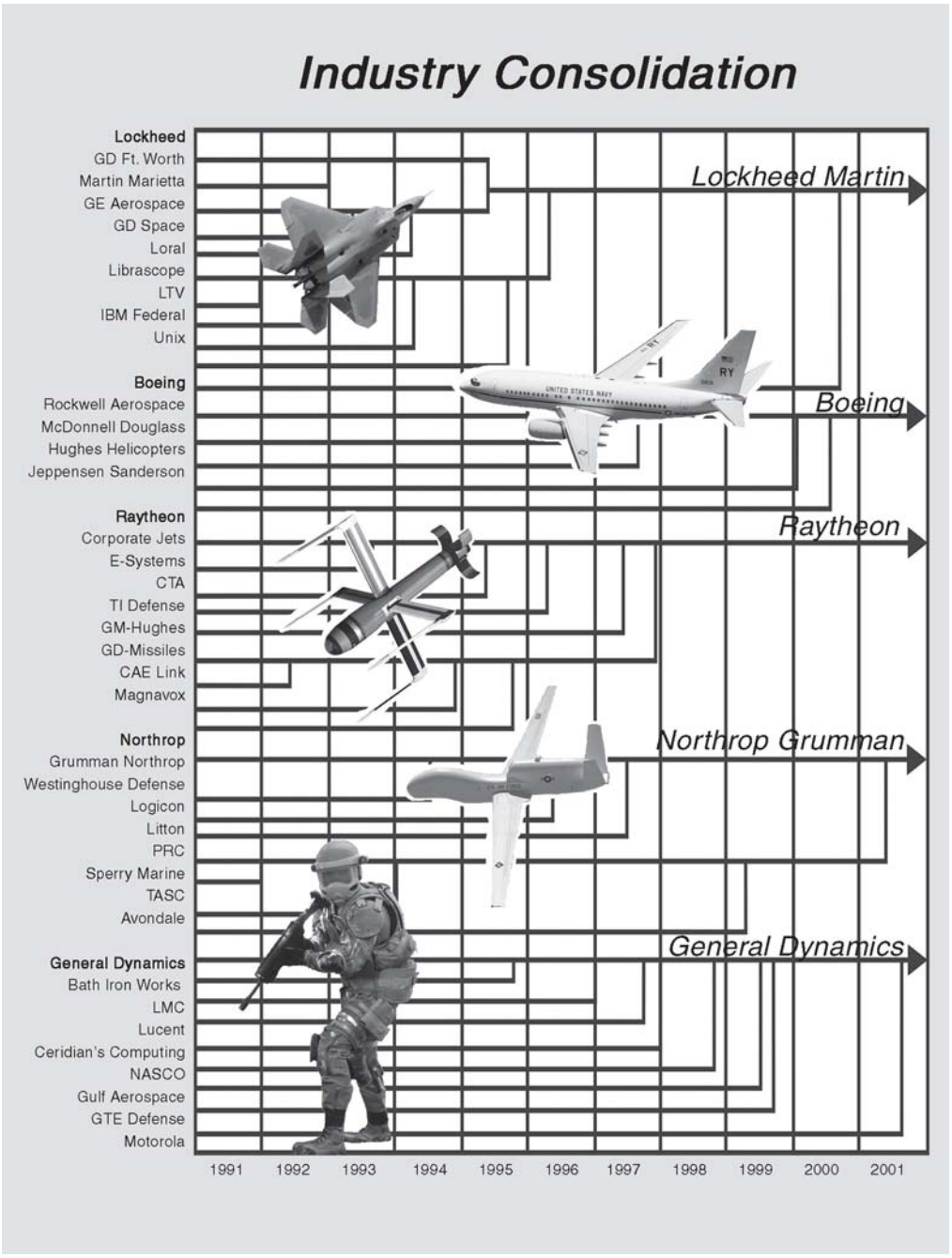
Industry Consolidation
Lockheed
GD Ft. Worth
Martin Marietta
GE Aerospace
GD Space
Loral
Librascope
LTV
IBM Federal
Unix
Boeing
Rockwell Aerospace
McDonnell Douglass
Hughes Helicopters
Jeppensen Sanderson
Raytheon
Corporate Jets
E-Systems
CTA
TI Defense
GM-Hughes
GD-Missiles
CAE Link
Magnavox
Northrop
Grumman Northrop
Westinghouse Defense
Logicon
Litton
PRC
Sperry Marine
TASC
Avondale
General Dynamics
Bath Iron Works
LMC
Lucent
Ceridian's Computing
NASCO
Gulf Aerospace
GTE Defense
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Lockheed Martin
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AN INITIAL LOOK AT TECHNOLOGY AND INSTITUTIONS ON DEFENSE INDUSTRY CONSOLIDATION

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Conventional wisdom holds that defense industry consolidation resulted from decreased defense spending. However, we maintain that understanding dynamic changes in key defense institutions helps provide a more complete explanation for observed consolidation. Specifically, we examine the interaction of evolving technology and changing institutions. Institutions reviewed include procurement policies, the weapons requirements process, and procurement organizations. We take an initial look at the industry, and highlight how these changes influenced transaction costs in the defense industry, more fully explain the forces driving consolidation, and provide greater insight to policy makers seeking to improve the performance of the defense industry. Further research is needed to build a robust institutional framework of the defense industry and the related government agencies to allow better policy prescriptions.

Still much of the public discussion of weapons acquisition problems proceeds as if the terms "competition," "price," "buying," and "seller" had the meanings they do in a market system.
(Peck & Scherer, 1962)

Over the past 20 years, 75 plus United States defense specialized firms/divisions merged into five major defense firms, or prime contractors (Commission on the Future of the Aerospace Industry, 2002). Almost universally the consolidation of the past 20 years has been explained as a result of decreased defense spending or capacity underutilization (e.g., Augustine, 1997; Deutch, 2001) and has been accompanied by concerns over the level of competition between remaining prime contractors (Ricks, 1996). Often the defense industry is compared with a competitive market of common commercial products and assumed to be inefficient. However, competitive markets of common commercial

products display multiple competitors and customers where prices can be predicted from given levels of supply and demand. Meanwhile, a defense market with differentiated weapon systems as products displays important differences from a classic competitive market (Peck & Scherer, 1962; Sapolsky & Gholz, 1998), and it should be recognized that assumptions about the applicability of competitive marketplaces can result in dubious policy recommendations (King & Driessnack, 2003; Langlois & Robertson, 1995).

Traditional explanations for the consolidation of the defense industry based on decreased defense spending are not consistent with a long-term view of the industry. Although recent defense industry consolidation is unprecedented, the U.S. defense budget has followed a cyclical pattern with both decreases and increases in spending since 1952 (see Figure 1). This suggests that the most recent defense industry consolidation has been driven by factors beyond decreased defense spending. Markusen's (1998) prediction that surviving defense firms would become smaller and focus more on commercial markets has not come to pass. For example, while Boeing offers both commercial and defense products, it grew larger through its acquisition of McDonnell Douglas, which increased its reliance on defense. Additionally, although mergers have consolidated the number of firms and decreased the number of personnel employed by defense firms, Department of Defense (DoD) Industrial Policy reports consistently show industry capacity has not undergone equivalent reductions.

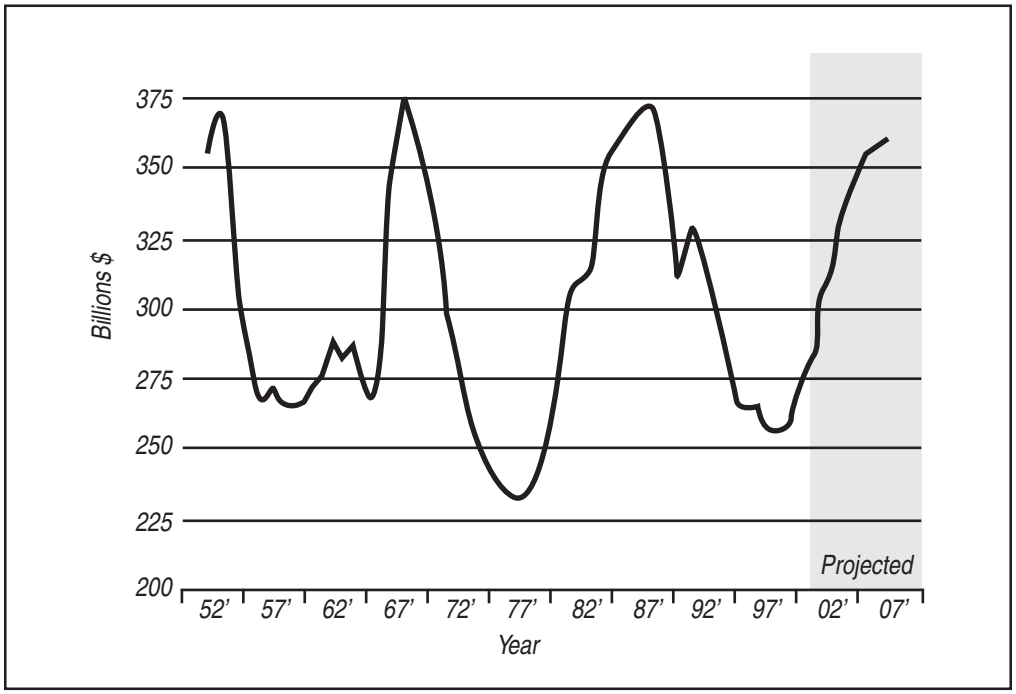

Figure 1. Defense Spending 1952-1997 in FY1996 Dollars

Peck and Scherer (1962) cautioned against applying traditional assumptions of a competitive price-driven market to the defense industry as their applicability is tenuous, at best. The defense market is unique and displays an increased role of government where it acts as both a buyer of goods and regulator of the market. Government actions predominate the defense market as it sets the rules (e.g., regulates contract types) and alone is responsible for uncertainty of demand as the sole buyer of defense goods.[1] Government represents an active institution in the defense industry, and institutions contribute to market structure by defining transaction costs (Hoskisson, 2000). The neo-classical economic view, which is often the basis of current industrial policies, minimizes the role of transaction costs and the impact of institutions on firms.

Our contribution involves applying an evolving framework called New Institutional Economics (Greenwood & Hinings, 1996; North, 1999; Williamson, 1985) to the defense industry. The result is an initial assessment of the impact of institutions in changing transaction costs, and the potential relationship these changes played in the recently observed defense industry consolidation. Existing research has recognized that transaction costs play a role in defense markets. For example, Rogerson (1994) recognized the key role of government in shaping the defense procurement process and unique characteristics that impact weapons procurement incentives. He goes on to lament that economics has largely been absent from shaping defense industry institutions and its regulatory environment because of the unique nature of defense procurement. Our goal is to facilitate a better understanding of the defense industry and its efficiency by providing a framework that allows more informed policy recommendations through a better explanation of the role of institutions in the defense industry.

Defense Industry Consolidation

Our analysis begins with a summary of the defense industry. We define defense firms similar to Chu and Waxman (1998) as firms that have established capabilities and competencies in dealing with the DoD. An important implication of this definition is that defense firms have evolved to become *specialized* in the sense that they focus on the transactions with a monopsony customer—the agencies and organizations in the DoD and not in any particular product or technology. Our initial look focuses on the top of the defense industry hierarchy, the 5 firms, Lockheed Martin, Boeing, Raytheon, Northrop Grumman, and General Dynamics, which have consolidated to increase both their share of the defense business and percentage of their business dependent on defense work.

"Defense firms sell unique products in a monopsony where the only buyer is the U.S. government."

These defense firms are public firms, but many of the similarities to commercial firms operating in the U.S. market end there. Defense firms sell unique products in a monopsony where the only buyer is the U.S. government. Contract competitions typically involve situations where 'winner takes all,' and R&D costs for

their high-technology products are largely subsidized (McNaughter, 1989; Peck & Scherer, 1962). Viewing defense firms as operating in a traditional commercial market would require that the specialized knowledge for doing business with the government could be easily obtained (Chu & Waxman, 1998). Further understanding the defense industry consolidation requires understanding a market defined by the transactions with U.S. government procurement offices utilizing highly stylized rules for contracting. We employ New Institutional Economics (NIE) to examine the role technology and institutions played in defense industry consolidation.

"There are multiple unique technologies required for different categories of weapon systems."

New Institutional Economics

The basic unit of analysis or core of the NIE framework is transaction costs and how they are determined by the interaction of changing institutions, environment, and enforcement arrangements of formal and informal market rules. When examining transaction costs, the question that needs to be resolved is on what principal dimension does a transaction differ (Williamson, 1996). Additionally, Williamson indicates that similar effort is needed to understand differences in governance structures that bring order to transactions.

Our analysis begins by examining how defense industry transactions changed as a result of the advancement in technology and the need for integrated weapons, evolving government institutions, and impact of *winner take al* contracts. Again, our goal is to see how changing institutions and transaction costs can also help explain defense industry consolidation. We do not claim that these forces are the only ones acting on defense firms. Instead, we highlight that they represent contributing forces that have not been previously examined, in comparison to decreased procurement funding. Our findings suggest that changing institutions and transaction costs provides a more complete story of the forces driving defense industry consolidation.

Evolving Technology

Technological change can have extensive impacts on the competitive dynamics of industries (Anderson & Tushman, 1990). There are multiple unique technologies required for different categories of weapon systems. We focus on providing examples from fighter aircraft where significant advances in core and supporting technologies can be observed to demonstrate that maturing technology has contributed to defense industry consolidation. As technology matures, a dominant design is established, and there is pressure for firms to consolidate, as fewer product offerings exist in a market (King, Covin & Hegarty, 2003).

In the case of fighter aircraft technology, following World War II, technology evolved from reciprocating engines to jet engines driving changes to basic aircraft design. Uncertainty about potential performance and product design drove a large number of unique aircraft designs from multiple defense firms. For example, a

total of nine prime contractors designed and flew 40 different fighter aircraft designs during the 1940s and 1950s (Lorell & Levaux, 1998). However, as jet fighter technology matured the number of aircraft designs fell with less than a dozen U.S. fighter aircraft developed since 1960. Maturing technology contributes to pressures on major defense firms to consolidate as fewer aircraft designs required fewer prime contractors that are capable of integrating and manufacturing fighter aircraft. A related observation that supports this statement is that there have been no new entrants into U.S. manned aircraft production since 1945 (Birkler, Bower, Drezner, Lee, Lorell, Smith, Trimble, &Younossi, 2003). Additionally, the aircraft types that are produced are maintained longer and upgraded more often. Upgrade contracts are typically awarded to the original prime contractor, requiring defense firms to retain a workforce able to manage multiple technology insertion programs.

The award of the F-22 Raptor and F-35 Joint Strike Fighter contracts to Lockheed Martin has resulted in a situation where no other new manned fighter aircraft program is in design or planned to be in design for at least the next 10 years. This reduction in the number of aircraft designs may be far more influential on industry consolidation than decreased defense spending. For example, the Joint Strike Fighter is the largest DoD program to date in terms of its anticipated budget value. The consolidation of aircraft type is also consistent with bomber and cargo aircraft. We maintain this consolidation of weapon systems influenced industry consolidation more than the cycles in defense spending. However, institutional factors also contributed to defense industry consolidation.

Changing Institutions

In looking at the consolidation in the defense industry it is important to consider the changing institutions. Institutions are the formal and informal rules along with their enforcement arrangements that influence the nature of the transactions and their costs (Furubotn & Richter, 1998). Combined with evolving technology, changing institutions have influenced market forces within the defense industry. We summarize the forces that have influenced defense firms with the goal of providing insight on the drivers of defense industry consolidation beyond decreased defense spending. Specifically, the evolution of government procurement practices has likely impacted consolidation within the defense industry. We examine the government procurement practices in three areas—defense procurement policy, requirements generation, and the organization of government procurement agencies—that shape the interaction of exchanges between the government and defense contractors.

"Maturing technology contributes to pressures on major defense firms to consolidate as fewer aircraft designs required fewer prime contractors that are capable of integrating and manufacturing fighter aircraft."

Procurement Policy

Since WWII, a set of diverse organizations in each service evolved from their

various histories to manage weapons system procurement. The government did not buy as a monopsony, instead numerous organizations for each service acted as independent actors on the market for particular service weapons. The policies of these organizations have evolved to become unified with the development of common policies and regulations. Government procurement policies and regulations are outlined in the DoD 5000 series regulations and contractual management procedures (the interface with commercial industry) in the form of the Federal Acquisition Regulation (FAR). These procurement practices define the interaction between the government and firms in the defense industry.

"In general, 20 years ago contractors *specialized* not only on a particular weapon system, but also on the unique procurement organization within each armed service."

The FAR has evolved as an all-encompassing regulation governing federal procurement in the past 20 years—a period that aligns with the defense industry's consolidation. The origin of the present day FAR was the Armed Services Procurement Act of 1947 (Nagle, 1999). Following that act the number and size of regulations governing procurement steadily grew. By 1979, there were 877 different sets of procurement regulations including directives, bulletins, and instructions, comprising 64,600 pages of regulations. Since then, the specific policies for each armed service and the various other non-DoD government agencies have been consolidating into a single federal regulation. Progress has been made to establish the FAR as the single federal procurement policy (Nagle, 1999).

In general, 20 years ago contractors *specialized* not only on a particular weapon system, but also on the unique procurement organization within each armed service. For example, as recently as the 1980s, each Service had separate contract monitoring processes that drove firms to specialize in dealing with individual armed services. If a firm did business with multiple branches of the military, it was not unusual for each service to have its own contract monitoring personnel assigned to a firm's plant full time.

This has changed over the past 20 years with a series of unifying events. One example is the single-process initiative (SPI) that began, in 1994, and in a matter of two-years time relieved defense firms from multiple processes driven by numerous government procurement offices. The oversight was placed under a single defense agency, Defense Contract Management Agency (DCMA), eliminating almost all of the unique service-oriented contract monitoring offices.

The creation of a single office further contributed to the standardization of government processes. It should be noted that the single process initiative did not eliminate the unique requirements of the government, but reduced the ability of the different DoD agencies and services to require unique processes. The contractor could have a single set of processes for a given facility or across multiple facilities. As government procurement became more standardized, defense firms were less constrained to specializing for each armed service—widening their

opportunities to take advantage of their specialization. This may have contributed to defense industry consolidation in that niche firms may have decided to exit the industry as they realized their niche would be encroached upon as uniform government procurement practices increased competition and reduced transaction costs required to deal with multiple armed service weapons procurement organizations.

The same consolidation and standardization that happened on the FAR also occurred with the DoD 5000 series; the policy focused on government procurement processes and thus influenced the structure of the procurement organizations. The 5000 series was first issued in July 1971, as an initiative of then Deputy Secretary of Defense David Packard (Przemieniecki, 1993) with the primary theme of centralized policy and decentralized execution (Ferrara, 1996). The initial focus was on the procurement of major weapon systems, allowing the services to continue to acquire non-major systems under their own policies. However, in 1987, the 5000 series was extended to all procurement programs, and consolidated over 60 different directives, instructions and memoranda. The 5000 series has continued to reduce the number of unique armed services processes. This reduction along with the evolving technology and move toward joint programs (more than one armed service involved) has moved the various armed services toward a single monopsony (single customer) versus a collection of monopsony buying related but not the same products. An example is the past purchase of fighter aircraft by the Navy, like F/A-18s, and the Air Force, like F-16s, to the joint purchase of the F-35 Joint Strike Fighter.

Requirements Generation

The requirements generation process establishes the collective intent of the government on what weapon systems are purchased. Requirements generation operates in conjunction with the Planning, Programming, Budgeting, and Execution (PPBE) process used to manage resources by applying constraints. While internal to the government, requirements generation is visible to industry and provides information on the future intent of the government-buying preferences. Government selection and procurement of given weapon systems is not independent of evolving technology.

The number of aircraft ultimately purchased has fallen as technological advances deliver additional capability. For example, by 1958, when the F-4 fighter prototype first flew (Smith & Friedman, 1980), the speed of fighter aircraft reached a plateau and technology changed to focus on guided missiles, which represented a growing percentage of aerospace industry sales and in many cases were viewed as a substitute for aircraft (Simonson, 1968). The increased capability of aircraft from technology advances, such as guided weapons, simply translated into a requirement for fewer numbers of aircraft. For example, the impact is clearly demonstrated in comparing U.S. Air Force procurement quantities of F-4 aircraft (2,600) to F-117 stealth fighters (59). However, the resulting capability is comparable in that a single F-117's bombing effectiveness equates to 95 F-4 aircraft

"The number of aircraft ultimately purchased has fallen as technological advances deliver additional capability"

(Toffler & Toffler, 1993). The general impact of available technology delivering more capable weapon platforms suggests fewer major defense firms were needed (Deutch, 2001). Additionally, an increased emphasis on jointness has led to the Joint Strike Fighter becoming the single planned replacement aircraft for the Air Force's F-16, the Navy's F/A-18, and the Marine's AV-8B.

Further decreasing the number of different aircraft designs, the trend in requirements generation has been toward joint programs, or programs that meet the needs of more than one armed service. Emphasis on joint weapon programs has steadily increased since the F-111 aircraft was originally designed to meet the needs of two services—the Air Force and Navy (Smith & Friedman, 1980). Among other initiatives, the Goldwater-Nichols Department of Defense Reorganization Act of 1986 made the Joint Chiefs of Staff advocates for a joint military perspective with the vice Chairman of the Joint Chiefs of Staff (VCJCS) responsible for chairing the Joint Requirements Oversight Council (JROC), a special council on military requirements (Owens, 1994). After the termination of the Navy's A-12 aircraft program, in 1991, joint programs took hold as the dominant paradigm as the termination essentially ended service- and mission-unique aircraft programs (Jefferson, 1991). The emphasis on joint programs has also increased the monopsony power of the government as procurement is further centralized from the different armed services.

"Another consideration is that each aircraft program essentially involves a *'winner take all'* competition for manufacturers."

Another consideration is that each aircraft program essentially involves a "*winner take all*" competition for manufacturers. The most recent fighter aircraft competition involved the Joint Strike Fighter (JSF), and the associated development contract was awarded to Lockheed-Martin and Boeing in November 1996 (*Wall Street Journal*, 1996a). One month later, after just ending similar merger discussions only six months earlier, Boeing announced a merger with McDonnell Douglas, the loser of the JSF competition (*Wall Street Journal*, 1996b). The *only* change in prospects for McDonnell Douglas, after it scuttled merger discussions with Boeing earlier the same year, was the JSF contract award. As the JSF represented the only major fighter aircraft contract anticipated for at least a decade, consolidation represented a reasonable reaction. The JSF program also demonstrates the level of emphasis on joint programs. The JSF is the planned replacement for the Navy F/A-18, Air Force F-16 and Marine AV-8B aircraft, plus aircraft for several foreign military partners that are participating in the program. Maturing technology, winner take all competitions, and increased emphasis on joint programs all contributed to fewer aircraft programs that, in turn, drove consolidation as each factor signaled a requirement for fewer aircraft manufacturers.

Government Organization

The most existing literature on the defense industry overlooks the organization of government agencies. However, due to

the interaction between government and defense contractor offices, changes to the structure of government procurement organizations also impacts defense firms. Procurement organizations have undergone two primary changes—centralization and downsizing.

The centralization of procurement policy and intervention by Congress through the Goldwater-Nichols Department of Defense Reorganization Act of 1986, created consistent government procurement oversight by establishing Program Executive Officers (PEOs). The PEO structure for the majority of procurement programs established a streamlined authority through the civilian leadership from the Service Acquisition Executive (SAE), the most senior service official for acquisitions of weapon systems, to each weapon system program manager. This change lessened the influence of other varied organizations in the DoD and respective services from the day-to-day operations of weapons system procurement.

Reduced defense budgets have placed an emphasis on downsizing of government procurement agencies that are largely viewed as ancillary to the armed services mission of winning wars. Traditionally government program offices issued various contracts to different prime contractors for different subsystems of an overall weapon system and the government acted as the integrator. However, reduced personnel resources following the end of the Cold War led to government program offices placing more effort on contract, resulting in a migration of tasks and associated transactions from the government to defense firms acting as prime contractors.

This migration of responsibility was generally known as Total System Program Responsibility (TSPR). Under this concept a defense firm selected as the prime contractor for a program was given this "total responsibility" under broad integration contracts. The prime contractor is now often responsible for integration of an overall system, instead of the government's weapon system program office. Increased responsibility by prime contractors had the effect of limiting the number of contracts available from the government as subsystem contracts previously issued by the government were bundled within a prime contractor's weapon system contract. The combined effects of centralization and downsizing led to a shift in workload from government-buying agents to prime defense contractors, and reduced government unique transaction costs with the market. The competitive impact of this shift in subcontract management from the government to defense firms is unknown, and represents an opportunity for future research.

"Reduced defense budgets have placed an emphasis on downsizing of government procurement agencies that are largely viewed as ancillary to the armed services mission of winning wars."

While the number of government procurement personnel has decreased, there was increased emphasis on ensuring they were better trained. Congress passed the Defense Acquisition Workforce Improvement Act (DAWIA) in 1990, and it outlined education and certification procedures for a professional procurement workforce. Centralization of procurement policies was followed by centralization of training, and in 1992 Defense Acquisition

University (DAU) was formed. The consolidation of the training for government personnel on the unique institutional mechanisms and structures further demonstrated government procurement policy centralization that was helping to prompt defense industry consolidation. The consolidation of processes would only be strengthened as government procurement personnel received training on uniform procurement practices from a centralized training organization.

SUMMARY

Forces relating to changing technology and changing government institutional practice corresponded with decreased defense spending to drive defense industry consolidation. Changing government practice includes joint procurement, centralization of procurement policy, standardization of government procurement organization, and standardized training of a core of professional procurement personnel. Together these evolving changes led to common government policies that changed the dynamic in the defense industry and pressured defense firms to reduce transaction costs through consolidation. Viewing the defense industry consolidation using this framework provides a more complete explanation than reduced defense spending. The framework also provides a better foundation for future policy recommendations.

"Together these evolving changes led to common government policies that changed the dynamic in the defense industry and pressured defense firms to reduce transaction costs through consolidation."

DISCUSSION

The central message of this paper is that the U.S. government holds a unique position in the defense industry as both a monopsony customer and as a federal government with regulatory oversight that controls the mechanisms in the market. This position allows the government to have a hyper influence on the institutions governing the mechanisms of exchange and thus the structure of the defense industry. Evolving government policies and their impact on transaction costs (North, 1990) brings clarity to explaining recent defense industry consolidation.

Our observations are consistent with views of institutions impacting transaction costs and the structure of markets. We find that both government procurement organizations and defense firms should be viewed as rationally reducing transaction costs and thus the structure of the defense market. The defense industry experiences a unique set of transaction costs from those experienced in commercial-oriented free markets, and the application of competitive market prescriptions focused on prices to the defense industry is inappropriate.

An institutional framework that considers transaction costs provides a more complete picture for moving forward and assessing defense industry efficiency issues that concern policy makers. The current view commonly held within the government and the literature focuses on competition driving defense industry efficiencies and preventing defense firms from collecting monopoly rents. This view is derived from traditional supply and demand models with multiple suppliers and customers and has less application considering the unique nature of the defense industry. For example, the Truth in Negotiation Act

(TINA) of 1962 and creation of the Defense Contract Audit Agency in 1965 (Lorell, *et al*., 2000) has created a system where the government provides a counterbalance to any monopoly power, ensuring it only pays fair and reasonable costs for products.

The changes in the defense industry over the past 20 years represent the government and firms rationally reducing transaction costs through centralization and consolidation respectively, but not a substantial increase use of free market mechanisms. It is unlikely that the defense industry will ever approximate a competitive market, as long as the government remains a monopsony customer with regulatory oversight.

Any application of a competitive market framework will shed limited light on the realities of defense industry structure and its evolution. We show that expanding the view of the defense industry to include institutions and related transaction cost provides improved explanation for observed defense industry phenomenon, or in the present case industry consolidation. Institutions and transaction costs can provide a more realistic framework for economic analysis, and should play a more active role in framing policy recommendations.

The defense industry is typically characterized as inefficient. However, determining the efficiency of a market needs to consider constraints imposed by transaction costs, and an outcome without a feasible and superior alternative should be accepted as efficient (Williamson, 1985). The *feasibility* of alternatives needs to be understood within the institutions relating to a market, or relevant legal, economic, and political realities, which in the case of the defense industry, play a larger role than a traditional competitive marketplace. For activities in the public sector, external costs imposed on the operation of markets may be higher than necessary—reducing these costs requires modifying the institutions governing decision-making heuristics (Buchanan & Tullock, 1962). Indeed, the preoccupation with rational choice and efficient market often blind people to the implications of complex environments and the realities of incomplete information (North, 1999). Recognizing path dependence is key to understanding long-run economic change, and our review shows the additional forces that evolving government institutions placed on defense firms likely contributed to consolidation.

In closing, reduced defense spending alone does not fully explain the consolidation of defense firms witnessed during the 1990s, as decreased defense spending has occurred in the past without similar consolidation. The unique nature of the defense industry makes the application of traditional price driven explanations and associated policy recommendations from competitive markets tenuous. Examination of the interaction of evolving technology, changing institutions, to include the procurement policy, weapons requirements process, and the procurement organizations on transaction costs in the defense industry will more fully explain the forces driving consolidation and provide greater insight for policy makers seeking to improve the performance of the defense industry. Further research is needed to develop a robust institutional framework of the defense industry and the related government agencies.

ENDNOTE

1. Even Foreign Military Sales (FMS) typically are handled through the DoD, or U.S. government.

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