depth leadership and management experience in acquisition, supply chain management, logistics, and financial management.

RADM Vincent holds a master's in Business Administration from George Washington University. He also is a Certified Navy Material and Acquisition Professional, and is DAWIA Level III certified in both Contracting and Logistics.

He is past-president of the National Contract Management Association and served on its board of directors as well as the following boards: Navy League National Capital Council; NDIA Washington DC Chapter; Board of Directors Procurement Round Table; and Board of Visitors, Defense Acquisition University.



# Unintended Consequences of Advocating Use of Fixed-Price Contracts in Defense Acquisition Practice

**Chong Wang**—Assistant Professor of Financial Management, Graduate School of Business & Public Policy, NPS. Professor Wang teaches courses related to accounting and finance. His research fields are financial and management accounting, corporate finance, and economics. His latest research investigates the cost efficiency issue in the context of defense contracts. Professor Wang's work has been published in *Accounting and Finance*. His latest working paper with his coauthors appears in the prestigious National Bureau of Economic Research (NBER) working paper series. He has presented his various working papers in a number of academic conferences, including selective American Accounting Association Annual Meeting, and Western Finance Association Annual Meeting. He is currently co-PI of the DoD project entitled, "The Excessive Profits of Defense Contractors: Evidences, Explanations and Policy Implications," funded by the Acquisition Research Program at NPS. His other DoD-related research projects include the impact of contract types on cost efficiency, as well the cross-sectional variation of defense contracts performance. Professor Wang has a PhD in Economics and a Master of Science in Statistics from Iowa State University, and a Bachelor of Science in Management Science from the University of Science & Technology of China. [cwang@nps.edu]

**Joseph San Miguel**—PhD, CPA, and Professor of Financial Management, Graduate School of Business & Public Policy, Naval Postgraduate School. Dr. San Miguel received his PhD at The University of Texas at Austin. He has taught at NYU, Harvard, Stanford, and Dartmouth, in addition to consulting and teaching executive programs for numerous companies. His interests are strategic resource management, strategic control, and corporate financial reporting. [jsanmiguel@nps.edu]

## Abstract

Frequent and substantial cost overruns in Major Defense Acquisition Programs (MDAP) have been criticized by the administration, lawmakers, and taxpayers. Critics often blame the dominant use of cost-plus contracts in the defense procurement system as the root cause of the inefficiency. In turn, a strong preference for fixed-price contracts as opposed to cost-plus contracts has been expressed on multiple occasions. In this research, we highlight the possible unintended consequences of advocating wider use of fixed-price contracts in Department of Defense (DoD) acquisitions. The implication of this study is that the mindset that fixed-price contracts are better than cost-plus contracts is misleading and can potentially do more harm than good in DoD major weapon system acquisition.

## Introduction

Cost overruns in Major Defense Acquisition Programs (MDAP)<sup>1</sup> have become more frequent and more significant in recent years. In 2008, a Government Accountability Office (GAO, 2009) study found that approximately 70% of 96 MDAP were experiencing huge cost overruns, reaching over \$295 billion (a 26% overrun) over the life of the projects. As a result, a series of legislative and executive efforts have been undertaken to address the cost efficiency problem in the gargantuan defense procurement system since President Barack

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<sup>1</sup> MDAPs are programs that are estimated by the Under Secretary of Defense for Acquisition, Technology, and Logistics to require an eventual total expenditure for research development, test, and evaluation of more than \$365 million, including all planned increments, based on fiscal year 2000 constant dollars (approximately \$509 million in fiscal year 2010 dollars); \$2.190 billion of procurement funding, including all planned increments (approximately \$3.054 billion in fiscal year 2010 dollars); or are designated as a major defense acquisition program by the milestone decision authority.



Obama took office. For example, the Congress unanimously passed the Weapon Systems Acquisition Reform Act (WSARA), which was signed into law by President Obama on May 22, 2009. WSARA presents a new approach to contain cost increases across the military Services' new weapon systems. Some in Congress state that the Act represents the most dramatic changes to the defense acquisition system in twenty years. From the White House, President Barack Obama issued the Memorandum on Government Contracting on March 4, 2009 to urge federal contracting agencies to improve the effectiveness of their acquisition practices and contracting performance. Top Pentagon officials also echoed their support of improving cost efficiency within an increasingly resource-constrained environment.<sup>2</sup>

One widely held belief behind the wave of dissatisfaction over the defense procurement system is a strong dislike of the popular use of cost-plus contracts. The critics' view is that cost-plus contracts effectively give a blank check to contractors and are the root cause of cost inefficiency. Naturally, they in turn become the strong proponents of the alternative fixed-price contracts. For example, the Presidential Memorandum explicitly stated that "there shall be a preference for fixed-price type contracts" (Obama, 2009, p. 1). Not surprisingly, Ashton Carter, the Under Secretary of Defense (AT&L), in his interview with Bloomberg's Peter Cook on September 14, 2010, expressed his support of "increasing the use of fixed-price contracts" (Carter, 2010). Mr. Carter also requested the Defense Business Board (DBB, 2010) form a task group to provide recommendations on how the DoD might better utilize fixed-price contracts. He asked the task group to "consider the use of fixed-price contracting *across the full spectrum of the acquisition life cycle* and provide recommendations based on best business practices, on when and how fixed-price contracting might provide savings and reduce risk." Mr. Carter also requested the task group to "develop a rule set for using fixed-price contracts over other contract types." This clearly demonstrates that the Pentagon's senior policymakers' preference for fixed-price contracts spans the full spectrum of the acquisition process and goes beyond a conceptual favor to an operational level. In summary, the policy push in favor of fixed-price contracts is strong and is being implemented.

It is our concern that the ongoing policy push toward fixed-price contracts may already go too far. In this paper, we will highlight the possible unintended consequences of advocating wider use of fixed-price contracts in the DoD acquisition context. The implication to policymakers is that fixation on the mindset that fixed-price contracts are better than cost-plus contracts is misleading and can potentially do more harm than good in DoD major weapon systems acquisition practice.

## **The Unique Contracting Environment of the DoD**

The DoD is both the biggest and the most unique federal contracting agency. In contrast to a typical commercial contracting scenario, where many bidders compete to make an objective market price readily available, the DoD contracting environment is characterized by the following unique features:

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<sup>2</sup> "The attacks of September 11, 2001, opened a gusher of defense spending that nearly doubled the base budget over the last decade.... (Now) the gusher has been turned off, and will stay off for a good period of time.... Therefore, as the Defense Department begins the process of preparing next year's Fiscal 2012 budget request, I am directing the military services, the joint staff, the major functional and regional commands, and the civilian side of the Pentagon to take a hard, unsparing look at how they operate- in substance and style alike. The goal is to cut our costs and to transfer those savings to force structure and modernization within the programmed budget" (Gates, 2010).





1. Defense contractors normally face substantive business risks, which if not shared by the government, could be prohibitively high. Such risks stem from extreme difficulty and uncertainty in major weapon systems' design, development, and production. Other contributing factors are changing the DoD requirements (often a moving rather than static target) and changing the integration process between the development and manufacturing as well as between the prime contractor and the sub-contractors. Additional risks arise from the compliance costs associated with federal acquisition policies and the scrutiny from federal agencies. The cost burden for establishing a government-unique infrastructure and disclosures of cost and pricing data and other business sensitive information surely elevates the contractors' discomfort level.
2. The DoD is the sole buyer in major weapon systems acquisition. Being the sole buyer presents two implications. First, defense contractors' technological investments and capital expenditures, often huge due to the complexity of the tasks, only produce non-transferable assets and hence add even more risk to the firm. Second, the economy of scale, usually achieved through a large base of demand, is less likely to materialize. In the last two decades, the consolidation of firms in the defense industry<sup>3</sup> is an indication of the firms' struggle to achieve a better economy of scale<sup>4</sup> through the supply side.
3. The DoD contracting environment is not only a "sole-buyer" case, but also involves a "sole-seller" setting. Due to the extreme complexity and uncertainty inherent in major weapon systems, the long evolution and competition often result in a sole-source contractor situation in which only one (or a few contractors) is (are) capable of undertaking the contract. Other contributing factors to the sole-source situation include the DoD's need for secrecy, expediency, and/or safeguarding human resources. We emphasize that the DoD's unique sole-source contracting environment is unlikely to change anytime soon. For MDAPs, spending on single-source contracts in recent years has increased considerably from 76% in 2004 to 87% in 2008 (Berteau, Hofbauer, & Sanok, 2010). The economic downturn since 2008, coupled with ongoing DoD cost-saving initiatives (fueled by the pressure of reducing the federal budget deficit) will likely induce a new wave of mergers and acquisitions (M&A) and, in turn, reduce competition. Hence, the industry consolidation trend we have witnessed during the past two decades (e.g., Boeing acquired McDonnell Douglas, Lockheed acquired Martin Marietta, and Northrop acquired Grumman) may continue despite the WSARA effort to promote competition. We emphasize that this seemingly sub-optimal sole-source industry structure, that is, monopoly or at most oligopoly, may actually offer the best solution. The huge risk associated with being the sole buyer as well as the enormous uncertainty in R&D, justifies the higher rate of return, which can be partly achieved through a more concentrated industry structure and a higher economy of scale. Hence, while we understand and appreciate the ongoing DoD efforts to promote competition and therefore a better

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<sup>3</sup> Throughout the 1990s, hundreds of defense contractors disappeared in a massive consolidation. According to a Bureau of Labor Statistics study by economist Allison Thomson, federal and civilian defense employment fell by almost 3.35 million jobs between 1987 and 2005.

<sup>4</sup> Hensel (2010) found that greater efficiencies followed the defense industry consolidation.



established market price, such efforts may not yield meaningful results. Perhaps we should acknowledge that the observed defense contracting environment is a natural choice of economic Darwinism, which we must accommodate.

4. Significant information asymmetry exists between the DoD and the defense contractors in such a unique sole-buyer and sole-seller case. As a result, agency problems arise from the conflict of interest, and the defense acquisition system is subject to abuses from contractors.

To summarize, the DoD contracting environment is unique in the sense that an MDAP contract is typically a sole-buyer and sole-seller case, in which market competitive forces rarely exist and significant information asymmetry and potential agency problems prevail. On the contractor side, the business risk is too enormous to be borne by contractors themselves. On the government side, the major concern is the potential abuse of the system, which stems from the agency problems due to information asymmetry.

### **Unintended Consequences of Advocating Wider Use of Fixed-Price Contracts in the DoD Context**

As argued in the introduction, currently there is a strong preference among lawmakers as well as policymakers for increased use of fixed-price contracts in the defense procurement system. While we acknowledge that fixed-price contracts may be superior in certain situations, such situations are quite limited in defense contracts. More commonly, the DoD faces a “single-source” contracting environment in which competition does not exist or is very low and significant information asymmetry prevails. Fixed-price contracts in these settings may not be effective. In the following, we highlight the possible unintended consequences of advocating wider use of fixed-price contracts in the DoD acquisition context.

#### ***Unintended Consequence #1: Fixed-Price Contracts Do Not Provide Risk-Sharing Benefits***

A contracting firm given a fixed-price contract would bear all the risks. Hence, the first unintended consequence of fixed-price contracts is the absence of a risk-sharing benefit provided to the contractors by the government. Because the business risks associated with major weapon systems are very high, it is vital to ensure that the risk is shared by the government so the private contractors have incentive to undertake the highly risky projects that are essential to the national security and necessary for winning military conflicts. Without risk sharing by the government, it is unavoidable that certain important but risky projects would be forgone by the contractors because the uncertainty is too high to be borne by contractors themselves.

#### ***Unintended Consequence #2: Fixed-Price Contracts May Lead to Higher Government Payments***

The logic behind the preference for fixed-price contracts, which may sound sensible at first glance, is fundamentally flawed in the DoD context. The proponents of fixed-price contracts normally assume that a reasonable cost estimate is available in most DoD contracting scenarios, but this assumption rarely holds in MDAP situations. On the contrary, ex ante, neither the government nor the contractor possesses the necessary information to



form a good cost estimate. However, the contractor has an informational advantage on cost estimation.

The impact on the contractors' incentives in the case of fixed-price contracts is twofold. First, to ensure against great downstream uncertainty, the contractor will tend to provide the government with a high cost estimate to obtain a higher fixed-price contract. This is a typical "risk-premium" story. A rational risk-averse contractor will submit a higher-than-expected cost estimate and hence, on average, the government will pay more for a fixed-price contract than for a cost-plus contract.

Second, due to information asymmetry, the contractor has both motive and ability to artificially inflate the cost estimate to command additional "information rents." The combined demand for risk premium and the desire to extract information rents determine that there is no guarantee that taxpayers will be better off in a fixed-price contract as opposed to a cost-plus contract. We expect that, in general, a fixed-price contract in the absence of a market-established price and information symmetry will lead to a higher payment from the government than under a cost-plus contract.

In addition, the cost of extracting information rents in a fixed-price contract is smaller than that for a cost-plus contract. This is because under the cost-plus scheme the contractor must incur the actual costs in order to get reimbursed. Whereas, the manipulation of the cost estimate under a fixed-price contract has little tangible cost. So, *ceteris paribus*, in a fixed-price contracting environment, the contractor has a stronger, not a weaker, incentive to extract information rents, provided that information asymmetry makes it difficult for the government to dispute the inflated cost estimate.

A recent study by the Defense Business Board (DBB) indicated that cost overruns and schedule delays are less related to the contract types, but more related to the poor assessment of risks, inadequate planning of requirements, cost realism, stability of requirements, and quality of program leadership. This casts doubt on the popular critique that cost-plus contracts, which dominate MDAPs, primarily contribute to the huge and frequent cost overruns. Moreover, there is no evidence showing that those programs under fixed-price contracts necessarily result in higher cost efficiency.

### ***Unintended Consequence #3: Fixed-Price Contracts May Promote Inefficient Industry Structure***

Motivated by the preference toward fixed-price contracts and the worry about frequent no-bid defense contracts, policymakers are eager to promote a more competitive defense industry structure. The intention is good and justified: A market price established by the competitive forces needs to be present for fixed-price contracts to work. For instance, concerning acquisition process changes, WSARA encourages competition. Specifically, § 202 requires the Secretary of Defense to take measures to ensure competition at both the prime contract level and the subcontract level throughout the life cycle of a program "as a means to improve contractor performance" (p. 19). Available measures include the following: (1) competitive prototyping (at system or subsystem level) is required prior to a Milestone B (Engineering & Manufacturing development) decision; (2) dual-sourcing; (3) unbundling of contracts; (4) using modular, open architectures to enable competition for upgrades; and (5) the licensing of additional suppliers. Prime contractors are also required to ensure their "make-or-buy" decisions give "full-and-fair consideration" to qualified sources other than themselves for major subsystems and components.



Moreover, WSARA legislation tries to nurture competition through more tightly controlling Organizational Conflict of Interest (OCI). OCI exists when a contractor can unduly benefit from its existing relationship in competitions for future work. Of particular concern to critics of the current system were situations in which contractors providing system engineering, technical services, or administrative support to the government were able to define the terms of future competitions or influence the source selection in a way to benefit themselves. While this concern about the inappropriate conflict of interest is justifiable, a draconian approach to OCI can create significant unintended negative consequences. One notable critique came from Goure (2010):

The pool of expertise in sophisticated system engineering and technical analysis for complex, often highly classified defense areas is quite limited. There is only one Skunk works for example. But if a company such as Lockheed Martin is barred from working on the next stealth fighter or SR-71 because it has helped in the initial research and development effort, the nation will be the loser.<sup>5</sup>

All the efforts above, though well intentioned, may promote inefficient industry structure. The conventional economic wisdom that a competitive industry structure is better than a more concentrated one may simply be untrue in the special defense industry. Policymakers need to be reminded that the single-source contracting environment is a natural result of long-term competition among contractors and the evolution of the free market economy. It is an optimal response to the unique features of the DoD major weapon systems acquisition environment. Specifically, extreme complexity and difficulty of the projects eliminate most competitions over time; the lack of an economy scale mechanism from the demand side makes industry consolidation the only option to achieve cost efficiency from the supply side; and the abnormally high business risks require a higher rate of return, which can be partly realized from a monopoly or oligopoly industry structure.

To conclude, the present industry structure is an outcome of economic Darwinism and perhaps the best choice we have given the one-of-a-kind DoD contracting setting. An artificial effort to change the status quo and the policy push to reverse the industry consolidation trend are likely to be counter-productive and fail.

## **Cost-plus Contracts: Problems and Remedies**

### ***The Problems***

The pros and cons of cost-plus versus fixed-price contracts have been extensively investigated in the extant literature (Chapman & Ward, 1994a, b; Loeb & Surysekar, 1994). In general, fixed-price contracts are optimal if little uncertainty exists in technological requirements and developments. In the section titled Unintended Consequences of Advocating Wider Use of Fixed-Price Contracts in the DoD Context, we point out that the DoD contracting environment rarely offers this confidence. The Army Future Combat System (FCS; DoD, 2009), one example of many MDAPs, provides an excellent illustration of a system of complex electronic weapon systems that proved too difficult to design and

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<sup>5</sup> "Skunk Works is an official alias for Lockheed Martin's Advanced Development Programs (ADP), formerly called Lockheed Advanced Development Projects. Skunk Works is responsible for a number of famous aircraft designs, including the U-2, the SR-71 Blackbird, the F-117 Nighthawk, and the F-22 Raptor.... The designation 'skunk works' ... is widely used in business, engineering, and technical fields to describe a group within an organization given a high degree of autonomy and unhampered by bureaucracy, tasked with working on advanced or secret projects" ("Skunk Works," 2010).



implement within growing budgets. Similarly, the Navy's modular Littoral Combat Ship (LCS; GAO, 2010) is an ongoing struggle to merge functionality and technology and stay within cost estimates.

In the previous examples of high uncertainty and emerging technology, risk sharing is vital to motivate private contractors to engage in complex defense projects. Hence, cost-plus contracts are preferred to fixed-price contracts because they effectively shift the risk from the contractor to the government.

However, the benefits of risk sharing associated with cost-plus contracts come with a price. Because cost-plus contracts are most often applied to the projects with high uncertainty and information asymmetry, they are subject to the contractor's manipulation of cost reporting. Critics basically argue that the contractor has a blank check from the government, and hence they have little incentive to contain cost. Moreover, under a particular form of cost-plus contracts, in which the contracting firm's profit is a fixed percentage of the cost, the contractor would have strong incentive to inflate the cost. Even when the profit is a pre-specified fixed dollar amount, the contracting firm as well as the management of the firm may be able to derive some private benefits from incurring a larger cost. One possible example is the "empire building" behavior that rewards managers by growing a firm beyond the optimal level (Jensen, 1986; 1989).<sup>6</sup> Hence, cost-plus contracts could lead to potential abuse of the system and cost inefficiency. This problem basically underlies the major arguments made by critics.

### ***The Remedies***

In this section, we introduce to policymakers that a traditional cost-plus incentive contract can be refined such that the new form of contract not only keeps the conventional risk-sharing benefits, but also aligns the contractor's incentive with the incentive of the government. This new type of contract is called "budget-based cost-plus scheme," which belongs to the larger topic of menu of contracts discussed in the literature. This body of literature has broad applications in executive compensation contracts, regulation, and government procurement contracts (Laffont & Tirole, 1986, 1993; McAfee & McMillan, 1987; Melumad & Reichelstein, 1989; Reichelstein, 1992).

A traditional cost-plus incentive contract takes the following form:

$$P = c + \pi(c) \tag{1}$$

where,

$$\pi(c) = \alpha + \beta^*(TC - c) \tag{2}$$

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<sup>6</sup> "Managers have many incentives to expand company size beyond that which maximizes shareholder wealth. Compensation is one of the most important incentives. Many studies document that increases in executive pay are strongly related to increases in corporate size rather than value. The tendency of companies to reward middle managers through promotions rather than annual performance bonuses also creates a cultural bias toward growth. Organizations must grow in order to generate new positions to feed their promotion-based reward systems. Finally, corporate growth enhances the social prominence, public prestige, and political power of senior executives. Rare is the CEO who wants to be remembered as presiding over an enterprise that makes fewer products in fewer plants in fewer countries than when he or she took office-even when such a course increases productivity and adds hundreds of millions of dollars of shareholder value. The perquisites of the executive suite can be substantial, and they usually increase with company size" (Jensen, 1989, p. 66).



Note that  $P$  is the price paid by the government to the contractor;  $c$  is the actual reported cost as agreed by the auditor; and  $\pi(c)$  is the contractor's profit, which includes a target profit  $\alpha$ , and an incentive term for cost overruns (or underruns) above (below) a pre-specified target cost  $TC$ . The parameter  $\beta$  (a positive coefficient between 0 and 1) is the cost share parameter. Because the profit is penalized (rewarded) when there exists a cost overrun (underrun), the contractor is motivated to be more cost efficient.

The primary drawback of the traditional cost-plus-incentive contract is that the government frequently does not possess necessary information to form a basis for estimating target cost  $TC$  due to significant information asymmetry. If  $TC$  is set too high, the contractor receives windfall bonuses at the expense of taxpayers. On the other hand, if  $TC$  is set too low such that the cost overrun is unavoidable, the contractor will be unfairly penalized.

Contractors (firms) usually have superior information concerning the expected cost of the project, yet the government cannot rely on the firms' estimates because contractors, as agents, may not truthfully reveal their beliefs due to the conflict of interests. One possible remedy to this dilemma is to introduce an optimal design of incentive contracts to ensure that the contractors (who have an information advantage) voluntarily and truthfully reveal their beliefs about the project's estimated cost. The theoretical setting is the classical principal-agent contracting model where the principal (i.e., the government) carefully designs the contract format, such that the agents (i.e., the contractors), in maximizing their own benefits, behave in the way that the principal desires.

Consider a refinement of the traditional cost-plus incentive contract in which the task of estimating target cost shifts from the government to the better informed contractor. Thus, Equation 2 is modified as follows:

$$\pi(c, \overline{TC}) = \alpha(\overline{TC}) + \beta(\overline{TC}) * (\overline{TC} - c) \quad (3)$$

where  $\overline{TC}$  is the estimate of  $TC$  submitted by the contractor.

Another important modification is that both  $\alpha$  (target profit) and  $\beta$  (cost share parameter) are no longer constants. Instead, they vary with  $\overline{TC}$  to provide the correct incentives for the contractors to truthfully reveal their unbiased cost estimate.

It can be shown<sup>7</sup> that if the functional forms of  $\alpha(\overline{TC})$  and  $\beta(\overline{TC})$  are carefully chosen, a contract in the form of Equation 1 and Equation 3 would desirably induce the "truth-telling" behavior.

For instance, consider:

$$\alpha(\overline{TC}) = \frac{N}{\overline{TC}} \quad (4)$$

where the government will set the constant  $N$  as an input to target profit.

$$\beta(\overline{TC}) = -\alpha'(\overline{TC}) = \frac{N}{\overline{TC}^2} \quad (5)$$

<sup>7</sup> Proof available upon request.

Now, by Equation 3, the menu of contracts presented to the firm by the government is as follows:

$$\pi(c, \overline{TC}) = \frac{N}{\overline{TC}} + \frac{N}{\overline{TC}^2} * (\overline{TC} - c) \quad (6)$$

Without losing any generality, assume that the contracting firm has the following private information, which is unknown to the government:  $c$ , as a random variable, has three equally possible outcomes: 50, 100, and 150. Therefore, the unbiased cost estimate is 100. The contractor has three choices in terms of submitting the budget (target cost): either tell the truth (i.e.,  $\overline{TC} = 100$ ) or underreport (without losing generality, let's assume  $\overline{TC} = 50$ ), or overreport (without losing generality, let's assume  $\overline{TC} = 150$ ). The decision problem for the contracting firm facing this particular budget-based cost-plus scheme reduces to the following in Figure 1, where the firm's profit under each combination of  $\overline{TC}$  and  $c$  is calculated based on Equation 6. Then for each  $\overline{TC}$ , the probability weighted expected profit is computed. The firm will choose  $\overline{TC}$  to maximize its expected profit. In our example, the contractor's expected profit is maximized by submitting  $\overline{TC} = 100$ , which is exactly the firm's unbiased cost estimate. Equivalently stated, the firm voluntarily and truthfully revealed private information and hence reduced information asymmetry.

Firm's Profit		$C$ (actual reported cost)			Firm's Expected Profit
		50 (p=1/3)	100 (p=1/3)	150 (p=1/3)	
$\overline{TC}$ (target cost budget)	50	N/50	0	-N/50	0 (underreport)
	110	3N/200	N/100	N/200	N/100 (tell the truth)
	150	N/90	2N/225	N/150	2N/225 (overreport)

**Figure 1. An Example of Budget-Based Cost-Plus Scheme (i.e., Equations 1 & 6) Inducing the Contractor's Truth-Telling Behavior**

The budget-based cost-plus scheme represents a contracting scenario in which the government (the principal) presents the sole-source contracting firm (the agent) a menu of contracts based on target cost (budget) submitted by the firm ( $\overline{TC}$ ) and the firm's actual reported cost ( $c$ ; as shown in Equation 3). In practice, the firm is given a payoff matrix based on certain combinations of its submitted budget and the actual cost incurred. The firm, as demonstrated above, will choose its best unbiased estimate of the project cost to submit as the budgeted target cost in order to maximize its own benefit. The government, therefore, avoids potential overpayment to the firm, which may occur under traditional cost-plus incentive contracts.

## Conclusion

In this study, we highlighted the unintended consequences of advocating increased use of fixed-price contracts in DoD major weapon systems acquisition. As a policy implication, we caution the Pentagon that the fixation on the mindset that fixed-price contracts are better than cost-plus contracts in limiting cost overruns is dangerous and could potentially do more harm than good to acquisition reform.

Cost-plus contracts should remain as a major contracting tool in MDAPs to facilitate the implementation of major weapon systems projects that are otherwise too risky to be undertaken by defense contractors. Moreover, we demonstrate that the contractors' opportunistic cost misbehavior under traditional cost-plus contracts can be mitigated by using the budget-based cost-plus scheme.

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Unintended Consequences of Advocating Use of

Fixed-Price Contracts in Defense Acquisition Practice

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## Road Map

- Research Question
- Motivation
- The Uniqueness of the DoD Contracting Environment
- Unintended Consequences of Advocating Wider Use of Fixed-Price Contracts in DoD Context
- Cost-Plus Contracts: Problems and Remedies
- Conclusion

## Research Question

- Is the current policy makers' preference for fixed-price contracts as opposed to cost-plus contracts in DoD acquisition practice justifiable? What are the potential negative consequences of advocating use of fixed-price contracts?

## Motivation

- Large cost overruns in Major Defense Acquisition Programs (MDAP)
  - *According to GAO report, in 2008 approximately 70% of 96 MDAP experienced huge cost overruns, reaching over \$295 billion (a 26% overrun) over the life of the projects.*
- Widespread criticisms from various sources in Congress, the Administration, and taxpayers.
  - *A major critique is that the increasing use of cost-plus contracts is a key contributing factor to large and frequent cost overruns.*

- *In a briefing on his acquisition reform on March 4, 2009, the President stated that “The days of giving defense contractors a blank check are over,” and pledged that his reforms would end unnecessary no bid, cost-plus contracts.*
- A clear preference toward fixed-price contracts
  - *“There shall be a preference for fixed-price type contracts”–“Memorandum on Government Contracting”, President Barack Obama, March 4, 2009.*
  - *Ashton Carter, the Pentagon’s top weapons buyer, in his interview with Bloomberg’s Peter Cook on September 14, 2010, echoed his support of “increasing the use of fixed-price contracts”.*

– *Ashton Carter asked the Defense Business Board (DBB) to form a Task Group to “consider the use of fixed-price contracting across the full spectrum of the acquisition life cycle and provide recommendations based on best business practices, on when and how fixed-price contracting might provide savings and reduce risk.” Mr. Carter also requested the Task Group to “develop a rule set for using fixed-price contracts over other contract types.”*

- Is this ongoing policy push toward fixed-price contracts beneficial to tax-payers? Are cost-plus contracts justifiably out of favor? Any potential unintended consequences from wide use of fixed-price contracts?

## The Uniqueness of the DoD Contracting Environment

- DoD is both the biggest and the most unique federal contracting agency.
- What is special about MDAP?
  - Significant uncertainty exists in terms of technological development, DoD requirements (often a moving rather than static target), and the integration process between the development and manufacturing as well as between the prime contractor and the sub-contractors.
  - The compliance costs associated with federal acquisition policies and the scrutiny from federal agencies.



- Economy of scale, usually achieved through a large base of demand, is less likely to materialize.
- The business risk associated with non-transferable technological investments and capital expenditures within defense industry is significant.
- Due to the extreme complexity and uncertainty inherent in MDAPs, the long evolution and competition often result in a sole-source contractor situation
- Other contributing factors to the sole-source situation include the DoD's need for secrecy, expediency, and/or

safeguarding human resources.

- To summarize, MDAP contract is typically a sole-buyer-and-sole-seller case, in which market competitive forces rarely exist and significant information asymmetry and potential agency problem prevail.
- On the contractor side, the business risk, if not shared by the government, could be prohibitively high.
- On the government side, the major concern is the potential abuse of the system which stems from the agency problem due to information asymmetry.

## Unintended Consequences of Advocating

### Wider Use of Fixed-Price Contracts in DoD Context

- Fixed-price contracts may work efficiently in normal circumstances where sufficient competition and complete certainty on technological applications exist, however, defense contracts rarely offer such confidence.
- Consequence 1: *Fixed-price contracts do not provide risk-sharing benefits*
  - Without risk-sharing by the government, it's unavoidable that certain important but risky projects would be forgone by the contractors because the uncertainty is too high to be borne by contractors themselves.

- Consequence 2: *Fixed-price contracts may lead to higher government payments.*

- The proponents of fixed-price contracts normally assume that a reasonable cost estimate is available in most DoD contracting scenarios, but this assumption rarely holds in MDAP situations.
- Ex ante, neither the government nor the contractor possesses the necessary information to form a good cost estimate. However, the contractor has an informational advantage on cost estimation.
- The impact on the contractors' incentives in the case of fixed-price contracts is twofold:

- \* First, to ensure against great downstream uncertainty, the contractor will tend to provide the government with a high cost estimate to obtain a higher fixed-price contract. This is a typical “risk-premium” story.
  - \* Second, due to information asymmetry, the contractor has both motive and ability to artificially inflate the cost estimate to command additional “information rents”.
  - \* The combined demand for “risk premium” and the desire to extract “information rents” determine that there is no guarantee that taxpayers will be better-off in a fixed-price contract as opposed to a cost-plus contract.
- In addition, the cost of extracting “information rents” in a fixed-price contract is smaller than that for a cost-plus

contract.

- In conclusion, a fixed price contract in the absence of a market established price and information symmetry will lead to a higher payment from the government than under a cost-plus contract.
- Consequence 3: *Fixed-price contracts may promote inefficient industry structure.*
  - Motivated by the preference toward fixed-price contracts and the worry about frequent no-bid defense contracts, policy makers are eager to promote a more competitive defense industry structure. For instance, concerning acquisition process changes, WSARA encourages competition. Specifically, 202 requires the Secretary of

Defense to take measures to ensure competition at both the prime contract level and the subcontract level throughout the life-cycle of a program “as a means to improve contractor performance.” Prime contractors are also required to ensure their “make or buy” decisions give “full and fair consideration” to qualified sources other than themselves for major subsystems and components.

- Moreover, WSARA legislation tries to nurture competition through more tightly controlling Organizational Conflict of Interest (OCI). OCI exists when a contractor can unduly benefit from its existing relationship in competitions for future work.
- Critique: “The pool of expertise in sophisticated system engineering and technical analysis for complex, often highly

classified defense areas is quite limited. There is only one Skunk works for example. But if a company such as Lockheed Martin is barred from working on the next stealth fighter or SR-71 because it has helped in the initial research and development effort, the nation will be the loser.”—Dr. Daniel Goure.

- Critique: Conventional economic wisdom that a competitive industry structure is better than a more concentrated one may simply be untrue in the special defense industry. Policy makers need to be reminded that the “single-source” contracting environment is a natural result of long-term competition among contractors and evolution of the free market economy. It is an optimal response to the unique features of the DoD major weapon systems acquisition environment. Specifically, extreme complex and difficulty of



the projects eliminate most competitions over time; the lack of economy scale mechanism from demand side makes industry consolidation the only option to achieve cost efficiency from supply side; and the abnormally high business risks require higher rate of return which can be partly realized from a monopoly or oligopoly industry structure.

- Conclusion: The present industry structure is an outcome of economic Darwinism and perhaps the best choice we have given the one-of-a-kind DoD contracting setting. An artificial effort to change the status quo and the policy push to reverse the industry consolidation trend are likely to be counter-productive and fail.

## Cost-Plus Contracts: Problems

- The benefits of risk sharing associated with cost-plus contracts come with a price. Since cost-plus contracts are most often applied to the projects with high uncertainty and information asymmetry, they are subject to the contractor's manipulation of cost reporting.
- Critics basically argue that the contractor has a blank check from the government and hence they have little incentive to contain cost.
- Even when the profit is a pre-specified fixed dollar amount, the contracting firm as well as the management of the firm may be able to derive some private benefits from incurring a larger

cost. One possible example is the “empire building” behavior that rewards managers by growing a firm beyond the optimal level (Jensen (1986, 1989)).

- Therefore it is vital to address the agency problem that arises from the information asymmetry. We argue that this can be done within the framework of cost-plus contracts so that we can achieve better cost efficiency while in the meantime retain the benefit of risk sharing as well.

## Cost-Plus Contracts: Remedies

- A traditional cost-plus incentive contract can be refined such that the new form of contract not only keeps the conventional risk-sharing benefits, but also aligns the contractor's incentive with the incentive of the government.
- “Budget-based cost-plus scheme” offers policy makers a better choice than fixed-price contracts to improve traditional cost-plus contracts.
- A traditional cost-plus incentive contract takes the form as follows:

$$P = c + \pi(c) \tag{1}$$

$$\pi(c) = \alpha + \beta * (TC - c) \tag{2}$$

where  $P$  is the price paid by the government to the contractor;  $c$  is the actual reported cost as agreed by the auditor; and  $\pi(c)$  is the contractor's profit, which includes a target profit  $\alpha$ , and an incentive term for cost overruns (or underruns) above (below) a pre-specified target cost  $TC$ . The parameter  $\beta$  (a positive coefficient between 0 and 1) is the cost share parameter. Since the profit is penalized (rewarded) when there exists a cost overrun (underrun), the contractor is motivated to be more cost efficient.

- The primary drawback of the traditional cost-plus-incentive contract is that the government frequently does not possess necessary information to form a basis for estimating target cost due to significant information asymmetry. If  $\beta$  is set too high, the contractor receives windfall bonuses at the expense of taxpayers. On the other hand, if  $\beta$  is set too low such that the cost overrun is unavoidable, the contractor will be unfairly

penalized.

- Contractors (firms) usually have superior information concerning the expected cost of the project, yet the government cannot rely on the firms' estimates since contractors, as agents, may not truthfully reveal their beliefs due to the conflict of interests.
- One possible remedy to this dilemma is to introduce an optimal design of incentive contracts to ensure that the contractors (who have an information advantage) voluntarily and truthfully reveal their beliefs about the project's estimated cost.
- The theoretical setting is the classical principal-agent contracting model where the principal (i.e., the government) carefully designs the contract format, such that the agents (i.e., the contractors), in maximizing their own benefits, behave in the way that the principal desires.

- Consider a refinement of the traditional cost-plus incentive contract where the task of estimating target cost shifts from the government to the better informed contractor. Thus, equation (2) is modified as follows:

$$\pi(c, \overline{TC}) = \alpha(\overline{TC}) + \beta(\overline{TC}) * (\overline{TC} - c) \quad (3)$$

Where,  $\overline{TC}$  is the estimate of  $TC$  submitted by the contractor. Another important modification is that both  $\alpha$  (target profit) and  $\beta$  (cost share parameter), are no longer constants. Instead, they vary with  $\overline{TC}$  to provide the correct incentives for the contractors to truthfully reveal their unbiased cost estimate.

It is necessary to impose the following restrictions to the functional forms of  $\alpha(\overline{TC})$  and  $\beta(\overline{TC})$  such that:

$$\alpha'(\overline{TC}) < 0, \alpha''(\overline{TC}) > 0, \beta(\overline{TC}) = -\alpha'(\overline{TC}) \quad (4)$$

Insert Figure 1 for the curvature of  $\alpha(\overline{TC})$

- It can be demonstrated that the contracts characterized by equations (1), (3) and (4) will, as desired by the government, induce contractors to voluntarily submit their unbiased project cost estimate while maximizing their own benefits.
- To illustrate, insert Figure 2
- In summary, a menu of contracts characterized by equations (1), (3) and (4) would effectively induce the truth-telling behavior that is desirable under information asymmetry.
- A specific example is given in the paper (p14-15).
- A search of the DAMIR database shows that, out of the 69 active MDAPs for which we can identify their contract types, none of them uses “budget-based cost-plus scheme”. Thus, the potential improvement to cost-plus contracts is very high.



## Conclusion

- The mindset that fixed-price contracts are better than cost-plus contracts in limiting cost overruns may be misleading and could potentially do more harm than good to acquisition reform.
- Cost-plus contracts should remain as the major contracting tool in MDAPs to facilitate the implementation of major weapon systems projects that are otherwise too risky to be undertaken by defense contractors.
- The contractors' opportunistic cost misbehavior under traditional cost-plus contracts can be mitigated by using the "budget-based cost-plus scheme".