DEFENSE CONTRACTOR PROFIT

THESIS

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Abstract

This research seeks to achieve two objectives: 1) to provide a comprehensive survey of research related to defense contractor profitability, and 2) to conduct an updated analysis of such profitability. No previous comprehensive survey of the topic was found in the academic literature. Therefore, the provision of such a survey may significantly benefit future researchers. A paucity of recent defense contractor profit research related was identified; only one published study analyzed data after 2000 and none used data more recent than 2010. This research reconciles the gap in recent defense contractor profit studies via objective two.

Panel data analysis is employed to examine the profitability of defense contractors between 2009 and 2018. The relationship between contractor influence in the defense marketplace and profits from defense business is explored as well as the relationship between contractor operating risk and defense business profits. Additionally, the relationship between defense contractor profitability and the percentage of total sales attributed to defense (versus commercial sales) is investigated. Neither contractor influence, nor risk was found to have a moderating effect on defense business profits. The empirical evidence did however indicate a positive relationship between contractor profitability and the percentage of total sales from defense business.

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Clayton S. Eilert

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I. Introduction

Background

Alexander Hamilton, then Secretary of the Treasury, noted in his 1791 *Report on the Subject of Manufactures* that a provision for annual purchases of military weapons from domestic suppliers would economically benefit such manufacturers while bolstering national defense (Hamilton, 1791). Two hundred years later the United States still benefit from a collection of domestic defense suppliers that has evolved to what is now referred to as the defense industrial base. This base provides national security through its ability to rapidly innovate and deliver the enhanced military lethality and technological dominance necessary to deter and prevail during conflict (U.S. Department of Defense, 2018). Originally, from the 1790s to 1941, civilian firms were leveraged to meet military manufacturing and supply needs only during periods of conflict when such needs exceeded the capacity of government owned arsenals and shipyards (Lynn, 2014). The incredible scale of the Second World War however, with its profusion of emergent warfighting technologies, ushered in the era of a standing defense industry via President Roosevelt's War Production Board in 1942. The War Production Board officially coordinated the conscription of major U.S. civilian industries, such as automobile production, into domestic wartime service (Lynn, 2014). When World War II concluded the industrial players conscripted into wartime service did not quietly return to strictly civilian enterprises as was standard for the terminus of previous United States conflicts. Instead, many corporations retained divisions solely committed to defense contracting (Lynn, 2014). Over the following decades these defense focused divisions grew and evolved while continuing to meet the United States' military needs--ultimately attracting numerous new entrants into the burgeoning defense industry. Former U.S. Deputy Secretary of Defense William J. Lynn III notes that defense contractors in today's age meet not only vital military requirements but also deliver technologies that greatly enrich the daily lives of civilians with developments like GPS and the internet (Lynn, 2014).

Publicly traded corporations engaged in defense contracting, like corporations with a purely commercial focus, must generate sufficient shareholder value in order to sustain continued operations. Consequently, the depth, breadth, and continued existence of United States defense contractors -- the core of our nation's defense industrial base -- is inextricably linked to their profitability. Defense contractor profitability therefore yields associated implications to national security, technological advancement and innovation, and both taxpayer and shareholder value. Given these implications, it is unsurprising that defense contractor profits have garnered abiding attention from elected representatives, government officials, and academics since the inception of the defense industry following World War II.

Research Objectives and Questions

This research effort seeks to achieve two objectives: (1) to provide a comprehensive survey of the extant research literature examining the topic of defense contractor profitability, and (2) to conduct a recently updated analysis of such profitability, inspired by the aforementioned survey. No previous comprehensive survey of the topic appears to be found in the academic literature. Therefore, the provision of such a survey herein may be a considerable contribution to subsequent researchers in the field. Also, this survey identified a paucity of recent research in the field of defense contractor profits and seeks to reconcile this via objective two.

Motivated by the survey of literature, this research is focused on addressing three questions. First, how might a defense contractor's level of market influence correlate to the profitability of their defense business? Second, how might a defense contractor's operating risk relate to the profitability of their defense business? Finally, what is the relationship between defense contractor profitability and the percentage of total sales attributed specifically to defense (versus commercial sales)?

Limitations and Scope of Research

Objective one--the research survey--is relatively unconstrained. It is limited to unclassified and publicly available research germane to the profitability of defense contractors published (or otherwise made available) at the time the survey was conducted. The scope of the literature survey consists almost entirely of peer-reviewed and published academic research articles, and United States government or government-sponsored studies; however, several books of exceptional merit--owing to the expert authority of the author--have been included.

Objective two--the recently updated analysis of defense contractor profitability--was constrained in several ways. First, the data for analysis was strictly limited to that which was unclassified and publicly available. This research did not have access to any private corporate data. Only such figures mandated for discloser by the Securities and Exchange Commission (SEC) or voluntarily provided in annual corporate filings to the SEC were analyzed. Second, corporate data collected from the SEC's website and Yahoo! Finance was assumed accurate. Similarly, annual government contracting figures reported by the Federal Procurement Data System were also assumed to be accurate. Additionally, data availability was limited to that from publicly traded, domestic corporations actively operating at the time of the study. Data for analysis was not available from defunct, private, not-for-profit, or previously acquired organizations or firms.

The limitations faced by objective two of this research serve to define its scope. Specifically, the analysis of defense contractor profitability targets publicly traded United States defense contractors listed in the annual Top 100 Contractors Report published by the Federal Procurement Data System between 2009 and 2018.

Thesis Overview

This thesis consists of five chapters. A survey of defense contractor profit literature is provided in Chapter 2. First, a review of the linkage between defense contractor profits and (1) national security, (2) innovation and technological supremacy, and (3) taxpayer and shareholder value is presented. Next, a discussion of the challenges related to assessing contractor profit and comparing various profit study outcomes is offered. The remainder of Chapter 2 is dedicated to a detailed survey of defense contractor profit research prior to 2019. Chapter 3 introduces the methodology employed for conducting a current analysis of defense contractor profitability between 2009 and 2018. Next, the hypotheses used to explore the research questions are developed and how they are tested is explained. The components of the model used, including the period of study and variables employed are described. Also, justification for each of the model component's specification is provided. Lastly, the data and methodology used to analyze the data are discussed. Chapter 4 details the results of the analysis described in Chapter 3 and answers the research questions. Chapter 5 provides the conclusions of this research and suggests potential follow-on research.

II. Survey of Literature

Chapter Overview

Before approaching a detailed survey of defense contractor profit research, it is important to possess an understanding of why one should care about the profits earned by defense contractors and the challenges related to previous studies of the topic. This chapter first outlines the implications of defense contractor profit on: 1) national security; 2) innovation and technological supremacy; and 3) taxpayer and shareholder value. Next, the challenges of assessing defense contractor profits are discussed. This section describes the different ways that defense contractor profit has been measured and how "defense contractor" has been defined and used in research. Then, the challenges of comparing profits due to differing market structures and risk are explored. Finally, a survey of defense contractor profitability research is provided. This survey is separated into three sections: 1) studies which examine profitability from the firm level; 2) those that study profitability from the business segment level; and 3) studies which have been sponsored by the government.

The Importance of Defense Contractor Profit

By examining defense contractor profit one can gain insight into the financial health of individual firms and the defense industry at large. These profits may also serve as a way to gauge the effects of changes in Federal defense acquisition regulations, procedures, and priorities. Given the enormity of the United States' annual defense procurement budgets, which averaged 3.18% of the total annual national budget between 2009 and 2018 (Office of Management and Budget; 2020), it is important that our acquisitions process works as intended.

Procurement process impacts aside, defense contractor profit is an important consideration because it sustains the continued operations of firms serving the defense industrial base. Since these firms are no longer conscripted into meeting the nation's defense needs, profits attainable in the defense industry must be sufficient to attract and retain domestic businesses to supply defense goods and services. Ideally, the profit opportunities afforded by the defense industry would fall within a type of "goldilocks zone". Perceived excessive profits are unpalatable to taxpayers who bear the price of such profits--which are seen as poor stewardship of government budgetary resources. Conversly, taxpayers suffer a Cadmean victory if profits in the defense industry become so miniscule as to produce a market of last resort. Ultimately, the depth and breadth of the United States defense industrial base is inextricably linked to the profitability of contractors serving therein. Defense contractor profitability is an important area of study because of the associated implications to national security, technological advancement and innovation, and both taxpayer and shareholder value.

National Security

Civilian firms provide viable productive capacities which are important to defense in two ways: 1) they fortify the supply chain by maintaining arsenals and outfitting the military services on a daily basis; and 2) they deliver production surge capabilities during periods of conflict. During World War II President Franklin D. Roosevelt referred to the U.S. domestic defense manufacturing capability--i.e., the defense industrial base--as the "arsenal of democracy" (Roosevelt, 1940). Today, civilian firms continue their tradition of making vital contributions to our nation's security. The defense industrial base is explicitly noted as foundational to U.S. national defense in Executive Order No. 12,919 (1994). In light of the central role defense contractors play in national defense, their profitability is an important consideration; it contributes to the financial well-being and thus longevity of the firm.

Innovation and Technological Supremacy

Porter's Five Forces Framework for analyzing competition in industry explains that a profitable industry incites market entry by new firms (Porter, 1979). Further, the entrance of new firms increases industry competition and--as noted by then Under Secretary of Defense Ashton B. Carter--these new entrants "renew and refresh the technology base, and ensure that defense is benefitting from the main currents of emerging technology" (Carter, 2011). Therefore, the profitability of defense contractors is an important element in fostering innovation. In fact, economic profits have been cited as an optimal way to motivate innovation among defense contractors (Rogerson, 1989). Such innovation has delivered pioneering advancements like stealth technology, night-vision goggles, and unmanned aircraft--which give our troops a distinct battlefield advantage. Other innovations born of the defense industry--such as Duct Tape, walkie-talkies, GPS navigation, and the internet--have also permeated and improved the daily lives of civilians.

Taxpayer and Shareholder Value

When considering defense contractor profitability, it may first appear that taxpayer and corporate shareholder interests are diametrically opposed. However, there are instances when that is not true. Given the Defense Department's reliance on the industrial base to buttress national security, taxpayer and corporate shareholder interests are aligned in many ways when promoting a vibrant and financially stable defense industry. A highly productive defense base that is both cost-efficient and cost-effective is most likely to function as part of a profitable business environment. This profitable environment benefits corporate investors and taxpayers alike; the former viewing profits as an end goal and the latter viewing profitability as a means to secure national defense. Taxpayers also benefit from the fact that the domestic defense industry is a major employer. The defense industry afforded 2.3 million jobs for Americans in 2000 (Else, 2000) and accounted for roughly 1.3% of total private sector employment in 2018 through the provision of 1.6 million jobs (U.S. Department of Defense, 2018). Taxpayer interests are aligned with some level of defense contractor profitability given that profits keep defense contractors in business; and they in turn provide not only defense goods and services but numerous jobs to the American public. Taxpayers are loath however, to feel they may be unduly subsidizing the defense base. This sentiment is rather vividly expressed by Adams and Adams who repine that "defense contractors seem to be safely sheltered in the womb of government with their umbilical cord tied to the U.S. Treasury" (Adams & Adams, 1972). Defense procurement scandals involving $600 ashtrays and $800 toilet seats (Greer & Liao, 1986) offer further evidence of taxpayer sensitivity to contractor profit. This profit sensitivity may be further exacerbated given that voters at large significantly overestimate the actual levels of national defense outlays (Jones, 1999). David Kaun notes that defense contractors themselves are also sensitive to the perception of excessive profitability -- or the "cardinal sin of a monopolist" (Alchian & Kessel, 1962) -- as such a perception would "raise congressional and public ire, and may call for increased regulation" (Kaun, 1988). In fact, Scherer (1964) cites that executives of defense contracting firms had commented that is was unwise to earn and retain profits above 10% on any single incentive contract and had even choose to voluntarily refund--with some regularity--any profits above that level although under no legal requirement to do so. Scherer further references the General Accounting Office's proclivity to audit in detail contracts which generated profits to defense contractors above 12% and states that Congress' unfailing reaction had been to suspect profiteering (1964). The delicate balance of taxpayers' -- and to some extent, defense contractors'-- somewhat conflicted interests surrounding defense contractor profitability adds yet another angle of analysis to this multifaceted issue.

Challenges in Assessing Defense Contractor "Profit"

Measuring Profit

Assessing the profitability of defense contractors is a particular challenge given the numerous ways in which "profit" can be specifically defined, interpreted, and operationalized for research. Primarily, differences in profitability assessments appear to stem from the use of either accounting or market-value based measures. Accounting measures of profitability have been popularly justified on the grounds that information provided by balance sheets and income statements is simply the best data available (Hirschey & Wichern, 1984). Many proponents of accounting-based profit measures concede that such methods are not perfect though. For example, the usefulness of comparisons based on such information may be dulled due to differences in accounting practices between firms or industries (Bowlin, 1995). Greer & Liao specifically note that the allocation of corporate overhead and other costs between divisions and across contracts may distort the profit attributed to any specific division (1986). Thus, accounting practices may allow for the arbitrary redistribution of profits among various segments within the firm. Other academics have confirmed defense contractors' opportunity for cost shifting via accounting practices (Lichtenberg, 1992; Rogerson, 1992; Thomas & Tung, 1992). Ultimately, Greer and Liao conclude that investigations into a firm's defense business profits should simultaneously consider their commercial profits (1986). After completing a firm-level profit study, Bowlin also remarks that comparisons distinguishing between the defense and commercial business segments would be informative (1995). Fisher and McGowan remonstrate the use of accounting measures entirely by suggesting that firm-level data makes inferences about relative profit rates impossible -- thus completely devaluing the use of accounting profit data (1983). If accepted, Fisher and McGowan's argument would render an analysis of defense industry profits intractable. However, their stance regarding the use of accounting profit has generated much dissent. Long and Ravenscraft rebutted that Fisher and McGowan "ignore substantial evidence that accounting profits do, on average, yield important insights into economic performance" (1984). Ira Horwitz noted in a moderate response that the shortcomings of accounting-based profit measures should not disqualify their use entirely; but rather that such analysis should be undertaken thoughtfully with a keen awareness of those shortcomings (Horowitz, 1984).

While the use of accounting measures of profitability has been widespread (Weidenbaum, 1968; Agapos & Gallaway, 1970; Carroll, 1972), other academics have championed the use of market-value data (Stigler & Friedland, 1971; Canes & Watts, 1976; Hirschey & Wichern, 1984). Such advocates conclude that market-value data provide unique and valuable perspectives regarding firm profitability. Still others conclude that both accounting and market measures should be used to assess profitability (Ross, 1983; Myers, Peterson, McClenon, Konvalinka, & Wood, 1985; Mayer-Sommer & Bedingfield, 1989). Stephen Ross notes that market-value data communicates profit information from an expectational perspective while accounting data provides an alternate view of the same firm from a historical perspective (1983). He argues that by comparing accounting and market-value data we gain a more complete understanding of a firm's profitability. Hirschey and Wichern similarly accept that using both accounting and market data (although both are individually imperfect) produces unique and highly beneficial (although still imperfect) measures of profitability (1984). Ultimately, the profusion of defense contractor profitability studies employing accounting measures, market-value measures, or both indicates a willingness among researchers to accept such data imperfections.

Defining "Defense Contractor"

The challenges of defining and measuring profit notwithstanding, assessments of profitability are especially labored given the heterogeneity of firms that may rightly claim the title "defense contractor". According to the Code of Federal Regulations a defense contractor is "any individual, firm, corporation, partnership, association, or other legal non-Federal entity that enters into a contract directly with the DoD to furnish services, supplies, or construction" (Operational Contract Support, 2012). Firms that meet the preceding definition vary widely along several dimensions. Defense contractors populate the spectrum from burgeoning small business startups to mature conglomerates (Pownall, 1986). Some contract the provision of goods -- others services. Goods contracted span diverse offerings from software to clothing to armaments. Contracted services range from janitorial work to cloud computing and storage. Some contractors generate 100% of their total revenues from government sales while others operate a defense segment contributing to less than 1% of the firm's revenues (Pownall, 1986). Even within a single firm there may be multiple segments with varying degrees of defense related business. McGowan and Vendrzyk consider three unique segment types within defense contracting firms: 1) commercial segments (those with only commercial revenues); 2) government segments (those with revenues predominantly from government business); and 3) mixed segments -- those with revenues from both commercial and government business (2002). The clear diversity of defense contracting firms, the business segments within those firms, and the goods and services which they provide all contribute to a very broad definition of the title "defense contractor". Such a broad definition has supported a tremendous variety in the scope and treatment of sample firms utilized in defense contractor profit studies. Such studies have therefore produced a full-spectrum assortment of results which have very often led to contradictory conclusions among researchers.

Challenges in Comparing Assessed Profits

Academics have noted that the profits associated with defense contracting have been perennially studied and passionately debated (Mayer-Sommer & Bedingfield, 1989). Besides the lack of a consensus definition of defense contractor profit, a comparison of their profits is also complicated by the diversity of both the market structures and risk under which they operate. Therefore, scholarly comparisons of defense contractor profitability cannot be made without adequate allowances for different market structures and risk (Jones, 1999). Defense market structures populate the full economic spectrum from free competition to monopsonies and oligopolies (Greer & Liao, 1986). However, many scholars note the preponderance of a monopsony-oligopoly configuration in the defense industry whereby the government is typically the only consumer of defense goods--or one of very few consumers--and suppliers are highly concentrated (Adams & Adams, 1972; Gansler, 1980; Deutch, 2001; Dupre & Gustafson, 1962; Gholz & Sapolsky, 2000; Greer & Liao, 1986; Marfels, 1978; Perry, 1979; Suarez, 1976; Weidenbaum, 1968). In addition to market structure, the risk associated with defense business is a key component of profit performance assessments (Bohi, 1973). However, Zhong and Gribbin note that there is no direct measure available in prior research for quantifying risk (2009). The lack of any direct measure of defense contractor risk has led to myriad risk assessment methodologies among academics--which has produced a dissensus of findings. Methods of assessing risk have ranged from correlating the variability of a company’s total sales over time with the defense share of those total sales (Stigler & Friedland, 1971) to examining investment risk using of the Capital Asset Pricing Model's "beta coefficient" (Bicksler & Hess, 1976; Higgs & Trevino, 1992). While some researchers have concluded that defense business is riskier than non-defense business (Brown & Stothoff, 1976; Greer & Liao, 1986; Stigler & Friedland, 1971; Weidenbaum, 1968), several of their peers have concluded the opposite (Bicksler & Hess, 1976; Higgs & Trevino, 1992). Of course, market structure and risk are not the only factors expected to influence defense profits. Kaun's "Where Have all the Profits Gone?" provides analysis which examines: economic conditions specific to the industry; differential product demand within the industry; general economic conditions; general military environment; and general political environment (1988). Given the impact both market structure and risk have on defense contractor profitability it is important that they are not overlooked when making any profitability assessments or comparisons.

Survey of Profitability Research

As previously mentioned, the profitability of U.S. defense contractors has been widely examined. Both academic researchers and government sponsored studies have probed contractor profitability employing myriad financial measures, samples, and a varying spectrum of dates. One commonly recurring theme has been the use of the Top 100 Contractors Report (Federal Procurement Data System-Next Generation, 2018) as a basis for selecting a sample of defense contractors to study. The Top 100 Contractors Report is produced annually by the U.S. General Services Administration. It provides a rank-ordering of federal contractors by total (unclassified) obligated dollar amount. This data is broken out by vendors specifically serving the Department of Defense versus other government agencies like the Department of Homeland Security or the Environmental Protection Agency and can be sorted by either the number of contract actions or the total dollars obligated during the report period.

As disparate have been the inputs into contractor profit studies and their conclusions, so too have been the date ranges of data analyzed. Published studies have used data from as early as 1942 (Agapos & Gallaway, 1970) and as recently as 2010 (Wang & San Miguel, 2012). A relative deluge of studies focused on the 1960s through 1980s; this trend slowed to a trickle incorporating data from the 1990s with only one published study incorporating data after the year 2000.

Presenting a comprehensive review of the extant literature regarding defense contractor profitability is complicated by the chronology of publish dates versus research periods, the diverse methodologies employed, and the wide range of conclusions presented. Many literature reviews of previous profit studies presented as part of newer research articles throughout the decades have simply presented antecedents chronologically. This survey broadly categorizes U.S. defense contractor profitability studies into one of three groups: 1) those which primarily examine profitability at the firm level; 2) those which examine profitability in terms of business segments within or between firms; and 3) studies conducted by or specifically sponsored by the government (which may conduct either firm-level or segment-level analysis). Such a taxonomic delivery of prior research provides the reader an intuitive analysis of the methodologies and conclusions presented within each study. For example, an astute reader will understand that the profit implications are fundamentally different if using firm-level data or if using segment-level data; the use of firm-level data has been quite popularly employed but may blur the distinction between defense and commercial business contributions to profit. Conversely, segment-level accounting data may distinguish between defense and commercial contributions to contractor profits. But, these conclusions may be clouded due to potential cost shifting behavior within or between segments -- as alluded to by Admiral Hyman Rickover during his 1969 testimony before House of Representatives subcommittee on appropriations (Department of Defense Appropriations for 1970, 1970) and researched by Rogerson (1992), Thomas and Tung (1992), and Lichtenberg (1992). Additionally, the conclusions presented by government sponsored research may be received with greater skepticism given the interdependence of the government and defense industrial base. The following survey of U.S. defense contractor profitability studies is delivered chronologically within the three broad aforementioned categories.

Firm-Level Profitability

Firm-level data has been widely used to investigate defense contractor profitability since the 1960s. The first of such studies to be popularly recognized is Murray Weidenbaum's 1968 work titled "Arms and the American Economy: A Domestic Convergence Hypothesis." The study compares six large defense contractors to six commercial firms with similar sales volumes over two four-year periods, 1952-1955 and 1962-1965. The study concludes that the defense firms clearly exhibited lower profit margins on sales during both periods, but their capital turnover rates (dollars of sales per dollar of net worth) were far greater than their commercial peers during both periods (Weidenbaum, 1968). Ultimately, "the higher turnover rates for defense companies more than offset the lower profit margins. Hence, their return on net worth (net profits as a percent of stockholder's investment) is considerably higher" (Weidenbaum 1968). Weidenbaum notes that the differences between the defense and commercial firms widened between the periods of study. He also comments that although defense contractors enjoyed greater relative profitability, investors reflected a less favorable evaluation compared to commercial firms in terms of both price per earnings ratios and bond ratings during both periods. Weidenbaum surmises that the higher profitability of defense firms is attributable to governmental provision of plant and equipment and progress payments (fixed and working capital), while the suppressed stock and bond market evaluations relate to the significant volatility of military requirements which dictate the fortunes of individual defense contractors. Weidenbaum concludes that the market reflects an increasing distinction between defense and commercially oriented firms thus supporting his “domestic convergence” between defense contractors and the state.

In 1970 Agapos and Gallaway’s “Defense Profits and the Renegotiation Board in the Aerospace Industry” was published. This study estimated statistical profit functions for the aerospace industry between 1942 and 1967 by employing multiple least squares regression techniques with a data set of 23 large defense (aerospace manufacturing) firms. The 23 firms were separated into two groups -- prime contractors with roughly 80% or more of their sales subject to renegotiation under the Renegotiation Act of 1951, and those with less than 80% (but more than 50%) of sales subject to renegotiation (Agapos & Gallaway, 1970). The study investigated two primary issues: defense contractor profitability relative to: 1) demand shifts during periods of war (World War II, The Korean War, and the Vietnam War); and 2) the presence of the Renegotiation Board. Agapos and Gallaway draw two main conclusions from their research. First, they found there is almost no evidence that positive shifts in demand for military products enable aerospace firms to extract excessive profits. Secondly, they discovered the Renegotiation Act led to an inflation of aerospace profits that were then largely negotiated away by the board -- which they posit was a contingency that appeared to become accounted for by initial contractor pricing in light of renegotiation boards. In conclusion, the scholars ratiocinate that the justification of the Renegotiation Act is “quite debatable” based on their findings.

Arthur Burns reacted to Agapos and Gallaway's 1970 research article stating that their conclusions were "dubious--indeed quite likely wrong" (Burns, 1972). He insists that for Agapos and Gallaway to legitimately establish their conclusions they would have required privileged data files from the renegotiation board. According to Burns, such files were not available to them. He further argues that the total profit and aggregate defense expenditure data used by Agapos and Gallaway did not allow for the necessary segregation of renegotiable and non-renegotiable sales and profits of the selected companies. Burns also asserts that Agapos and Gallaway's data did not support the necessary allocation of net worth and assets to renegotiable and non-renegotiable business due to aerospace contractors' heavy reliance on government plant and equipment and progress payments. Burns then takes aim at the conclusion that contractors began to "build into contract proposals an additional contingency which can then be renegotiated away by the board" (Agapos & Gallaway, 1970). He rebuts this conclusion with three points. First, Burns points out that renegotiation boards examine aggregate fiscal year profit from all contracts--not individual contracts. Padding individual contracts just enough to offset renegotiations but not so much to make the aggregate profit perilously susceptible to renegotiation would be quite difficult. Second, the addition of renegotiable contingencies to contracts would make them less competitive relative to rival contractors in the initial bidding process. Thus, unless such action was pervasive, it would seem unlikely. Lastly, Burns notes that Agapos and Gallaway's contingency theory views renegotiation as a bargaining process --which it is not. Burns closes his response to Agapos and Gallaway's study by describing it as "as combination of sophisticated econometric techniques and crude statistical data" with the shortcomings of the latter unrepaired by the former (Burns 1972).

Stock market investment analysis is another way in which the firm-level performance of defense contractors has been examined. George Stigler and Claire Friedland used the total market rate of return to an investor as their primary metric (1971). They select this market value measure to avoid the practical complications inherent to accounting data--such as segregating assets and income between a firm's segments. The total market rate of return represents the sum of stock price appreciation (or depreciation) and dividends divided by the initial value of the stock. Stigler and Friedland compared the results of a $1000 investment in each of 54 large defense contractors' stocks--with dividends reinvested--to the same such investment in each stock listed upon the New York Stock Exchange in June 1948. They compared the total market rate of return of the two previously described investment strategies between the years 1948-1961 and 1958-1968. Stigler and Friedland conclude that: 1) in the 1950's investments in defense contractors were almost twice as profitable as the investments in all listed stocks; 2) in the 1960's investments in defense contractor stocks did approximately as well; and 3) in the 1950s total market rate of return for investments in defense firms was positively correlated to the ratio of defense to total sales (no such relationship in the 1960s). Stigler and Friedland close with a very brief and tentative assertion that defense business seemed to be somewhat riskier than commercial business in the 1950s and 1960s.

Bicksler and Hess (1976) assert that Stigler and Friedland's methodology failed to consider risk at all. Therefore, they reexamined Stigler and Friedland's findings by applying the Capital Asset Pricing Model to the same two investment portfolio sets. Bicksler and Hess conclude that empirical evidence conflicts with Stigler and Friedland's conclusions noting that "the prices and yields of large defense contractors did not have disequilibrium risk-adjusted returns" and that their relative risk was not significantly different (Bicksler & Hess 1976).

In 1973, Douglas Bohi acknowledges the divergent defense profit conclusions of preceding studies by Weidenbaum, Agapos and Gallaway, and Stigler and Friedland--and sought to clarify the issue. He cites defense profitability as a matter of critical importance because excessive profit rates waste resources and strain taxpayers while exceedingly low profit rates threaten the quality and depth of the defense base (Bohi, 1973). Bohi's study investigated the profit performance of defense industry firms relative to that of commercially oriented firms between 1960 and 1969. He constructed a sample of 36 defense firms consistently appearing on the "Top 100 Defense Contractors" report over his period of study. To be included in the sample, the firms needed to average 20% or more of their total sales in defense contracts over between 1960 and 1969. Non-profit firms or those appearing inconsistently on the Top 100 list were excluded. The list of 36 defense firms was compared against the Fortune 500 largest manufacturers for the same period. Bohi's study measured profit as returns on net worth. He avoided measuring returns on total capital invested because defense firms extensively employ government supplied capital--not available to commercial firms--at unreported rates. This precluded constructing an adjusted total capital measure necessary for meaningful profit comparisons between defense and commercial firms. Net worth however, Bohi contends, eventually reflects the overall asset-liability structure unique to each firm. First, Bohi conducts a t-test to determine if the samples' profit means were drawn from populations with equal profit means -- he is unable to reject the null hypothesis at the 95% probability level. Therefore, Bohi concludes that it is unlikely the profit performance between defense and commercial firms is statistically different. Second, Bohi tests for a correlation between a firm's percentage of defense business and its overall profit performance. He finds no apparent relationship between the two. Third, he considers Weidenbaum's (1968) "domestic convergence" theory that defense business is becoming increasingly concentrated among large firms already rooted in the defense industry. Bohi finds that between 1960 and 1969 defense contractors had actually been increasingly diversifying into commercial business with his 36 sample defense firms netting decreasing average proportions of total U.S. defense procurement dollars during that time. Lastly, Bohi examines if the Vietnam war has altered the profitability of defense business. He finds that the profits of both defense and manufacturing oriented firms increased during the Vietnam war period; but the increases were not significantly different between the groups. Additionally, Bohi notes that defense contractors' proportions of defense business fell during this period--indicating that rising profits were attributable to non-defense business generally buoyed by war spending.

Grace Pownall was one of the first researchers to extend firm level defense contractor profit studies into the 1970s (Pownall, 1986). Distinct from previous studies, Pownall did not provide a comparison between defense and commercial firms. Instead, she analyzed the stock prices of 88 defense contracting firms between 1968 and 1970 for evidence of capitalized changes in profitability associated with the establishment of the Cost Accounting Standards Board (CASB). Pownall notes that in the 1960s most defense contracts were awarded on a cost-reimbursement basis; and therefore any mandated changes to a contractor's cost accounting system would directly impact their present value of future cash flows. The uniform cost accounting standards to be enforced by CASB would limit a defense contractor's potential to overstate reimbursable costs on government contracts--a method whereby defense firms could extract excess rents from taxpayers for the benefit of shareholders. Pownall's study examined two phases of market reaction impacts to shareholder wealth for the 88 firm sample: phase 1, the time period in which regulators were debating the necessity and feasibility of imposing

CASB; and phase 2, the period in which the need for CASB was taken as a given and regulatory debate focused on the scope and nature of regulations to be imposed. Pownall found evidence of significant contractor shareholder losses associated with phase 1. But, evidence also indicated the phase 1 losses were reversed by significant phase 2 gains in shareholder wealth. Pownall further tested and concluded that these responses were uniform small responses across the sample--not large swings in market value experienced by only a few firms. Pownall concludes her results suggest investors viewed CASB as an impediment to at least some contractors' ability to squeeze excessive cost reimbursements from the government.

In 1989 Mayer-Sommer and Bedingfield propelled the currency of defense industry profit research into the late 1970s. They studied the period between 1968 and 1977 utilizing firm-level data to measure profits based on both market returns and accounting returns (Mayer-Sommer & Bedingfield, 1989). They address the choice to avoid using business segment level data in their research citing previous research (Greer & Liao, 1986) explaining the difficulties in allocating costs and revenues among defense and commercial segments. Also cited is Peck and Scherer's (1962) analysis that commercial segments benefit from their defense segment peers by: 1) using defense funded work to develop technical skills with commercial applications; 2) obtaining commercial patent rights stemming from work on military contracts; and 3) enhanced access to raw materials through defense related activities which also benefit commercial business processes. Mayer-Sommer and Bedingfield also appear convinced by the work of Bohi (1973), Fox (1974), and Gansler (1980) which explain specific labor cost (efficiency) benefits enjoyed by commercial business segments which employ workers originally trained in defense business segments. Having settled on the use of firm-level data, they investigated 3 measures of profitability: 1), market returns earned by stockholders; 2) corporate accounting returns; and 3) the compensation of corporate top management. The authors note that top management compensation had yet to be considered as part of defense profit research. Market returns in this study were measured as dividends and capital gains or losses during each period. Accounting returns were analyzed as the arithmetic mean of the ratio of a firm's net income (or loss) to average stockholders' equity for each year in the observation period. This accounting measure provides an approximation of accounting returns to the shareholders--as opposed to Return on Assets which describes accounting returns to the firm. Mayer-Sommer and Bedingfield targeted the study period of 1968 to 1977 specifically to compliment and extend extant literature as well as to include defense activity and disengagement related to the Vietnam war. Additionally--noting Pownall 1986--they selected a starting point prior to potential impacts stemming from CASB regulatory discussions. The cut-off for the study period was set at 1977 to avoid complications from regulatory changes in executive compensation disclosures mandated by the Securities and Exchange Commission taking effect the following year. In selecting their sample of defense oriented firms, Mayer-Sommer and Bedingfield target companies that met two criteria: 1) the firm needed to be listed at least five times between 1968 and 1977 on the DoD's list of The Top 100 Companies Receiving the Largest Dollar Volume of Military Prime Contract Awards; and 2) during the years a company appeared on the 100 Companies list, its average percentage of military prime contract awards to total corporate sales needed to be at least 20%. These criteria served to exclude firms of questionable defense orientation--i.e., firms with high dollar volumes of defense sales but low percentages of military sales to total sales. Ultimately, Mayer-Sommer and Bedingfield identified a sample of 27 defense-oriented firms and 71 commercially-oriented firms. The commercially-oriented firms were paired to the defense-oriented firms based on matching S&P industry codes, similarity of annual sales, and continued operations over the entire study period. Based on their statistical analysis, Mayer-Sommer and Bedingfield conclude that defense-oriented firms did not yield higher market returns for shareholders during the period examined. Similarly, they were unable to find significant differences in the accounting returns of defense and commercially-oriented firms. Finally, Mayer-Sommer and Bedingfield find that the top management for defense contracting firms enjoyed significantly higher rates of compensation increases from 1968 to 1977 -- resulting in 1977 compensation levels eclipsing that of their top manager peers at commercially oriented firms.

Trevino and Higgs noted that although no one had updated the Stigler and Friedland study (1971) of 1950s and 1960s defense contractor profitability, the controversy regarding such profitability continued during the 1970s and 1980s (Trevino & Higgs, 1992). Therefore, they sought to provide their own study of defense contractor profitability. Their principle aim was to update the analysis of shareholder total market rate of return during 1970 to 1989. Over the same period, they also evaluated two accounting measures of return (Return on Investment and Return on Assets), the relative riskiness of defense and commercial firms, and the cumulative market returns of a defense portfolio compared to a market portfolio. Trevino and Higgs' defense contractor sample consisted of publicly traded for-profit U.S. corporations listed in the top 50 on the DoD's 1979 list of The Top 100 Companies Receiving the Largest Dollar Volume of Military Prime Contract Awards. They use the Standard & Poor's 500 stocks as a comparative standard representing the overall market. Trevino and Higgs' research indicates that "for the period 1970-1989 as a whole, by every measure, the top defense firms outperformed the market by a huge margin" (Trevino & Higgs, 1992). For the 1970's, their sample of defense contractors posted a similar Return on Investment as the overall market, a slightly better Return on Assets, and a much better total market rate of return. For the 1980's, the sample of defense contractors posted substantially better Returns on Investment and Returns on Assets than the overall market and roughly equal total market rate of returns. For the 1970s and 1980s combined, the defense contractors outpaced the overall market substantially according to Returns on Investment, Returns on Assets, and total market rate of returns. Because investors in top defense contractors seized much better total market rates of return than investors in the S&P 500 over the 20-year study period, Trevino and Higgs next assessed the riskiness between the two investment strategies. They based this assessment on the computed beta coefficients according to the Capital Asset Pricing Model. They found that the defense contractor investment portfolio was no riskier than investing in the overall market. This contradicted Stigler and Friedland's (1971) tentative assertion that investing in defense contractors was riskier. Finally, Trevino and Higgs assessed the differences in cumulative returns between their defense contractor portfolio and the S&P 500 from 1979 to 1980. They conclude that while the S&P 500 investment portfolio increased in valued by a multiple of 8.19, their sample defense contractor portfolio posted a multiple of 14.78, representing a far greater return to investors.

Econometric industry segment analysis by Lichtenberg (1992) compliments and extends the research by Rogerson (1992) and Thomas and Tung (1992)--detailed in the segment profitability section of this survey--who advanced cost-shifting hypotheses explaining how defense contractors may become more profitable relative to strictly commercial firms. Lichtenberg similarly argues that shifting commercial business costs into government business segments may be a viable method for defense contractors to reduce commercial operating expenses. He explains that this allows contractors, at the firm level, to be more profitable than other companies even if the government business segment only earns normal profits. Lichtenberg asserts, that defense contractor profitability should be examined at the firm level.

In his study, Lichtenberg directly compares the annual firm-level profit rates (Return on Assets) of companies engaged at least partially in defense contracting to purely commercial firms across almost 9,300 industry segments spanning the years 1983 to 1989. His results provide strong support that defense contractors are substantially more profitable. Based on Lichtenberg's calculations, government contractors as a whole earned Returns on Assets that were 68% to 82% greater than commercial firms. He also found that firms intensely involved in government contracting--whose government sales averaged 84% or more of total sales--earned nearly three times more Return on Assets than did non-contractors. Lastly, Lichtenberg investigates Rogerson's (1992) assertion that accounting rules for overhead allocation incentivize contractors to employ less capital per worker for producing defense items and more capital per worker for producing commercial items. His analysis, consistent with Rogerson's (1992) assertion, indicates that the capital intensity of government contractors is inversely related to the proportion of government work they perform.

Using data envelopment analysis, Bowlin (1995) assessed the broad financial condition of the aerospace-defense industrial base relative to the S&P 500 from 1978 to 1992. To do this he compared data from between 30-32 defense firms to 38-45 S&P 500 listed commercial firms (the specific number of defense and commercial firms compared varied each year between 1978-1992). While Bowlin did not singularly consider profit, his financial performance analysis assessed multiple variables simultaneously to provide a comparison of the overall financial wellbeing of defense and commercial firms during his study period. Variables considered included net sales, net income, cash flow from operations, end-of-year market value of equity, total assets, stockholders' equity, plant and equipment, and number of employees. Bowlin's research indicated that the commercial firms exhibited better financial condition than defense firms for the full duration of the study; but the relative financial condition between defense and commercial firms held steady.

Noting that prior research had left the diversity of profitability among defense contractors largely unexplored, Zhong and Gribbin investigated factors hypothesized to contribute to such diversity (2009). Using firm level data from 1984 through 1998, Zhong and Gribbin employed Ordinary Least Squares regression techniques for their analysis. Three factors influencing the correlation between the percentage of a firm's defense sales to its total sales and the firm's rate of profits were examined: 1) the risk of defense business; 2) the level of innovation involved in defense work; and 3) the influence of defense contractors. Zhong and Gribbin used capital intensity as a proxy for defense business risk, they noted that increased capital assets committed by a firm correspond to a higher assumed operating risk. Research and development intensity (reported R&D expenses divided by a firm's total sales) was used at a proxy for innovation. Consistent with Karpoff et al. (1999) and McGowan and Vendrzyk (2002), Zhong and Gribbin consider influence as a degree of market and/or political power wielded by a defense contractor. The influence of each defense firm is specifically measured as the value of yearly sales to the government. Zhong and Gribbin's regression model also controls for specific industry effects (using Compustat Standard Industrial Classification codes) and size effects (measured by total firm sales). The empirical results of Zhong and Gribbin's investigation indicate that higher percentages of defense sales relative to total sales are related to lower Return on Assets for a firm -- suggesting that defense work is less profitable than commercial work for defense contractors. The results also indicate that all three factors of risk, innovation, and influence are positively associated with the profit rates of defense contractors. Zhong and Gribbin surmise that the profit link to both risk and innovation seems reasonable while the association between influence and profits of defense contractors is a suggested topic for future research.

The most recently published literature discovered and reviewed is that by Chong Wang and Joseph San Miguel, “The Excessive Profits of Defense Contractors: Evidence and Determinants” (2012). Wang and San Miguel note that the relative historic paucity of academic research into defense contractor profitability has worsened since the 1990s. This lit review concurs with their assessment--finding only two other academic studies published since 2000 (McGowan & Vendryzk, 2002; Zhong & Gribbin 2009). In a departure from previous studies, Wang and San Miguel’s research explicitly investigates whether defense contractors earn “excessive” profits. And, finding evidence of such profits, they provide alternative predictors thereof. Their methodology employs “an innovative measure of excessive profit” based upon matching defense and commercial firms by industry, year, and size. Wang and San Miguel’s data set is based on 110 publicly traded defense contractors recorded in fedspending.org’s 2008 list of Top 500 Recipients (by dollar awarded) of Defense Contract Awards. These 110 contractors from the 2018 list were studied across the 61 year range between 1950 and 2010. The authors rationalized using the same firms across all 61 years by assuming “significant contracting relationship continuity between the government and defense contractors”. This yielded 4,099 firm-year observations within the Compustat database. Next, each yearly defense firm observation was matched to a benchmark--a commercial firm recorded in the same year with a matching 4-digit Standard Industrial Classification Code. Benchmark size matching was considered in each of two ways: total assets and total revenue. Wang and San Miguel’s “excessive” profit measure was then the calculated difference in profit between each defense contractor firm-year in the sample and the profit of its associated benchmark firm-year. Their empirical evidence reveals an average excessive Return on Assets of 1.12% and excessive Return on Common Equity of 3.65% (each statistically significant at <.01% level) for defense contractors. They also find an excessive average profit margin ratio of 0.28% (significant at the 5% level) for defense contractors. Lastly, Wang and San Miguel assert that the operating margin ratio is commonly used by the defense industry to support claims of *inferior* profitability -- the average of which was not statistically different between the two groups in their study. Having established evidence supporting the excessive profitability of defense contractors, Wang and San Miguel next explore two determinants of such profitability: industry consolidation and poor corporate governance. Noting significant consolidation within the defense industry after 1992, Wang and San Miguel regress their measures of excessive profit against a dummy variable representing either pre-1992 or otherwise. They find that defense contractor Returns on Assets and profit margin ratios both increased after 1992. This held whether benchmark size was matched based on total assets or revenue. Wang and San Miguel consider that increased profitability after the defense industry consolidation starting in 1993 may be the result of either increased bargaining power or political influence wielded by remaining firms ([Deutch, 2001] thoroughly details this consolidation). Finally, they explore if "poor corporate governance" is a determinant of defense contractors' excessive profitability. One way they operationalize poor corporate governance is by defense contractors led by a dual-titled CEO and Chairmen of the Board. The argument being that such a dual-title confers too much power and too little oversight in a single corporate leadership position. Wang and San Miguel ultimately find that excessive profitability--measured by both Return on Assets and profit margin ratio--is greater for firms with CEOs also serving as Chairmen of the Board. This finding held whether size was considered relative to total assets or revenue.

Segment Profitability

While firm-level data has been employed to study defense contractor profitability since the 1960's the use of segment-level data for profit analysis is a practice that has more recently evolved--apparently introduced in the academic literature by Greer and Liao in 1986. Greer and Liao investigate the period 1963 thru 1982 to assess both the risk and returns of defense contractors during those 20 years. They use regression analysis to disaggregate firm-level rates of return between the defense and commercial segments of 25 aerospace firms. They explored both the return on sales and the return on net worth as a function of a firm's percentage of defense business. Greer and Liao's analysis indicate that engaging in defense business negatively impacted a firm's overall return rates--measured by either return on sales or return on net worth. Additionally, they considered the relative profitability between defense and commercial business for their sample. They found that the return on sales for defense business was considerably lower than that of commercial business. With the exception of 1976 through 1978, defense business was also less profitable when measured by return on net worth. The 3-year period of exception is attributed by Greer and Liao to the issuance of Defense Procurement Circular 76-3, they claim 76-3 regulated significant changes to DoD's profit policy that intended to spur capital investment by defense contractors and increase their potential profit levels. Hypothesizing that industry capacity utilization rates might be another factor affecting defense business profits, Greer and Liao conducted further regression testing. This additional analysis provided strong support--statistically significant at the 5% level--that defense business profitability by both return on sales and return on net worth was positively related to the aerospace industry's capacity utilization rates. Simply put, defense business was more profitable when the industry was busier and less profitable when it was less busy. Furthermore, they found that defense and commercial business approached profit parity as aerospace industry capacity utilization increased. Finally, Greer and Liao assess the relative risk of defense business from both a management and a market based view. They considered the volatility of defense business profits as a management view of risk and concluded that it was higher than that of commercial business. For a market view of risk Greer and Liao used the *Value Line* “Price Stability Index”--which measures volatility of returns in the equities market. This measure indicated that the market also viewed defense business as riskier than commercial business. Greer and Liao then provide some commentary as to why firms may be attracted to defense contracting given the evidence that such business generates lower returns with higher risk. They speculate that: 1) generous government supplied capital investment for defense contracts boosts a firm’s return on investment; 2) managers may be pursuing advantageous technology transfers stemming from defense contracting; 3) securing defense contracts provides a means by which firms can shift corporate overhead from commercial business to make it more competitive; and 4) firms may gain a marketing advantage through their association with producing “state-of-the-art” defense products. Although outside of the scope of this review, Greer and Liao also provide analysis of weapons systems cost variation relative to capacity utilization and an examination of capacity utilization as a tool for cost estimation.

In 1992, research by Rogerson, and Thomas and Tung promoted separate cost-shifting hypotheses to explain how government contractors may generate higher profits than their non-contractor peers. Rogerson establishes a theoretical argument explaining that overhead cost allocation rules allow--and even incentivize--defense contractors to shift costs from commercial work onto the government. He explains that defense contracts represent cost-*sensitive* revenues for a firm because those products are largely priced based on cost. Alternately, commercial work generates cost-*insensitive* revenues whereby product price is determined by competitive market forces. Rogerson finds that these opposite revenue streams motivate defense contractors to substitute direct labor and capital inversely between defense and commercial segments -- under-capitalizing the production of defense products and over-capitalizing production of commercial items. This means that defense segments will employ excess direct labor because it is typically the basis for allocating overhead reimbursed by the government. In due course, this strategy increases total contractor overhead borne by the government while simultaneously reducing a firm's commercial business costs (increasing profits). While Rogerson (1992) detailed overhead allocation cost shifting incentives theoretically, Thomas and Tung (1992) used empirical evidence to demonstrate the propensity of defense contractors operating under cost reimbursement contracts to shift pension costs to the government. Under the pension cost shifting scenario, Thomas and Tung argue that defense contracting firms can reduce commercial business expenses by overfunding pension plans while employees work on defense contracts--when costs are reimbursed; later those excess pension assets are withdrawn as employees perform non-government work. While Thomas and Tung establish that defense contracting firms fund pensions differently than strictly commercial firms, they do not address if the pension cost shifting strategy actually results in abnormal defense contractor profits earned at government expense.

Bowlin (1999) applied data envelopment analysis to assess the financial performance of defense business segments. This is a different perspective from Bowlin (1995)--which also used data envelopment analysis--but instead characterized the financial condition of defense contractors at the firm level. Bowlin (1999) compared the defense-oriented business segments to the non-defense business segments of 18 firms between 1983 and 1992. The 10-year range of data studied by Bowlin (1999) compliments most of that covered by his 1995 study. The 18 firms were randomly sampled from the "Top 100 defense contractors" for 1989 as published in the print magazine *Government Executive*. Business segments were classified as "defense" if over 50% of their total sales were defense related and "non-defense" otherwise. Bowlin (1999) used data envelopment analysis to develop a financial performance measure of each segment based on five variables: operating profit, operating cash flows, sales, operating expenses, and identifiable assets. He also conducted analysis using traditional financial ratios to compare to his data envelopment analysis findings. Such ratios included Asset Turnover, Return on Sales, Cash-Return on Sales, Return on Assets, and Cash- Return on Assets. The results of Bowlin's (1999) analyses indicate that the financial performance of defense business segments was distinctly superior to that of non-defense segments in 1983. Then, from 1983 to 1989 defense segment performance fell relative to non-defense segments--falling below non-defense segments in 1988. Finally, from 1990 to 1992 Bowlin's (1999) analyses indicated a recovery trend in the financial performance of the defense segments--which generally outperformed the non-defense segments yet again.

In 2002, McGowan and Vendrzyk evaluated the segment profitability of defense contractors to test the cost shifting hypotheses forwarded a decade earlier by Rogerson (1992), Thomas and Tung (1992), and Lichtenberg (1992). McGowan and Vendrzyk were specifically interested in the relationship between excessive defense contractor profits and the ability to allocate overhead costs from commercial work onto contracted government work using accepted cost-accounting methods. They theorized that in the pursuit of excess profits, a defense contractor's ability to engage in cost shifting is different across its business segments. To test this relationship, McGowan and Vendrzyk classified three business segments within defense contracting firms: 1) segments with only commercial revenues were classified as "commercial segments"; 2) segments with revenues predominantly attributed to government contracts were considered "government segments"; and 3) segments with revenues derived from both sources were labeled "mixed segments". Along with segment *type*, McGowan and Vendrzyk also investigated if the relation between cost shifting behavior and segment profitability was influenced by either a firm's *market power* in the defense industry or the level of *competition* for defense contracts. They assert that the greatest opportunity for cost shifting is manifest *within* the mixed segments and is less likely to occur in either the commercial or government segments--or *across* segments. They also contend that cost shifting opportunities are positively related to a firm's market power and inversely related to the level of competition in the defense contracting market. McGowan and Vendrzyk compiled a sample of 104 defense contractors and analyzed the associated *Compustat* business segment file data across two time periods: 1984 to 1989 and 1994 to 1998. The two time periods were considered to represent eras of low and high competition respectively for defense contracts. In the sample, contractors were considered to wield market power if they were ranked in the DoD's annual report of *100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards*. Otherwise, they were not considered to wield market power. Profit was measured by Return on Assets. McGowan and Vendrzyk's analysis was completed using a repeated-measures analysis of variance model. They find that from 1984-1989 (the low competition period) the government segments--with more than 90% of revenues derived from government work--earned abnormally high Returns on Assets compared to the mixed or commercial segments. These findings are consistent with Lichtenberg's (1992) assertion that the most highly government-oriented contractors are significantly more profitable. However, from 1994-1998 (the high competition period) McGowan and Vendrzyk's results indicate that there was no significant difference in Return on Assets between government, commercial, and mixed business segments for defense contractors. This stabilization of profits between segments in the later period was attributed to decreased returns in government segments with no significant change in the mixed or commercial segments. Also, they found that contractors wielding market power were not able to capture excess profits via cost-shifting in either time period. Therefore, McGowan and Vendrzyk contest Rogerson's (1992) and Thomas and Tung's (1992) assertion that cost-shifting drives excess defense contractor profitability. Instead, they suggest the non-accounting explanation that low competition for defense contracts is more likely to explain excess profits earned from government contracting.

Government Sponsored Studies

Government sponsored studies into defense contractor profitability abound. They have generated much discussion, and numerous subsequent investigations by academics and government agencies alike have followed. Such government sponsored studies have failed to produce a consensus of results either across or between periods of study and have endured a barrage of criticism regarding both form and substance. In the interest of reasonable concision, only a select few of the more foundational government sponsored studies are explicitly reviewed herein. The Logistics Management Institute developed an extensive annotated bibliography of profit studies--primarily government sponsored--as part of their "Profit '76" study (Department of Defense, 1976). Readers interested in a particularly thorough review of defense contractor profit research between 1965 and 1975 may be interested in reviewing that work. No similar compendium of defense contractor profit studies after 1975 was found as part of this research.

Logistics Management Institute, Defense Industry Profit Review - 1968

In 1970, the Logistics Management Institute (LMI) published its report for the DoD examining the profits earned in the defense industry from 1958 through 1968 (1970). The sample included data from a group of 40 defense contractors. The data was voluntarily provided by the participating contractors at LMI's request and delineated assets and net income between each contractor's defense and commercial business segments. The study compared separately a company's defense business and commercial business to the Federal Trade Commission-Securities and Exchange Commission (FTC-SEC) universe of 3500 companies; the study depicted profit in relation to sales, equity capital, and total capital invested. The principal conclusion of the report was that for 1958-1961 defense business was more profitable than commercial business within the same company and the FTC-SEC portfolio of companies; the opposite was true between 1962-1968. However, the results of the report were pointedly questioned for two reasons: 1) the sample data was not independently collected; and 2) the high likelihood for self-selection bias by participants -- the argument being defense contractors with high profitability would be less likely to participate in order to avoid public and governmental scrutiny.

Government Accounting Office, Defense Industry Profit Study

The General Accounting Office (GAO)--known as the Government Accountability Office since 2004--followed LMI with a report of their own in 1971 (1971). The GAO study collected data spanning 1966 thru 1969 from 74 DoD contractors via questionnaire. Separately, audit data on 146 DoD contracts--collected directly by GAO investigations occurring throughout that same period--was also gathered. The contractor furnished data represented overall defense business while the data gathered from GAO investigations related to individual defense contracts. The GAO provided profit conclusions based on three measurements: 1) profit as a percentage of sales; 2) profit as a percentage of total capital investment; and 3) profit as a percentage of equity capital investment by stockholders. The GAO concluded that: 1) profit on defense work (before federal income taxes) measured as a percentage of sales was significantly lower than comparable commercial work; and 2) profits measured as a percentage of both total capital invested and equity capital invested were generally not significantly different between defense and commercial business (defense profits being slightly lower). However these conclusions were based upon analysis of the contractor self-reported defense business data and not the contract specific audit data collected by the GAO. When the audit data was examined, it was found that average rates of return for individual contracts significantly exceeded the average annual profits rates calculated from the self-reported questionnaire data. For example, Kaun (1988) notes that the overall rate of return as a percent of total capital on the 146 audited contracts was 28.3%; but only 11.2% if using the contractor self-reported data. Ultimately, this generated substantial criticism and cast considerable doubt on the GAO's conclusions. The GAO defended the use of the questionnaire data, based on three rationale. First, they note the audit data was not a representative sample because of its small size relative to total procurement actions during the period of study (over 180,000 a year). Second, the questionnaire data provided insight from an overall defense business perspective not an individual contract basis. Lastly, the audit data likely disproportionately excluded "loss-contracts" with large unsettled claims (which one would infer to skew profit results positively if excluded).

Logistics Management Institute, Profit '76

The purpose of DoD's Profit '76 study (Logistics Management Institute, 1977) was to: 1) determine profits of defense contractors on both defense and non-defense business; and 2) examine the relationship between earnings and capital investments in assets which increase productivity and lower costs. This study employed segment-level financial data of 64 large defense contractors from 1970 through 1974--which was collected and analyzed by a Certified Public Accounting firm. The study also used data on 5000 durable goods companies provided by the Federal Trade Commission. It compared defense profitability with that of durable goods manufacturers and utilized Return on Assets as the principal financial basis of its analysis. Return on Assets as computed in this study was income divided by assets (less progress payments and cash). This study was criticized for non-response bias as usable data was received from only 48.1% of defense contractors invited to participate. Ultimately, Profit ’76 concluded that: 1) defense segments generated profit on sales of 4.7% compared to the 17.1% profit on sales of commercial segments or 6.7% of durable goods companies; and 2) defense segments generated 13.5% profits on total assets compared to 17.6% for commercial segments and 10.7% durable goods companies. Jacques Gansler--former Under Secretary of Defense for Acquisition, Technology, and Logistics--noted that this study confirmed “the profits for small defense companies was much less than for large ones, and that there were very wide variations among segments of the defense industry.”

Department of Defense, Defense Financial and Investment Review (DFAIR)

The DFAIR Commission assessed “the profitability of defense work and its reasonableness in comparison with the profitability of the non-defense sector” (U. S. Government Accountability Office, 2019). DFAIR was accomplished similarly to the Profit ’76 study; relying primarily on self-reported segment-level data from 76 major defense contractors (a 60.3% response rate) covering 1970 through 1983. This defense sector data was then analyzed against comparable data from the durable manufacturing industries segment of the U.S. Commerce Department’s *Quarterly Financial Reports* for the manufacturing, mining, and trade sectors. Also similar to Profit ’76, DFAIR used Return on Assets as the basis of its analysis. However, unlike the Profit ’76 study which computed Return on Assets as income divided by assets *less* progress payments and cash, DFAIR computed Return on Assets as income divided by total assets less cash -- but *including* progress payments. DFAIR concluded that the profitability of defense business was similar to that of commercial business between 1970 and 1979 and relatively higher than commercial business from 1980 to 1983.

General Accounting Office, Government Contracting: Assessment of the Study of Department of Defense Contractor Profitability

In 1986 the GAO was tasked to assess the completeness, accuracy, and adequacy of DFAIR and validate its findings. The GAO agreed with DFAIR’s identification of Return on Assets as the appropriate financial measure of profitability at the segment level. However, they firmly denounce DFAIR’s methods of asset valuation and profit calculation. Specifically, the GAO disagreed with DFAIR’s treatment of progress payments whereby inventories considered to belong to the government through such payments were included in the asset base when computing Return on Assets. According to the GAO such treatment is “inconsistent with conventional financial analysis, generally accepted accounting practices, government contract provision, and the Profit ‘76 study, which all indicate that progress payments should be subtracted from assets to determine the asset base in making any Return on Assets calculation” (U. S. General Accounting Office, 1986). The GAO notes that progress payments should have been treated as reimbursements to the contractor for expenses incurred--thus offsetting inventories and accounts receivable and reflecting a contractor’s total asset figures accurately. By failing to subtract progress payments from assets, DFAIR increased the amount of total assets used in the denominator of the Return on Assets calculation; this “dramatically” reduces calculated Return on Assets--which “results in an inaccurate indication of a company’s profitability” (U. S. General Accounting Office, 1986). The impact this treatment has on profit comparisons between defense and non-defense firms is profound. The GAO found that DFAIR’s progress payment treatment cut defense business Return on Assets by 56%; but only suppressed commercial manufacturing’s Return on Assets by a mere 4%. The GAO analyzed DFAIR’s data using the conventional calculation of Return on Assets (progress payments subtracted from asset base) and found strikingly different results. They concluded that defense contractors were 35% more profitable than their commercial counterparts from 1970-1979 and 120% more profitable from 1980 to 1983. The GAO also evaluated publicly available data and found that “defense business was substantially more profitable than comparable non-defense firms during the period 1975 to 1983” (U. S. General Accounting Office, 1986).

More Recent Government Studies

In 1990, the GAO reported on “Financial Measures for Evaluating Contractor Profitability” (1990). The report did not assess contractor profitability but rather investigated which financial measurement would best be employed to that end. It concluded that Return on Assets--being a ratio of income to assets--is the principal measure that should be employed for calculating profitability of government contractors. The GAO supports this conclusion for three reasons: 1) it would provide a basis for measuring the cumulative impact of policies; 2) it can be computed at the segment level of the firm; and 3) it is derived from auditable, historical financial data. The GAO notes that when evaluating profitability the defense industry has generally opposed the use of Return on Assets if progress payments are subtracted from assets. This stems back to GAO’s 1986 study (U. S. General Accounting Office, 1986) which computed

Return on Assets in this way and reported significantly higher profitability for defense contractors as compared to non-defense contractors between 1970 and 1983.

In 1991, the GAO further promoted using Return on Assets to measure defense contractor profitability citing that Return on Assets also recognizes government financing's impact on contractor profit levels (U. S. General Accounting Office, 1991). In 2008 the Institute of Defense Analysis presented that defense contractors enjoyed low operating margins coupled with high returns. They contend this was the result of government contract financing partially funding the extended product cycles of defense contractors (Institute of Defense Analysis, 2008).

In 2019 the GAO published the report "*DOD Should Comprehensively Assess How its Policies Affect the Defense Industry*". Like the title suggests, the report recommends the DoD conduct a comprehensive assessment regarding the impacts of contract financing and profit policies on the defense industry. The report further recommends the assessment be updated on a recurring basis. Within the report GAO highlights the need for an updated assessment and cites that Office of Defense Price and Contracting officials acknowledge the last comprehensive study of DoD contract financing and profit policies was completed by the 1985 DFAIR Commission--over 30 years prior. The DoD reviewed and commented on the 2019 report--and ultimately concurred with GAO's recommendation. Additionally, DoD indicated it would pursue funding in fiscal year 2020 to contract the recommended study.

Conclusion

The United States defense industry has served the country's military manufacturing and supply needs during both peace and conflict for over 200 years. During this period, the defense industrial based evolved from industrial players conscripted into wartime service to divisions and corporations voluntarily committed to continuously serving national defense needs, delivering innovative technologies powering both military and civilian advancement. The continued existence, and therefor profitability, of this defense base is vital to the nation's security. This profitability spurs advancement and innovation and is keenly important to both taxpayers and shareholders.

Studies attempting to assess defense contractor profitability are challenged by the multitude of ways in which profit can be operationalized for research. Intricacies inherent to both accounting and market profitability data have inspired numerous methodologies and conclusions among researchers. Further complicating the matter, the broad definition of the term “defense contractor” has supported a wide variety in the scope and treatment of both sample firms and business segments included in contractor profit studies. Such studies have therefore produced an extensive variety of results from the 1940s on. Very often, the conclusions among researchers are contradictory both between and within periods of study. There is no clear trend in the conclusions reached by defense contractor profit researchers; not by period of study, publish date, method of analysis, definition of variables, or characterization of sample. The reasonableness of any research conclusions regarding defense contractor profit should therefore be individually considered and scrutinized by the reader.

III. Methodology

Chapter Overview

This chapter develops the hypotheses used to explore the research questions and explains how they are tested. The components of the model including the period of study and variables employed are described. Also, justification for each of the model component's specification is provided. Lastly, the data and methodology of analysis are discussed.

Hypothesis Development

Numerous previous studies note that the defense marketplace is not described by a freely competitive model. Instead the mechanisms of free competition are disrupted in the defense industry by predominant demand-side monopsony and supply-side oligopoly market structures. The Defense Acquisition System operates under these market structures, which impact the prices and profits negotiated on defense contracts. The monopsony-oligopoly structure in the defense marketplace may lead to a scenario whereby defense suppliers leverage their market and/or political power to realize greater profits from the Department of Defense. Such a possibility has been explored by previous studies under the captured regulator framework (Leitzel 1992; Karpoff et al., 1999). Leitzel (1992) concludes that "a regulatory capture model of the DoD appears plausible." Karpoff et al. (1999) establish evidence that "the regulation of procurement fraud works to transfer wealth toward influential defense contractors." Additionally, McGowan and Vendrzyk (2002) and Zhong and Gribbin (2009) find evidence supporting a positive relationship between defense contractor influence and profitability. The supply-side oligopoly market structure in defense contracting may provide a complementary explanation linking influence and contractor profit outside the captured regulator context. Under this construct, the relative scarcity of firms capable of suppling vital defense products boosts their influence as the Department of Defense finds itself increasingly dependent on them. This could then prompt those contractors to charge higher rates--which provides an explanation for a positive relationship between contractor influence and profit. Further, defense contractor influence may be of particular interest during the study period of this research given that DoD procurement budgets generally declined over this period. This budgetary slide translates to decreased demand for the defense industry which Zhong, Gribbin, and Qian (2012) note can motivate firms in regulated industries--especially defense--to seek a competitive edge through focused active lobbying. Lichtenberg (1989) found evidence that more government-oriented defense contractors (versus commercially oriented) have a higher propensity to contribute to political action committees (PAC). Specifically, he found that such contractors sponsored PACs supporting more candidates and with substantially higher average contributions per candidate. This increased lobbying by defense firms serves to boost their relative levels of influence within the industry.

H1: *Ceteris paribus, profits earned by defense contractors from defense sales is positively related to their level of influence in the defense contracting market.*

The relationship between defense contractor profits and risk has been considered by numerous academics (Bohi, 1973; Zhong & Gribbin, 2009; Stigler & Friedland, 1971; Bicksler & Hess, 1976; Higgs & Trevino, 1992; Brown & Stothoff, 1976; Greer & Liao, 1986; Weidenbaum, 1968; Agapos & Galloway, 1970). The DoD also recognizes the link between contractor profit and risk and aims to establish equitable returns when pricing negotiated contracts. The Federal government’s procedures to balance defense contractor risk and reward through negotiated contracts are codified in the Federal Acquisitions Regulation (FAR) and the Defense Federal

Acquisitions Regulation Supplement (DFARS). Specifically, DFARS subpart 15-405 Price negotiation mentions that government contracting officers are to target a contract type and price that provide contractors the greatest incentive for efficient and economical performance. The ultimate objective being "a price that is fair and reasonable to both the Government and the contractor" and that "the negotiation of a contract type and a price are related and should be considered together with the issues of risk and uncertainty to the contractor and the Government." DFARS 15.404-4 explicitly states that contractor profit--as a financial reward--is in the government's best interest because it stimulates efficient contract performance, attracts the best capabilities of qualified business concerns, and maintains a viable industrial base. Thus, the risk assumed by firms for engaging in defense work should be positively associated with profits.

H2: *Ceteris paribus, profits earned by defense contractors from defense sales is positively related to their risks from engaging in defense business.*

Many previous studies over the last half century have considered the difference in profitability between defense and commercial business (Weidenbaum, 1968; Stigler & Friedland, 1971; Bicksler & Hess, 1976; Bohi, 1973; Mayer-Sommer & Bedingfield, 1989; Trevino & Higgs, 1992; Lichtenberg, 1992; Bowlin, 1995 & 1999; Zhong & Gribbin, 2009; Wang & Joseph San Miguel, 2012; Greer & Liao, 1986; McGowan & Vendrzyk, 2002). As previously discussed, the conclusions reached by these scholars have exhibited great variety. Therefore, it is of substantial interest to this study to provide a more current assessment of the relative profitability between defense and commercial business. This will be examined by determining if a significant relationship is observed during the study period between a contractor's profitability and their percentage of total sales attributable to defense. The following null hypothesis is developed:

H3: *Ceteris paribus, the profitability of defense contractors is not significantly related to their percentage of total sales attributable to defense.*

Tests of Hypotheses

Hypotheses H1 and H2 are intended to explore separately the effects of "influence" and "risk" on the correlation between a defense contractor's profitability and its percentage of defense sales to total sales. Hypothesis H1 examines if there is a significant relationship between a defense contractor's percentage of defense sales to total sales and its profitability. Consistent with many previous researchers (Weidenbaum, 1968; Agapos & Gallaway, 1970; Stigler & Freidland, 1971; Bohi, 1973; Bicksler & Hess, 1976; Pownall, 1986; Mayer-Sommer & Bedingfield, 1989; Trevino & Higgs, 1992; Lichtenberg, 1992; Bowlin, 1995; Zhong & Gribbin, 2009; Zhong, Gribbin, & Qian, 2012; Wang & San Miguel; 2012), this study employs firm level profitability data and does not consider a contractor's business-segment level data or figures related to specific defense contracts. Comparing intra-firm segment returns separated along defense business and commercial business lines can lead to "intractable accounting problems" (Trevino & Higgs, 1992). For example, Greer and Liao (1986) note the difficulty in attributing common costs between a firm's defense and commercial operations. Bohi (1973) notes the same challenge in separating profits by defense and commercial business due to the particular "externalities" of defense business. Bohi's externalities include: 1) patents from defense work that are owned by the firm which yield subsequent benefits to commercial business; and 2) recruiting and training cost for defense business employees who are later retained and employed for commercial work. Additionally, Zhong and Gribbin (2009) point out that changes in Securities and Exchange Commission disclosure requirements in 1999 led many firms to discontinue reporting segment sales to the government--so examining firm level profits avoids data availability problems. The use of firm level data also sidesteps complications arising from potential accounting cost shifting activities described by Lichtenberg (1992), Rogerson (1992) and Thomas and Tung (1992).

This study assesses hypotheses H1, H2, and H3 following Zhong and Gribbin's (2009) approach but uses panel data analysis methods rather than Ordinary Least Squares (OLS) regression. Hypotheses H1 and H2 will measure if the correlation between the percentage of defense sales to total sales and the firm's profit rate varies significantly according to the H1 variable of "influence" or the H2 variable of "risk". Similar to Zhong and Gribbin (2009), hypothesis H3--how defense sales impact a firm's profitability--is assessed by measuring the significance and estimated correlation between the percentage of defense sales to total sales and the firm's profit rate.

Period of Study

A review of the literature highlights the great diversity in methods and operationalized variables previously employed to understand and quantify the historical profit performance of defense contractors. However, the absence of any studies examining this topic since 2010 is striking; therefore the primary motivation for this study is to investigate defense contractor performance between 2009 and 2018. Exploring this 10-year period is consistent with Bowlin (1999) who also studies a 10-year period--noting that it should be sufficiently long to capture business and product cycles affecting both defense and commercial business.

The study period begins in the wake of the 2008 financial crisis--colloquially known as The Great Recession--and continues through the subsequent economic recovery. According to the DoD's FY2020 Green Book (2019) U.S. gross domestic product (GDP) fell over $510B from $15.63T in 2008 to $15.12T the following year (FY2012 Constant Dollars). The economy steadily regained traction thereafter however--with the GDP in 2011 finally surpassing 2008 levels at $15.69T. GDP continued to grow to $18.34T in 2018. This trend in GDP is reflected in Figure 1.

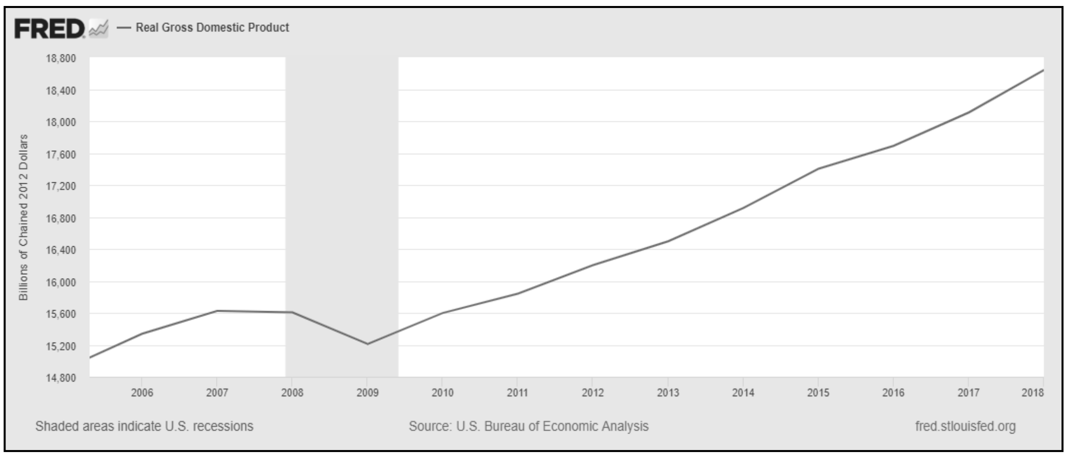


Figure 1: Real GDP, 2008-2018. (U.S. Bureau of Economic Analysis, 2019)

Defense procurement budgets did not show this same growth trend between 2008 and 2018 however. According to the FY2020 Green Book (2019), Total Obligation Authority for DoD Procurement dropped from $201.574B in FY2008 to $154.211B in FY 2018 (in FY2020 Constant dollars). DoD Procurement budgets were projected to drop even further to $143.416B in FY2024. The trend of U.S. national defense expenditures over the study period is reflected in Figure 2.

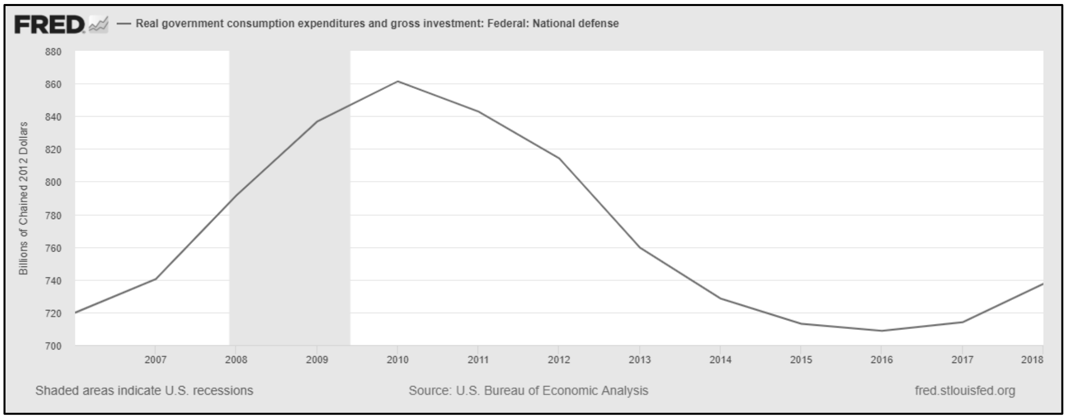


Figure 2: Real National Defense Expenditures 2006-2018 (U.S.Bureau of Economic Analysis, 2019)

Bowlin (1999) acknowledged the potential for defense budget cutbacks to shape the financial condition of the defense industry. He also recognized that major military operations and other turmoil in the Middle East impact the financial performance of the defense industry. This further highlights the importance of studying the decade spanning 2009 to 2018--which witnessed continued involvement in the Global War on Terrorism sparked by the terrorist attacks of September 11, 2001. Major U.S. military operations during the study period may potentially impact the U.S. economy, defense budgets, and defense contractor profitability. Named operations during the study period include Operation Enduring Freedom and Operation Freedom’s Sentinel in Afghanistan, Operation Iraqi Freedom and Operation New Dawn in Iraq, an Operation Inherent Resolve against the Islamic State along the Syrian-Iraqi Border (Congressional Research Service, 2019).

Model

The primary econometric model for analysis in this research is shown in Equation 1.

$$ROA_{it} = \beta_0 + \beta_1 (Influence_{it} * \% \; Defense \; Sales_{it}) + \beta_2 (Risk_{it} * \% \; Defense \; Sales_{it}) \quad (1)$$

$$+ \beta_3 \% \; Defense \; Sales_{it} + \beta_4 Influence_{it} + \beta_5 Risk_{it} + \beta_6 Year_{it} + \beta_7 Size_{it} + \beta_8 Industry_{it}$$

$$+ \beta_9 DoD \; Procurement \; Budget_{it} + \beta_{10} GDP_{it} + U_{it}$$

Where the subscript designation *i* refers to the observed cross-sectional unit (the firm); subscript designation *t* refers to the time period; *ROA* is Return on Assets; *Influence* is the percent of total DoD prime contract dollars received; *% Defense Sales* is the percent of total firm sales attributable to the U.S. Government; *Risk* is the sum of net property, plant, equipment, and intangible assets divided by total sales; *Year* is a set of nine dummy variables corresponding to each year from 2009-2018; *Size* is the total annual sales in U.S. dollars for the firm; *Industry* is a set of seven dummy variables corresponding to the first two digits of the SIC code for the firm, *DoD Procurement Budget* is the nominal DoD procurement budget in U.S. dollars; *GDP* is the nominal gross domestic product of the U.S. expressed in dollars; and *U* is the unobservable error term.

The component variables of the model are described in the following sections--Table 1 provides a brief summary. Both the cross-sectional and time series nature of this research's data set (described later) are reflected respectively in the subscript notational components *i* and *t*.

Table 1: Definition of Variables

Variable	Role	Definition
ROA_{it}	Dependent Variable	Measured as net income divided by total assets for firm *i* in year *t*
% Defense $Sales_{it}$	Main Effect Variable	Measured as sales to U.S. Government divided by total sales for firm *i* in year *t*
$Influence_{it}$	Proxy for Influence	Measured as the percent of total DoD prime contract dollars received by firm *i* in year *t*
$Risk_{it}$	Proxy for Risk	Measured as net property, plant, equipment, and intangible assets divided by total sales for firm *i* in year *t*
($Influence_{it} \times$ % Defense $Sales_{it}$)	Interaction Variable	Measured as the product of the independent variables Influence and % Defense Sales for firm *i* in year *t*
($Risk_{it} \times$ % Defense $Sales_{it}$)	Interaction Variable	Measured as the product of the independent variables Risk and % Defense Sales for firm *i* in year *t*
$Year_{it}$	Control Variable	Measured as one of 9 dummy variables corresponding to each year from 2009-2018 for firm *i* in year *t*
$Size_{it}$	Proxy for Size Control Variable	Measured by the total annual sales for firm *i* in year *t*
$Industry_{it}$	Control Variable	Measured as one of 7 dummy variables corresponding to the first two digits of the SIC code for firm *i* in year *t*
DoD Procurement $Budget_{it}$	Control Variable	Measured as the nominal DoD procurement budget for firm *i* in year *t*
GDP_{it}	Control Variable	Measured as the nominal U.S. GDP for firm *i* in year *t*
U_{it}	Error Term	Unobservable error term for firm *i* in year *t*

Theorized Model:

$$ROA_{it} = \beta_0 + \beta_1 (Influence_{it} * \%\ Defense\ Sales_{it}) + \beta_2 (Risk_{it} * \%\ Defense\ Sales_{it})$$

$$+ \beta_3\ \%\ Defense\ Sales_{it} + \beta_4\ Influence_{it} + \beta_5\ Risk_{it} + \beta_6\ Year_{it} + \beta_7\ Size_{it} + \beta_8\ Industry_{it}$$

$$+ \beta_9\ DoD\ Procurement\ Budget_{it} + \beta_{10}\ GDP_{it} + U_{it}$$

Coefficient of Interest	Hypothesis Tested
β_1	H1 explores the effects of "influence" on the correlation between a defense contractor's profitability and its percentage of total sales from defense. A positive β_1 supports H1.
β_2	H2 explores the effects of "risk" on the correlation between a defense contractor's profitability and its percentage of defense sales to total sales. A positive β_2 supports H2.
β_3	H3 explores how, controlling for other factors, the percentage of total sales from defense relates to profitability of the firm. The sign and significance of β_3 drive conclusions related to H3.

Dependent Variable

Return on Assets (ROA) will be used as the dependent variable to test the three hypotheses. This ratio is commonly used by investors to gauge how efficiently a company has used its resources to obtain income. ROA--defined as net income divided by total assets--is an indicator of corporate financial health and ability to effectively manage assets. ROA is expressed as a percentage with a higher ROA indicating greater asset efficiency. The use of ROA for measuring defense contractor profitability is consistent with the GAO's 1987 and 1990 report recommendations and numerous academic researchers (Agapos & Gallaway, 1970; Trevino & Higgs, 1992; Bowlin, 1999; Karpoff, Lee, & Vendrzyk, 1999; McGowan & Vendrzyk, 2002; Zhong & Gribbin, 2009; Wang & San Miguel, 2012). The GAO (1990) describes that ROA is the most desirable measure of contractor profitability for three reasons: 1) it provides a basis to measure the cumulative impacts of government procurement policies; 2) it can be computed at the segment level; and 3) it is easily derived from historical, financial, and audited data.

Other traditional profitability measures were considered but ultimately dismissed for this analysis. As the GAO (1990) notes, Return on Sales is a less desirable profit measure than ROA because it is based on output rather than input values and provides no measure of how effectively a firm invests its capital. Return on Equity (ROE)-- defined as net income divided by shareholder equity--was eliminated from this analysis because it can be easily manipulated by the firm. ROE can be artificially boosted by increasing reliance on debt financing or reducing the number of outstanding shares. Since debt financing is not captured by ROE's denominator, the risk of overleveraging can be obfuscated. Alternatively, share repurchases can also be used by corporate management to increase ROE by decreasing the denominator. Further, the GAO (1990) found that ROA could also be an acceptable surrogate for ROE. They tracked ROA and

ROE for the S&P Industrials index--an index commonly associated with the defense industry--over a period of 18 years and concluded that the two ratios moved in tandem. Finally, using ROA as a profit measure is also consistent with Mayer-Sommer & Bedingfield's (1989) conjecture that Congress, the press, and the public all rely more heavily on accounting measures of profitability than on market measures such as share price.

Moderating Independent Variables

Influence

Prior defense contractor profit literature has considered the effect of contractor influence on profits. Scherer (1964) outlines that in the defense market, contractors selected to provide defense goods acquire highly specialized physical and intellectual assets through the servicing of their contracts. Scherer (1964) further describes that servicing previous contracts could increase a contractor's bargaining power for winning future contracts as the government's previous commitment may restrict the ability to shop around for alternative contractors. The contract servicing scenario described by Scherer (1964) thus appears to link a defense contractor's execution of government contracts with increases in relative bargaining power within the defense marketplace. Later scholars seem to accept Scherer's linkage between government contract fulfillment and increased bargaining power as logically synonymous with increased market influence. Studies by Karpoff et al. (1999) and McGowan and Vendrzyk (2002) both employed the Department of Defense's annual report of *100 Companies Receiving the Largest Dollar Volume of Prime Contract Awards* as a way of identifying influential defense contractors. Firms not listed in the top 100 ranking were considered non-influential by both studies. Karpoff et al. (1999) state that "a firm's presence in the Top 100 list attests to its success in obtaining defense contract awards and, therefore, its influence within the DoD."

Zhong and Gribbin (2009) similarly considered contractor influence but instead measured influence by a defense contractor's total annual sales to the Government. Zhong and Gribbin (2009) noted their measure of influence as consistent with that used by Karpoff et al. (1999) and McGowan and Vendrzyk (2002) however because "a large volume of prime contract awards results in a large amount of sales to the DoD in the awarding and/or the following years." Like Karpoff et al. (1999), McGowan and Vendrzyk (2002), and Zhong and Gribbin (2009), this study also accepts the link between prime contract award volumes and contractor influence. Specifically, the proxy for influence is measured as the percentage of DoD total prime contract award dollars received by a firm in each year.

Risk

Previous research has noted that engaging in defense contracting business represents a type of operational risk assumed by the firm with no measure available to quantify it directly (Zhong & Gribbin, 2009). To proxy for the operating risk of defense contractors, Zhong and Gribbin (2009) used capital intensity -- defined as the sum of net property, plant, and equipment (PPE) and intangible assets divided by total sales. They reasoned that operating risk for defense contracting is positively related to capital asset commitment because high capital intensity is associated with high fixed costs relative to total costs. They further explain that demand decreases for defense products have disproportionately negative impacts on profits of defense contractors with higher levels of capital intensity. Greer and Liao (1986) echo this idea in their study of defense market profitability noting that "when demand falls, firms (particularly those with larger fixed costs) should engage in vigorous price competition to attract business." Miller and Bromiley (1990) also highlight that capital intensity contributes to a firm's risk through the possibility of capital obsolescence – when technological change devalues capital investments.

The idea that facilities and equipment investments represent a business operating risk borne by defense contractors also appears consistent Federal acquisition publications. The Air Force Institute of Technology (AFIT) and the Federal Acquisition Institute (FAI) have jointly developed a set of reference volumes known as the Contract Pricing Reference Guides (CPRG). The CPRG serve as instructional guidance for federal contracting personnel and provide examples of applying pricing policies to pricing problems. The CPRG explicitly notes that defense contractors considering entering into a contract with the Government must take into account the risk of various contract obligations--one such risk being investment risk. The CPRG defines investment risks as “costly investments for such things as facilities, equipment, and materials” that contractors may have to make in order to perform on a contract. This definition is also in line with the Defense Financial Acquisition Regulation Supplement (DFARS) which directs Government contracting officers to consider capital investment as part of a profit-analysis factor. The capital investments factor takes into account the contribution of contractor investments to contract performance (DFARS 15-404, (d), (iv)). This suggests that these capital investment contributions from contractors are a business operating risk to be compensated for in profit negotiations. The CPRG further links capital investments such as property, plant, and equipment as operating risks faced by contractors in detailing the uses of government furnished property (GFP). The CPRG states *“Government furnished property is one way [contracting officers] can reduce the risk to the contractor and thus make a contract more attractive. GFP, including Government-owned equipment, facilities, and materials, provided to the contractor can lower contract costs by shifting investment risk from the contractor to the Government.”* Using capital intensity to proxy defense contractor operating risk is justified on the basis of: 1) the precedent of such a proxy in previous research; and 2) the connection between risk and facilities, equipment, and materials investments plainly noted in Federal acquisition regulations and associated instructional guidance publications. Therefore, this study adopts Zhong and Gribbin's (2009) capital intensity proxy of operating risk--defined as the sum of net PPE and intangible assets divided by total sales.

Main-Effect Independent Variable

The percentage of defense sales to total sales will be used as the main effect independent variable for the profitability of defense contractors. Sales to the U.S. Government and total sales figures for defense contractors are found in publicly available annual corporate 10-K filings to the Securities and Exchange Commission. Here, sales to the government are considered synonymous with defense sales since defense sales account for the majority portion of all sales to the U.S. Government (consistent with Lichtenberg, 1992; Thomas & Tung, 1992; McGowan & Vendrzyk, 2002; Zhong & Gribbin 2009; and Zhong, Gribbin, & Qian, 2012). The sign and significance of the correlation between a firm's percentage of defense sales and its profit will indicate generally if defense or commercial business is more profitable.

Control Variables (Year, Industry, Size, DoD Procurement Budget, GDP)

McGahan and Porter (2002) studied the variance in accounting profitability across a broad cross-section of American firms and concluded that both year and industry are important controls for accounting profitability. Year is included in the model to control for the potential time trend of general economic growth each year post-2008 as well as political cycles such as elections that may affect the defense industry. The year variable is represented by one of nine dummy variables corresponding to each year from 2009 to 2019. Albuquerque (2009) echoes McGahan and Porter's (2002) suggestion to consider industry when studying firm performance. In line with prior research, industry specific effects will be controlled for in this model (Mayer-

Sommer & Beddingfield, 1989; Lichtenberg, 1992; McGowan & Vendrzyk, 2002, Zhong & Gribbin, 2009, Wang & San Miguel, 2012). Gansler (1980) highlights that the defense industry is not a single industry but rather an assortment of many different industries with significant sectoral differences. The sectoral characteristics impacting defense contractors are thus unique to their specific industry membership. The industry variable will take on one of eight values corresponding to the first two digits of each firm's Standard Industrial Classification code (SIC code). SIC codes are a four-digit classification system used to categorize U.S. businesses by industry with the first two digits identifying the businesses Major Group as detailed in Figure 3.

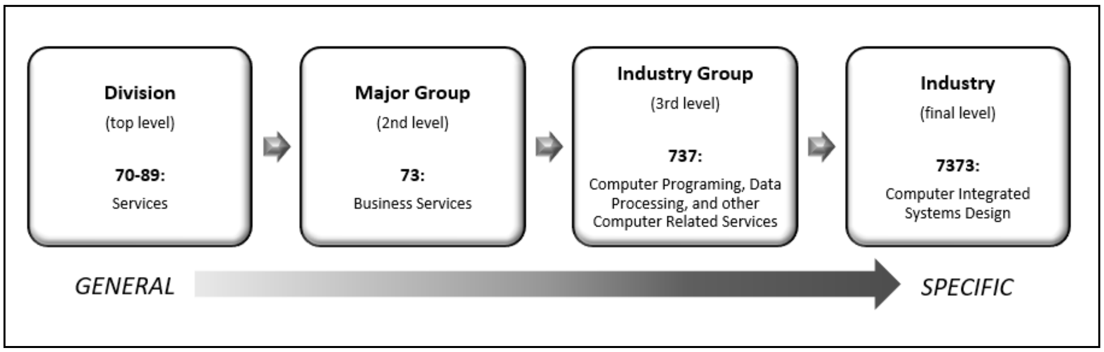


Figure 3: Example Breakdown of SIC Code 7373

In addition to controlling for industry, previous scholars (Core, Holthausen, & Larcker, 1999; Albuquerque, 2009) have noted the importance of controlling for size effects on firm performance. The control variable for the size effect is measured by the total annual sales for each firm--consistent with previous defense contractor profit research (Zhong & Gribbin, 2009; and Wang & San Miguel, 2012). Annual DoD procurement budgets are included in the model to control for changes in aggregate demand for defense related goods and services from year to year. Similarly, U.S. GDP is included in the model to control for macroeconomic realities impacting firm performance.

Sample and Data Collection

The original target sample for this research included all publicly traded U.S. defense contractors listed on the annual Top 100 DoD Contractors Report for each year between 2009 and 2018. An excerpt of the 2018 report is shown in Figure 4. The inclusion/exclusion criteria for the sample data set is summarized in Table 2 and described in the following text.

Global Vendor Name	Number of Actions	Dollars Obligated	%Total Actions	%Total Dollars
LOCKHEED MARTIN CORPORATION	139,504	$38,927,027,508.13	0.3830%	10.7740%
BOEING COMPANY	19,142	$27,491,316,584.52	0.0520%	7.6090%
RAYTHEON COMPANY	12,684	$18,123,246,176.90	0.0350%	5.0160%
GENERAL DYNAMICS CORPORATION	28,976	$14,265,283,704.71	0.0790%	3.9480%
NORTHROP GRUMMAN CORPORATION	10,294	$10,790,731,503.74	0.0280%	2.9860%

Figure 4: Excerpt of 2018 Top 100 Contractors Report (DoD)

Table 2: Sample Data Set Inclusion/Exclusion Criteria

Parameter	Inclusion Criteria	Exclusion Criteria
Time Period	2009 - 2018	Periods before 2009 or after 2018
Firm Type	Publicly traded and headquartered in the United States	Foreign firms, privately held firms, not-for-profit organizations
Defense Contractor	Listed in annual Top 100 DoD Contractors Report	Not Listed in annual Top 100 DoD Contractors Report
Financial Data	Income Statement and Balance Sheet available on Yahoo! Finance, and government sales reported in annual 10-K report as either nominal value of % of total sales	Income Statement and Balance Sheet not available on Yahoo! Finance (delisted firms), or government sales not reported in annual 10-K report as either nominal value of % of total sales
Firm Observation Periods	Two or more firm-year observations during study period	Only 1 firm-year observation during study period

Targeting the top 100 DoD contractors over a 10-year period yields a maximum potential data set of 1000 contractor-year observations. The period of study served as the initial exclusion criteria for the sample and has been previously described. The second exclusion criteria of targeting only firms listed on the annual Top 100 Contractors report was selected for two reasons. First, the Top 100 report serves as a way to identify defense contractors that would logically be considered most important from the U.S. government's point of view as well as those contractors for whom defense business is a significant concern from the firm's point of view. Top 100 firms are primary contributors to the defense industry whose continued business interests are likely to be substantially tied to the success of their DoD contracting operations. Second, the Top 100 list was widely employed in prior research it was also used in this research to lend some degree of similarity with previous studies. Next, private firms were excluded from the target sample because their financial statements are not typically available publicly. Non-profit organizations were also excluded from the target sample. Although there are non-profits which have contracting relationships with the DoD, the business and market mechanisms they operate under are significantly different than those faced by for-profit firms--and are thus outside the scope of this research. Because this research is focused on U.S. defense contractor profitability, foreign firms were also excluded from the target sample.

Excluding private firms (244 observations) such as Redstone Defense Systems and Afognak Native Corporation decreased the sample to 756 contractor-year observations. Excluding non-profits (62 observations) like Johns Hopkins University and foreign firms (166 observations) such as the Rolls-Royce Corporation further decreased the sample observations from 756 to 528. The data set now contained only the Top 100 publicly traded U.S. defense contractors for each of the years between 2009 and 2018, and listed (1) the total contract dollars obligated to each contractor for each year and (2) the percent of total DoD procurement obligations captured by each contractor in each year. With the sample data set initially scoped according to the preceding discussion, the collection of corporate financial data for each firm began.

Yahoo! Finance Premium was the database used for collecting historical financial data such as total revenue, net income, and total assets (among myriad other figures) from the annual Income Statements and Balance Sheets of each of the sample firms. Additional reductions to the sample dataset resulted from limitations in Yahoo! Finance's database. The database did not contain information for any companies not currently traded. This limitation therefore eliminated from the sample data set any company that was delisted since being published in a previous Top 100 Contractors report. Reasons a company may have been delisted include ceasing operations, declaring bankruptcy, merging with another company and adopting their name, or becoming a private corporation. After accounting for this limitation to the Yahoo! Finance database, the sample data set now totaled 376 firm-year observations.

The next datapoint needed to be collected was the total sales to the U.S. government for each of the remaining firm-year observations. Collecting this information required manually searching each contractor's Annual 10-K Report. Each 10-K report is filed with the SEC and made available online through their Electronic Data Gathering, Analysis, and Retrieval system (EDGAR). 10-K reports provide a detailed summary of a company's financial condition to include audited financial statements. Each 10-K report is organized into 4 main parts and 15 subcomponents--one subsection reports business segment information which often details sales to the U.S. government. The reporting requirements for the "Segment Reporting" subsection are outlined by the Financial Accounting Standards Board (FASB) Accounting Standards Codification (ASC) Topic 280. Because of the uniqueness of each firm's business operations, they are not specifically required in all circumstances to provide a detailed accounting of the firm's sales to the U.S. government. Therefore, the data set was again reduced by those companies for which government sales were not reported. It is important to note that most contractors reporting sales to the U.S. government provide the dollar value of such sales. However, several contractors--such as Leidos Holdings Inc.--only report the percentage (sometimes provided as an approximate) of the firm's total revenues attributable to the U.S. government. In such cases, the dollar value of government sales was calculated from this percentage and the firm's total sales. Consequently, any calculations employing approximate sales percentages would slightly reduce the accuracy of numbers used in the data set. Additionally, one contractor (The Boeing Company) reported annual sales to the U.S. Government which included foreign military sales brokered through the U.S. Government. No additional accounting information was available to exclude such foreign military sales from sales specifically attributable to the U.S. Government as the end customer. Therefore, if such sales figures were accepted some unspecified amount of measurement error would be introduced into the data set. After consideration, Boeing's government sales figures were admitted to the data set. This was based on the reasoning that the U.S. Government--not foreign militaries--is likely the end customer for the majority of the annual sales figures in question. This reasoning is supported by the logic that since Boeing is headquartered in the U.S., they would be primarily subject to U.S. laws limiting their business dealings abroad. Further, since the sales in question relate to products with a military application it is reasoned that such sales activities to foreign militaries would be very significantly restricted.

Finally, three firms with just a single observation were removed from the data set. This was because panel data techniques (described in the following section) will be used to analyze the dataset and such techniques require at least two observations from each cross-sectional unit (firm). After addressing all exclusion criteria and data limitations, the final sample data set identified 27 individual firms across 209 firm-year observations. Of the 27 firms, 13 were Top 100 contractors for each of the 10 years between 2009 and 2018. Lockheed Martin was the top contractor by total dollars obligated for each of the 10 years studied. Industrial classifications of firms in the sample spanned 17 unique 4-digit SIC codes and 8 different Major Groups.

Panel Data Analysis

The previously described sample data set has a unique structure making it distinctly suited for panel data analysis -- that is, the sample is a cross-section of defense contractors observed over multiple periods of time. Because panel data models describe individual behavior both across time and across individuals, they are well suited for studying the dynamics of change (Gujarati, 2004). The general population regression model using panel data is written as:

$$y_{it} = \beta_0 + \beta_1 x_{1,it} + \beta_2 x_{2,it} + \ldots + \beta_k x_{k,it} + u_{it} \ , \tag{2}$$

where y is the value of the dependent variable and subscripts i and t refer to the individual (firm) and time period respectively, β_0 is the intercept, β_1 through β_k represent the marginal effect that a change in independent variable x_1 through x_k respectively has on y holding all other independent variables constant, and u represents the error or unobservable term. The error term contains much information including both true randomness and factors that affect the dependent variable that are not accounted for by one of the independent variables. As noted by Hilmer and Hilmer (2014), because of the spatial-temporal nature of panel data the error terms are different in each period. Therefore, there exists the possibility that the composition of the error terms changes over time. Allowing for the potential of some but not all of the components of the error term to change over time, the error term for panel data is more explicitly specified as:

$$u_{it} = (\alpha_i + \varepsilon_{it}) \ , \tag{3}$$

where u_{it} is a composite error term for individual (firm) i in time period t, α_i is a time-invariant component that varies across individuals but not time periods, and ε_{it} is a time-variant component that varies across both individuals and time. Hilmer and Hilmer (2014) explain two important assumptions made regarding the time-variant and time-invariant components of the error term. First, the time-invariant component of the error term is assumed to be correlated to the independent variables of the population regression model. Second, it is assumed that the time-variant component of the error term is not correlated with the independent variables for any time period in the population regression model. These assumptions are foundational to selecting the most appropriate estimation technique for panel data sets. There are four primary estimation techniques for panel data: pooled models, first-differenced models, fixed effects models, and random effects models.

Pooled Cross-Section Analysis

While it would be possible to estimate an Ordinary Least Squares (OLS) regression model by combining the data from all 10 years of the study period into one large cross-section, this technique would forgo the considerable analytical insights afforded by considering both the spatial and temporal dimension inherent in the panel nature of the sample data set (Hilmer & Hilmer, 2014). This model produces constant (identical) coefficients for intercepts and slopes for every individual (firm) observed (Gujarati, 2004). Therefore, this estimation technique is not targeted for use by this research.

First-Differenced Models

First-differenced models are a way to control for time-period differences in panel data. In first-differencing the values of the dependent and independent variables in time period t-1 are subtracted from the associated values in time period t (Hilmer & Hilmer, 2014). This process removes the time-invariant component from the error term. Because the time-invariant component of the error term is assumed to be correlated with the independent variables, removing it by differencing allows for unbiased estimates (Hilmer & Hilmer, 2014). Essentially, this is a way to consider the specific nature or “individuality” of the observed cross-sectional units (firms) that does not change over time. One limitation of first-differencing is that it is impossible to estimate marginal effects of independent variables that are either constant across time periods (e.g., gender) or increase by a fixed amount over time (e.g., age).

Fixed-Effects Models

Fixed-effects models are another method of removing the time-invariant component of the error term in panel data. This can be done by estimating a “constant-free” model (no intercept) by including a dummy variable representing every cross-sectional unit (firm) observed in the sample. Hilmer and Hilmer (2014) explain that this technique removes the individual-specific component from the error term by controlling for it directly in the regression model. If the number of individuals (firm) in the sample is large however, this method may become tedious and consume large numbers of degrees of freedom. Hilmer & Hilmer (2014) also detail a second way to estimate a fixed-effect model through a process referred to as “demeaning”. Demeaning removes the time-invariant component of the error term--or individual effect--by subtracting the average value of each individual (firm) from the observed values of each observation for each individual (firm) for the dependent variable and all independent variables. The results of either first-differencing or fixed-effects modeling are equivalent (Mundlak, 1978). Like first-differencing models, fixed-effect models cannot estimate marginal effects of independent variables that are either constant across time or increase by a fixed amount over time.

There are many ways in which the defense contracting firms in the sample data set may be individually unique thus making fixed-effect panel analysis useful. The firms may have different corporate cultures or value sets that may affect profitability yet are difficult to quantify specifically. Management style and talent as well as leadership aversion to or acceptance of risk are likely to vary uniquely between firms. The aggregate morale, talent, and commitment of employees may vary in ways that impact profitability. Also, there may be certain time-effects in a panel data set of contractor profit; this might be thought of as an “individual effect” of specific time periods. United states electoral cycles, the timing of implementation of laws and policies, and shifting geo-political and economic realities could be instances that make a time period individually unique in the way it impacts contract profits between periods. Similar to the idea that there may be something about corporate culture (individual effect) that is difficult to quantify but nonetheless does impact profitability, there may be something about the nature of one time period that effects profitability differently than other periods. In light of these potential individual and time effects, fixed-effects modeling will be the primary method of analysis in this research.

Random-Effects Models

If the time-invariant component of the error term is not correlated to the independent variables, first-differencing and fixed-effect models which remove the time-invariant component from the model are unnecessary. Because they control for--but do not completely remove--the time-invariant component of the error term, random-effects panel models provide a way of generating efficient and unbiased estimates for instances when the time-invariant component is not correlated to the independent variables (Hilmer & Hilmer, 2014). Random-effects models might be inappropriate for most economic applications because there is seldom an instance where the time-invariant component of the error term (specific nature of firm) is not correlated to one or more of the independent variables (Hilmer & Hilmer, 2014). Additionally, Wooldridge (2010) notes that “in many applications, the whole point of using panel data is to allow for (the time-invariant component of the error term) to be arbitrarily correlated with the (independent variables)" and that "a fixed-effects analysis achieves this perfectly." For detailed explanations of panel data techniques, readers are referred to Gujarati, 2004; Hilmer & Hilmer, 2014; or Wooldridge, 2010.

Summary

This chapter developed the hypotheses used to explore the research questions and explained how they are to be tested. The model, its component variables, and the period of study employed have also been described. Additionally, justification for each of the model component's specification was provided. Lastly, the data and methodology used to analyze the data were discussed. The following chapter will cover analysis and results.

IV. Analysis and Results

Chapter Overview

This chapter presents the analysis conducted according to the methodology presented in the previous chapter and examines the results. Statistical analysis was conducted using R, an open source software for data manipulation and statistical computing and modeling (R Core Team, 2019). Panel analysis was conducted using the "plm" package in R (Croissant & Millo, 2018).

Baseline Model - Twoway Fixed Effects

As described in Chapter 3, it is hypothesized that in the panel data set of contractor profit, both individual and time fixed effects may be significant. Therefore, the "twoway" model which accounts for both individual and time fixed effects will serve as the baseline for beginning analysis in R with the plm package. The twoway fixed effects model is specified as follows:

$$ROA_{it} = \beta_0 + \beta_1 (Influence_{it} * \%\ Defense\ Sales_{it}) + \beta_2 (Risk_{it} * \%\ Defense\ Sales_{it}) \tag{4}$$

$$+ \beta_3 \%\ Defense\ Sales_{it} + \beta_4\ Influence_{it} + \beta_5\ Risk_{it} + U_{it}\ ,$$

where the variable definitions are the same as described in Table 1. In the twoway fixed effects model, the "Industry" variable from Equation 1 is necessarily excluded because it does not vary for an observed firm across time periods. Similarly, the "GDP" and "DoD Procurement Budget" variables are necessarily excluded because they do not vary between firms in a given time period. Also, the two aforementioned variables would be logically subsumed into the modeling effect for time fixed effects--which controls for differences across years. The theorized "Size" variable from Equation 1 is also excluded because it is logically subsumed into the individual fixed effect controlled for in the twoway fixed effect model. Here, the ability of each defense contracting firm to leverage their size in pursuit of profits is theorized to be an individual fixed effect specific to each firm. This size leveraging capability would then be included in the time-invariant component of the composite error term U_{it} which is correlated with each independent variable. As shown in Figure 5, the p-values of the "Influence" variable and "Influence x Defense Sales" interaction term, as well as that of the overall model are significant at the 0.05 level in the twoway fixed effects model.

```
Coefficients:
                  Estimate Std. Error t-value Pr(>|t|)
PctDefenseSales  0.021072   0.042101  0.5005  0.61736
InfluenceXDef   -3.134307   1.457213 -2.1509  0.03291 *
RiskXDef        -0.044996   0.149389 -0.3012  0.76363
Risk            -0.136794   0.087731 -1.5593  0.12082
Influence        2.126842   0.876033  2.4278  0.01625 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Total Sum of Squares:    0.21818
Residual Sum of Squares: 0.20093
R-Squared:      0.079081
Adj. R-Squared: -0.14019
F-statistic: 2.88529 on 5 and 168 DF, p-value: 0.015848
```

Figure 5: Twoway Fixed Effect Model Output

Considering Significance of Individual and Time Fixed Effects Separately

After the twoway model of both individual and time fixed effects was shown to be significant overall, the next step in analysis was to separately check if individual fixed effects were significant and if time fixed effects were significant. The individual fixed effects only model is also specified by Equation 4. As shown in Figure 6, the p-values of the "Influence" variable and

“Influence x Defense Sales” interaction term, as well as that of the overall model are still significant at the 0.05 level--slightly more so than in the twoway effects model.

```
Coefficients:
                  Estimate Std. Error t-value Pr(>|t|)
PctDefenseSales  0.0280249  0.0396983  0.7059 0.481149
InfluenceXDef   -3.6292684  1.3967516 -2.5984 0.010156 *
RiskXDef        -0.0075699  0.1485803 -0.0509 0.959424
Risk            -0.1499619  0.0848424 -1.7675 0.078862 .
Influence        2.3118914  0.8453940  2.7347 0.006879 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    0.23452
Residual Sum of Squares: 0.21599
R-Squared:      0.079014
Adj. R-Squared: -0.082289
F-statistic: 3.03706 on 5 and 177 DF, p-value: 0.011767
```

Figure 6: Individual Fixed Effects Model Output

An F test for twoway fixed effects versus individual fixed effects only--shown in Figure 7--yields a p-value of 0.1922. Therefore, we fail to reject the null hypothesis at 0.05 level of significance and conclude there is no significant time effects. A Breusch-Pagan (1980) Lagrange Multiplier Test for time effects--Figure 8--yields a p-value of 0.794 and similarly dictates failure to reject the null hypothesis thus concluding there is no significant time fixed effects.

```
F test for twoways effects

data:  ROA ~ PctDefenseSales + InfluenceXDef + RiskXDef + Risk
+ Influence +  ...
F = 1.3988, df1 = 9, df2 = 168, p-value = 0.1922
alternative hypothesis: significant effects
```

Figure 7: F test for Twoway Fixed Effects Versus Individual Effects Only

```
Lagrange Multiplier Test - time effects (Breusch-Pagan)
for unbalanced panels

data:  ROA ~ PctDefenseSales + InfluenceXDef + RiskXDef + Risk
+ Influence
chisq = 0.068169, df = 1, p-value = 0.794
alternative hypothesis: significant effects
```

Figure 8: Breusch-Pagan Lagrange Multiplier Test for Time Fixed Effects

Next, a pooled model is created to test for significant individual fixed effects. As explained in Chapter 3, a pooled model is essentially a regular OLS regression model that assumes a constant intercept and slope regardless of the firm or time period observed. The pooled model is also specified by Equation 4--albeit with the regular OLS assumptions on the error term. The output for the pooled model is shown in Figure 9.

```
Coefficients:
                  Estimate Std. Error t-value  Pr(>|t|)
(Intercept)      0.0493535  0.0084075  5.8702 1.753e-08 ***
PctDefenseSales  0.0277766  0.0133228  2.0849  0.038329 *
InfluenceXDef   -1.5991337  0.4964192 -3.2213  0.001486 **
RiskXDef        -0.0212289  0.0626593 -0.3388  0.735112
Influence        0.8661947  0.3400535  2.5472  0.011599 *
Risk            -0.0521016  0.0380013 -1.3710  0.171873
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    0.34588
Residual Sum of Squares: 0.30465
R-Squared:      0.1192
Adj. R-Squared: 0.097507
F-statistic: 5.49453 on 5 and 203 DF, p-value: 9.1094e-05
```

Figure 9: Pooled Model Output

An F test for individual effects--shown in Figure 10--yields a p-value less than the 0.05 level of significance. Therefore, we reject the null hypothesis and conclude there is statistically significant support for individual fixed effects in the panel data set.

```
        F test for individual effects

data:  ROA ~ PctDefenseSales + InfluenceXDef + RiskXDef + Influence
+  ...
F = 2.7946, df1 = 26, df2 = 177, p-value = 3.63e-05
alternative hypothesis: significant effects
```

Figure 10:F Test for Individual Fixed Effects

Testing for Random Effects

Next a random effects model--also specified by Equation 4--was generated to conduct specification testing. The random effects model was tested against the individual fixed effects model previously shown to be statistically significant. In R, random effects models for unbalanced panel data sets can be computed using one of three estimator transformations: "swar" (Swamy & Arora; 1972), "amemiya" (Amemiya; 1971), "walhus" (Wallace & Hussain; 1969). The output of the random effects model using the “swar” estimator is shown in Figure 11.

```
Effects:
                    var   std.dev share
idiosyncratic 0.0012203 0.0349322 0.779
individual    0.0003472 0.0186325 0.221
theta:
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.2017  0.4475  0.4900  0.4560  0.4900  0.4900

Residuals:
     Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
-0.274266 -0.012646  0.004671 -0.000016  0.016185  0.116736

Coefficients:
                  Estimate Std. Error z-value  Pr(>|z|)
(Intercept)      0.0499127  0.0121620  4.1040 4.061e-05 ***
PctDefenseSales  0.0285256  0.0190331  1.4987  0.133943
InfluenceXDef   -2.1369637  0.7446292 -2.8698  0.004107 **
RiskXDef         0.0075418  0.0865045  0.0872  0.930525
Influence        1.2547273  0.5033704  2.4927  0.012679 *
Risk            -0.0784291  0.0500789 -1.5661  0.117323
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    0.27138
Residual Sum of Squares: 0.24638
R-Squared:      0.092131
Adj. R-Squared: 0.06977
Chisq: 20.6002 on 5 DF, p-value: 0.00096374
```

Figure 11: Random Effects Model Output (Swarmy-Arora's Transformation)

Hausman's specification test for random effects models (Hausman, 1978) was used to determine which model was the correct specification for this research's data set--the individual fixed effects model or the random effects model. The results of the Hausman specification test are shown in Figure 12.

```
Hausman Test

data:  ROA ~ PctDefenseSales + InfluenceXDef + RiskXDef + Influence +
...
chisq = 5.0038, df = 5, p-value = 0.4154
alternative hypothesis: one model is inconsistent
```

Figure 12: Hausman Specification Test Results

Based on the Hausman test we fail to reject the null hypothesis at the 0.05 level of significance and conclude that the random effects model is the correct specification. This means that there is no statistically significant support that the time-invariant component of the error term, α_i , is correlated with the regressors. While Figure 12 displays the Hausman specification test results comparing the individual fixed effects model to the random effects model using the "swar" estimator, the interpretation of results is not impacted by alternatively using the "amemiya" or "walhus" random effects estimator transformations -- which yield Hausman specification test p-values of 0.3666 and 0.4158 respectively.

After concluding that the random effects model is correctly specified over the individual fixed effects model, a comparison to the pooled OLS model is necessary to determine if random effects are indicated or if there is no panel effect and the OLS model is better. The Breusch-Pagan (1980) Lagrange Multiplier Test for random effects is employed for this purpose via the "plmtest" in R. The results of this test, shown in Figure 13, indicate that at the 0.05 level, there is statistically significant evidence of random panel effects.

```
Lagrange Multiplier Test - (Breusch-Pagan) for unbalanced panels

data:  ROA ~ PctDefenseSales + InfluenceXDef + RiskXDef + Influence +
...
chisq = 22.925, df = 1, p-value = 1.684e-06
alternative hypothesis: significant effects
```

Figure 13: Breusch-Pagan Lagrange Multiplier Test for Random Effects

Model Selection Recap

At this point in the panel data modeling process, the analysis has concluded that the random effects model is indicated. Analysis started with a theoretically supported twoway (time and individual) fixed effects model. An F-test and Breusch-Pagan Lagrange Multiplier Test for time effects both failed to indicate statistically significant support for time fixed effects. Next, a separate F-Test did indicate statistically significant support for individual fixed effects. Therefore, a Hausman test was then employed to determine which model was the correct specification for this research's data set; the individual fixed effects model, or the random effects model. The Hausman test provided statistically significant evidence that the random effects model was appropriate. Finally, the Breusch-Pagan Lagrange Multiplier Test for random effects indicated that there is a statistically significant random effect in the panel data set; and therefore the random effect model is better able than the pooled OLS model to deal with unobserved heterogeneity.

Considering Heteroskedasticity and Autocorrelation

After the model selection process has been completed, any attempt to interpret variable coefficients or significance without first considering potential heteroskedasticity and/or autocorrelation would be premature. Heteroskedasticity occurs when the error term has nonconstant variance while autocorrelation is when the error term in one time period is correlated with the error term in another time period (Hilmer & Hilmer, 2014). Heteroskedasticity and autocorrelation both lead to situations where the parameter estimates of the model are unbiased but are not minimum variance among all unbiased estimators (Hilmer & Hilmer, 2014). Another consequence of heteroskedasticity and/or autocorrelation is that the calculated standard errors are incorrect. As a result, all measures of precision (t-stats, p-values, confidence intervals, and F-tests) based on those standard errors are also incorrect. The hypotheses of this research hinge on the ability to reliably test and interpret the significance of the modeled variables. Therefore, heteroskedasticity and autocorrelation must be tested for, and if present, corrected.

The Breusch-Pagan Test (1979) is used to test for heteroskedasticity and the Breusch–Godfrey Test (Breusch, 1978; Godfrey, 1978) for panel models tests for autocorrelation. The Breusch-Pagan Test and the Breusch–Godfrey Test were both conducted at the 0.05 level of significance. The Breusch-Pagan Test did indicate the presence of heteroskedasticity, while the Breusch–Godfrey Test did not indicate the presence of autocorrelation. Given these results, White's Heteroskedastic Consistent Standard Errors (White, 1980) are used to re-estimate heteroskedasticity consistent standard errors for the random effects model. The original and heteroskedasticity consistent coefficient estimates and p-values are shown in Figure 14.

```
Original coefficient estimates:

                  Estimate Std. Error  t value  Pr(>|t|)
(Intercept)      0.0499127  0.0121620   4.1040  5.88e-05 ***
PctDefenseSales  0.0285256  0.0190331   1.4987  0.135497
InfluenceXDef   -2.1369637  0.7446292  -2.8698  0.004542 **
RiskXDef         0.0075418  0.0865045   0.0872  0.930611
Influence        1.2547273  0.5033704   2.4927  0.013479 *
Risk            -0.0784291  0.0500789  -1.5661  0.118880
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

--------------------------------------------------------------

Heteroskedasticity consistent coefficient estimates:

                  Estimate Std. Error  t value  Pr(>|t|)
(Intercept)      0.0499127  0.0100715   4.9558  1.516e-06 ***
PctDefenseSales  0.0285256  0.0132330   2.1556   0.03229  *
InfluenceXDef   -2.1369637  1.2023057  -1.7774   0.07700  .
RiskXDef         0.0075418  0.0915493   0.0824   0.93443
Influence        1.2547273  0.7731014   1.6230   0.10615
Risk            -0.0784291  0.0444814  -1.7632   0.07937  .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Figure 14: Original and Heteroskedasticity Consistent Coefficient Estimates for the Random Effects Model

Random Effects Panel Model Regression Results

The final model is still defined by Equation 4 below, with random effects being determined as correctly specified and thusly providing estimates that are consistent and efficient.

$$ROA_{it} = \beta_0 + {}_{1} (Influence_{it} * \%\ Defense\ Sales_{it}) + \beta_2 (Risk_{it} * \%\ Defense\ Sales_{it}) + \beta_3\ \%\ Defense\ Sales_{it} + \beta_4\ Influence_{it} + \beta_5\ Risk_{it} + U_{it} \quad (4)$$

The heteroskedasticity consistent coefficient estimates for the random effects model shown in Figure 14 now allow for accurate interpretation of the variable coefficients. The results indicate that only one variable in the model -- % Defense Sales -- is significantly related to a defense contractor’s profitability (as measured by Return on Assets) at the 0.05 level of significance.

The coefficient and statistical significance of the interaction term “Influence × % Defense Sales” in the final model guides the interpretation of hypothesis H1, defined as follows:

H1: *Ceteris paribus, profits earned by defense contractors from defense sales is positively related to their level of influence in the defense contracting market.*

The interaction term “Influence × % Defense Sales” is not statistically significant at the 0.05 level. The interaction term’s p-value of 0.077 is somewhat close to the chosen level of significance though, which might suggest the possibility for some evidence that a defense contractor’s influence relative to their level of total sales attributable to defense could relate to their profitability. However, considering the coefficient estimate’s sign (-2.137) is opposite of that predicted by hypothesis H1, the matter appears rather definitively settled. Hypothesis H1 is rejected at the 0.05 level of significance and we conclude that there is no statistical evidence in the random effects model that the profits of contractors for their defense sales are positively related to their level of influence in the defense contracting market.

The second coefficient of interest is that of the interaction term “Risk × % Defense Sales” and relates to hypothesis H2 which is defined as follows:

H2: *Ceteris paribus, profits earned by defense contractors from defense sales is positively related to their risks from engaging in defense business.*

The p-value of this interaction term is 0.934, which provides considerable support for the conclusion related to this hypothesis. That is, that at the 0.05 level of significance we reject hypothesis H2 and conclude there is no statistically significant evidence that profits earned by defense contractors from defense sales is positively related to their risks assumed from engaging in defense business.

The firm's percentage of defense sales to total sales was the only statistically significant variable in the model at the 0.05 level. This coefficient estimate is related to hypothesis H3, defined as follows:

H3: *Ceteris paribus, the profitability of defense contractors is not significantly related to their percentage of total sales attributable to defense.*

Because the two interaction terms previously discussed were found to be insignificant in the model, the coefficient estimate for the % Defense Sales variable is interpreted as a main-effect: for every 1% increase in a defense contractor's percentage of total sales attributable to defense, a 0.0285% increase in their Return on Assets is predicted. This indicates that H3 should be rejected, and we conclude at the 0.05 level of significance that defense contractor profit is significantly related (positively) to their percentage of total sales attributable to defense. Put another way, the higher percentage of total sales from defense sales is related to higher Returns on Assets suggesting that, for the firms studied, defense sales may generally be more profitable than commercial sales.

The final model output with heteroskedasticity consistent coefficient estimates reported and condensed hypotheses test conclusions is summarized in Table 2

Table 3: Summary of Final Model

Final Model, Random Effects:

$$ROA_{it} = \beta_0 + \beta_1 \text{ (Influence}_{it} \text{ * \% Defense Sales}_{it}) + \beta_2 \text{ (Risk}_{it} \text{ * \% Defense Sales}_{it}) + \beta_3 \text{\% Defense Sales}_{it} + \beta_4 \text{ Influence}_{it} + \beta_5 \text{ Risk}_{it} + U_{it}$$

Unbalanced Panel: n = 27, T = 2-10, N = 209

Effects:

	var	std.dev	share
idiosyncratic	0.0012203	0.0349322	0.779
individual	0.0003472	0.0186325	0.221

theta:

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.2017	0.4475	0.4900	0.4560	0.4900	0.4900

Total Sum of Squares:	0.27138
Total Sum of Squares:	0.27138
Residual Sum of Squares:	0.24638
R-Squared:	0.092131
Adj. R-Squared:	0.06977
Chisq:	20.6002 on 5 DF
p-value:	0.00096374

Residuals:

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
-0.274266	-0.012646	0.004671	-0.000016	0.016185	0.116736

	Dependent Variable: ROA_{it}					
Independent Variables	**Relationship Predicted**	**Relationship as Estimated**	**Coefficient**	**t-stat**	**p-value**	
$Intercept$			0.0499127	4.9558	1.516E-06	
$Influence \times \% \, Defense \, Sales_{it}$	+	-	-2.1369637	-1.7774	0.07700	
$Risk \times \% \, Defense \, Sales_{it}$	+	+	0.0075418	0.0824	0.93443	
$\% \, Defense \, Sales_{it}$	?	+	0.0285256	2.1556	0.03229	*
$Influence_{it}$	?	+	1.2547273	1.6230	0.10615	
$Risk_{it}$	?	-	-0.0784291	-1.7632	0.07937	

* Significant at the 0.05 level

Coefficient of Interest	Hypothesis Tested & Conclusion
β_1	Hypothesis H1 explores the effects of "influence" on the correlation between a defense contractor's profitability and its percentage of defense sales to total sales. This interaction term is not statistically significant at the 0.05 level, consequently Hypothesis H1 is rejected.
β_2	Hypothesis H2 explores the effects of "risk" on the correlation between a defense contractor's profitability and its percentage of defense sales to total sales. This interaction term is not statistically significant at the 0.05 level, consequently Hypothesis H2 is rejected.
β_3	Hypothesis H3 explores how the percentage of total sales from defense relates to profitability of the firm. The sign and significance of β_3 indicate a higher percentage of total sales from defense is related to a higher ROA for the firm

V. Conclusion

Chapter Overview

This chapter concludes this research effort. First, the findings of the research are summarized. Next, a discussion regarding the limitations impacting the research is provided. Finally, the chapter concludes by addressing potential areas of future research related to defense contractor profitability.

Research Findings

The survey of literature provided in Chapter 2 inspired three questions explored by this research. Due to the spatial-temporal nature of the data set, panel data analysis was the method employed to investigate the research questions. First, three panel data estimators--pooled OLS, fixed effects, and random effects--were each examined to determine which one provided the most efficient and consistent estimates when modeling the unbalanced data set of 209 firm-year observations from 27 defense contractors across 10 years. Although a twoway fixed effects model was initially proposed based on the theory that both significant individual fixed effects and time fixed effects were present, the model selection analysis demonstrated that a random effects panel model was a more appropriate model for the data. The implication of this specification is that individual firm effects are not correlated with any of the regressors in the model. Therefore, individual specific heterogeneity is controlled for in the random effects model as a component of the composite error term. This results in the intercept and slopes of regressors remaining constant across firms, with the differences between firms stemming from their individual specific error variances. With the model specification settled, the research questions were then evaluated.

The first research question considered the effect of a contractor's influence in the defense marketplace on the correlation between their profitability and their percentage of total sales from defense. Here, "influence" was hypothesized as a moderating variable affecting the direction and strength of the relationship between profitability and a firm's percentage of total sales from defense. Since there is no direct measure of contractor's influence in the defense marketplace, a proxy was used. This proxy was measured as the percent of total DoD prime contract award dollars received by a firm in a given year. The hypothesis was explored by including the interaction term "Influence x % Defense Sales" in the model and then assessing the potential role of "influence" as a moderating variable by evaluating the significance and parameter estimate of the interaction term. Ultimately, the interaction term was not found to be statistically significant at the 0.05 level, indicating influence did not have a moderating effect on the correlation between defense contractor profitability and their percentage of total sales from defense.

The second research question considered the effect of risk on the correlation between a defense contractor's profitability and its percentage of total sales from defense work. Similar to influence, "risk" was hypothesized as a moderating variable affecting the direction and strength of the relationship between profitability and a firm's percentage of total sales from defense. Risk was proxied as the net property, plant, equipment, and intangible assets scaled by total sales for the firm in a given year. The interaction term "Risk x % Defense Sales" was included in the models to assess risk as a potential moderating variable. To this end, the significance and parameter estimate of the interaction term were evaluated. Ultimately, the interaction term was not found to be statistically significant at the 0.05 level, indicating risk did not have a moderating effect on the correlation between defense contractor profitability and their percentage of total sales from defense.

Finally, this research examined if a significant relationship existed between a defense contractor's percentage of total sales attributable to defense work (versus commercial) and their profitability; and if so, what the sign of that relationship was. The final random effects model indicated that at the 0.05 level of significance, defense contractor profit was positively related to their percentage of total sales attributable to defense. Plainly stated, the statistical evidence suggested that higher percentages of defense sales related to higher Returns on Assets -- implying that for the firms studied, defense sales were generally more profitable than commercial sales.

Limitations

The primary limitation of the analytical findings presented herein is the generalizability to U.S. defense contractors at large. The population of all U.S. defense contractors is extensive and heterogeneous. This study is based off only 27 of those contractors and 209 unique firm-year observations spanning a 10-year period. Access limitations to the powerful databases and data integrators commonly used by finance industry professionals--such a Bloomberg terminals--necessitated a sample selection technique primarily reliant instead on the publicly available "Top 100 Contractors Report" produced by the U.S. General Services Administration and provided by the Federal Procurement Data System - Next Generation. This sample selection technique likely reduced the population heterogeneity captured in the sample by focusing only on those prominent contractors with which the U.S. government was most closely associated financially. This reduction in sample heterogeneity very likely impacted the research findings and thus would significantly limit the generalizability of those findings to the larger population of all U.S. defense contractors.

Also, the dynamic nature of the defense contracting environment limits the application of these current findings to either previous or future time periods. Market conditions and defense procurement regulations evolve along with the technologies and products the defense industrial base produces and the levels of demand they satisfy. All these factors may be significant determinants impacting defense profits which may differ considerably between any two time periods.

Future Research

There are several possibilities to expand on this research along related lines. One area of suggested exploration would be to study differences in defense contractor profit at the contract level. This may allow for a greater understanding of the interaction of profit as an incentive and contract performance across different contractors. This understanding could potentially be used to improve either the defense contracting process or contract performance outcomes, or both.

Additionally, in reviewing literature for this research it was noted that a few previous scholars had attempted to quantify and study the idea of "excessive" defense contractor profit. None of the research reviewed however explicitly considered the differences between accounting and economic profits. Economic profits may offer a logical and standardized way to quantify excessive profits. In this vein, considering the difference between return on invested capital (ROIC) and the weighted average cost of capital (WACC) may be particularly productive. When ROIC is greater than WACC a company is generating returns from the capital it invests that exceed the minimum required returns of the firm's capital providers, capturing economic profits.

Furthermore, the empirical evidence from this research suggested that defense sales were more profitable than commercial sales for the contractors sampled. An exploration into whether this finding holds in either broader samples or across time may prove particularly interesting and enlightening.

Finally, any research similar to that presented herein would benefit greatly from access to the more robust databases and data integrators commonly used by finance industry professions and other researchers. Such databases and data services include: Bloomberg terminals, Compustat, Morningstar Direct, The Value Line Investment Survey, and The Center for Research in Security Prices (CRSP) datasets among others.

Summary

This chapter concludes this research effort, which strove to provide two primary contributions to the field of defense contractor profit research: 1) a thorough survey of previous defense contractor research; and 2) an updated analysis of defense contractor profitability. The chapter began by summarizing the analytical research findings and then discussed the limitations of the research. Finally, suggestions for related future research were provided.

Appendix

Table 4: Summary of Defense Profit Studies and Findings

AUTHOR	DATE	TAXONOMY	PERIOD OF EXAMINATION	FINDINGS REGARDING DEFENSE BUSINESS
Weidenbaum	1968	Firm	1952-1955 & 1962-1965	Defense firms more profitable than commercial firms, more so in second period
Agapos & Gallaway	1970	Firm	1942-1967	No evidence of excessive (aerospace) profits relative to positive demand shifts; net zero affect on profits from Renegotiation Act
Stigler & Friedland	1971	Firm	1948-1961 & 1958-1968	Defense Stockholder returns almost double the market during 1950s, approximately the same (but less) during the 1960's
Bohi	1973	Firm	1960-1969	Defense and commercial profit performance not statistically different
Bicksler & Hess	1976	Firm	1958-1968	No price/yield disequilibrium returns to Defense stocks
Pownall	1986	Firm	1968-1970	Defense shareholders lost wealth prior to CASB, losses offset by post-CASB gains
Mayer-Sommer & Bedingfield	1989	Firm	1968-1977	No significant difference in market or accounting returns between defense and commercial business
Trevino & Higgs	1992	Firm	1970-1989	Defense outperforms market by huge margin over whole period; returns similar to market in 1970s and substantially better during 1980s
Lichtenberg	1992	Firm	1983-1989	Defense substantially more profitable than commercial business
Bowlin	1995	Firm	1978-1992	Financial condition of defense firms significantly worse than commercial firms
Zhong & Gribbin	2009	Firm	1984-1998	Defense business is less profitable than commercial business
Wang & San Miguel	2012	Firm	1950-2010	Defense business excessively profitable relative to commercial; defense increasingly profitable after 1992
Greer & Liao	1986	Segment	1963-1982	Defense business is less profitable than commercial business
Rogerson	1992	Segment	N/A, Theoretical Equation	Firms incentivized to allocate costs on defense contracts to potentially increase profits
Thomas & Tung	1992	Segment	1975-1983	Pension cost shifting could potentially decrease commercial business expenses
Bowlin	1999	Segment	1983-1992	Defense more profitable 1983-1987; defense less profitable 1988-1889; defense more profiable again 1990-1992
McGowan & Vendrzyk	2002	Segment	1984-1989 & 1994-1998	Defense segments abnormally profitable 1984-1989; not significantly different between 1994-1998

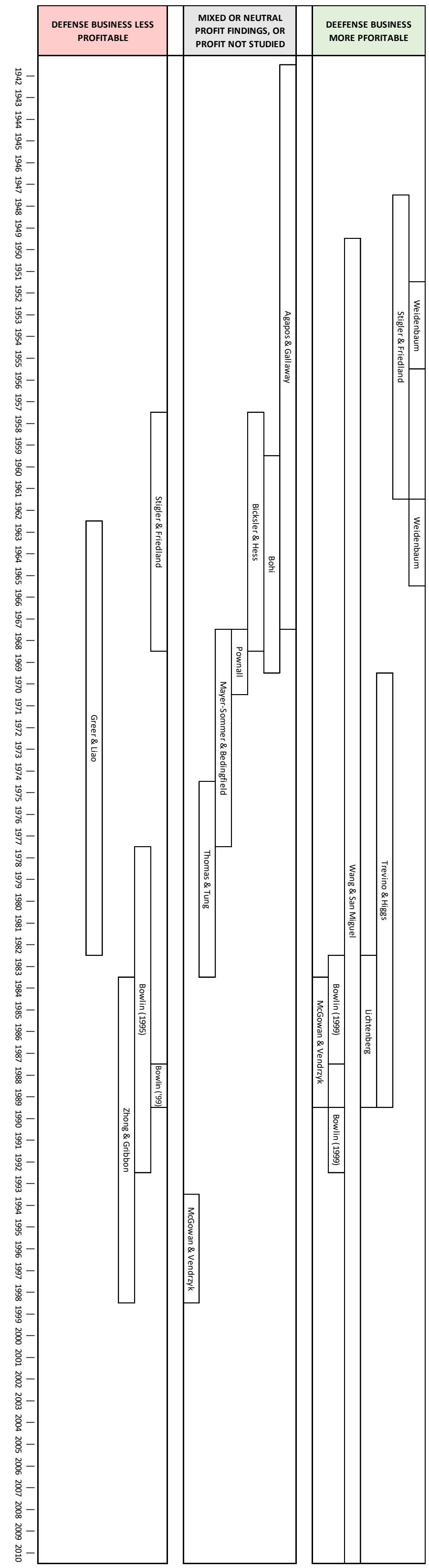


Figure 15: Defense Contractor Profit Study Periods and Findings

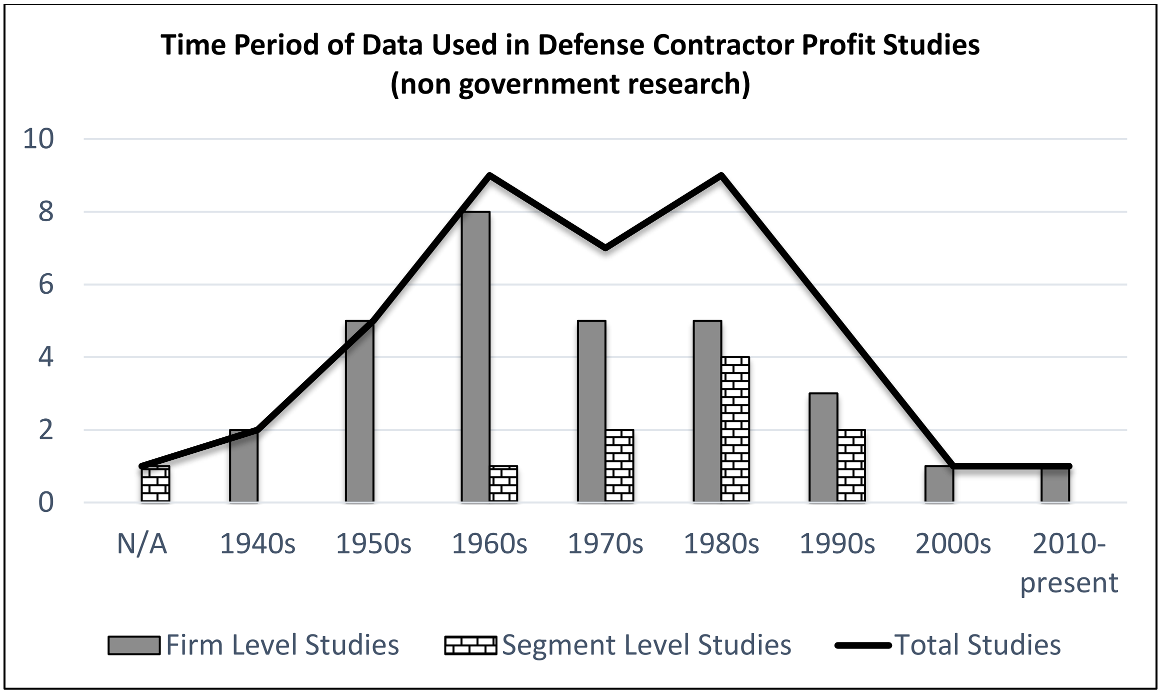
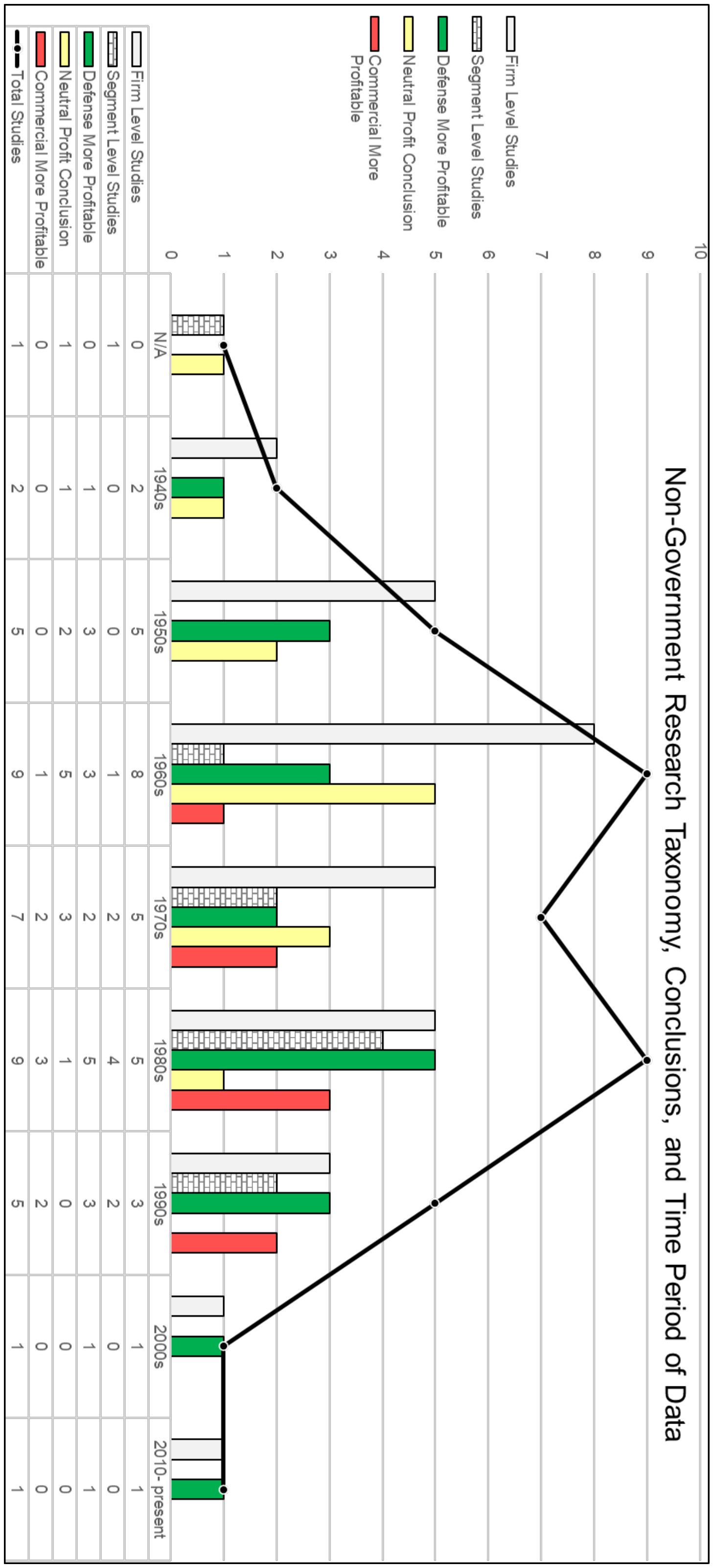


Figure 16: Time Period of Data Used in Defense Contractor Profit Studies



	N/A	1940s	1950s	1960s	1970s	1980s	1990s	2000s	2010-present
Firm Level Studies	0	2	5	8	5	5	3	1	1
Segment Level Studies	1	0	0	1	2	4	2	0	0
Defense More Profitable	0	1	3	3	2	5	3	1	1
Neutral Profit Conclusion	1	1	2	5	3	1	0	0	0
Commercial More Profitable	0	0	0	1	2	3	2	0	0
Total Studies	1	2	5	9	7	9	5	1	1

Figure 17: Non-Government Research Taxonomy, Conclusions, and Time Period of Data

Table 5: Correlation Matrix of Variables

	Year	ROA	% Defense Sales	Influence	Risk	Influence × % Defense Sales	Risk × % Defense Sales
Year	1.0000						
ROA	0.0151	1.0000					
% Defense Sales	-0.0404	0.0451	1.0000				
Influence	-0.0383	-0.0978	0.1975	1.0000			
Risk	0.1674	-0.2377	-0.0630	-0.0244	1.0000		
Influence × % Defense Sale	-0.0606	-0.1401	0.3641	0.9397	-0.0496	1.0000	
Risk × % Defense Sales	0.1183	-0.1993	0.4104	0.0667	0.7858	0.1470	1.0000

Table 6: Firm-Year Observations in Data Set by SIC Code & Firm

SIC Description (Code) & Associated Firms (Stock Ticker)	Firm-Year Observations
AIRCRAFT (3721)	**10**
THE BOEING COMPANY (BA)	10
AIRCRAFT AND PARTS (3720)	**18**
AAR CORP (AIR)	8
TEXTRON INC (TXT)	10
AIRCRAFT ENGINES AND ENGINE PARTS (3724)	**20**
HONEYWELL INTERNATIONAL INC (HON)	10
UNITED TECHNOLOGIES CORP (UTX)	10
GUIDED MISSILES AND SPACE VEHICLES AND PARTS (3760)	**10**
LOCKHEED MARTIN CORP (LMT)	10
HEAVY CONSTRUCTION OTHER THAN BUILDING CONST CONTRACTORS (1600)	**36**
FLUOR CORP (FLR)	10
GREAT LAKES DREDGE AND DOCK CORP (GLDD)	7
JACOBS ENGINEERING GROUP INC (JEC)	10
KBR INC (KBR)	9
HOSPITAL AND MEDICAL SERVICE PLANS (6324)	**10**
HUMANA INC (HUM)	10
MEASURING AND CONTROLLING DEVICES, NEC (3829)	**8**
CUBIC CORP (CUB)	8
MOTOR VEHICLES AND PASSENGER CAR BODIES (3711)	**10**
OSHKOSH CORP (OSK)	10
RADIO AND TV BROADCASTING AND COMMUNICATIONS EQUIPMENT (3663)	**2**
VIASAT INC (VSAT)	2
RETAIL CATALOG AND MAIL ORDER HOUSES (5961)	**4**
CDW CORP (CDW)	4
SEARCH, DETECTION, NAVIGATION, GUIDANCE, AERONAUTICAL SYS (3812)	**22**
L3 TECHNOLOGIES INC (LHX)	2
NORTHROP GRUMMAN CORP (NOC)	10
RAYTHEON COMPANY (RTN)	10
SERVICES COMPUTER INTEGRATED SYSTEMS DESIGN (7373)	**19**
CACI INTERNATIONAL INC (CACI)	10
LEIDOS HOLDINGS INC (LDOS)	4
SCIENCE APPLICATIONS INTERNATIONAL CORP (SAIC)	5
SERVICES ENGINEERING SERVICES (8711)	**9**
AECOM (ACM)	5
VSE CORP (VSEC)	4
SERVICES FACILITIES SUPPORT MANAGEMENT SERVICES (8744)	**4**
VECTRUS INC (VEC)	4
SERVICES MANAGEMENT SERVICES (8741)	**9**
MANTECH INTERNATIONAL CORP (MANT)	9
SHIP AND BOAT BUILDING AND REPAIRING (3730)	**18**
GENERAL DYNAMICS CORP (GD)	10
HUNTINGTON INGALLS INDUSTRIES INC (HII)	8
Grand Total	**209**

Table 7: Average ROA, % Defense Sales, Influence, & Risk by SIC and Firm Name

SIC Description (Code) and Firm (Stock Ticker)	Average ROA	Average % Defense Sales	Average Influence	Average Risk
SERVICES FACILITIES SUPPORT MANAGEMENT SERVICES (8744)	**7.41%**	**99.09%**	**0.30%**	**0.0068**
VECTRUS INC (VEC)	7.41%	99.09%	0.30%	0.0068
SEARCH, DETECTION, NAVIGATION, GUIDANCE, AERONAUTICAL SYS (3812)	**7.39%**	**79.12%**	**3.68%**	**0.1453**
L3 TECHNOLOGIES INC (LHX)	6.26%	74.50%	1.51%	0.3031
NORTHROP GRUMMAN CORP (NOC)	7.42%	86.91%	3.53%	0.1513
RAYTHEON COMPANY (RTN)	7.59%	72.26%	4.27%	0.1077
AIRCRAFT ENGINES AND ENGINE PARTS (3724)	**6.94%**	**11.51%**	**1.16%**	**0.2935**
HONEYWELL INTERNATIONAL INC (HON)	7.45%	10.28%	0.40%	0.2251
UNITED TECHNOLOGIES CORP (UTX)	6.43%	12.74%	1.91%	0.3619
SHIP AND BOAT BUILDING AND REPAIRING (3730)	**6.65%**	**79.23%**	**3.09%**	**0.2744**
GENERAL DYNAMICS CORP (GD)	6.98%	64.11%	4.28%	0.1498
HUNTINGTON INGALLS INDUSTRIES INC (HII)	6.25%	98.13%	1.61%	0.4303
RETAIL CATALOG AND MAIL ORDER HOUSES (5961)	**6.65%**	**11.69%**	**0.14%**	**0.0796**
CDW CORP (CDW)	6.65%	11.69%	0.14%	0.0796
HOSPITAL AND MEDICAL SERVICE PLANS (6324)	**6.23%**	**75.60%**	**1.13%**	**0.0338**
HUMANA INC (HUM)	6.23%	75.60%	1.13%	0.0338
SERVICES COMPUTER INTEGRATED SYSTEMS DESIGN (7373)	**5.90%**	**92.59%**	**0.55%**	**0.0837**
CACI INTERNATIONAL INC (CACI)	5.19%	94.32%	0.51%	0.0651
LEIDOS HOLDINGS INC (LDOS)	5.22%	82.25%	0.60%	0.1817
SCIENCE APPLICATIONS INTERNATIONAL CORP (SAIC)	7.86%	97.40%	0.58%	0.0423
AIRCRAFT (3721)	**5.55%**	**33.90%**	**6.45%**	**0.1636**
THE BOEING COMPANY (BA)	5.55%	33.90%	6.45%	0.1636
MEASURING AND CONTROLLING DEVICES, NEC (3829)	**5.36%**	**51.50%**	**0.13%**	**0.0894**
CUBIC CORP (CUB)	5.36%	51.50%	0.13%	0.0894
SERVICES MANAGEMENT SERVICES (8741)	**5.23%**	**98.94%**	**0.31%**	**0.0911**
MANTECH INTERNATIONAL CORP (MANT)	5.23%	98.94%	0.31%	0.0911
MOTOR VEHICLES AND PASSENGER CAR BODIES (3711)	**4.18%**	**36.10%**	**0.82%**	**0.1595**
OSHKOSH CORP (OSK)	4.18%	36.10%	0.82%	0.1595
HEAVY CONSTRUCTION OTHER THAN BUILDING CONST CONTRACTORS (1600)	**3.98%**	**29.44%**	**0.35%**	**0.1466**
FLUOR CORP (FLR)	5.42%	12.90%	0.45%	0.0466
GREAT LAKES DREDGE AND DOCK CORP (GLDD)	-0.92%	64.00%	0.15%	0.5245
JACOBS ENGINEERING GROUP INC (JEC)	4.70%	23.50%	0.25%	0.0532
KBR INC (KBR)	5.38%	27.56%	0.49%	0.0677
SERVICES ENGINEERING SERVICES (8711)	**3.85%**	**46.70%**	**0.26%**	**0.0997**
AECOM (ACM)	1.34%	22.00%	0.34%	0.0589
VSE CORP (VSEC)	6.98%	77.58%	0.15%	0.1507
AIRCRAFT AND PARTS (3720)	**3.21%**	**30.78%**	**0.38%**	**0.2065**
AAR CORP (AIR)	2.69%	34.46%	0.12%	0.2115
TEXTRON INC (TXT)	3.62%	27.84%	0.59%	0.2025
GUIDED MISSILES AND SPACE VEHICLES AND PARTS (3760)	**-0.46%**	**78.78%**	**10.45%**	**0.1407**
LOCKHEED MARTIN CORP (LMT)	-0.46%	78.78%	10.45%	0.1407
RADIO AND TV BROADCASTING AND COMMUNICATIONS EQUIPMENT (3663)	**-0.53%**	**45.64%**	**0.14%**	**1.1258**
VIASAT INC (VSAT)	-0.53%	45.64%	0.14%	1.1258
Grand Total	**5.11%**	**53.93%**	**1.85%**	**0.1655**

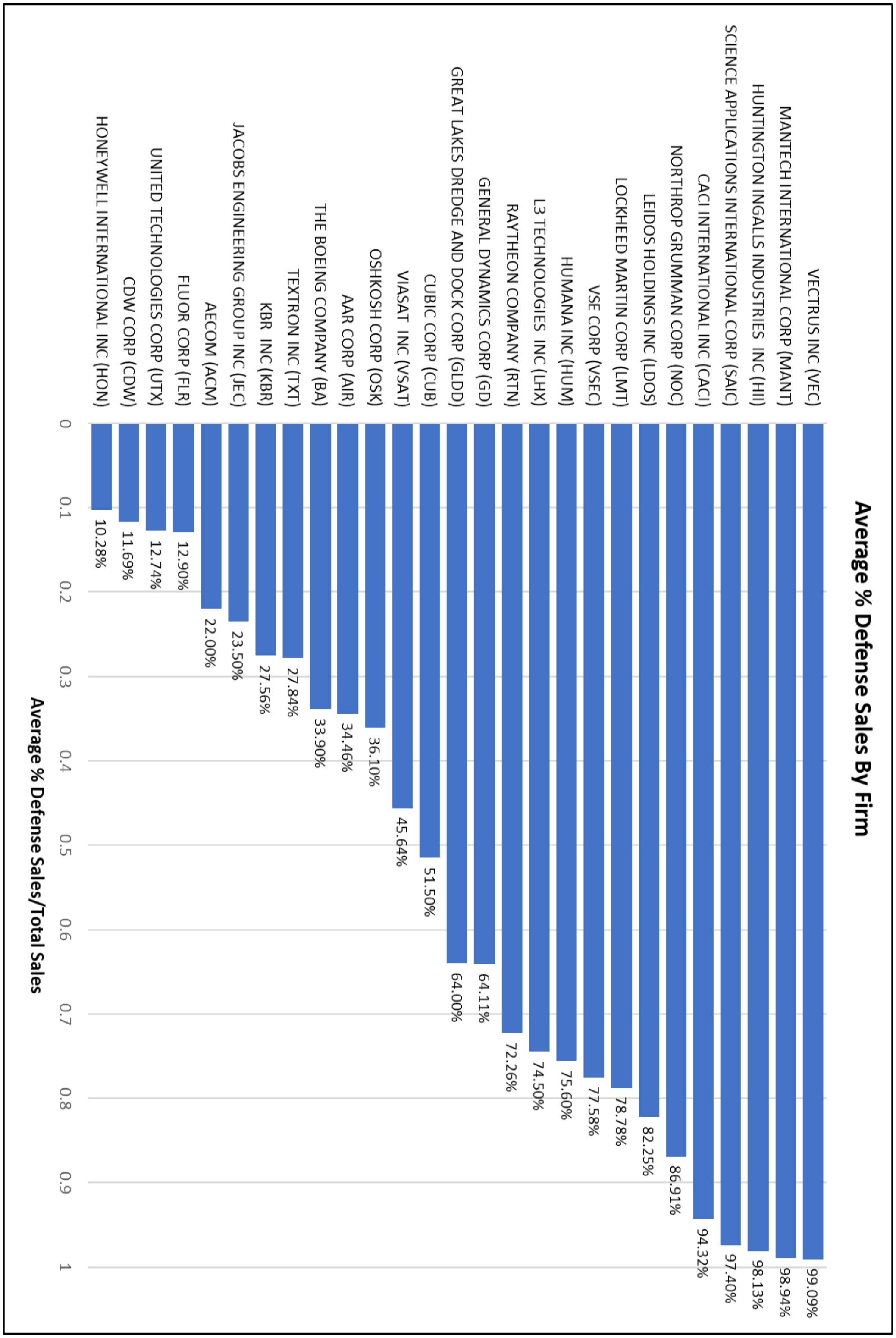


Figure 18: Average % Defense Sales by Firm

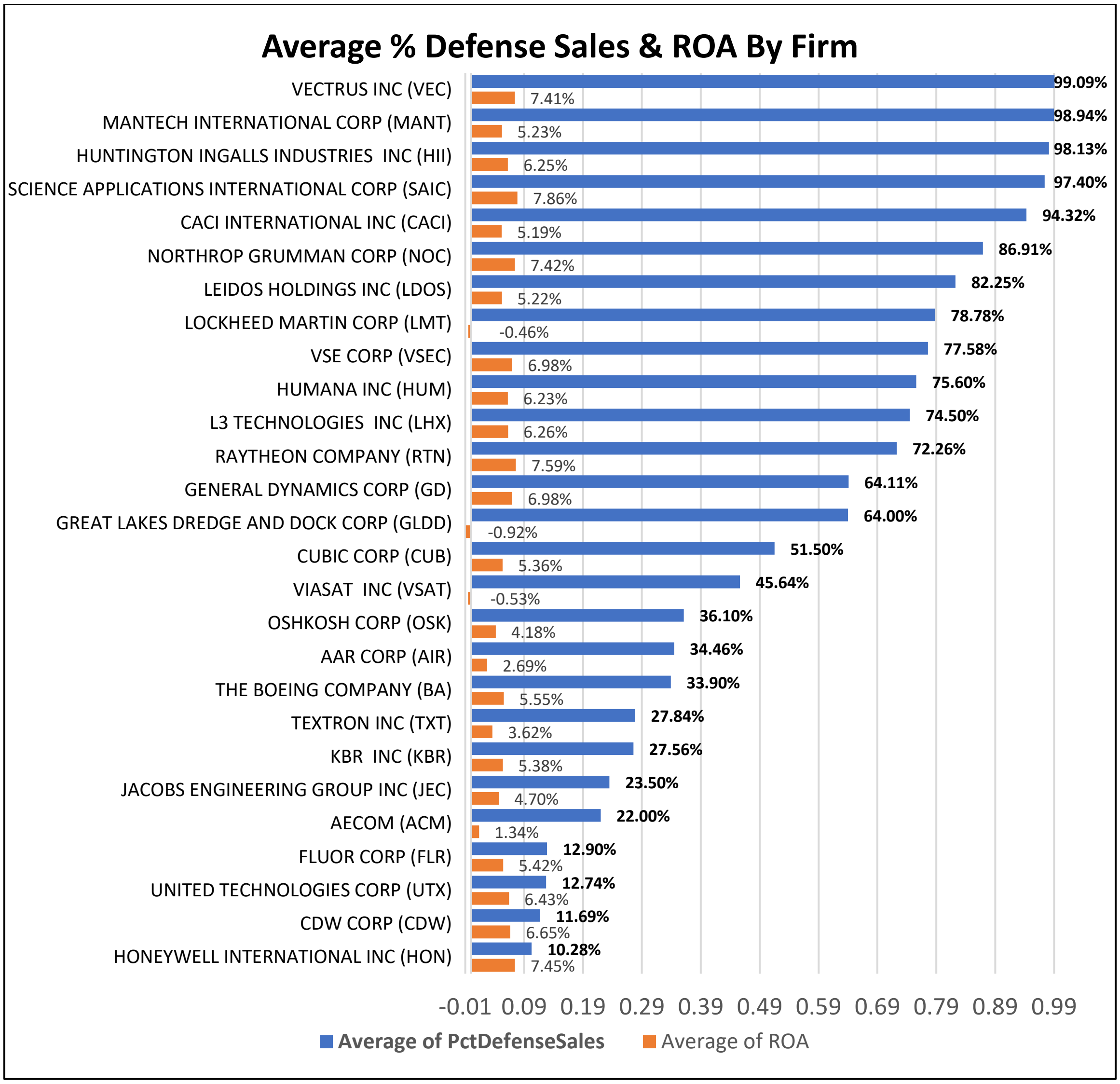


Figure 19: Average % Defense Sales & ROA by Firm

Table 8: Percent of Total DoD Prime Contract Award Dollars Received by Each Firm in Each Year

	% of Total DoD Prime Contract Award Dollars Received									
Firm Name (Stock Ticker)	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
AAR CORP (AIR)		0.13%	0.13%	0.12%	0.15%	0.11%	0.12%		0.08%	0.10%
AECOM (ACM)					0.13%		0.23%	0.43%	0.45%	0.48%
CACI INTERNATIONAL INC (CACI)	0.45%	0.66%	0.61%	0.54%	0.50%	0.52%	0.46%	0.47%	0.48%	0.42%
CDW CORP (CDW)						0.11%		0.15%	0.17%	0.11%
CUBIC CORP (CUB)	0.13%	0.15%	0.12%	0.13%	0.14%	0.14%	0.14%	0.12%		
FLUOR CORP (FLR)	0.20%	0.51%	0.74%	0.52%	0.70%	0.32%	0.29%	0.25%	0.23%	0.77%
GENERAL DYNAMICS CORP (GD)	4.33%	4.04%	5.04%	3.81%	3.94%	4.80%	4.32%	4.27%	4.27%	3.95%
GREAT LAKES DREDGE AND DOCK CORP (GLDD)	0.11%				0.19%	0.13%	0.18%	0.09%	0.13%	0.21%
HONEYWELL INTERNATIONAL INC (HON)	0.47%	0.39%	0.44%	0.39%	0.40%	0.33%	0.41%	0.33%	0.36%	0.51%
HUMANA INC (HUM)	0.95%	0.90%	0.93%	0.97%	1.14%	1.24%	1.30%	1.21%	1.14%	1.50%
HUNTINGTON INGALLS INDUSTRIES INC (HII)			0.87%	2.05%	1.85%	1.42%	1.13%	1.49%	2.10%	1.96%
JACOBS ENGINEERING GROUP INC (JEC)	0.25%	0.29%	0.28%	0.27%	0.25%	0.29%	0.26%	0.20%	0.13%	0.27%
KBR INC (KBR)	1.28%	0.99%	0.61%	0.14%	0.14%		0.21%	0.16%	0.38%	0.46%
L3 TECHNOLOGIES INC (LHX)									1.53%	1.48%
LEIDOS HOLDINGS INC (LDOS)							0.56%	0.55%	0.77%	0.51%
LOCKHEED MARTIN CORP (LMT)	8.66%	8.07%	9.64%	8.38%	12.19%	8.83%	10.77%	12.13%	15.01%	10.77%
MANTECH INTERNATIONAL CORP (MANT)	0.18%	0.41%	0.46%	0.49%	0.41%	0.26%	0.22%	0.20%	0.15%	
NORTHROP GRUMMAN CORP (NOC)	5.05%	4.33%	3.74%	2.69%	3.01%	3.25%	3.48%	3.61%	3.11%	2.99%
OSHKOSH CORP (OSK)	1.76%	2.01%	1.34%	0.43%	0.57%	0.19%	0.52%	0.48%	0.47%	0.44%
RAYTHEON COMPANY (RTN)	4.23%	4.03%	3.77%	3.98%	4.31%	4.16%	4.53%	4.28%	4.35%	5.02%
SCIENCE APPLICATIONS INTERNATIONAL CORP (SAIC)						0.23%	0.70%	0.73%	0.74%	0.52%
TEXTRON INC (TXT)	0.35%	0.61%	0.68%	0.66%	0.89%	0.56%	0.58%	0.65%	0.46%	0.46%
THE BOEING COMPANY (BA)	5.69%	5.01%	5.46%	7.79%	6.38%	6.34%	5.35%	8.17%	6.65%	7.61%
UNITED TECHNOLOGIES CORP (UTX)	1.95%	1.89%	1.96%	2.22%	1.80%	2.15%	2.45%	2.19%	0.82%	1.71%
VECTRUS INC (VEC)							0.27%	0.33%	0.31%	0.32%
VIASAT INC (VSAT)								0.13%		0.14%
VSE CORP (VSEC)	0.21%	0.14%						0.15%	0.12%	
Grand Total	**36.25%**	**34.57%**	**36.81%**	**35.59%**	**39.08%**	**35.38%**	**38.51%**	**42.76%**	**44.38%**	**42.70%**

** Top 24% of Values for Each Year are Highlighted*

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14. ABSTRACT
This research seeks to achieve two objectives: 1) to provide a comprehensive survey of research related to defense contractor profitability, and 2) to conduct an updated analysis of such profitability. No previous comprehensive survey of the topic was found in the academic literature. Therefore, the provision of such a survey may significantly benefit future researchers. A paucity of recent defense contractor profit research related was identified; only one published study analyzed data after 2000 and none used data more recent than 2010. This research reconciles the gap in recent defense contractor profit studies via objective two. Panel data analysis is employed to examine the profitability of defense contractors between 2009 and 2018. The relationship between contractor influence in the defense marketplace and profits from defense business is explored as well as the relationship between contractor operating risk and defense business profits. Additionally, the relationship between defense contractor profitability and the percentage of total sales attributed to defense (versus commercial sales) is investigated. Neither contractor influence, nor risk was found to have a moderating effect on defense business profits. The empirical evidence did however indicate a positive relationship between contractor profitability and the percentage of total sales from defense business.

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