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The Effects of International Defense Sales on Aerospace Prime Contractor Profitability

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THE EFFECTS OF INTERNATIONAL DEFENSE SALES ON AEROSPACE PRIME CONTRACTOR PROFITABILITY

THESIS

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Abstract

Faced with declining defense budgets following the end of the Cold War in the early 1990s, US defense contractors needed to explore other sources of revenue outside of typical domestic defense sales to survive. Expansion into the international defense sales market was one of the avenues pursued by defense contractors attempting to capture profits (Deutch, 2001). However, not many studies have been found assessing the relationship between international defense sales and profitability since then.

This research examines the relationship between international defense sales and profitability using data collected on the top five US defense contractors from 1994-2021. Time-series analysis is employed to explore the relationship between international defense sales and profitability. Furthermore, this research also explores the relationship between commercial sales and profitability. The results of the analysis indicated that for Boeing, there is a statistically significant negative relationship between the percentage of international defense sales and profitability. Additionally, the study found that there is a significant positive relationship between the percentage of commercial sales and profitability for Boeing and Lockheed Martin.

Acknowledgments

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Gregory T. Sanders

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THE EFFECTS OF INTERNATIONAL DEFENSE SALES ON AEROSPACE PRIME CONTRACTOR PROFITABILITY

I. Introduction

Background

International defense sales play an important role in the national security of the United States by establishing relationships with our international allies. International defense sales by the US occur primarily through two government programs: Foreign Military Sales (FMS) and Direct Commercial Sales (DCS). FMS allow defense articles and services to be procured by the United States (US) Department of Defense (DoD) on behalf of international partners (DSCA, 2022). DCS allows US defense contractors to sell defense articles and services directly to international partners without interference from the DoD (DSCA,2022). Establishing relationships with allies is paramount because the US does not fight any war alone. In the 2022 Missile Defense Review, there is explicit language indicating that international defense sales will be used as a tool to strengthen relationships with America's missile defense allies (Missile Defense Review, 2022).

In addition to establishing alliances, international defense sales also provide an additional source of revenue outside of traditional domestic defense sales to help preserve the US Defense Industrial Base (DIB). For most US defense contractors their primary source of revenue is earned through domestic defense sales which are heavily dependent on the US defense budget. International defense sales allow US defense contractors to take advantage of the defense budgets of other foreign governments. They can provide the DIB with a stable source of revenue even when America's defense budgets are

declining. Declining defense budgets have the potential to strain the profitability of US defense contractors. If the DIB cannot maintain a certain level of profits, many defense contractors may go out of business. Losing defense contractors presents a national security concern as there is an increased risk of not being able to meet Warfighter requirements. It was expected that the DIB was going to shift their focus to international defense sales when US defense budgets declined following the end of the Cold War.

Following the end of the Cold War in the early 1990s, the US defense budget declined as there was no longer an imminent threat to US national security (Deutch, 2001). In 1993, under John Deutch's tenure as the Under Secretary of Defense for Acquisitions and Technology, a pro-consolidation policy was implemented by the DoD. The purpose of this policy was to help the DIB become more efficient in the face of declining Research, Development, Test, and Evaluation (RDTE) and Procurement defense budgets (Deutch, 2001). Consolidation aimed to decrease the amount of assets comprising the defense industry through mergers and acquisitions (M&A) (Deutch, 2001). It was believed that there was no longer a need for the abundance of defense contractors present in the United States following the years after the Cold War. This rapid decline of the number of US defense contractors was commonly referred to as the Drawdown of the DIB.

Unexpectedly, the consolidation policy was reversed in 1998, when the DoD became concerned with the reduced level of competitiveness in the DIB (Deutch, 2001). Low competition translates to less innovation across defense weapon systems, premium prices paid by the US government for weapon systems, and the potential inability to ramp up production in times of war. With the pro-consolidation policy reversed, large-scale

acquisitions between defense companies were less likely to be approved. For instance, in 1998 the DoD turned down the proposed acquisition of Northrop by Lockheed Martin and the purchasing of Newport News Shipbuilding by General Dynamics (Deutch, 2001). It became more difficult for US defense contractors to purchase other defense companies in hopes of boosting profitability and forced them to find other ways to meet their long-term financial goals.

One way defense contractors combated the declining US defense budgets, and the reversal of the pro-consolidation policy was by increasing their share of international defense sales (Bitzinger, 1994; Deutch, 2001). However, there have not been many studies found assessing the relationship directly between international defense sales and the profitability of a defense contractor. Profitability is defined as a firm's ability to generate earnings. It is typically expressed as a ratio, and measured as a percentage (Gibson, 1987). This research will explore this relationship using data from the top five US aerospace defense contractors.

The defense contractors analyzed in this study are Lockheed Martin, Raytheon, General Dynamics, Northrop Grumman, and Boeing. These companies are referred to colloquially as the Big Five because they receive the largest portion of DoD Procurement funds according to the federal government's Top 100 contractors report (Federal Procurement Data System, 2021). It is important to analyze profitability of these companies because they are responsible for delivery of most of the DoD's largest weapon systems. Additionally, these companies have survived since the mid to late 1990s allowing for over twenty-five years of data collection.

Research Objective and Questions

The primary research question examined is: How does the percentage of international defense sales, relative to domestic defense sales, relate to the Big Five defense contractors' profitability?

The following secondary research questions were developed to assist in exploring the primary research question:

1) How do US defense budgets relate to the Big Five defense contractors' profitability?

2) How do US defense budgets relate to revenue earned from international defense sales by the Defense Industrial Base (DIB)?

3) How does the percentage of commercial sales, relative to domestic defense sales, relate to the Big Five defense contractors' profitability?

Methodology

Time-series regression analysis was the primary method used in this research. Before transitioning into time-series analysis, correlation analysis was used to assess the relationships between some of the variables in the research questions. The primary source of data was the 10-K annual reports filed to the Security Exchange Commission (SEC) by each defense contractor from 1994-2021. These reports contained financial data for each contractor in the form of balance sheets, cash flow statements, and income statements. Additionally, Yahoo! Finance premium was used to cross-check the data listed in the 10-Ks for each contractor.

To answer the primary research question, the percentage of international defense sales was calculated for each contractor. This involved manually searching the 10-Ks and determining the amount of revenue allocated to international defense sales (FMS and DCS), commercial sales (domestic and foreign), and domestic defense sales also known as sales to the US Government. The revenue allocated to each of these categories could not be accurately determined for every contractor from 1994-2021,therefore, assumptions had to be made. This was due to the inconsistences in the revenue reporting methods between the contractors. Additionally, the revenue reporting methods changed across the years for the defense contractors. A detailed methodology explaining how the revenue was allocated to each category for each defense contractor is located in Appendix A. To mitigate some of the data standardization issues, the time-series analysis models were only run for contractors whose data was the most consistent. The time-series models were conducted on Lockheed Martin (1994-2021), General Dynamics (1999-2021), and Boeing (1994-2011).

Limitations

The primary limitation of this study was that assumptions had to be made about the exact amount of revenue allocated to the international defense, commercial, and domestic defense categories. This led to the complete exclusion of data from Raytheon and Northrop Grumman for use in the time-series models. This also led to some of the observations being excluded for General Dynamics and Boeing.

Additionally, when analyzing the international defense sales market both data from the FMS and DCS programs must be considered. The data available on DCS is

inconsistent and not updated in subsequent years when new information becomes available. The FMS data is consistent and is updated annually. The major issue with data from DCS is that a large majority of the data represents authorizations for defense articles and services. Authorizations only represent the value of the licenses for defense equipment and services authorized for sale by a defense contractor. It does not represent the dollar amount of defense articles and services sold through DCS. As a result, only FMS data was used to assess the international defense market. This method also remains consistent with prior research (Grimmett, 1998; Thrall & Dorminey, 2018).

Thesis Overview

This paper is broken into five chapters. The first chapter provided the introduction of the topic, the research objective and questions, a summary of the methodology used, and the limitations of the study. Chapter II provides a literature review on how defense contractor profitability is related to US defense budgets. The chapter also provides an overview on how the international defense sales market has changed since the end of the Cold War. Finally, the chapter explores how international defense sales and other revenue diversification methods relate to defense contractor profitability. Chapter III describes the methodology used to answer the research questions. Chapter IV provides the results and analysis associated with the methodology in Chapter III. Chapter V presents the conclusions of the study, research findings, and areas for future research.

II. Literature Review

Chapter Overview

This chapter begins with the discussion of the relationship between US defense budgets and defense contractor profitability. Next, the revenue maximizing behavior of defense contractors and its effects on profitability is discussed. Then, the relationship between international defense sales and defense contractor profitability is examined. Finally, the chapter proceeds to introduce commercial sales and mergers and acquisitions (M&A) and how they may relate to a defense contractor's profitability.

US Defense Budgets

US defense budgets have the potential to impact the profitability of defense contractors. For US defense contractors their primary source of revenue comes from sales to the US Government. Sales to the US Government are highly dependent on US defense budgets since these budgets dictate the maximum amount the government intends to spend on defense in a given year. Therefore, increases or decreases to US defense budgets can impact revenues for defense contractors, which is a major component of profitability. Figure 1 displays a graph of the combined US defense budgets for RDTE and Procurement in constant fiscal year (FY) 2022 dollars from FY1990-FY2021.

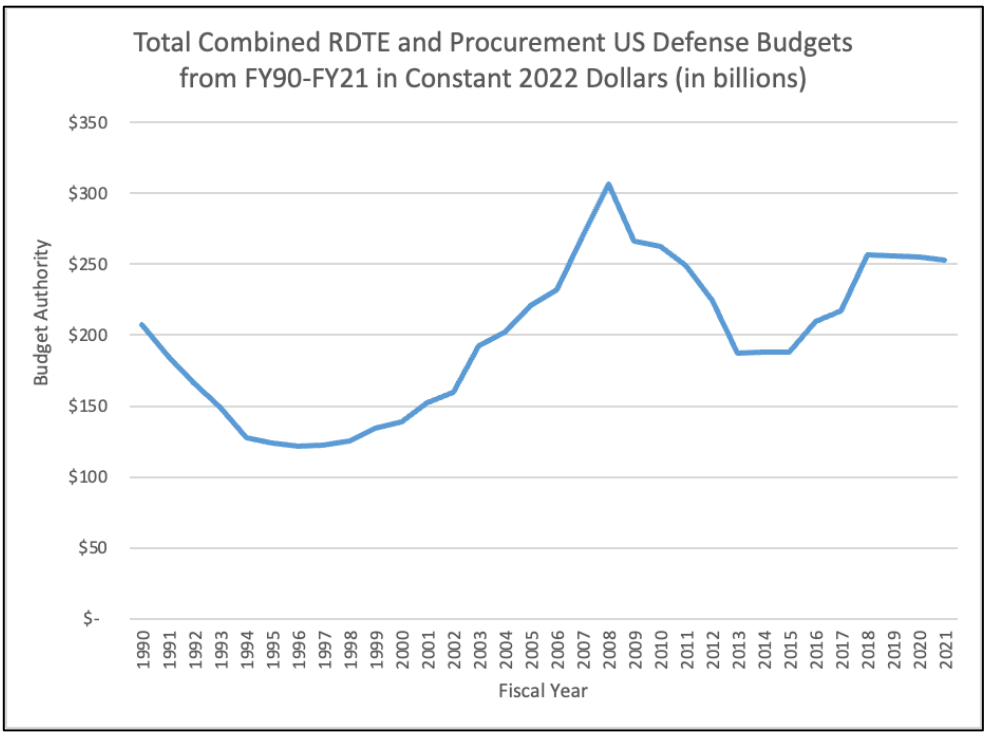


Figure 1: Total Combined RDTE and Procurement US Defense Budgets from FY1990-FY2021 (FY22 President's Budget Green Book)

Figure 1 shows a steep decline to the defense budget from 1990-1994 followed by a period of relatively stable funding from 1995-1996. From 1990-1994, it was expected that revenues from sales to the US government would decrease for US defense contractors. In response, defense contractors sold their defense assets or engaged in M&A to share the costs associated with defense assets at an attempt to remain profitable (Deutch, 2001). The defense budget increased initially in 1997 and continued to rapidly increase following the terrorist attacks on September 11, 2001, initiating the Global War on Terror (GWOT). The defense budget increased every year up until 2008 with a peak of $300 billion. The budget increases from the GWOT positively impacted the revenues of the DIB (Thrall et al., 2020; Hartung, 2021). The budget decrease following 2010 is

primarily due to a drawdown in funding associated with the wars in Afghanistan and Iraq and the Budget Control Act (BCA) of 2011 (McCormick et al., 2017). The BCA imposed mandatory thresholds (budget caps) on budgets through sequestration (McCormick et al., 2017). This time period was no different than the early 90's. It was still expected that decreases to the defense budget would negatively impact the revenues of defense contractors (McCormick et al., 2017). The rational for the defense budget increases from 2015-2021 was to compete with China's surge in military power and as a result prime defense contractor revenue increased (Hartung, 2021). The literature reviewed in this section support the expectation that when the defense budget increases, domestic defense revenues for defense contractors are positively impacted. However, when the budget falls defense contractors expect their revenue to decrease.

When revenues are negatively impacted this can ultimately lead to a decrease in the company's overall profitability. During periods of declining defense budgets, defense contractors should not solely rely on sales to the US government to obtain profits. Instead, they should invest in other revenue sources that are not dependent on US defense budgets. The next section will discuss why defense contractors might explore other sources of revenues to obtain profits. Additionally, it will briefly discuss some of the methods pursued by defense contractors in hopes of earning profits.

Revenue Maximization Strategy for Defense Contractors

Economist William Baumol argued that firms that operate in oligopolistic environments seek to maximize total revenue rather than profit (Baumol, 1958). However, there is a minimum profit constraint associated with the theory. Once a firm's

profit surpassed a vaguely defined minimum level, the firm would be willing to sacrifice additional profits if it could obtain an increase in total revenue (Baumol, 1958). Additionally, profits only needed to be high enough to help finance expansion plans and make dividends on stocks attractive enough for potential investors (Baumol, 1958).

Baumol (1958) acknowledges that his theory is not generalizable across all firms in every industry. However, the theory can be applied to the top five prime US defense contractors. These prime contractors operate in oligopolistic environments as they are the remaining sellers for US major weapon systems due to the large wave of M&A in the 90's (Deutch, 2001; OUSDA&S, 2022). Therefore, in this analysis the top prime defense contractors are assumed to be operating under the revenue maximizing strategy.

When US defense budgets decrease, contractors must find other sources of revenue outside of sales to the US government to achieve their financial goals. Defense contractors can use various methods of diversification to take advantage of additional sources of revenue. Interindustry diversification refers to expansion into new product markets for the firm (Hitt et al., 1997). Intraindustry diversification refers to the firm's presence in more than one product line in the same industry (Stern & Henderson, 2004). Geographic diversification refers to the expansion of products across borders to attract new customers (Doukas & Lang, 2003).

Prime defense contractors can pursue these methods of diversification in three ways. For geographic diversification, a defense contractor can pursue international defense sales which is the main focus of this analysis. Increasing the international defense sales portfolio allows US defense contractors to take advantage of the defense budgets of international partners and friendly countries. Defense contractors can shift to making

commercial products as a form interindustry diversification. Engaging in commercial sales allows US defense contractors to potentially capture revenue from non-defense products and services from domestic and international customers. Finally, defense contractors can use M&A to obtain revenues from intraindustry diversification by buying defense contractors in other defense product markets. Similarly, M&A can be used by defense contractors to purchase commercial companies as a form of interindustry diversification, rather than making their own commercial products. The next sections will discuss the literature on international defense sales, commercial sales, and M&A and how each method may relate to a defense contractor's profitability.

International Defense Sales

There are two programs within the United States that facilitate the international sales of defense articles and services: 1) Foreign Military Sales (FMS) and 2) Direct Commercial Sales (DCS). The Arms Export Control Act (AECA) is the US law covering the regulations and guidelines of the transfer of defense articles and services through FMS and DCS. AECA section 47 (22 U.S.C 2794) defines a defense article as:

"(A) any weapon, weapons system, munition, aircraft, vessel, boat, or other implement of war, (B) any property, installation, commodity, material, equipment, supply, or goods used for the purposes of making military sales, (C) any machinery, facility, tool, material, supply, or other item necessary for the manufacture, production, processing, repair, servicing, storage, construction, transportation, operation, or use of any article listed in this paragraph, and (D) any component or part of any article listed in this paragraph". The same section of the AECA defines a defense service as:

"any service, test, inspection, repair, training, publication, technical or other assistance, or defense information (as defined in section 2403(e) of this title), used for the purposes of making military sales, but does not include design and construction services under section 2769 of this title".

According to the Defense Security Cooperation Agency (DSCA), FMS (often referred to as government-to-government sales) is a US Government program that is responsible for exporting defense articles and services to international partners (DSCA, 2022). The intent of the FMS program is to build and maintain healthy international relations and increase our global security posture. DSCA runs the FMS program on behalf of the DoD. Defense articles and services are procured through the DoD's acquisition system by the US Government, on behalf of the interested international partners. Eligible partners can choose to fund this process with their own funds or funds can be provided by US Government-sponsored assistance programs (DSCA, 2022). Direct Commercial Sales (DCS) is a process that allows international partners to procure defense arms and services directly from US defense contractors. This process does not involve the DoD; however, the US defense contractors must still obtain commercial export licenses from the Department of State to be able to sell directly to our international partners (DSCA, 2022).

It is important to note that FMS and DCS are not competing systems. All international sales, regardless of FMS or DCS, must serve to promote US foreign policy and strategic interests. Neither international sales system is better than the other in all aspects. They each have specific advantages, and complex decisions must be made on

deciding which system to use due to the preferences of non-US purchasers and the applicable US regulation.

FMS offers non-US purchasers a total package approach when acquiring defense articles. Defense articles acquired under FMS are regulated by the Federal Acquisition Regulation (FAR). The FAR dictates clear expectations for US contractors on products to be submitted with weapon systems such as information detailing cost, schedule, performance, and sustainment (Gilman et al., 2014). The FMS program is preferred by non-US purchasers for two reasons. These customers usually want the DoD to lead contract negotiations, in hopes of those relationships with US defense contractors being leveraged for better deals. The other reason is that they prefer the transparency provided by the DoD acquisition process (Gilman et al., 2014).

DCS provides more flexibility to the non-US purchaser and US defense contractor looking to pursue an international defense sale. DCS provides flexibility in the structure of the sale for characteristics such as the type of contract selected, priority of laws to be enforced during sale (US, International, or combination of US and International), inspection and performance specifications, means of financing, and delivery requirements (Gilman et al., 2014). DCS does not include participation by the DoD, so any sales under DCS are not subject to DoD acquisition regulation under the FAR. This allows for a more creative approach for both parties in finalizing an international defense sale. However, this puts more pressure on both parties to maintain the knowledge and expertise to negotiate, enforce, and/or update the international defense sales contract (Gilman et al., 2014). The DCS program is preferred by non-US purchasers that are looking for more freedom in contract negotiation and are confident in their knowledge of US law and

defense contracting policies. DCS is also a better for customers that prefer a more hands on relationship with the US defense contractor, rather than letting the DoD facilitate the process through FMS (Gilman et al., 2014).

International Defense Sales following the End of Cold War

The following section provides a review of the literature regarding how the international defense sales market was expected to change following the end of the Cold War. When defense budgets were declining from 1990-1993 (Figure 1), it was predicted that the international defense sales market would increase (Grimmett, 1993;Vartabedian & Broder, 1994; Deutch, 2001;Thrall & Dorminey, 2018). Grimmett (1993) and Thrall and Dorminey (2018) believed an increase in international demand for American made weapons was expected after their successful performance in the Persian Gulf War. Furthermore, the Clinton Administration shifted their efforts towards policies that would aid the transfer of international arms by the DIB to combat the post-Cold War declining defense budgets (Vartabedian & Broder, 1994). It was expected that defense exports were going to make up 25% of a US defense contractor's revenue after initiation of the new international arms policies (Vartabedian & Broder, 1994). However, what these authors did not anticipate was the 9/11 terrorist attacks and how that would impact US defense budgets and international defense sales.

The US defense budget increased from 2001-2008 (Figure 1) primarily due to the GWOT and America's presence in Iraq and Afghanistan. Even when US defense budgets were increasing during this time, the international arms market expanded (Thrall et al., 2020). Thrall et al. (2020) attributed the increase in the international arms market to the US's new focus on strengthening international relationships to enhance national security

following the terrorist attacks.

There were also reports regarding the percentage of international defense sales by US defense contractors following the budget cuts imposed by the BCA of 2011. The BCA imposed mandatory thresholds (budget caps) on defense spending from FY12 to FY21 (McCormick et al., 2017). In response, Frank Kendall--the current Secretary of the Air Force--advocated for policies to be put in place to increase FMS to help maintain the strength and capabilities of the US and its allied nations (Sherman, 2012). The idea was that increased FMS would help preserve the defense industrial base since US defense budgets were projected to decline over the next decade. Additionally, increased FMS would establish relationships with friendly countries and partner nations to further US international influence (Sherman, 2012). The literature reviewed in this section supported the belief that there would be an increase to the percentage of revenue from international defense sales by US defense contractors. The increases were expected in three time periods: in the early 1990s, during the first decade of the early 2000s and immediately following the BCA of 2011.

While there was an expectation of replacing lost domestic defense revenue, there was also a study conducted in 2015 stating that the revenue provided by international defense sales would not be enough to sustain the DIB. This study was conducted by McKinsey & Company, a consulting firm for companies in the aerospace and defense sector. This study analyzed the effects of declining US defense spending from 2010-2015 following the BCA on international defense sales of the DIB (Chinn et al., 2015). The top 37 defense contractors in the Top 100 Contractors report were the sample size for this study. The study concluded that domestic defense revenue lost across the DIB would not

be able to be fully replaced by international defense sales for every contractor (Chinn et al., 2015).

The anticipated revenue coming from international defense sales for some of the contractors was overly optimistic and was far above the defense budgets of international countries (Chinn et al., 2015). Furthermore, the study concluded that certain contractors could make up a significant portion of the loss in domestic defense revenue by allocating a larger percentage of their total sales to international defense sales. This would only work for contractors: 1) whose products and services were in high demand at the international level; 2) who could afford to expand their products and services to the international market; 3) whose organization is set up to deliver products and services internationally; 4) who has teams that can successfully perform the duties required of international products and services expansion; and 5) who can effectively navigate the complexities of offsets and regulation when making international defense sales deals (Chinn et al., 2015). The study did not identify which defense contractors would be able to achieve the result; it did though provide tips on how companies could expand their international defense sales portfolio--not surprising given that McKinsey & Company is a consulting firm (Chinn et al., 2015).

While an increase in the percentage of revenue from international defense sales may not be enough to sustain the entire DIB, there is room for growth that could be realized for some contractors. If there were any defense contractors that could implement McKinsey and Company's tips, it is the Big Five US defense contractors. These contractors are very familiar with the international arms market considering over the last twenty years the US has been the largest exporter of arms (SIPRI Database). Some of

their most sought-after systems are F-35 and F-16 combat aircraft (Lockheed Martin), Apache attack helicopters (Boeing), and precision guided bombs (Raytheon) (SIPRI Database).

The exact value of annual total international defense articles and services is difficult to determine because the market is composed of sales from FMS and DCS. FMS and DCS have different agencies that are responsible for consolidating the data on defense articles and services transferred through their respective programs. These agencies also have different methods of reporting international defense sales data. DSCA is responsible for consolidating data on the transfer of defense articles and services through FMS. The Directorate of Defense Trade Controls (DDTC) is responsible for consolidating data on the transfer of defense articles and services through DCS.

DSCA provides publicly available annual FMS data on defense articles and services to foreign entities dating back to 1950. Figure 2 provides the total annual value of defense articles and services purchased by foreign governments through the FMS program from fiscal years 1993-2021.

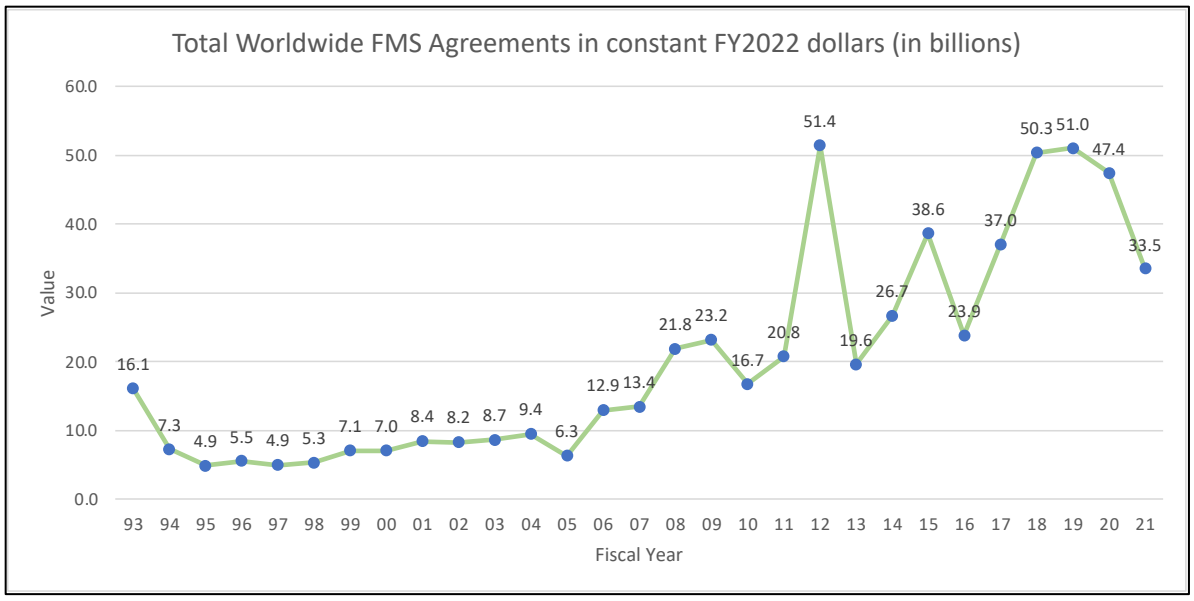


Figure 2: Total Worldwide FMS Agreements from FY1993-FY2021 (Defense Security Cooperation Agency)

Figure 2 shows how the FMS market has expanded from FY1993 to FY2021. In FY1993, there was an initial decrease in total worldwide FMS agreements followed by two more years of decline. This seemingly contrasts the idea that international defense sales across the DIB were increasing when defense budgets were decreasing in 1992 and 1993 in Figure 1. However, there was some growth beginning in 1999--one year after the reversal of the pro-consolidation policy--which could indicate a response to that policy change. There was some growth picking up in the 2000s and could be attributed to the need to support allies in the GWOT. FMS agreements experienced a surge in growth from 2005-2009--increasing from $6.3B to $23.2B supporting the claim made by Thrall et al. (2020) that international defense sales were increasing during the GWOT. When defense budgets were decreasing from 2011-2013 (Figure 1) during the BCA, FMS agreements peaked at $51.4B in 2012. This supported the claim made by Sherman (2012)

that international defense sales would increase in response to the BCA of 2011. In 2014, FMS agreements rose to $26.7B and increased the following year. Additionally, since 2014, the value of total worldwide FMS agreements has been above $20B annually peaking at $51B in 2019.

Overall, the FMS market did experience growth since the end of the Cold War even during periods where the domestic defense budget was increasing. This may indicate that even when US defense budgets are not falling, international defense sales are still worth pursuing for defense contractors. The inclusion of DCS must be considered as well when assessing the growth of the entire international defense sales market.

DDTC provides information on defense articles and services sold through DCS in a Section 655 report. However, there are many limitations with DCS data making it difficult to determine the true value of defense articles and services sold through this program. Most of the data provided by DDTC are for *authorizations*--which represents the maximum value of specific defense articles and services that can be exported to a country. This number does not represent how much countries actually spent on defense articles and services through DCS. Also, data on DCS authorizations is incomplete and lacks transparency (Freeman, 2018).

Figure 3 represents the worldwide annual total value of defense articles and services DCS from FY1999-FY2009. It is a safe assumption that some of the authorizations listed in Figure 3, become actual purchases by foreign countries, and therefore could contribute to the total value of the international defense sales market.

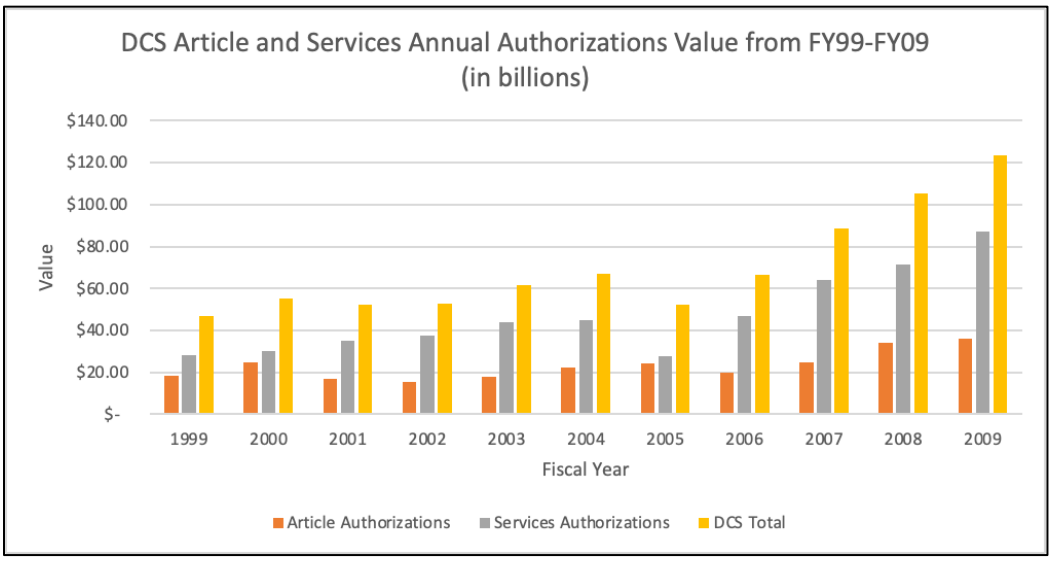


Figure 3: DCS Articles and Services Authorizations Annual Value from FY1999-FY2009 (Directorate of Defense Trade Controls)

The increase in services authorizations is the main driver of the increase in total DCS authorizations. This could mean that DDTC has anticipated that the demand for DCS services has grown considering the upward trend of service authorizations listed in Figure 3. Service authorizations are around $30B in FY1999 and raise to around $85B in FY2009. However, no direct impacts to the international defense sales market can be provided by this data since it represents authorizations only. The intent of this chart is to display the potential magnitude of sales that could occur through DCS.

The data surrounding defense exports was so low quality and unstandardized that it started to receive Congressional attention (U.S. Government Accountability Office, 2010) A report was generated by the Government Accountability Office (GAO) in 2010 titled "*Reporting on Exported Articles and Services Needs to be Improved*". The study highlighted several of the issues with export data such as DDTC not collecting data on actual shipment of services under DCS licenses, and the FMS and DCS programs having

different methodologies for reporting international defense sales data (U.S. Government Accountability Office, 2010). Most importantly, the GAO proceeded to do a study primarily focusing on FMS and DCS defense article exports from calendar years 2005 to 2009 using actual shipment data. The data on shipments of defense articles through DCS was retrieved from the Department of Commerce's US Census Bureau (Census). The study found that the value of total shipments of defense articles (FMS and DCS combined) remained relatively stable over the first 4 years of the time period with an increase to about $22B ($8.84B + $13.31B) in 2009. However, shipments of defense articles through DCS grew from $10.6B to $13.3B (about 25%) over the five-year period in comparison to FMS whose value of shipments did not show much growth. The study also found that out of $101B of defense articles exported over the five-year period, sixty percent of all the shipments were through DCS. These results are summarized in Figure 4.

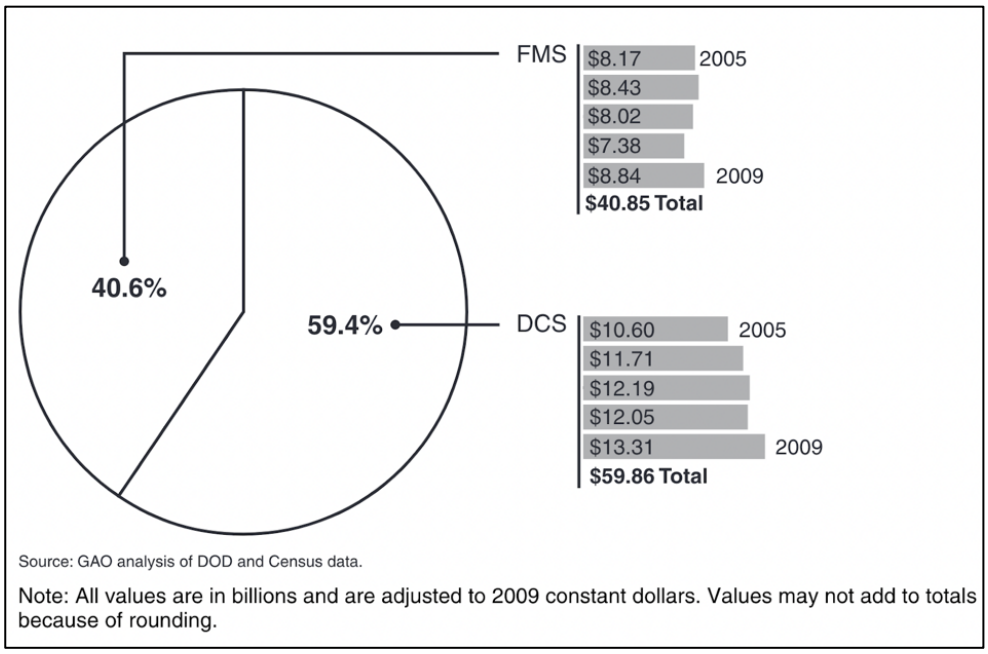


Figure 4: Exports of Defense Articles through DCS and FMS, Calendar Years 2005 -2009

(Directorate of Defense Trade Controls)

The results of the study indicate that there is potential for international defense sales through DCS to be larger than FMS. Regardless, it can clearly be shown in Figure 2 that the market for US defense articles and services has relatively grown over the last thirty years.

Assessing the Prime Defense Contractors' Percentage of International Defense Sales

Although there was an overall increase to the US international defense sales market over the last thirty years, that did not mean that every defense contractor experienced increases to their percentage of international defense sales. Figure 5 below shows the percentage of international defense sales (FMS and DCS) for three of the top five prime US defense contractors. Some data points are missing due to the inability to determine the most accurate amount of revenue comprising the contractor's international

defense sales. The data collection issues for the prime defense contractors' international defense sales will be discussed further in the methodology section.

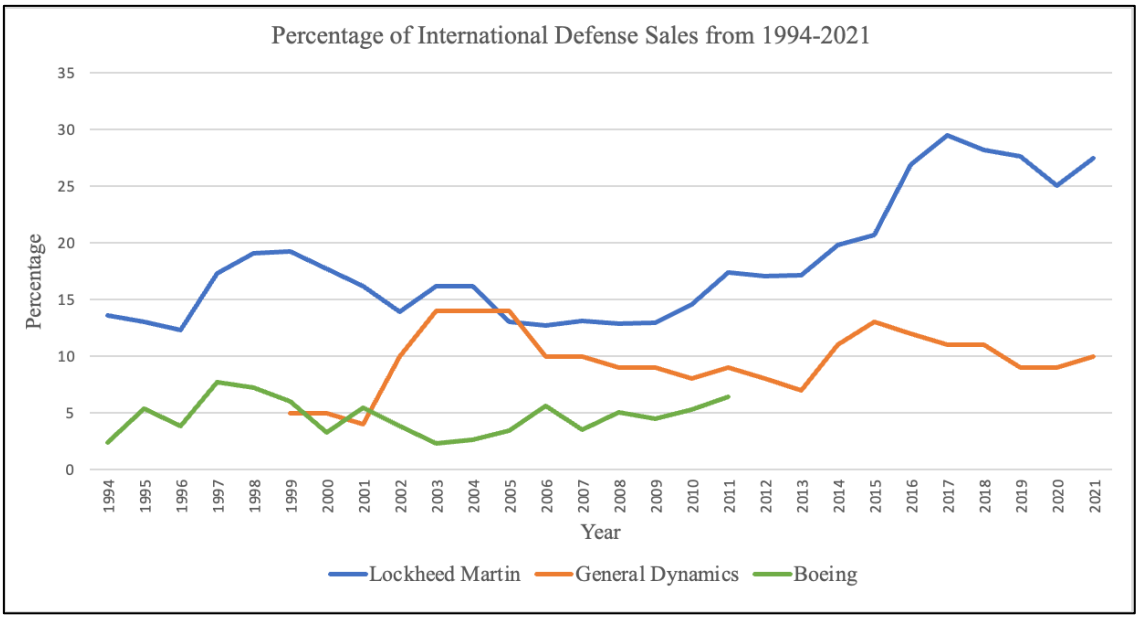


Figure 5: Percentage of International Defense Sales from 1994-2021 (SEC 10-K Annual Reports)

When US defense budgets were declining from FY1994-FY1996 (Figure 1), Lockheed Martin's percentage of international defense sales declined as well. Similarly, Boeing's percentage decreased from 1995-1996. This does not support the expectation that the percentage of international defense sales for defense contractors increased when US defense budgets declined. However, when US defense budgets were declining from 2008-2013, Lockheed Martin did see an overall increase to their percentage of international defense sales, but General Dynamics did not. This graph indicates that there is not a common trend for a defense contractor's revenue diversification strategy in response to declining defense budgets. It further confirms that a contractor's ability to shift a portion of their sales to international defense depends on more than changes to the defense budget. There has to be a demand for their products and defense contractors must

be able to afford to expand into the international market. For some contractors, expansion into the international defense sales market could be profitable, and for others it could hurt profitability. The next section will provide a review of the literature on how international defense sales might relate to a defense contractor's profitability.

International Defense Sales and Defense Contractor Profitability

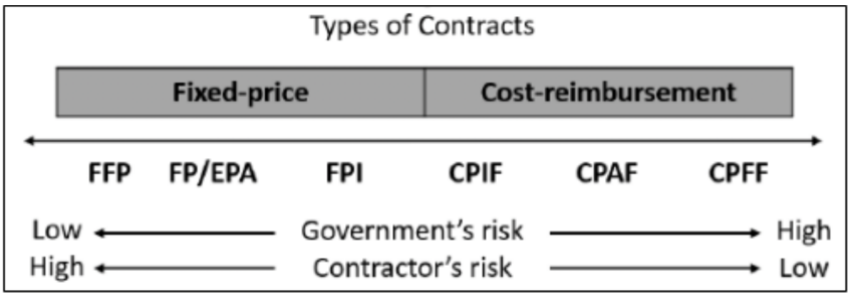
Even though for some defense contractors their percentage of international defense sales may have increased since in the end of the Cold War, this does not provide any insight on how their profitability was affected. This section will discuss the relationship between international defense sales and a defense contractor's profitability.

Most US defense systems available for sale through FMS to foreign governments have completed operational testing and are in full rate production (U.S. Government Accountability Office, 2017). Therefore, most FMS contracts are firm fixed price (FFP) since the costs associated with producing these systems should be relatively stable for US defense contractors (U.S. Government Accountability Office, 2017). After analysis of more than 78,000 FMS contracts from 2006-2017, the GAO found that 99% of the contracts were FFP (U.S. Government Accountability Office, 2017).

The FFP contract structure of FMS agreements provide defense contractors with opportunities to earn high profits. Research suggests that a defense contractor's profit is tied to how much risk they assume (Agapos & Gallaway, 1970; Zhong & Gribbin, 2009). Higher risks usually translate into higher profits. In a FFP contract, defense contractors assume higher risks because the government only gives them a fixed amount of money for their work effort. If the defense contractors cannot keep their costs low, they risk

overrunning the contract and not earning profit. However, if a contractor does manage to keep their costs low on a FFP contract they are rewarded for all of the risk they have assumed. In comparison, with cost reimbursement contracts the defense contractor's costs are paid for by the government so the risks to the contractor are lower.

Table 1: Defense Acquisition University (DAU) Comparison of Contract Types



Source: Retrieved from Defense Acquisitions University: https://www.dau.mil/tools/t/Comparison-ofMajor-Contract-Types-Chart

Table 1 provides a graphic on the different type of contracts and the level of risk associated with each. The purpose of this table is to highlight the level of risk contractors assume when working under different contracts. Considering the market for international defense sales has grown over the last thirty years (Figure 2), it is assumed that these FMS contracts have been relatively profitable for defense contractors. Otherwise, over the long run defense contractors would not continue to engage in these high-risk FFP contracts.

Additionally, the use of FFP contracts provide the opportunity for international defense sales to be more profitable than domestic defense sales. If international customers are willing to pay high prices on these FFP contracts, the profit margins associated with international defense contracts can be higher than domestic defense contracts. This is attributed to the fact that the costs on a FFP contract are usually known

and relatively stable since the systems involved are in full rate production (U.S. Government Accountability Office, 2017). However, domestic defense contracts also include development contracts. Typically, development contracts are not FFP because the costs associated with developing new cutting-edge technology are unknown and difficult to manage. Therefore, the costs related to these contracts have the potential to decrease the profit margins of the domestic defense sales segment for a US defense contractor. There are a couple of reasons why international customers may have a high willingness to pay for US defense equipment and services.

According to the Harvard Business School, willingness to pay (WTP) is the maximum price a customer is willing to pay for a particular product or service (Stobierski, 2020). In general, the higher the demand is for a product, the more customers are willing to pay for it. There are several factors that can influence a customer's WTP. Paddle, a software-as-a-service (SaaS) company who develops payment software, lists six factors that influence WTP: the nature of the economy, how in-season a product is, a consumer's personal price point, circumstantial needs in different customers, how scarce or rare a product is, and the quality or brand of a product (Paddle, 2023). The factors that will be focused on as they relate to international defense sales are circumstantial needs in different customers and the scarcity of a product.

Since the 9/11 terrorist attacks in 2001, the US has been selling weapons primarily to two regions: the Middle East and Asia Pacific (Thrall & Dorminey, 2018; Wezeman et al., 2022). Table 2 provides the value of all FMS articles and services sold and delivered to the US's top customers from 2002-2016. Countries in the Middle East include Saudi Arabia, Egypt, Israel, Iraq, and the United Arab Emirates. Taiwan,

Australia, Japan, and South Korea represent the Asia Pacific region. From 2002-2016 the Middle East and Asia Pacific regions purchased $117B in weapons from the US.

Table 2: Top 10 International Customers for United States Weapons from 2002-2016 (Security Assistance Monitor)

Country	Total Sales
Saudi Arabia	$25.8 billion
Egpyt	$17.1 billion
Israel	$15.2 billion
Taiwan	$15 billion
Australia	$10.5 billion
Japan	$9.4 billion
South Korea	$9.3 billion
Iraq	$8.9 billion
United Kingdom	$6.6 billion
United Arab Emirates	$6.3 billion

Paddle states that different consumers may be in different circumstances that largely affect their WTP (Paddle, 2023). One circumstantial difference between customers is their geographic location (Paddle, 2023). Customers may be willing to pay more based off their geographic location. The Middle East and Asia Pacific regions both have regional threats that may increase their WTP for US defense weapon systems and services.

For example, most of the countries in the Middle East have had to deal with the constant threat of Iran growing as a military power (Cordesman & Toukan, 2017). Cordesman and Toukan (2017) argue that the tensions between Iran and the Middle East (specifically Saudi Arabia and the United Arab Emirates) has triggered an ongoing arms race between the regions. In order to keep up with Iran's military power, countries in the

Middle East may be willing to pay high prices for US defense equipment and services. The Asia Pacific region also has a regional threat that may cause them to be willing to pay high prices for US defense equipment and services. Asia Pacific demand for US weapons has increased due to the perception of China as a threat (Thrall & Dorminey, 2018; Wezeman et al., 2022). Therefore, it is believed that the demand and WTP for US weapon systems and services is high in the Middle East and Asia Pacific regions. If the demand is high, countries in these regions may be willing to pay high prices on the FFP contracts involved with US defense equipment and services. Overall, this could lead to international defense sales being more profitable than domestic defense sales since defense exports typically do not involve weapon systems on cost volatile development contracts. Most of the revenue from international defense sales has come from the Middle East (Table 2), so Saudi Arabia will be used as an example to further explain the WTP concept.

According to the Stockholm International Peace Research Institute (SIPRI) database, Saudi Arabia is one of the world's top arms importers and majority of these imports has come from the US (Wezeman et al., 2017). SIPRI uses an internally developed measure to represent the volume of arms transferred called the Trend Indicator Value (TIV). The TIV for a weapon is derived from the unit's production cost. It does not represent the actual price paid for the weapon system. SIPRI has a TIV assigned to every weapon system based off the known unit's production cost. The quantity of the weapon system transferred then gets multiplied by this TIV to get the total TIV for the transfer (Holtom et al., 2012).

From 2012-2016, Saudi Arabia was the second largest importer of global arms at 8.2 percent (~$11.7B TIV), with 52 percent of their arms coming from the US (Wezeman et al., 2017). Continuing this trend, Saudi Arabia maintained this rank from 2017-2021 at 11 percent (~$14.9B TIV), with the US contributing to 82 percent of these imports (Wezeman et al., 2022). These metrics highlight the volume of arms being transferred from the US to Saudi Arabia. Essentially, for a nine-year period Saudi Arabia was ranked number two in arms imports bringing in over $25B TIV in arms with majority of them being received from the US. Therefore, this data shows that international defense sales by US defense contractors are heavily related to arms transfers to Saudi Arabia.

Saudi Arabia's WTP for US defense systems may be high due to the ongoing regional conflicts in the Middle East and major security threats within the country. Some of the threats that Saudi Arabia has had to endure over the years are ongoing attacks from ISIS/Al-Qaida since 2003, tensions between Sunnis and Shiites within the country, Iran's intentions to acquire weapons of mass destruction, political instability in Iraq, and the ongoing war in Yemen (Cordesman, 2018).

Another reason countries may have a high WTP for US defense systems, is the fact that not every country has their own large domestic DIB. Therefore, high quality weapon systems may be considered scarce products for countries in this predicament. Options for weapons in their country may be limited, and they may be willing to pay more for these weapons. For example, Saudi Arabia does not have a large domestic defense industry, so much of their defense spending for weapons goes to the US (Cordesman, 2016). According to the Saudi Vision 2030, a plan for Saudi economic reform, as of 2016 domestic defense spending was only two percent with their local

defense industry being represented by only seven defense contractors (Council of Economic and Development Affairs- Saudi Arabia, 2016). This could explain why Saudi Arabia has been the number two arms importer in the world for the last nine years (Wezeman et al., 2017 ; Wezeman et al., 2022). One of the goals listed in Saudi Vision 2030 was for domestic defense spending to increase to 50 percent by 2030 in order reduce military spending (Council of Economic and Development Affairs- Saudi Arabia, 2016). This could imply that Saudi Arabia feels that they have been being paying too much for defense equipment by outsourcing (primarily to the US). Although Saudi Arabia is only one example, when countries have to import most of their defense weapon systems from the US and also have a high WTP for defense equipment, the profitability of defense contractors could be positively affected.

Engaging in international defense sales could hurt profitability of defense contractors. One reason is due to the complexities of the pricing strategy associated with products sold in international markets (Raymond et al., 2001). There are many influential factors that firms must consider when setting the price for their international products. Some considerations when determining the pricing strategy for international products are currency fluctuations, tariffs on international products, and inflation in the foreign country (Casvusgil, 1988; Forman & Lacioni, 1999). If defense contractors are unable to determine the optimal pricing strategy, they can ultimately set the price too low and not be able to make up the costs associated with selling these products in the international market, negatively affecting profitability. Aside from these three factors, defense offsets have the ability to negatively impact the profitability of international defense sales.

Defense offsets are the benefits US defense contractors provide to foreign governments as conditions for purchasing defense articles and services through the FMS and DCS programs (Schinasi, 2004; Gilman et al., 2014). Foreign governments use offsets to lower the financial burden of purchasing defense articles and services from the US (Schinasi, 2004). Three common offset methods are purchasing, subcontracting, and technology transfer (Schinasi, 2004; US Department of Commerce and Bureau of Industry and Security, 2022). These three offset types represented 72.68 percent of all offset agreements (totaling $230.7 billion) reported from 1993-2020 (US Department of Commerce and Bureau of Industry and Security, 2022).

Purchasing involves the defense contractor buying off-the-shelf items from the foreign government (US Department of Commerce and Bureau of Industry and Security, 2022). Money spent on buying these items can be viewed as an additional cost associated with an international defense sales contract. This could hurt the overall profitability of the contract for a defense contractor.

Subcontracting grants a foreign contractor from the purchasing country a role in manufacturing the US defense weapon system on the international defense sales contract (US Department of Commerce and Bureau of Industry and Security, 2022). In this case, the US defense contractors are subject to the prices of the foreign contractor for their work instead of using their own US based subcontractors. These prices could be higher than what the US defense contractor anticipated and hurt the profitability on the contract.

Technology transfer can take the form of a defense contractor transferring all of the technical know-how for a defense weapon system to a foreign government (US Department of Commerce and Bureau of Industry and Security, 2022). This offset type

provides foreign governments with the ability to develop these American origin systems on their own, and potentially become competitors of US defense contractors (US Department of Commerce and Bureau of Industry and Security, 2022). If foreign countries are able to duplicate American made weapon systems then there would be no need for them to continue to purchase these systems from the US. This could potentially lead to a decrease in revenues and profitability from international defense sales by defense contractors.

Commercial Sales

According to the FAR, a commercial product is "customarily used by the general public or by nongovernmental entities for purposes other than governmental purposes" (FAR, 2022). Any revenue from products that fall into this category are considered to be commercial sales for defense contractors. Engaging in commercial sales by defense contractors is a form of product diversification since their core business revolves around producing and selling defense items. Diversification into commercial sales is typically done in two ways: either the defense firms internally develop commercial products and hope to sell them to commercial consumers, or they acquire commercial businesses (Bright, 2020).

Defense contractors diversify into commercial sales to reduce their dependence on domestic defense sales when the levels of US defense spending decrease (Fox, 1974; Reddy, 1991; Mandel, 1994). Bright argues that defense contractors pursue commercial sales for financial protection against government contract termination. Diversification

into commercial sales can be a way for a contractor to bring in revenue regardless on their level of involvement with government contracts (Bright, 2020).

Typically, defense contractors diversify into commercial businesses related to their core industry. Research suggests that diversification into related industries could positively affect profitability of a firm (Hitt et al., 1992). For example, defense contractors can transition from making military aircraft to producing commercial aircraft. Hitt et al. (1992) argued that diversification into related industries allows firms to leverage their resources and assets to create economies of scale and scope, which positively affects profitability.

Diversification into commercial sales could also hurt profitability of US defense contractors. Research suggests that US defense contractors are at a disadvantage when attempting to capture demand in commercial markets. It is believed by some researchers that defense contractors do not have much experience in performing within true free market competition since their primary customer is the US Government (Peck & Scherer, 1962; Kenkel & Jesmain, 2016). If defense contractors are unable to maintain a certain level of demand within this sector, diversification into commercial sales can negatively affect profitability. There are many differences between the commercial and defense sector that makes it more difficult for defense contractors to successfully transition to the commercial sector. In his book, *Democracy's Arsenal: Creating a Twenty-First-Century Defense Industry*, Jacques Gansler highlighted some differences and expectations between commercial and defense markets.

One of the differences argued by Gansler (2011) was the concept of market structure. The defense sector is a monopsony as there is primarily only one buyer (the US

Government) and in the commercial sector there are many buyers and sellers (Gansler, 2011). The relationship between the buyer and seller in these markets are vastly different. Peck and Scherer (1962) argued that the relationship between the DoD and a defense contractor on a government contract is much different than what a defense contractor would experience in the commercial sector. They argued that the DoD is essentially stuck with the contractor through the life of the contract. As a result, the contractor has developed a specialized expertise on the weapon system and has also acquired many assets to build and test the system (Peck & Scherer, 1962). The DoD knows that it would be too risky to switch contractors for this weapon system. Therefore, a contractor in this scenario could use its leverage as being the expert to continue to win follow on contracts.

However, in the commercial sector consumers do not feel as trapped to a seller of a particular item. There are many sellers in the market, and the risk of switching sellers for an item is much lower than it is for the DoD. Commercial consumers are not buying items to saves lives or bolster national security, so they may be more likely to explore other sellers. When transitioning into the commercial sector, defense contractors need to know how to obtain sales from consumers who have other alternatives. However, since much of a defense contractor's experience involves operating in an environment with little to no alternatives for their product, it is possible that they will not be able to obtain a significant portion of revenues from commercial sales. This could potentially negatively affect a defense contractor's profitability.

Another difference acknowledged between commercial and defense markets is that the demand of the buyer is different (Gansler, 2011). Commercial buyers purchase best value products, and therefore are price sensitive. They make constant tradeoffs

between the price of a product and its performance (Gansler, 2011). Defense contractors transitioning to the commercial sector are not used to dealing with a customer that is price sensitive. Therefore, they may not be able to price their commercial products appropriately to capture commercial revenues. Much of their pricing strategies revolve around doing business with the DoD who on the other hand is rarely price sensitive and pays whatever amount they deem necessary to obtain maximum performance (Gansler, 2011).

Defense contractors may also perform worse in commercial markets due to not having transparency of the consumers tastes and preferences to make a product that meets their needs. The Big Five defense contractors' primary customer is the DoD which mainly demands defense products and services. The requirements for these defense products are listed in specific documents such as the Initial Capabilities Document, Capability Development Document, and the Capability Production Document (DAU, 2022). These documents cover in detail the exact specifications the defense products must meet and is given to the defense contractors. In the commercial sector there are many different customers whose demands and requirements are not directly articulated in a document. Therefore, it is harder for a defense contractor to produce a product that meets the needs of commercial customers. Trying to determine what the commercial sector is demanding in terms of a product or service could be resource draining (money and labor hours) on a defense contractor's part which could negatively affect profitability.

Research also suggests that defense companies cannot compete with the level of money spent on innovation by commercial companies (Manyika et al., 2019). For a

company to experience profit growth, they must continue to find ways to make innovative products (Ahlstrom, 2010). For the Big Five defense contractors to be profitable in the commercial sector they will need to invest resources in developing innovative products that can capture demand. To boost innovation, companies must invest heavily in R&D spending. In an article published by William Lynn III, former US Deputy Secretary of Defense, the argument is made that it is hard for prime defense contractors to compete with the commercial sector because they do not have enough R&D funding to make competitive commercial innovative products (Lynn, 2014). Therefore, the demand for commercial products made by defense contractors could possibly be low leading to negative effects on profitability (Kenkel & Jesmain, 2016). The DoD funds most of the R&D investment by defense contractors. Any DoD funded R&D has to be applied to defense products only and cannot be used for the development of commercial products. Any extra R&D efforts aimed at innovation to compete with products in the commercial sector will have to be financed by the defense contractor's own cash. However, Lynn (2014) argues that defense contractors are reluctant to spending their cash reserves on R&D due to the uncertainty of US defense budgets.

This section introduced the concept of commercial sales and how they could potentially affect a defense contractor's profitability. The next section will provide a brief background on M&A. The section will also discuss how M&A may relate to the profitability of defense contractors.

Mergers and Acquisitions

According to the Corporate Finance Institute (CFI), M&A refers to the combination of two companies through a series of financial transactions. Although the terms merger and acquisition are often paired together, they have different meanings. A merger refers to two companies (generally the same size) combining to form a new single entity; an acquisition refers to the process of a larger company acquiring a smaller company, therefore absorbing the entire business of the acquired company (CFI, 2022).

M&A for defense contractors in the late 90's occurred primarily for one reason: it was highly encouraged by the DoD to promote efficiency within the DIB after the end of the Cold War. The DoD wanted defense contractors to consolidate through M&A to reduce the costs associated with physical assets allocated to defense (Deutch, 2001). For example, a defense contractor would still have to pay costs associated with operating a military aircraft production plant even if the plant was not being used. The purpose of consolidation was for defense contractors in this predicament to shut down these defense production plants and combine with other defense contractors to operate more efficiently.

As mentioned earlier, in 1998 this pro-consolidation policy was reversed when the DoD became concerned with the low number of defense contractors for major weapon categories (Deutch, 2001). Table 3 shows the number of US defense contractors by major weapon categories following the end of the Cold War. This table shows how consolidation gave rise to the Big Five contractors as we know them today. For example, in 1990 there were 13 US contractors for tactical missiles. By the end of 1998, this number fell to only 3.

Table 3: Consolidation of Major Weapon Categories from 1990-2020

Weapons category	Total U.S. contractors			Current U.S.-based prime contractors
	1990	1998	2020	
Tactical missiles	13	3	3	▶ Boeing ▶ Raytheon Technologies ▶ Lockheed Martin
Fixed-wing aircraft	8	3	3	▶ Boeing ▶ Northrup Grumman ▶ Lockheed Martin
Expendable launch vehicles	6	2	2	▶ Boeing ▶ Lockheed Martin
Satellites	8	5	4	▶ Boeing ▶ Lockheed Martin ▶ Hughes ▶ Northrup Grumman
Surface ships	8	5	2	▶ General Dynamics ▶ Huntington Ingalls
Tactical wheeled vehicles	6	4	3	▶ AM General ▶ Oshkosh ▶ General Motors
Tracked combat vehicles	3	2	1	▶ General Dynamics
Strategic missiles	3	2	2	▶ Boeing ▶ Lockheed Martin
Torpedoes	3	2	2	▶ Lockheed Martin ▶ Raytheon Technologies
Rotary wing aircraft	4	3	3	▶ Bell Textron ▶ Lockheed Martin (Sikorsky) ▶ Boeing

Source: Office of Commercial and Economic Analysis (OCEA) U.S. Aerospace & Defense Industry Consolidation Assessment, November 2021. Sources and information included CSIS, Bloomberg, Defense News, National Defense, Center for Defense, GAO, POGO.

Since the pro-consolidation policy was reversed, going forward large-scale M&A involving major defense companies were going to be harder to be approved by the DoD and Department of Justice. For instance, in 2022 the Federal Trade Commission, the organization responsible for enforcing US antitrust laws, blocked Lockheed Martin's $4.4 billion proposed acquisition of Aerojet Rocketdyne, the last US supplier of missile propulsion systems (FTC, 2022). However, there are still opportunities for defense contractors to acquire small and medium sized defense companies (Jean, 2009).

Mergers and Acquisitions and Defense Contractor Profitability

One primary benefit of M&A that can positively influence profits are access to economies of scale and scope (Shim, 2011). Economies of scale refer to benefits that come to businesses from the ability to lower costs and increase production. For example, production could increase from M&A if a business gains access to another production facility. Economies of scope refer to the ability to lower the production cost of one product due to the production of another related product. Economies of scope can lower overall costs of a product by sharing resources such as consumer databases, distribution chains, and technology (Teece, 1980). When company resources are consolidated through M&A, economies of scale and scope facilitate efficient operations, which in turn may enable an increase in profitability.

The ability for M&A to offer economies of scale and scope has been examined across different industries. Cummins and Xie (2013) and Hanweck and Hogan (1996) showed evidence that economies of scale were experienced by firms that diversified through M&A in the property-liability insurance industry. Cummins and Zi (1998) found similar results in the life insurance industry. Grabowski and Kyle (2012) argued that economies of scale and scope could present themselves in the biopharmaceutical industry from access to new technologies. There is not any reason why the same fundamental benefits offered by economies of scale and scope through M&A could not work in the defense industry.

M&A can be used by firms to eliminate competition, giving the remaining firms more market power and the ability to raise prices which could positively influence profitability (Trujillo et al., 2020). When there are less alternatives for a particular

product (in this case due to companies buying out the competition), the remaining firms have a greater market power in determining the price point for that product (Chatterjee, 1991; Devos et al, 2016). Prime defense contractors already have majority of the market power for defense systems since they are the sole producers of major weapon systems (Table 3). Any additional M&A of smaller defense companies by prime contractors gives them even more market power furthering their ability to raise prices for defense products. Defense contractors can also buy companies within their supply chain to potentially boost profitability.

Defense contractors can engage in vertical M&A to reduce transaction costs that negatively contribute to profitability (Chatterjee, 1991; D'Aveni & Ravenscraft,1994; Zarb & Noth, 2012). A vertical M&A is where a company buys or merges with a company along its supply chain for a particular product. Essentially the company is cutting out the middleman by buying a supplier. The acquiring company will no longer need to pay this supplier for their work in producing a product since they will either own or share resources with the supplier. Zarb and Noth (2012) stated that if this is done successfully the acquiring company can experience positive abnormal returns.

M&A can also allow defense contractors to diversify their business into commercial markets and take advantage of consumer demand not related to their core business and cyclical defense budgets (Bright, 2020). Lewellen (1971) and Morris et al. (2017) refer to this type of diversification as imperfectly correlated income streams. Imperfectly correlated means that changes in one source of income is not related to changes to another source of income. For example, at one point Lockheed owned Pacific Finance Corp, a consumer finance company, and it was a success (Bright, 2020). Having

sources of imperfectly correlated income streams can provide a hedge against risks associated with a business's primary source of income (Lewellen, 1971).

Summary

Based off the data provided on FMS, the international defense sales market did increase following the reversal of the consolidation policy in 1998 as large-scale acquisitions between defense contractors were strongly discouraged. The market did have an increasing trend from 2001-2012 following the terrorist attack on America. Similarly, the domestic defense budget was also increasing from 2001-2008 (Figure 1). This went against the traditional expectation that expansion into the international defense sales market was only a response to declining US defense budgets. Furthermore, the international defense sales market did increase significantly during the BCA of 2011. This confirmed claims that the market would see expansion during budget cuts. Overall, the international defense sales market has grown since the end of the Cold War.

Although revenue from international defense sales has increased for the DIB, profitability is the focus of this research. The literature reviewed supports that expansion into the international defense sales market could both positively and negatively affect profitability of defense contractors. The claim has also been made that international defense sales can be more profitable than domestic defense sales. There is also support that expansion into commercial sales could have both positive and negative effects on a defense contractor's profitability. Lastly, support has been provided that M&A could positively affect profitability. The next section will cover the methods used to empirically

analyze the relationships between international defense sales, commercial sales, and M&A on defense contractor profitability.

III. Methodology

Chapter Overview

The purpose of this chapter is to explain how the research questions will be analyzed. This chapter discusses the data collection process, model development, and a description of the variables used in the models .

Research Question Analysis

Research Question #1: How do US defense budgets relate to the Big Five defense contractors' profitability?

First, the relationship between US defense budgets and the Big Five defense contractors' profitability is explored. Domestic defense sales are the primary source of revenue for most defense contractors. US defense budgets are directly related to the amount of revenue that can be earned through domestic defense sales for the entire DIB. According to William Hartung--director of the Arms and Security program at the Center for International Policy--one-quarter to one-third of all Pentagon contracts have gone to the top five prime defense contractors (Hartung, 2021). The revenue from these Pentagon contracts has the potential to boost the profitability of the prime defense contractors. Therefore, US defense budgets may have the ability to impact defense contractor profitability.

Research Question #2: How do US defense budgets relate to revenue earned from international defense sales by the Defense Industrial Base (DIB)?

Next, the relationship between US defense budgets and international defense sales is explored. Declining US defense budgets have the ability to negatively affect a US defense contractor's profitability. Therefore, in this instance defense contractors would have to diversify into other sources of revenue outside of domestic defense sales to meet their revenue maximizing strategy. Recall, that there is a minimum profit constraint associated with the revenue maximizing strategy (Baumol, 1958). Expansion into the international defense sales market has been identified as a tactic pursued by defense contractors in response to declining defense budgets (Grimmett, 1993; Vartabedian & Broder, 1994; Deutch, 2001; Sherman, 2012; Thrall & Dorminey, 2018).

However, when analyzing Figure 1 (Total Combined RDTE and Procurement Defense Budgets FY1990-FY2021) and Figure 2 (Total Worldwide FMS Agreements FY1993-FY2021), there were years where both values were moving in the same direction. From FY1993-FY1994, both of the values were decreasing. This suggests that a decrease in US defense budgets does not necessarily translate into increased international defense sales for the entire DIB. Additionally, when US defense budgets were increasing from FY2001-FY2008, FMS agreements for the entire DIB also increased from FY2005-FY2008. This may suggest that even when US defense budgets are increasing, international defense sales may still be worth pursuing to obtain profits. An analysis of the relationship between these two variables will provide further insight on how they may relate to each other.

Research Question #3: How does the percentage of commercial sales, relative to domestic defense sales, relate to the Big Five defense contractors' profitability?

Engaging in commercial sales was identified as a response to declining defense budgets by defense contractors (Fox, 1974; Reddy, 1991; Mandel, 1994). Therefore, it is expected that as the percentage of commercial sales increases, the percentage of domestic defense sales decreases. Research suggests that defense contractors face difficulties in transitioning into markets where there are many buyers and sellers (Peck & Scherer, 1962; Kenkel & Jesmain, 2016). However, defense contractors could experience a positive effect on profitability if they transition into commercial industries related to their core business (Hitt et al., 1992). Whether it is positive or negative, the literature supports the argument that there may be a relationship between the percentage of commercial sales and a defense contractor's profitability.

Primary Research Question: How does the percentage of international defense sales, relative to domestic defense sales, relate to the Big Five defense contractors' profitability?

Since international defense sales are not the only thing that affects a defense contractor's profitability, research questions one and three were explored. These questions provided additional variables for use in the models generated to analyze the primary research question. Research question two explores the relationship between international defense sales by the DIB. The purpose of this question was to assess the claims made in Chapter II that there was going to be an expansion of the international defense sales market when US defense budgets declined. However, this question only examines how revenue from international defense sales may be impacted by defense budgets. This question does not assess the relationship between international defense

sales and a defense contractor's profitability. Therefore, the primary research question is explored last to examine this relationship.

Similar to commercial sales, international defense sales were also identified as an additional source of revenue to pursue in response to declining US defense budgets for US defense contractors. This implies that when the percentage of international defense sales is increasing, the percentage of domestic defense sales should be decreasing. Research suggests that this expansion at the expense of domestic defense sales could potentially induce both positive and negative effects on a defense contractor's profitability. Regions in the Middle East may be willing to pay high prices for US defense systems and services due to the threat of Iran and regional instability within the region. Most FMS contracts are firm fixed price (U.S. Government Accountability Office, 2017) and therefore offer the highest potential profit percentage because are they are high risk (Agapos & Gallaway, 1970; Zhong & Gribbin, 2009). On the contrary, pursuing international defense sales could hurt profitability due to the potential negative effects associated with defense offsets. Additionally, defense contractors may not be able to apply an effective pricing strategy for their international defense exports, which could negatively affect profitability (Raymond et al., 2001).

In summary, research suggests the relationship between the percentage of international defense sales and a defense contractor's profitability could be positive or negative. Due to the contradictory nature of the literature review on international defense sales, no definitive relationship between the two variables can be determined. Therefore, the results of the analysis will be used to discuss how these variables may relate to each other.

Methods of Analysis

First, correlation analysis was applied to assess the linear relationship between the variables in research questions one, two, and three. This processed consisted of generating scatterplots to assess the direction (positive or negative) of each relationship. Next, Pearson's Correlation Coefficient was used to assess the direction, strength, and statistical significance of each relationship. The closer the returned coefficient is to -1 or +1, the stronger the linear relationship (Hilmer & Hilmer, 2014). However, correlation between two variables does not mean one causes the other. Therefore, additional analysis was conducted to help answer the primary research question on the relationship between the percentage of international defense sales and defense contractor profitability.

Time-series analysis was used to further explore the primary research question. Specifically, the distributed lag model was used to analyze the data from Lockheed Martin, General Dynamics, and Boeing. This method employs Ordinary Least Squares (OLS) regression to time-series data to capture the effects of independent variables on the dependent variable (profitability) (Hilmer & Hilmer, 2014). This model also allows the effects of independent variables that may have a lag effect on the dependent variable to be controlled for in the model. Time-series data refers to data collected for one firm over multiple time periods (Hilmer & Hilmer, 2014). Time-series analysis allows for the relationship between international defense sales and profitability to be examined across time for each individual firm.

Period of Study

The time period of this analysis was 1994-2021. This time period captured the years following the end of the Cold War where researchers believed the percentage of international defense sales would increase. Similarly, it also captured the years affected by the Budget Control Act of 2011, where the percentage of international defense sales by defense contractors was expected to increase. This range also captures the duration of the GWOT where there was an expansion of both US defense budgets and FMS agreements for the entire DIB. Ideally, the first year of data collection would have been before 1990 in order to capture the baseline of international defense sales before the end of the Cold War. However, the database that was utilized to gather sales data for the defense contractors only contained data beginning in 1994. The next section will discuss the data gathering process in greater detail.

Sample and Data Collection Process

The sample used in this analysis was the five prime US defense contractors: Lockheed Martin, Northrop Grumman, Raytheon, General Dynamics, and Boeing. Financial data was primarily collected from the annual 10-K filings to the Security Exchange Commission for each contractor. These annual reports were located in the EDGAR database on sec.gov. Total assets, net income, total sales, and the amount spent on acquisitions of other businesses was collected for each contractor from 1994-2021. The data was obtained by manually searching the balance sheets, income statements, and cash flow statements listed in the annual 10-K reports. Additionally, the data collected was cross-checked by data provided by Yahoo! Finance Premium. Return on Assets

(ROA) and Net Profit Margin (NPM) were the profitability ratios used in this analysis. Their values were calculated from the data obtained on total assets, total sales, and net income.

To answer research question one, data was obtained on the DoD Research, Development, Test, and Evaluation (RDTE) and Procurement defense budgets from 1994-2021. The total amount representing the defense budget in each year was the sum of the two defense budgets. This data was obtained from the FY22 President's Budget Green Book. A graph of this data is shown in Figure 1.

Data was collected on international defense sales for the entire DIB to answer research question two. Only the data from Figure 2 (Total Worldwide FMS Agreements from FY1993-FY2021) from DSCA is used to answer this research question. The exclusion of DCS data when assessing the international defense sales market is common due to its inaccuracies (Grimmett, 1998; Thrall & Dorminey, 2018).

An annual report titled, "*Conventional Arms Transfers to Developing Nations"*, produced by the Congressional Research Service assesses international defense sales in the United States. The report only considers FMS data when determining the amount of international defense sales for US defense contractors and completely excludes data from DCS. The report stated, "It should be noted that data maintained on U.S. commercial sales (DCS) agreements and deliveries are incomplete and are not collected or revised on an ongoing basis, making them significantly less precise than those for the U.S. FMS program" (Grimmett, 1998). Thus, the FMS data provided by DSCA should be considered the most accurate data available.

The percentage of commercial and international defense sales had to be obtained for each contractor to answer research question three and the primary research question. A defense contractor's revenues are typically broken into three customer categories: international defense (FMS and DCS), commercial (foreign and domestic sales), and domestic defense (sales to the US Government). The 10-K reports were used to determine the percentages allocated to each revenue category for the defense contractors. The percentages were found by dividing the total revenue from each category by the contractor's total sales that year. However, in many instances it was difficult to accurately determine the revenues associated with each category.

Many of the contractors reported revenues in a way that could not be separated by customer type. For example, there were many cases where sales to the US government included sales from FMS. Similarly, there were instances where international defense and international commercial sales were reported together. This made it more difficult to accurately determine the revenue by customer type for some of the defense contractors. This was a major problem because this could drastically impact the statistical analysis associated with the primary research question. Assumptions were made for the three revenue categories in every year for all of the defense contractors. The only exceptions were Lockheed Martin, General Dynamics, and Boeing. Lockheed Martin reported their revenue by customer type using the breakout mentioned in the previous paragraph from 1994-2021 (28 observations). General Dynamics followed the same methodology as well from 1999-2021 (23 observations).

From 1994-2011 (18 observations), Boeing included FMS in their calculation for sales to the US Government with no way to determine how much FMS were contributing

to the overall total of sales to the US Government. However, they provided the total amount of international defense sales to two major regions: Asia, other than China, and Europe. This total was divided by the total annual sales to get the percentage of international defense sales. The portion of FMS that could not be removed from the sales to the US government figure was treated to be a part of domestic defense sales. The only downside to this method was that Boeing's percentage of international defense sales was underestimated while their percentage of domestic defense sales was overestimated (due to the inclusion of FMS that could not be removed). However, there was not a mix of revenues between international defense and domestic defense. Therefore, Boeing's data was still suitable for analysis, with the caveat that their percentage of international defense sales were technically underrepresented . Therefore, the time-series models were only conducted on data from these three contractors to provide the most robust results. The methodology for calculating the percentages allocated to the three revenue categories are found in Appendix A. This information is located in the appendix because each contractor categorized their revenue by customer type in different methods, and the methods were not consistent in every year.

Two Primary Models

After correlation analysis was conducted to observe the relationships between the variables in research questions one, two, and three, a more comprehensive model was developed to explore the primary research question. Correlation analysis only assesses the linear relationship between two variables. It does not consider other variables that may be influencing the relationship between the two variables involved in the correlation

analysis. Therefore, to establish a more robust analysis, a time-series model was developed. The purpose of this model was to determine the effects of international defense sales on defense contractor profitability, while controlling for other variables that may affect profitability. The same model was generated for the ROA and NPM dependent variables. The two models are shown below, followed by a description of the variables in the models.

The primary econometric time-series models for analysis are:

$$ROA_t = \beta_0 + \beta_1\ \%InternationalDefSales_t + \beta_2\ \%CommercialSales_t + \beta_3\ MerAcq_t + \beta_4\ MerAcq_{t-1} + \beta_5\ MerAcq_{t-2} + \beta_6\ MerAcq_{t-3} + \beta_7\ Size_t + \beta_8\ DomDefBudget_t + u_t \quad (1)$$

$$NPM_t = \beta_0 + \beta_1\ \%InternationalDefSales_t + \beta_2\ \%CommercialSales_t + \beta_3\ MerAcq_t + \beta_4\ MerAcq_{t-1} + \beta_5\ MerAcq_{t-2} + \beta_6\ MerAcq_{t-3} + \beta_7\ Size_t + \beta_8\ DomDefBudget_t + u_t \quad (2)$$

where t refers to the time period. The percentage of domestic defense sales was excluded as a variable in the models to prevent perfect multicollinearity with the other two revenue categories. The revenue categories are measured as percentages of total sales and must add up to 100%. Therefore, the value of one revenue type depends on the value of the other two revenue types. Additionally, excluding this revenue category allowed for the estimated effects of the %*InternationalDefSales* and %*CommercialSales* variables on profitability to be relative to domestic defense sales. In regression analysis, the interpretation of the marginal effect an independent variable has on the dependent variable assumes all other independent variables are held constant (Hilmer & Hilmer,

2014). For example, *%CommercialSales* is held constant when determining the marginal effect %*InternationalDefSales* has on the dependent variable. As a result, the percentage of domestic defense sales must decrease when the %*InternationalDefSales* increases by one unit, since the percentages are all a function of each other.

For the dependent variables in Models 1 and 2, *ROA* represents return on assets and *NPM* is net profit margin. For the independent variables, *MerAcq* represents the mergers and acquisitions independent variable. *DomDefBudget* represents the domestic defense budget. A summary of all the variables in the models and their definitions are listed in Table 4 below.

Table 4: Definition of Variables

Variable	Role	Description
ROA_t	Dependent Variable 1	Measured as net income divided by total average assets in year t
NPM_t	Dependent Variable 2	Measured as net income divided by annual total sales in year t
$\%InternationalDefSales_t$	Provide analysis for the Primary Research Question	Measured as international defense sales to foreign governments or organizations divided by total sales expressed as a percentage in year t
$\%CommmercialSales_t$	Control Variable	Measured as revenue from non-defense sales to domestic and foreign customers divided by total sales expressed as a percentage in year t
$MerAcq_t$	Control Variable	Expressed as the total dollar value spent on purchases of other businesses, net of cash acquired in year t
$MerAcq_{t-1}$	Control Variable	Expressed as the total dollar value spent on purchases of other businesses, net of cash acquired 1 year prior to year t
$MerAcq_{t-2}$	Control Variable	Expressed as the total dollar value

		spent on purchases of other businesses, net of cash acquired 2 years prior to year t
$MerAcq_{t-3}$	Control Variable	Expressed as the total dollar value spent on purchases of other businesses, net of cash acquired 3 years prior to year t
$Size_t$	Control Variable	Expressed as annual total sales in year t
$DomDefBudget_t$	Control Variable	Measured as the total amount of funding allocated to the defense Procurement and RDTE categories expressed in FY22 constant dollars in year t
U_t	Error Term	Unobservable error term in year t

Table 5: Coefficient of Interest

Coefficient	Primary Research Question Analysis
β_1	The empirical analysis for the primary research question examines, controlling for other factors, how the percentage of international defense sales relates to the profitability of the firm. The literature reviewed indicated that this relationship could be positive or negative. The sign and significance of β_1 will dictate analysis associated with the primary research question.

Dependent Variables (DVs)

Return on Assets (ROA) was one of the profitability ratios used in this analysis. ROA is defined as net income divided by total average assets; it is the profit that is generated from how a business uses its assets. The GAO conducted a study in 1990 identifying that ROA was the best measure of contractor profitability for three reasons: 1) it can determine the impact of government profit policies; 2) it can be computed at the segment level; and 3) it can be calculated from audited historical data (GAO, 1990). Additionally, ROA was found to be a more effective way to assess the long-run

performance of a company rather than analyzing dollar amounts or net worth (Agapos & Gallaway, 1970). Furthermore, it provides a standardized measure of performance for companies that may have different financial structures. For instance, net worth can be manipulated by how a company chooses to report its subsidiaries. However, ROA is a measure of how well a company uses its assets to make profits. For all of the aforementioned reasons, ROA was chosen as a more effective way to measure earnings performance as opposed to analyzing net worth (Agapos & Gallaway, 1970).

Net Profit Margin (NPM) was the other profitability ratio used in this analysis. NPM is defined as net income divided by total annual sales and shows how much profit is generated from sales after all expenses are accounted for (Stobierski, 2020). NPM is derived from a firm's pricing power and product innovation. If a firm's product has high demand and is difficult to duplicate by its competitor's, the firm can charge premiums to its customers (Soliman, 2008). NPM was selected as the additional metric to assess how defense contractor profitability is affected by their ability to price products. Recall that this research argues that Saudi Arabia may pay higher prices for the US defense equipment than the US government. This is expected to be reflected in a defense contractor's NPM not ROA, because ROA is more of a measure of asset efficiency.

Primary Research Analysis Variable

The percentage of international defense sales was the main variable of interest in this analysis. This percentage was calculated by dividing the firm's international defense (FMS and DCS) sales by total sales. This data was collected using the annual 10-K

reports. The detailed methodology for how this percentage was calculated for each contractor is in Appendix A.

Description of Control Variables

Control variables are independent variables that are known to affect the dependent variable, and therefore must be included in the model to assess the true effects of the main effect variable. The independent variables below are known to affect profitability.

Percentage of Commercial Sales

All domestic and international sales that were non-defense were identified as commercial. Examples of items that would fall into this category were sales of commercial satellites or aircraft that were utilized for nongovernmental purposes (FAR, 2022). This percentage was calculated by dividing the firm's combined domestic and foreign commercial sales in a given year. This data was also collected using the annual 10-K reports, and the detailed methodology can be found in Appendix A.

Mergers and Acquisitions

M&As were operationalized by the total amount spent on acquisitions, net of cash acquired in each year for every contractor. This data was collected from the annual 10-K reports. The literature reviewed indicates that M&A could positively influence profitability. M&A can offer economies of scale and scope that create efficiencies between companies to lower long run costs (Hanweck & Hogan, 1996; Cummins & Zi, 1998; Grabowski & Kyle, 2012). They also can provide opportunities for defense contractors to absorb revenues that are not dependent on US defense budgets (Lewellen, 1971; Morris et al., 2017). It is expected that as a firm invests more money into M&A,

they will receive an increase in profitability. However, the potential positive effects on profitability after M&A may not always be realized right away.

As a result, remaining consistent with the notion that it takes time for the effects of M&As to impact a firm's financial performance (Agrawal et al., 1992; Danzon et al., 2007), lag variables were created for M&A. A study conducted in 2022 indicated that three years post transaction was sufficient enough to capture the M&A effects on the acquiring firm's profitability (Amano, 2022). The study also argued that longer observation periods make the relationship between M&A and the firm's profitability more difficult to determine. This is attributed to the fact that there are many other things that can affect a firm's profitability after a M&A (Amano, 2022). Remaining consistent with this study, the *MerAcq* variable was lagged by three years. This allowed the effects on profitability in year t to be examined by M&A in years $t-1$,$t-2$, and $t-3$.

Size

Size was measured as the total annual sales in each year for the prime defense contractors. Size was added as a control variable to remain consistent with prior research (Core et al., 1999). Larger firms may have had greater growth opportunities (i.e., more available money on hand for investment opportunities) in the past that need to be controlled for when comparing firms (Core et al., 1999).

Domestic Defense Budget

The US defense budget can be viewed as a measure of demand for defense goods and services by the US Government. According to the 2020 *Top 100 Contractors Report,* the top contractors by DoD procurement dollars obligated that year were: 1) Lockheed Martin at 13% (~$76B), Raytheon at 4.9% (~$28B), General Dynamics at 4.4%

(~$25.3B), Boeing at 4% (~$25.2B), and Northrop Grumman at 2.5% (~$14.5B). Since the prime defense contractors receive the largest percentages of DoD procurement dollars, it is certain that changes to the defense budget will affect their profitability. RDTE dollars also play a role in the domestic defense revenues for prime defense contractors. RDTE funding finances research and development efforts for the DoD. This funding is provided for defense contractors to develop innovative defense products for government use (DAU, 2023). Although there are many other categories in the defense budget, RDTE and Procurement were determined to have the highest potential impact on the profitability of the defense contractors in this analysis. For example, the Operations and Maintenance defense budget provides funding for DoD civilian pay and the upkeep of military installations (DAU, 2023). The defense contractors in this analysis typically do not receive any of these funds since their core business revolves around building defense systems. As a result, the *DomDefBud* variable is represented by the combined DoD RDTE and Procurement budgets in each year over the time period analyzed. A graph of this data is shown in Figure 1.

Summary

This chapter covered how the research questions were analyzed. The period of study and its justification were also discussed. Descriptions of the data gathering process were provided and details on the sample were included. The models and their variables were described. Justification for the inclusion of control variables was also provided. The next chapter will cover the analysis and results associated with the methods listed in this chapter.

IV. Analysis and Results

Chapter Overview

This chapter presents the analysis associated with the methodology listed in Chapter III. This chapter also discusses the results of the analysis. The statistical analysis was conducted with the R software package. The correlations were conducted using the *cor.test* function in R with the method specified as *pearson*. The distributed lag time-series models were conducted using the *lm* function in R.

Correlation between US Defense Budget and ROA

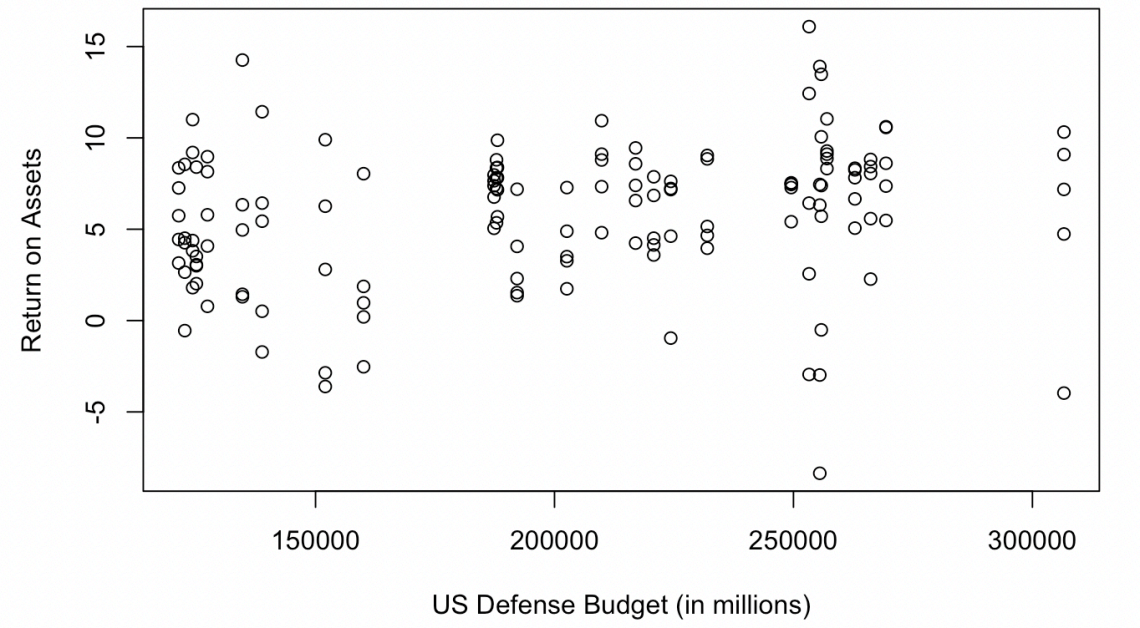


Figure 6: Scatterplot of the US Defense Budget and the Return on Assets of the Big Five Defense Contractors

Figure 6 plots the combined RDTE and Procurement defense budgets against the ROAs of the five contractors. The correlation was 0.21 indicating a positive, but weak

linear relationship between the US defense budget and the defense contractors' profitability. The p-value was 0.01 indicating that this relationship was statistically significant.

Correlation between US Defense Budget and NPM

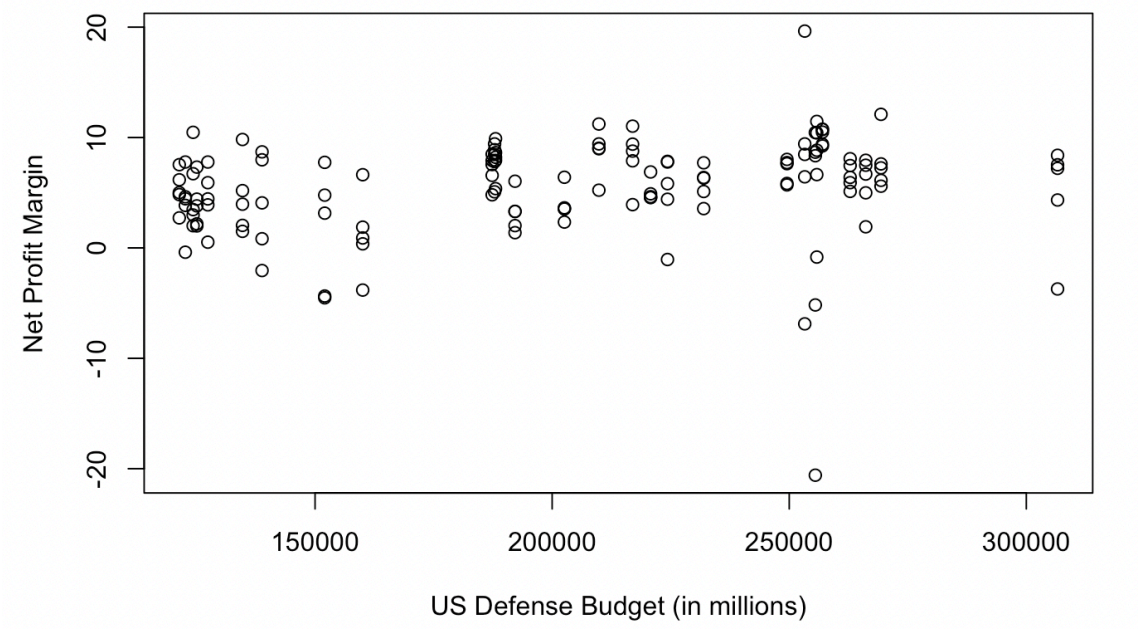


Figure 7: Scatterplot of the US Defense Budget and the Net Profit Margin of the Big Five Defense Contractors

Figure 7 plots the combined RDTE and Procurement defense budgets against the NPMs of the five contractors. The correlation was 0.19 indicating a positive, but weak linear relationship between the US defense budget and the defense contractors' profitability. This relationship was significant as well with a p-value of 0.02.

Correlation between US Defense Budget and Total Worldwide FMS Agreements

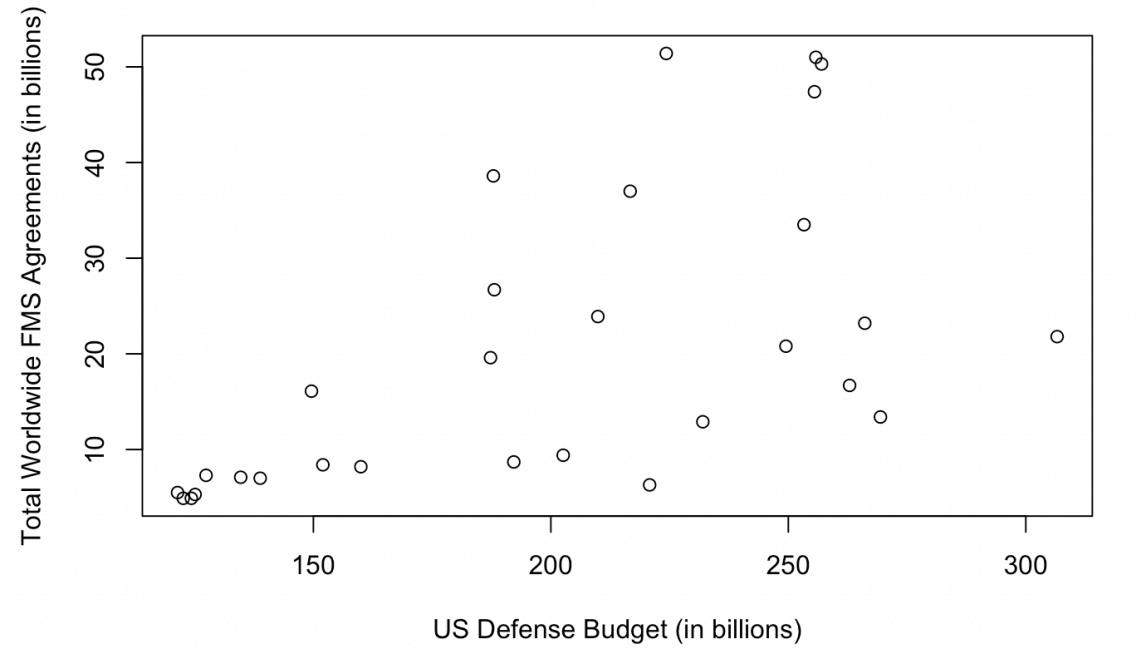


Figure 8: Scatterplot of the US Defense Budget and the Total Worldwide FMS Agreements

Figure 8 plots the combined RDTE and Procurement defense budgets against the value of Total Worldwide FMS Agreements (in billions). The correlation was 0.59 indicating a positive and moderate linear relationship between the US defense budget and Total Worldwide FMS Agreements. Additionally, this relationship was significant with a p-value of 0.000733. This suggests that when US defense budgets increase, the revenue from international defense sales earned by the entire DIB tends to increase as well.

Correlation between the % Commercial Sales and ROA- Lockheed Martin

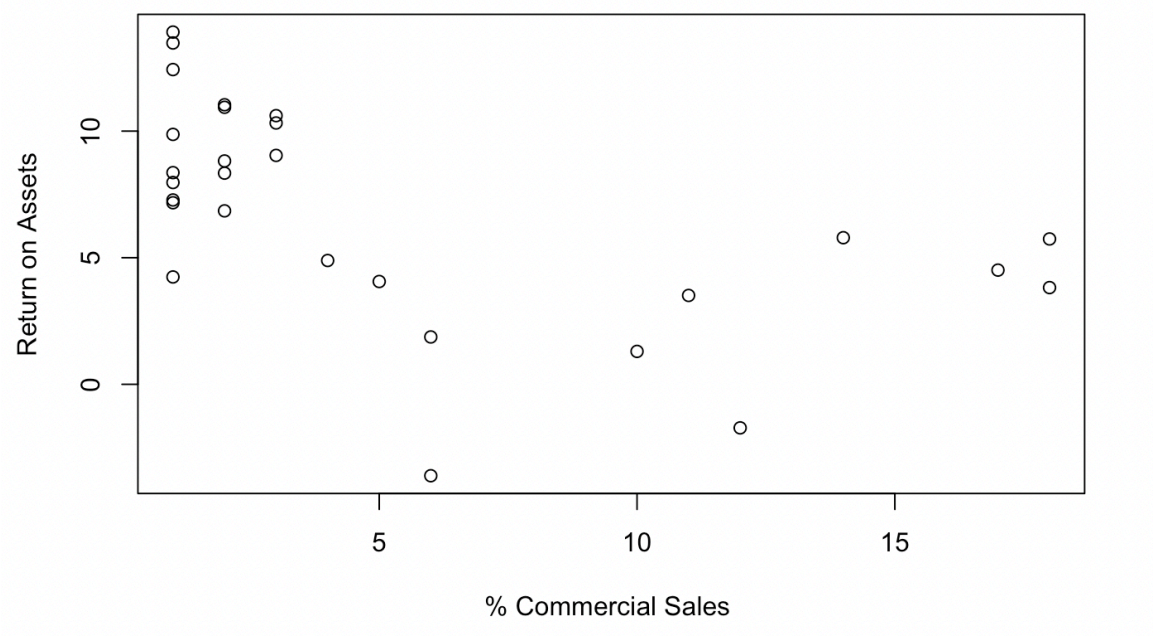


Figure 9: Scatterplot of the % Commercial Sales and Return on Assets- Lockheed Martin

Figure 9 plots the percentage of commercial sales and ROA for Lockheed Martin. The correlation was -0.55 indicating a negative and moderate linear relationship between the percentage of commercial sales and ROA. This suggests that these variables tend to move in opposite directions for Lockheed Martin. As the percentage of commercial sales increase, the company's ROA tends to decrease. This relationship was significant with a p-value of 0.002.

Correlation between the % Commercial Sales and ROA- General Dynamics

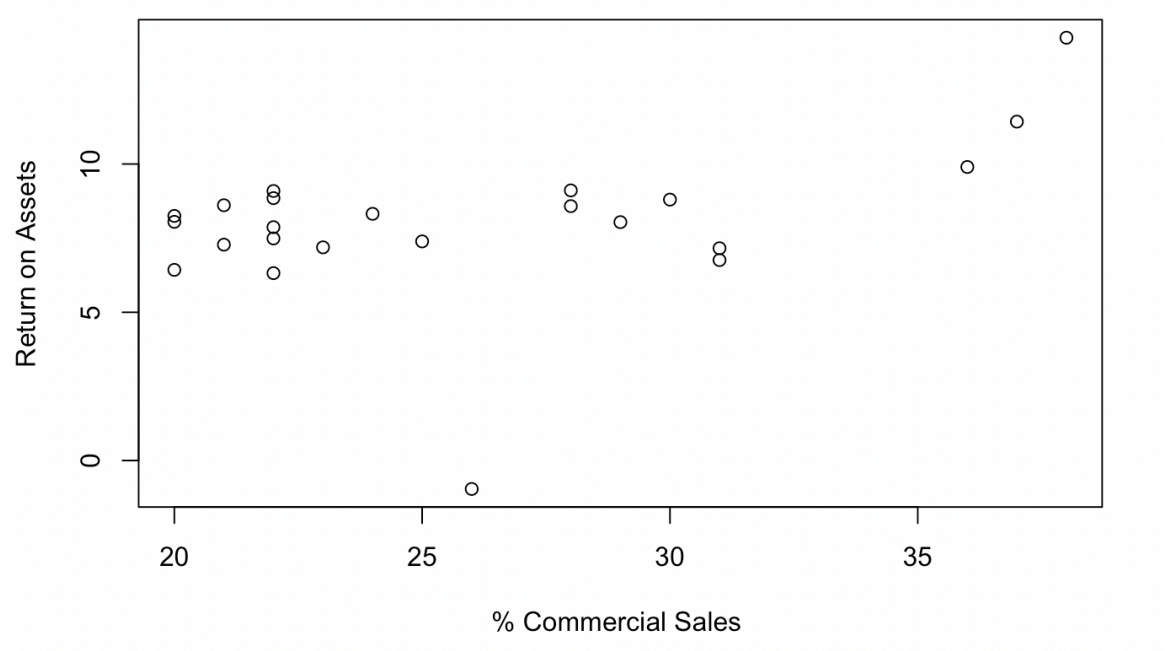


Figure 10: Scatterplot of the % Commercial Sales and Return on Assets- General Dynamics

Figure 10 plots the percentage of commercial sales and ROA for General Dynamics. The correlation was 0.43 indicating a positive and weak linear relationship between the percentage of commercial sales and ROA. This relationship was significant with a p-value of 0.04.

Correlation between the % Commercial Sales and ROA- Boeing

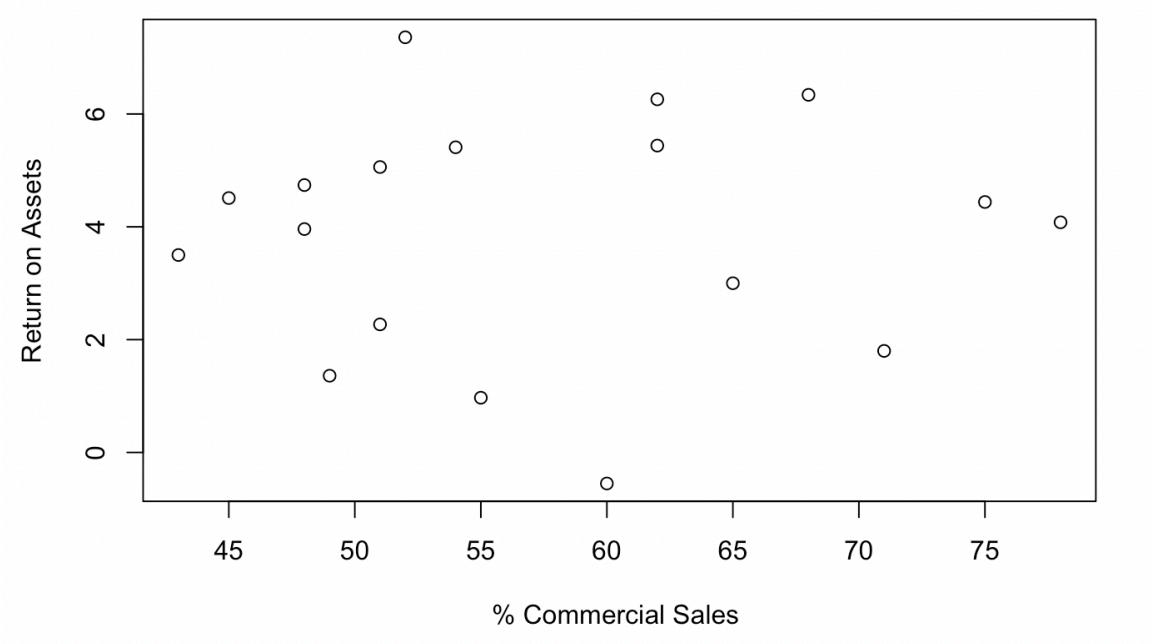


Figure 11: Scatterplot of the % Commercial Sales and Return on Assets- Boeing

Figure 11 plots the percentage of commercial sales and ROA for Boeing. The correlation was 0.019 indicating a positive and weak linear relationship between the percentage of commercial sales and ROA. This relationship was not significant with a p-value of 0.9376.

Correlation between the % Commercial Sales and NPM- Lockheed Martin

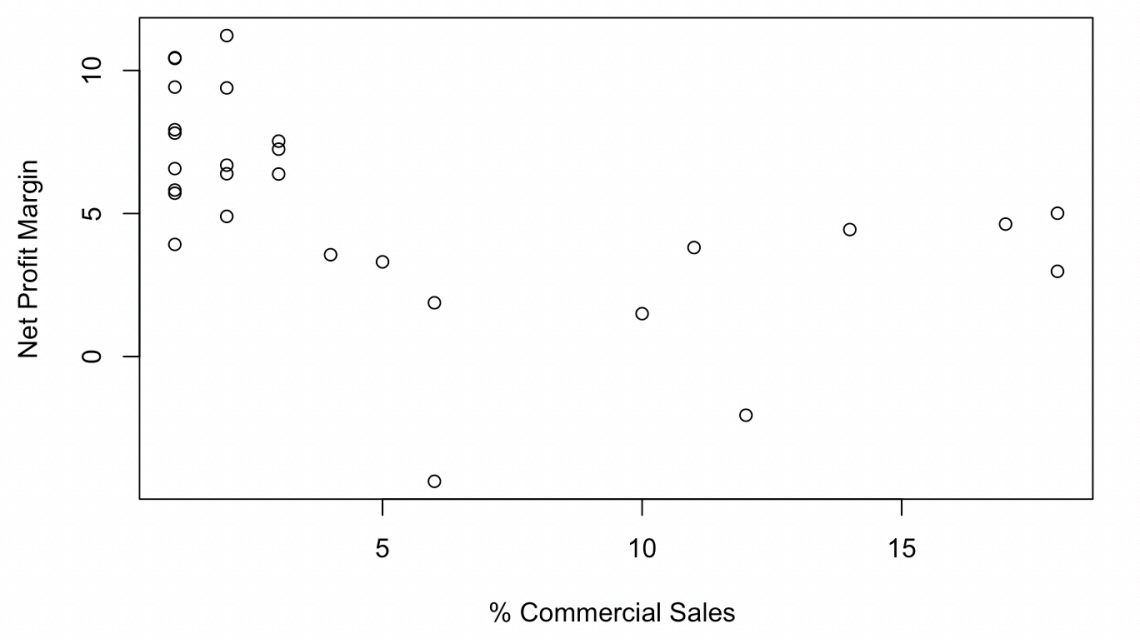


Figure 12: Scatterplot of the % Commercial Sales and Net Profit Margin- Lockheed Martin

Figure 12 plots the percentage of commercial sales and NPM for Lockheed Martin. The correlation was -0.49 indicating a negative and weak linear relationship between the percentage of commercial sales and NPM. As Lockheed Martin's percentage of commercial sales increased, their NPM tended to decrease. This relationship was significant with a p-value of 0.007.

Correlation between the % Commercial Sales and NPM- General Dynamics

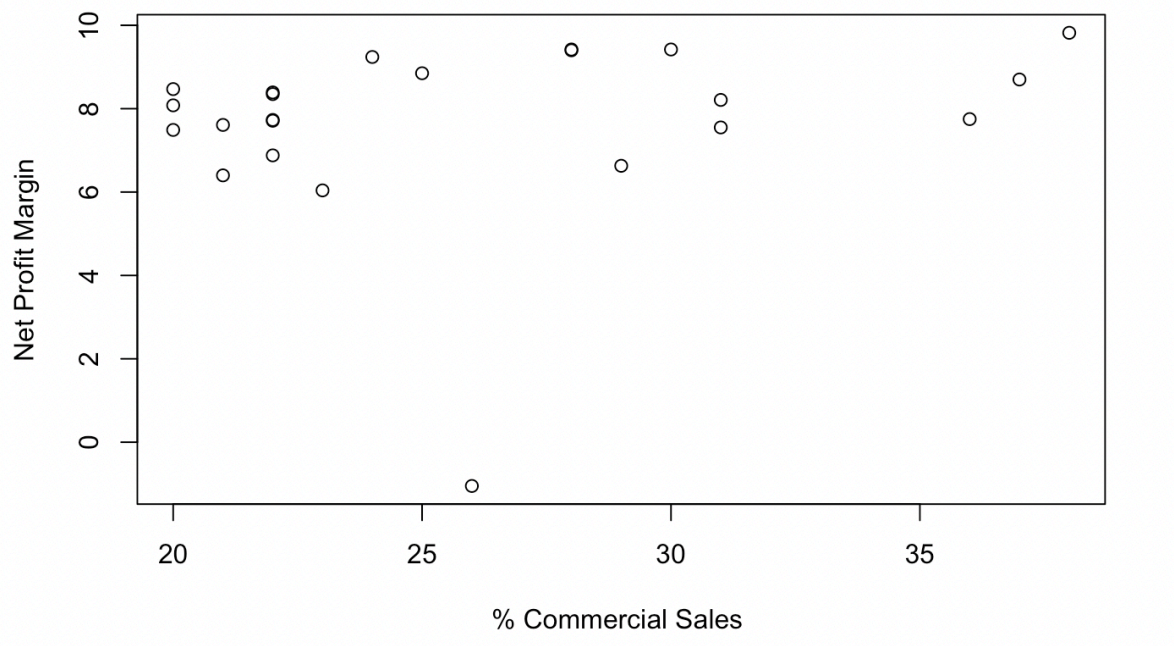


Figure 13: Scatterplot of the % Commercial Sales and Net Profit Margin- General Dynamics

Figure 13 plots the percentage of commercial sales and NPM for General Dynamics. The correlation was .18 indicating a positive and weak linear relationship between the percentage of commercial sales and NPM. This relationship was not significant with a p-value of 0.40.

Correlation between the % Commercial Sales and NPM- Boeing

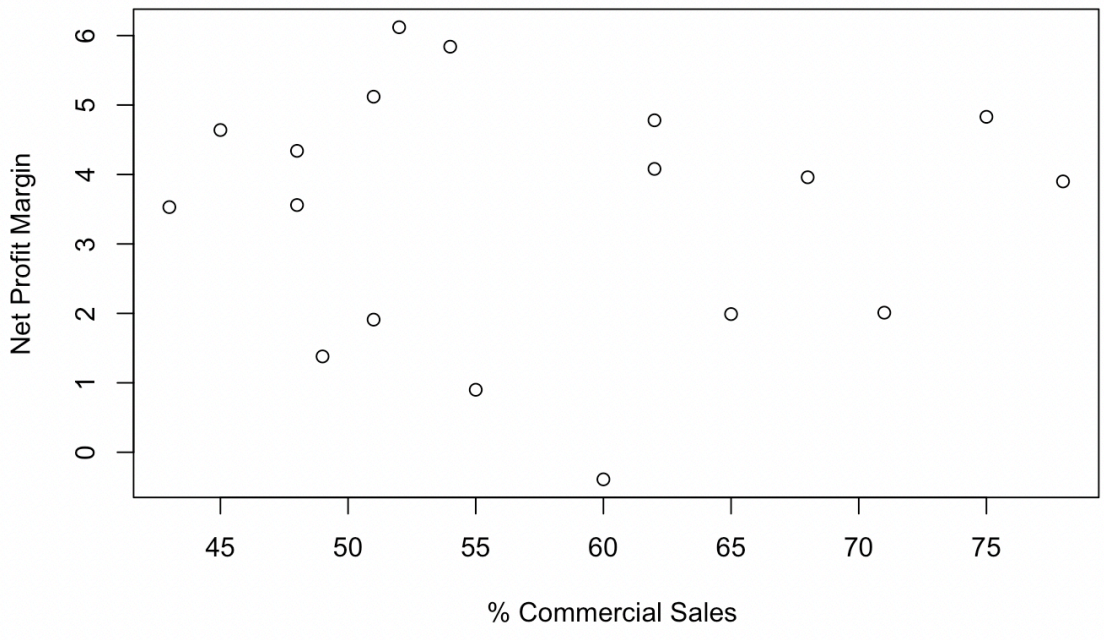


Figure 14: Scatterplot of the % Commercial Sales and Net Profit Margin- Boeing

Figure 14 plots the percentage of commercial sales and NPM for Boeing. The correlation was -.06 indicating a negative and weak linear relationship between the percentage of commercial sales and NPM. This relationship was not significant with a p-value of 0.82.

Summary

Table 6: Summary of Correlation Results

Correlation	Sign	Strength	Significant
US Defense Budget and ROA	+	weak	yes
US Defense Budget and NPM	+	weak	yes
US Defense Budget and FMS Agreements	+	moderate	yes
%Commercial Sales and ROA - LM	-	moderate	yes
%Commercial Sales and ROA - GD	+	weak	yes
%Commercial Sales and ROA - BA	+	weak	no
%Commercial Sales and NPM - LM	-	weak	yes
%Commercial Sales and NPM - GD	+	weak	no
%Commercial Sales and NPM - BA	-	weak	no

This section concludes the correlation analysis. A summary of the results is shown in Table 6. The research questions are revisited to discuss the results.

Research Question #1: How do US defense budgets relate to the Big Five defense contractors' profitability?

The correlation between US defense budgets and profitability (ROA and NPM) is positive and significant. This suggests that when US defense budgets increase, the defense contractors' profitability tends to increase. This was not surprising considering the most significant portion of a defense contractor's revenue typically comes from domestic defense sales. Since domestic defense sales are directly related to the US defense budgets, so the budgets have the potential to affect defense contractor profitability.

Research Question #2: How do US defense budgets relate to revenue earned from international defense sales by the Defense Industrial Base (DIB)?

The correlation between US defense budgets and total worldwide FMS agreements is positive and significant. This could be due to the fact that America does not fight any war alone. When America goes to war US defense budgets tend to increase. It is possible that the value of FMS agreements increases at the same time to offer weapons to US allies that provide US support during international conflicts. Additionally, this may suggest that when US defense budgets decrease in response to the end of a war, FMS agreements may decrease as well since the support from international allies is not as high of a priority. This could explain why FMS agreements and US defense budgets were decreasing together in the early years following the end of the Cold War in Figures 1 and 2.

Research Question #3: How does the percentage of commercial sales, relative to domestic defense sales, relate to the Big Five defense contractors' profitability?

With the ROA DV, the correlation between the percentage of commercial sales was only significant for Lockheed Martin and General Dynamics. However, for Lockheed Martin the correlation between the two variables was negative. The correlation may have been insignificant for Boeing because their dataset for this analysis contained less data points. For the NPM DV, the correlation between the percentage of commercial sales and profitability was only significant for Lockheed Martin. Similarly, the relationship between the two variables was negative. This suggests that as Lockheed Martin's percentage of commercial sales increased their profitability tended to decrease. This could indicate that Lockheed Martin may suffer from some of the difficulties with transitioning into the commercial sector listed in Chapter II. However, as indicated in Chapter III, correlation analysis only assesses the linear relationship between two

variables. There could be another variable that is influencing Lockheed Martin's profitability that needs to be considered. The time-series models will assess how this relationship holds while controlling for other variables that may influence profitability.

The next section will present and discuss the results of time-series models. Recall, the ROA DV model is specified by Equation 1, and the NPM DV model is specified by Equation 2 listed in Chapter III.

Time-Series Model ROA DV – Lockheed Martin

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -8.854629   4.094872  -2.162 0.043553 *
IntlDefSales -0.315409   0.156492  -2.015 0.058220 .
CommSales     0.336070   0.130597   2.573 0.018613 *
MerAcq       -0.185318   0.244443  -0.758 0.457677
MerAcqLag1   -0.600126   0.245735  -2.442 0.024548 *
MerAcqLag2    0.244612   0.253742   0.964 0.347146
MerAcqLag3   -0.283468   0.270548  -1.048 0.307899
Size          0.434589   0.092032   4.722 0.000148 ***
DomDefBud     0.008621   0.018928   0.455 0.653921
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.952 on 19 degrees of freedom
Multiple R-squared:  0.8536,    Adjusted R-squared:  0.7919
F-statistic: 13.85 on 8 and 19 DF,  p-value: 1.945e-06
```

Figure 15: Time-Series Analysis Results with ROA DV – Lockheed Martin

Figure 15 displays the results of the times-series regression model for Lockheed Martin. The overall model is significant at the .05 level. The r-squared for the model indicates that the independent variables explain 85% of the variation in ROA. The *CommSales*, *MerAcqLag1*, and *Size* variables are all significant at the .05 level.

Time-Series Model ROA DV – General Dynamics

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -20.21620   16.44870  -1.229   0.2393
IntlDefSales   0.37049    0.32128   1.153   0.2681
CommSales      0.60904    0.30103   2.023   0.0626 .
MerAcq        -0.11845    0.27515  -0.430   0.6734
MerAcqLag1    -0.13922    0.28984  -0.480   0.6384
MerAcqLag2    -0.23796    0.30655  -0.776   0.4505
MerAcqLag3    -0.36430    0.32864  -1.109   0.2863
Size          -0.24685    0.10241  -2.410   0.0303 *
DomDefBud      0.06624    0.03730   1.776   0.0975 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.429 on 14 degrees of freedom
Multiple R-squared:  0.445,     Adjusted R-squared:  0.1279
F-statistic: 1.403 on 8 and 14 DF,  p-value: 0.2767
```

Figure 16: Time-Series Analysis Results with ROA DV – General Dynamics

Figure 16 displays the results of the times-series regression model for General Dynamics. The overall model is not significant indicated by the p-value of .2767. There is no relationship between the independent variables and ROA for General Dynamics. However, that is it not likely to be true considering there is literature supporting that these variables have a relationship with profitability. This could indicate that the model needs to be improved, or that General Dynamics may have a unique characteristic within their company that is not being controlled for in the model.

Time-Series Model ROA DV – Boeing

```
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)  -10.731492   4.845806  -2.215  0.05404 .
IntlDefSales  -0.824913   0.246207  -3.350  0.00852 **
CommSales      0.171813   0.055755   3.082  0.01311 *
MerAcq         0.086995   0.250269   0.348  0.73613
MerAcqLag1    -0.143111   0.256894  -0.557  0.59105
MerAcqLag2     0.559919   0.229791   2.437  0.03757 *
MerAcqLag3     0.781530   0.256446   3.048  0.01385 *
Size           0.125462   0.041800   3.001  0.01492 *
DomDefBud      0.013614   0.008032   1.695  0.12430
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.232 on 9 degrees of freedom
Multiple R-squared:  0.815,     Adjusted R-squared:  0.6505
F-statistic: 4.955 on 8 and 9 DF,  p-value: 0.01382
```

Figure 17: Time-Series Analysis Results with ROA DV – Boeing

Figure 17 displays the results of the times-series regression model for Boeing. The overall model is significant at the .05 level, indicated by the p-value of .01382. The r-squared for the model indicates that the independent variables explain 82% of the variation in ROA. The *IntlDefSales*, *CommSales*, *MerAcqLag2*, *MerAcqLag3* and *Size* variables are all significant at the .05 level. The *MerAcqLag2* and *MerAcqLag3* variables for Boeing were positive and this could be due to the benefits of M&As discussed in the literature review, such as economies of scale and scope. On average, a $1B increase spent purchasing other businesses two years prior leads to an increase of .56 % in ROA for the current year. On average, a $1B increase spent purchasing other businesses three years prior leads to an increase of .78% in ROA for the current year. On average, a $1B increase in annual total sales leads to an increase of .13 % in ROA.

The marginal effects of the *IntlDefSales* and *CommSales* variables on ROA cannot be interpreted because all variables cannot technically be held constant. When either of these variables increases by 1% and the other is held constant in the model, the percentage of domestic defense sales has to change. This is due to the fact that all three of the revenue categories must equal 100%. Therefore, it can only be determined that *IntlDefSales* and *CommSales* have significant effects on ROA. Specifically relative to domestic defense sales, on average when *IntlDefSales* increases by 1%, ROA decreases and when *CommSales* increases by 1% ROA increases.

Tests of Heteroskedasticity and Autocorrelation

Without running tests of robustness on the models, the most accurate effects of the independent variables cannot be determined (Hilmer & Hilmer, 2014). To correctly assess the results of the regressions, the models were tested for heteroskedasticity and autocorrelation. Heteroskedasticity refers to the error term displaying nonconstant variance. Autocorrelation refers to the error term in one time period being correlated with an error term from a previous time period. If the error term had either one of these qualities, the estimated standard errors would be incorrect leading to incorrect interpretations of the p-values and t-statistics of the independent variables (Hilmer & Hilmer, 2014). If the error term in the models suffered from either one of these characteristics, it was corrected to accurately assess the regression's results.

To test for the presence of heteroskedasticity, the Breusch-Pagan test was conducted (Hilmer & Hilmer, 2014). If the result returned a p-value less than .05, the error term in the model was determined to have nonconstant variance. The p-values for

all three models returned values above .05 concluding that the error term had constant variance.

To test for the presence of autocorrelation, the Durbin-Watson test was conducted (Hilmer & Hilmer, 2014). If the result returned a p-value less than .05, the error term in the model was determined to be correlated with an error term from a previous period. Only the model for Lockheed Martin in Figure 15 failed the test of autocorrelation with a p-value of .004. The Newey-West robust standard errors method was used to correct for the autocorrelation since this is the most common method among researchers (Hilmer & Hilmer, 2014.) The Newey-West robust standard errors method returned updated values of the standard errors after correcting for the correlation in the error term.

```
Original Coefficients:
             Estimate  Std. Error t value Pr(>|t|)
(Intercept)  -8.854629   4.094872  -2.162 0.043553 *
IntlDefSales -0.315409   0.156492  -2.015 0.058220 .
CommSales     0.336070   0.130597   2.573 0.018613 *
MerAcq       -0.185318   0.244443  -0.758 0.457677
MerAcqLag1   -0.600126   0.245735  -2.442 0.024548 *
MerAcqLag2    0.244612   0.253742   0.964 0.347146
MerAcqLag3   -0.283468   0.270548  -1.048 0.307899
Size          0.434589   0.092032   4.722 0.000148 ***
DomDefBud     0.008621   0.018928   0.455 0.653921
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
------------------------------------------------------------

Autocorrelated Corrected Coefficients:
              Estimate  Std. Error t value  Pr(>|t|)
(Intercept)  -8.8546286  3.6133639 -2.4505 0.0241224 *
IntlDefSales -0.3154086  0.1618116 -1.9492 0.0661861 .
CommSales     0.3360699  0.1023375  3.2839 0.0039040 **
MerAcq       -0.1853182  0.1009366 -1.8360 0.0820599 .
MerAcqLag1   -0.6001260  0.1381405 -4.3443 0.0003493 ***
MerAcqLag2    0.2446124  0.1542457  1.5859 0.1292736
MerAcqLag3   -0.2834679  0.1820575 -1.5570 0.1359653
Size          0.4345890  0.0923412  4.7063 0.0001537 ***
DomDefBud     0.0086213  0.0158798  0.5429 0.5935050
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Figure 18: Original and Autocorrelation Corrected Results ROA DV – Lockheed Martin

After correcting for autocorrelation, the results of Lockheed Martin's model could be correctly interpreted. Figure 18. shows the original regression results, and the updated results after the autocorrelation was corrected. The p-values for *CommSales*, *MerAcqLag1*, and *Size* were still significant at the .05 level. For *CommSales*, on average a 1% increase relative to domestic defense sales, leads to an increase in ROA. The *MerAcqLag1* variable for Lockheed Martin was negative, indicating a negative relationship between the ROA in the current period, and purchases of businesses in the previous year. For *MerAcqLag1*, a $1B increase spent purchasing other businesses in the previous year leads to a decrease of .60 % in ROA for the current year. This could be

attributed to the fact that companies go through major capital restructuring after an M&A (Trujillo et al., 2020). For instance, a company could take on the debt of the acquired company, and that could negatively affect overall profitability. For *Size*, a $1B increase in annual total sales leads to an increase of .43% in ROA. Table 7 provides a summary of the models for all three defense contractors.

Table 7: Summary of Time-Series Model Results - ROA

					Dependent Variable ROA
Indepedent Variables	Predicted Relationship	Estimated Relationship	Coefficient	p-value	Model 1 Lockeed Martin
IntlDefSales	?	-	-0.315	0.066	
CommSales	?	+	0.336	0.004	*
MerAcq	+	-	-0.185	0.082	
MerAcqLag1	+	-	-0.6	0.00035	*
MerAcqLag2	+	+	0.245	0.129	
MerAcqLag3	+	-	-0.283	0.136	
Size	N/A	+	0.435	0.0001537	*
DomDefBudget	?	+	0.00862	0.594	
Overall Significance	0.00000195				
R-squared	0.85				
Indepedent Variables	Predicted Relationship	Estimated Relationship	Coefficient	p-value	Model 2 General Dynamics
IntlDefSales	?	+	0.371	0.268	
CommSales	?	+	0.609	0.063	
MerAcq	+	-	-0.119	0.673	
MerAcqLag1	+	-	-0.139	0.638	
MerAcqLag2	+	-	-0.238	0.451	
MerAcqLag3	+	-	-0.364	0.286	
Size	N/A	-	-0.247	0.03	*
DomDefBudget	?	+	0.0662	0.098	
Overall Significance	0.2767				
R-squared	0.45				
Indepedent Variables	Predicted Relationship	Estimated Relationship	Coefficient	p-value	Model 3 Boeing
IntlDefSales	?	-	-0.823	0.0085	*
CommSales	?	+	0.172	0.013	*
MerAcq	+	+	0.087	0.736	
MerAcqLag1	+	-	-0.143	0.591	
MerAcqLag2	+	+	0.56	0.038	*
MerAcqLag3	+	+	0.782	0.014	*
Size	N/A	+	0.126	0.015	*
DomDefBudget	?	+	0.0136	0.124	
Overall Significance	0.01382				
R-squared	0.82				

*Significant at the .05 level

Primary Research Question: How does the percentage of international defense sales, relative to domestic defense sales, relate to the Big Five defense contractors' profitability?

The relationship between the percentage of international defense sales and profitability was only significant for Boeing with a p-value of .0085. The coefficient on the *IntlDefSales* variable was also negative, indicating a negative relationship with profitability. This could be due to the fact that Boeing's profitability on the percentage of international defense sales is negatively affected by offsets and export costs as mentioned in the literature review. The relationship could also be negative because of Boeing's low number of observations in the model. Boeing only had 18 observations in the model, compared to Lockheed Martin's 28 and General Dynamic's 23. If Boeing had more data points for analysis the results may have been different. Also recall that the Boeing's percentage of international defense sales are also being underrepresented. There are FMS that are not being included in the model since Boeing calculates them with their sales to the US Government.

This concludes the analysis and results for the time series model conducted with ROA as the dependent variable. The next section presents the results of the same models conducted, but with NPM as the dependent variable.

Time-Series Model NPM DV – Lockheed Martin

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -6.471306   3.757597  -1.722 0.101274
IntlDefSales -0.256446   0.143602  -1.786 0.090102 .
CommSales     0.286740   0.119841   2.393 0.027216 *
MerAcq       -0.251844   0.224309  -1.123 0.275529
MerAcqLag1   -0.771933   0.225495  -3.423 0.002850 **
MerAcqLag2    0.105860   0.232842   0.455 0.654519
MerAcqLag3   -0.369700   0.248265  -1.489 0.152863
Size          0.373583   0.084452   4.424 0.000292 ***
DomDefBud    -0.003175   0.017369  -0.183 0.856881
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.791 on 19 degrees of freedom
Multiple R-squared:  0.8211,    Adjusted R-squared:  0.7458
F-statistic:  10.9 on 8 and 19 DF,  p-value: 1.178e-05
```

Figure 19: Time-Series Analysis Results with NPM DV – Lockheed Martin

Figure 19 displays the results of the times-series regression model for Lockheed Martin. The overall model is significant at the .05 level. The r-squared for the model indicates that the independent variables explain 82% of the variation in NPM. The *CommSales*, *MerAcqLag1*, and *Size* variables were all significant at the .05 level. These were the same variables that were significant for Lockheed Martin when ROA was the dependent variable.

Time-Series Model NPM DV – General Dynamics

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -23.04493   15.76759  -1.462   0.1659
IntlDefSales   0.47849    0.30798   1.554   0.1426
CommSales      0.59176    0.28856   2.051   0.0595 .
MerAcq        -0.13622    0.26376  -0.516   0.6136
MerAcqLag1    -0.15577    0.27784  -0.561   0.5839
MerAcqLag2    -0.33420    0.29386  -1.137   0.2745
MerAcqLag3    -0.42220    0.31503  -1.340   0.2015
Size          -0.06390    0.09817  -0.651   0.5256
DomDefBud      0.05149    0.03576   1.440   0.1718
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.329 on 14 degrees of freedom
Multiple R-squared:  0.2615,    Adjusted R-squared:  -0.1605
F-statistic: 0.6197 on 8 and 14 DF,  p-value: 0.7484
```

Figure 20: Time-Series Analysis Results with NPM DV – General Dynamics

Figure 20 displays the results of the times-series regression model for General Dynamics. The overall model is not significant as indicated by the p-value of .7484. Since this model uses the same dataset as the model with the ROA DV, it is no surprise that the overall model is insignificant once again. More than likely, General Dynamics has a characteristic specific to how they operate that is not being captured by the model. The inability to include all relevant independent variables in a regression model can lead to insignificance in the variables and the model as a whole.

Time-Series Model NPM DV – Boeing

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  -6.541540   4.849311  -1.349   0.2103
IntlDefSales -0.654843   0.246385  -2.658   0.0261 *
CommSales     0.117671   0.055795   2.109   0.0642 .
MerAcq        0.112339   0.250450   0.449   0.6644
MerAcqLag1   -0.131099   0.257079  -0.510   0.6224
MerAcqLag2    0.446274   0.229958   1.941   0.0842 .
MerAcqLag3    0.665669   0.256631   2.594   0.0290 *
Size          0.060326   0.041830   1.442   0.1831
DomDefBud     0.019167   0.008037   2.385   0.0409 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.232 on 9 degrees of freedom
Multiple R-squared:  0.7491,    Adjusted R-squared:  0.5261
F-statistic:  3.36 on 8 and 9 DF,  p-value: 0.04481
```

Figure 21: Time-Series Analysis Results with NPM DV – Boeing

Figure 21 displays the results of the times-series regression model for Boeing. The overall model is significant at the .05 level, indicated by the p-value of .04481. The r-squared for the model indicates that the independent variables explain 75% of the variation in ROA. The *IntlDefSales*, *MerAcqLag3* and *DomDefBud* variables are all significant at the .05 level. There is a negative statistically significant relationship between the percentage of international defense sales and NPM. For *MerAcqLag3*, on average a $1B increase spent purchasing other businesses three years prior leads to an increase of .67 % in NPM for the current year. This could be due to any of the positive benefits associated with M&A discussed in Chapter II. For instance, vertical M&A lower transaction costs associated with the production of products (Chatterjee, 1991; D’Aveni & Ravenscraft,1994; Zarb & Noth, 2012). If Boeing was able to buy one of its key

suppliers, the long-term effect could be an increase in the profit margin. Boeing would no longer have to pay the supplier for their work in the production process for a weapon system, and this could lower costs in the long run. Lastly, this was the only instance where *DomDefBud* was significant for any of the contractors in all models. For Boeing, on average a $1B increase to the domestic defense budget increases NPM by .019%.

The tests for heteroskedasticity and autocorrelation were conducted again on all the models. All of the models passed the heteroskedasticity test, concluding that their error terms had constant variance. Additionally, Lockheed Martin's model was the only model that failed the autocorrelation test again. The original and autocorrelated corrected estimates are displayed in Figure 22 below.

Original Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-6.471306	3.757597	-1.722	0.101274	
IntlDefSales	-0.256446	0.143602	-1.786	0.090102	.
CommSales	0.286740	0.119841	2.393	0.027216	*
MerAcq	-0.251844	0.224309	-1.123	0.275529	
MerAcqLag1	-0.771933	0.225495	-3.423	0.002850	**
MerAcqLag2	0.105860	0.232842	0.455	0.654519	
MerAcqLag3	-0.369700	0.248265	-1.489	0.152863	
Size	0.373583	0.084452	4.424	0.000292	***
DomDefBud	-0.003175	0.017369	-0.183	0.856881	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Autocorrelated Corrected Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)	
(Intercept)	-6.4713061	3.6133639	-1.7909	0.0892493	.
IntlDefSales	-0.2564463	0.1618116	-1.5848	0.1295049	
CommSales	0.2867397	0.1023375	2.8019	0.0113764	*
MerAcq	-0.2518444	0.1009366	-2.4951	0.0219672	*
MerAcqLag1	-0.7719328	0.1381405	-5.5880	2.175e-05	***
MerAcqLag2	0.1058598	0.1542457	0.6863	0.5008105	
MerAcqLag3	-0.3697004	0.1820575	-2.0307	0.0565206	.
Size	0.3735827	0.0923412	4.0457	0.0006903	***
DomDefBud	-0.0031752	0.0158798	-0.2000	0.8436419	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Figure 22: Original and Autocorrelation Corrected Results NPM DV – Lockheed Martin

After correcting for autocorrelation, the p-values for *CommSales*, *MerAcqLag1*, and *Size* were still significant at the .05 level. Furthermore, the *MerAcq* was significant with a p-value of .022. Because the coefficient was negative, this suggests that, on average, money spent purchasing other businesses leads to a decrease in NPM in the same year. This could happen if a company is not able to successfully manage the costs associated with managing its new business in the first year. This could initially lead to a decrease in profit margin, but over time the positive benefits of the acquisition could be realized. For *CommSales*, on average a 1% increase relative to domestic defense sales, leads to an increase in NPM. For *MerAcqLag1*, a $1B increase spent purchasing other

businesses in the previous year prior leads to a decrease of .77% in NPM for the current year. For *Size*, a $1B increase in annual total sales leads to an increase of .37% in NPM. For *MerAcq*, a $1B increase spent purchasing other businesses in the leads to a decrease of .25% in NPM in the same year. Table 8 provides a summary of the models for all of the defense contractors.

Table 8: Summary of Time-Series Model Results - NPM

					Dependent Variable NPM
Indepedent Variables	Predicted Relationship	Estimated Relationship	Coefficient	p-value	Model 1 Lockeed Martin
IntlDefSales	?	-	-0.256	0.13	
CommSales	?	+	0.287	0.011	*
MerAcq	+	-	-0.252	0.022	*
MerAcqLag1	+	-	-0.772	0.0000218	*
MerAcqLag2	+	+	0.106	0.5	
MerAcqLag3	+	-	-0.369	0.056	
Size	N/A	+	0.374	0.0007	*
DomDefBudget	?	-	-0.003	0.843	
Overall Significance	0.00001178				
R-squared	0.82				
Indepedent Variables	Predicted Relationship	Estimated Relationship	Coefficient	p-value	Model 2 General Dynamics
IntlDefSales	?	+	0.478	0.143	
CommSales	?	+	0.592	0.06	
MerAcq	+	-	-0.136	0.614	
MerAcqLag1	+	-	-0.156	0.584	
MerAcqLag2	+	-	-0.334	0.275	
MerAcqLag3	+	-	-0.422	0.202	
Size	N/A	-	-0.064	0.526	
DomDefBudget	?	+	0.051	0.172	
Overall Significance	0.7484				
R-squared	0.26				
Indepedent Variables	Predicted Relationship	Estimated Relationship	Coefficient	p-value	Model 3 Boeing
IntlDefSales	?	-	-0.655	0.026	*
CommSales	?	+	0.118	0.064	
MerAcq	+	+	0.112	0.664	
MerAcqLag1	+	-	-0.131	0.622	
MerAcqLag2	+	+	0.446	0.084	
MerAcqLag3	+	+	0.666	0.029	*
Size	N/A	+	0.06	0.183	
DomDefBudget	?	+	0.019	0.041	*
Overall Significance	0.04481				
R-squared	0.75				

*Significant at the .05 level

Primary Research Question: How does the percentage of international defense sales, relative to domestic defense sales, relate to the Big Five defense contractors' profitability?

Similar to the ROA models, the relationship between the percentage of international defense sales and profitability was only significant for Boeing with a p-value of .026. The coefficient on the *IntlDefSales* variable was still negative, indicating a negative relationship with profitability. It was expected that the potential negative effects of international defense sales on profitability would be better captured by NPM rather than ROA. Export costs can lower the profit margins on international defense sales. If Boeing is not able to price their defense products and services adequately this could lead to lower profit margins on international defense sales. Additionally, the potential for this relationship to be negative due to Boeing's lack of observations still applies.

This concludes the analysis and results chapter. The next section presents and discusses the research findings. It also addresses the limitations of the research and discusses areas for future research. The section will end with a summary of the research contributions.

V. Conclusions and Recommendations

Research Findings and Discussion

This research was conducted to determine the effect of the percentage of international defense sales on defense contractor profitability. To answer the primary research question, three secondary research questions were initially explored. First, this research found a statistically significant positive correlation between the US defense budget and defense contractor profitability. However, when entered into the regression models as the *DomDefBud* variable, it was only significant in Boeing's NPM model and its effect was small.

Second, the research found that there was a statistically significant positive correlation between US defense budgets and total worldwide FMS agreements. This was unexpected as most of the research reviewed anticipated the expansion of the international defense sales market only when there was a decline to US defense budgets. A positive correlation suggests that the two variables tend to increase and decrease together. This could be due to the US's need to supply their international allies with high quality weapon systems to help fight the Global War on Terror.

Next, this research identified that there was a statistically significant negative correlation between the percentage of commercial sales and profitability (ROA and NPM) for Lockheed Martin. However, when *CommSales* was entered into the time-series models, the relationship with profitability was found to be positive and significant for Lockheed Martin. Additionally, the analysis found the percentage of commercial sales

and profitability (ROA DV) had a statistically significant positive correlation in General Dynamics' model. However, neither of the time-series models produced significant relationships between the *CommSales* variable and profitability with General Dynamics' data. Although the correlations between *CommSales* and both measures of profitability were insignificant for Boeing, *CommSales* did have a significant positive effect on profitability in Boeing's ROA time-series model.

Finally, the results for the primary research question were only significant for Boeing's models. The percentage of international defense sales and profitability had a negative relationship in Boeing's models. As mentioned, this could be due to the fact Boeing's international defense sales are being underrepresented in the model, or that Boeing is suffering from some of the potential negative effects of international defense sales such as offsets and export costs.

Study Limitations

This study is not without limitations. The major limitation with this study is that the percentage of international defense sales could not be accurately determined for all of the prime defense contractors. This led to many potential observations being excluded from analysis in the time-series models.

Another limitation was that it was difficult to pinpoint the true growth of the international defense sales market, due to the inability to use data from DCS. If DCS data was able to be included the correlation between international defense sales by the DIB and US defense budgets may have been different.

In regard to the models, one limitation is that there was a low sample size of defense contractors. Therefore, it is difficult to determine if some of the results are not significant due to model specification, or because there is heterogeneity between the defense contractors. Heterogeneity refers to the differences or uniqueness between the firms observed. For example, the reason General Dynamics' models were insignificant could be due to the fact that they have some unobservable factor that makes them different than Lockheed Martin and Boeing. This could be a factor like employee motivation, or their CEO's attitude towards expansion. If this unobservable effect is significant and not captured in the model, the results of the model could be insignificant.

Similarly, each of the defense contractor's dataset is unique and this can potentially influence the results. For instance, the defense weapon systems that Lockheed Martin is selling internationally are different than what General Dynamics is selling. These weapon systems can have different profit margins that influences each firm's overall profitability.

Recommendations for Future Research

On the topic of model specification, the models could potentially suffer from omitted variable bias. This type of bias occurs when a significant independent variable is excluded out of the model. There is research that suggests that innovation is linked to profitability (Ahlstrom, 2010). A proxy for an innovation independent variable could be the defense contractor's internal research and development funding. Additionally, panel data analysis allows for heterogeneity between firms to be controlled for in regression models. However, these models tend to work better with larger sample sizes. If this method is explored it will provide details on whether the models used in this analysis are

incorrectly specified (because a larger sample should grant more statistical power), and if a significant relationship exists between international defense sales and profitability for a larger sample size.

Summary

This research primarily analyzed the relationship between the percentage of international defense sales and profitability for aerospace prime defense contractors. The analysis of the results indicated that for Boeing, there is a statistically significant negative relationship between the percentage of international defense sales and profitability. Additionally, there is a significant positive relationship between the percentage of commercial sales and profitability for Boeing and Lockheed Martin.

Appendix A.

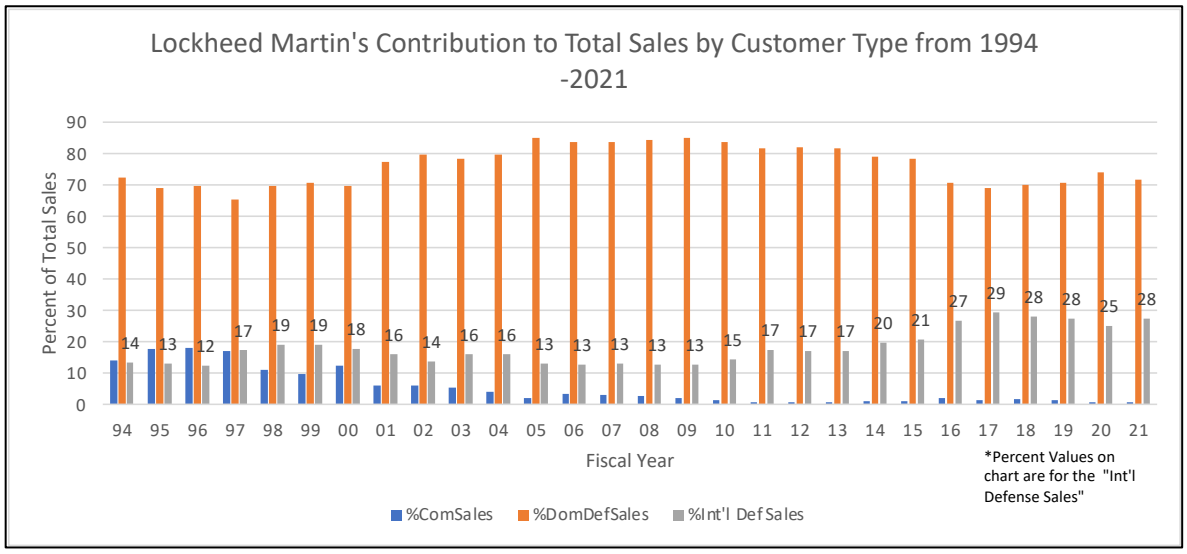


Figure 23: Revenue Mix by Customer Type - Lockheed Martin

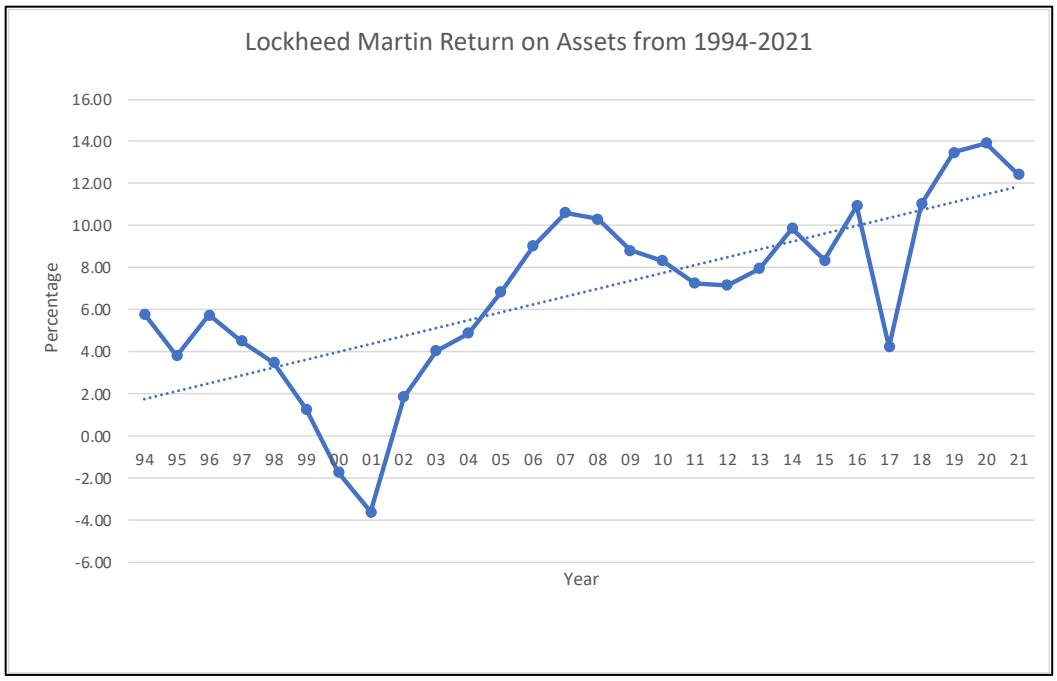


Figure 24: Return on Assets - Lockheed Martin

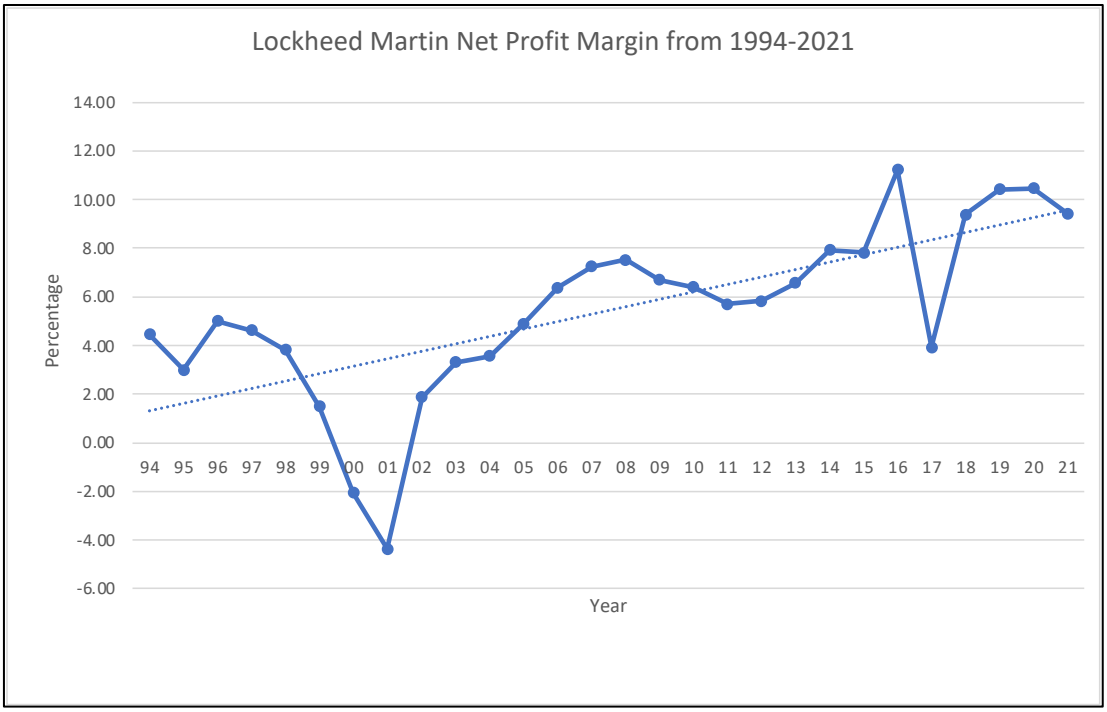


Figure 25: Net Profit Margin - Lockheed Martin

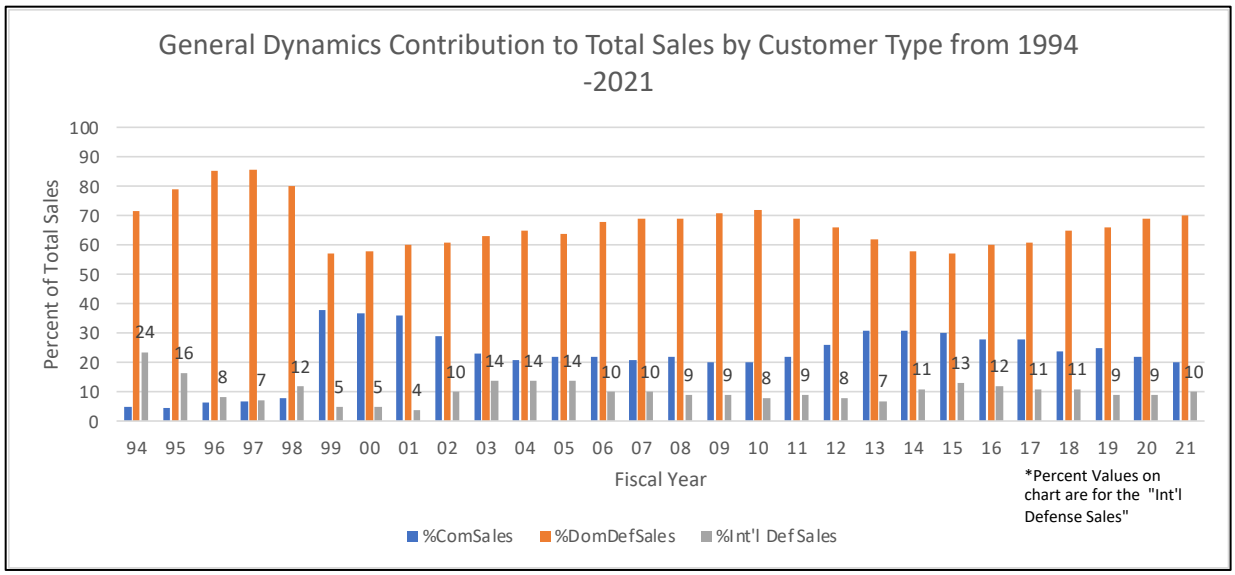


Figure 26: Revenue Mix by Customer Type - General Dynamics

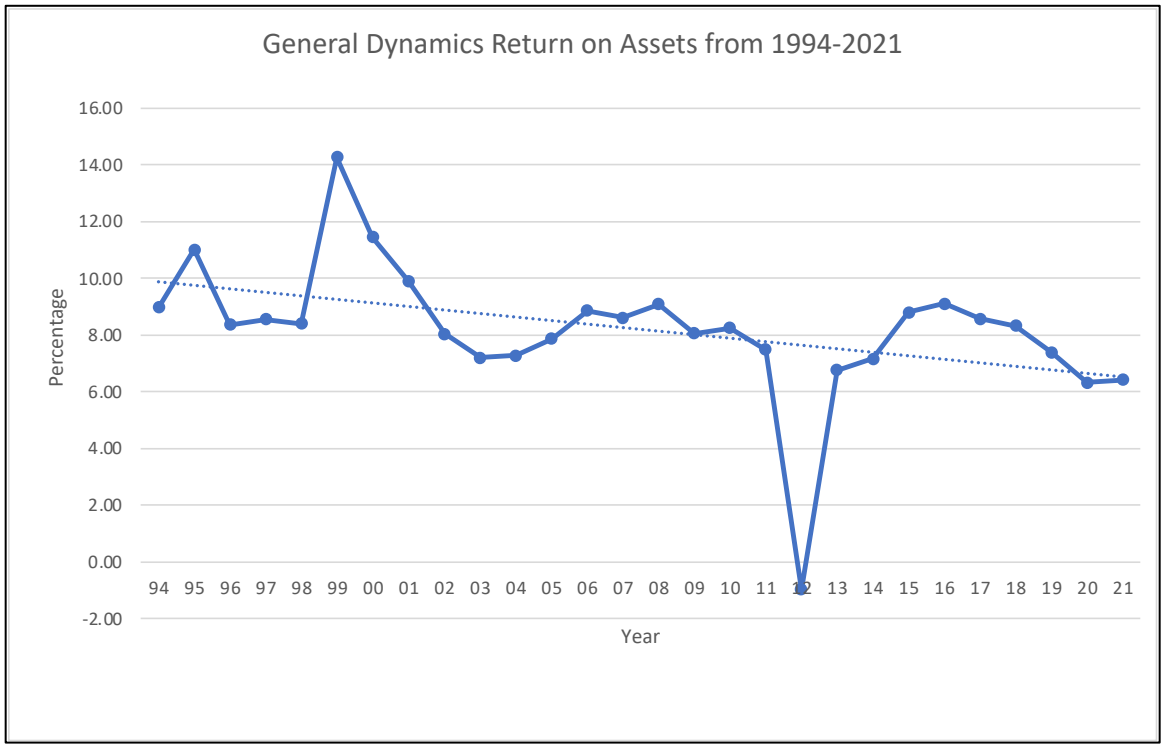


Figure 27: Return on Assets - General Dynamics

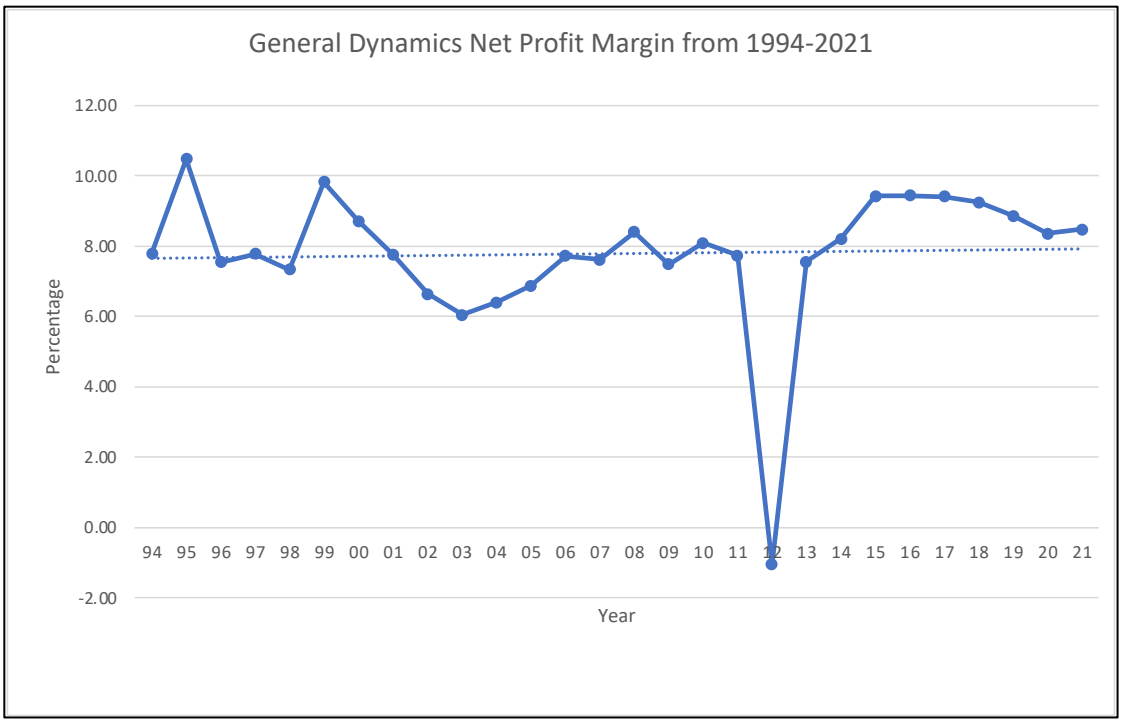


Figure 28: Net Profit Margin - General Dynamics

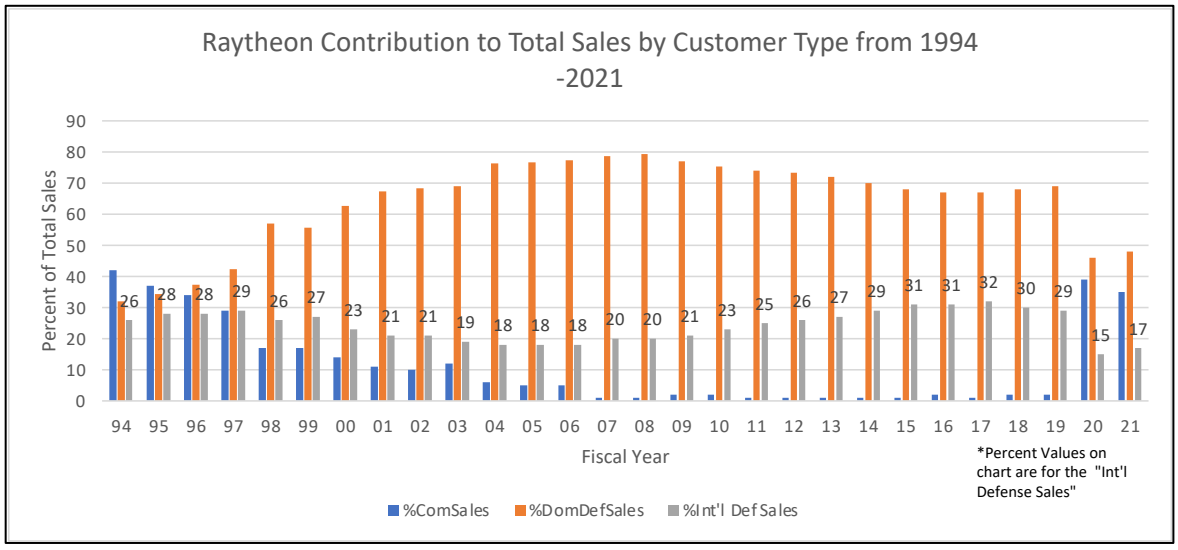


Figure 29: Revenue Mix by Customer Type – Raytheon

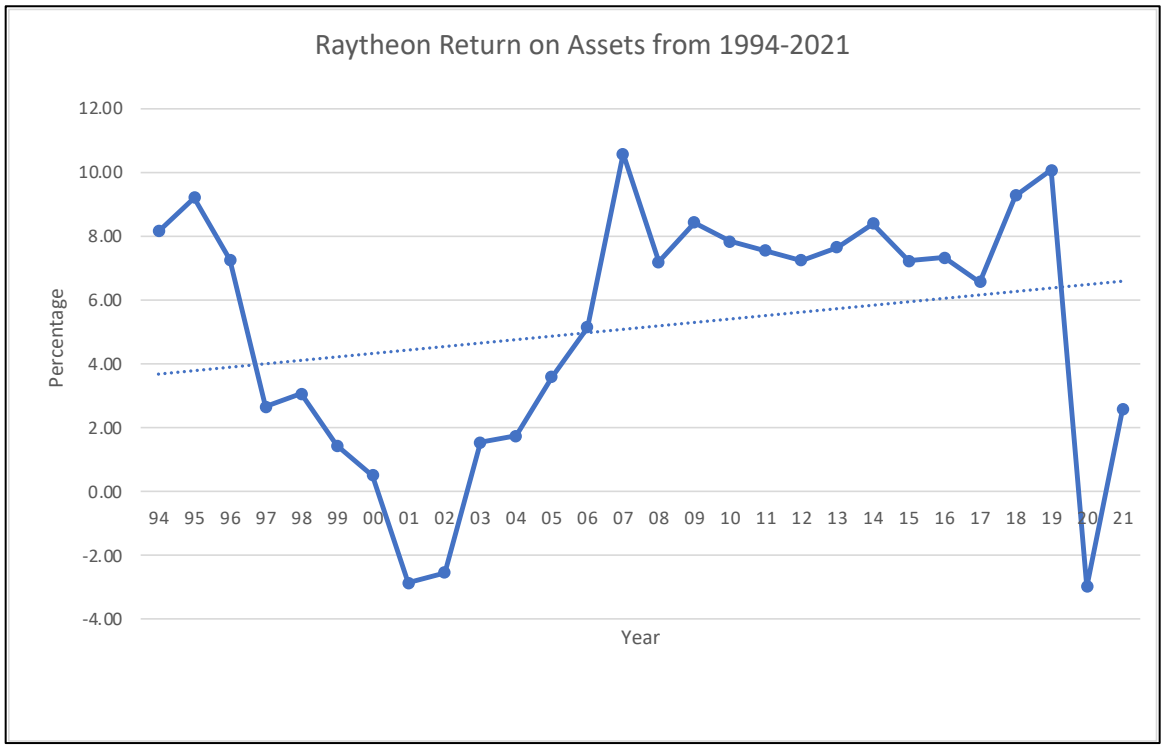


Figure 30: Return on Assets - Raytheon

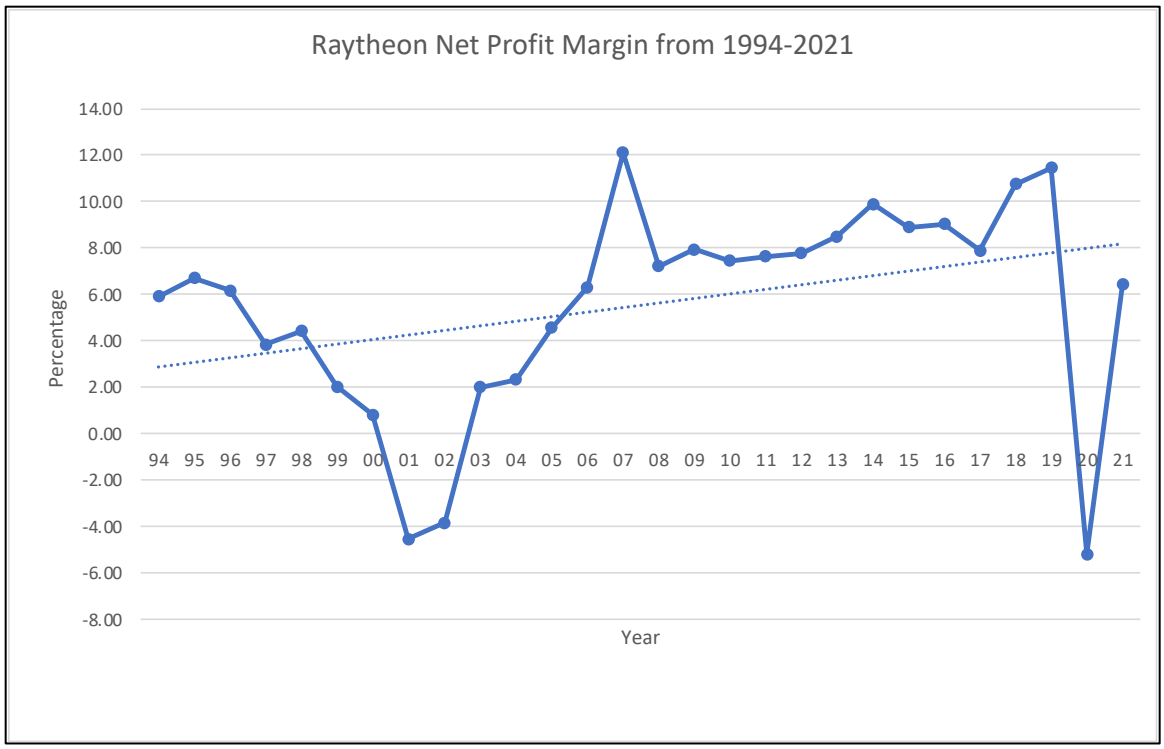


Figure 31: Net Profit Margin - Raytheon

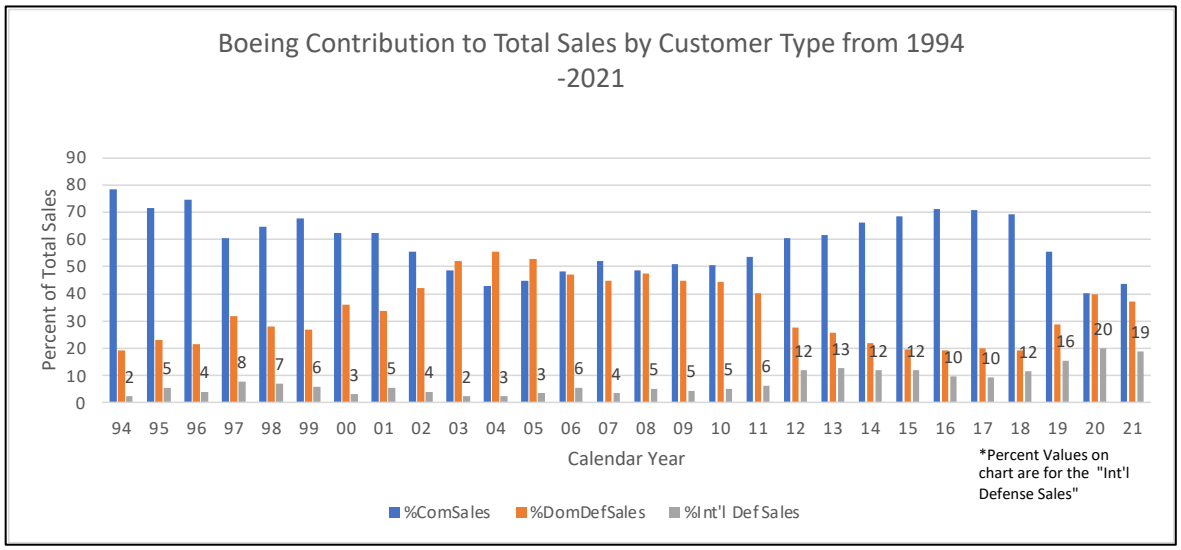


Figure 32: Revenue Mix by Customer Type - Boeing

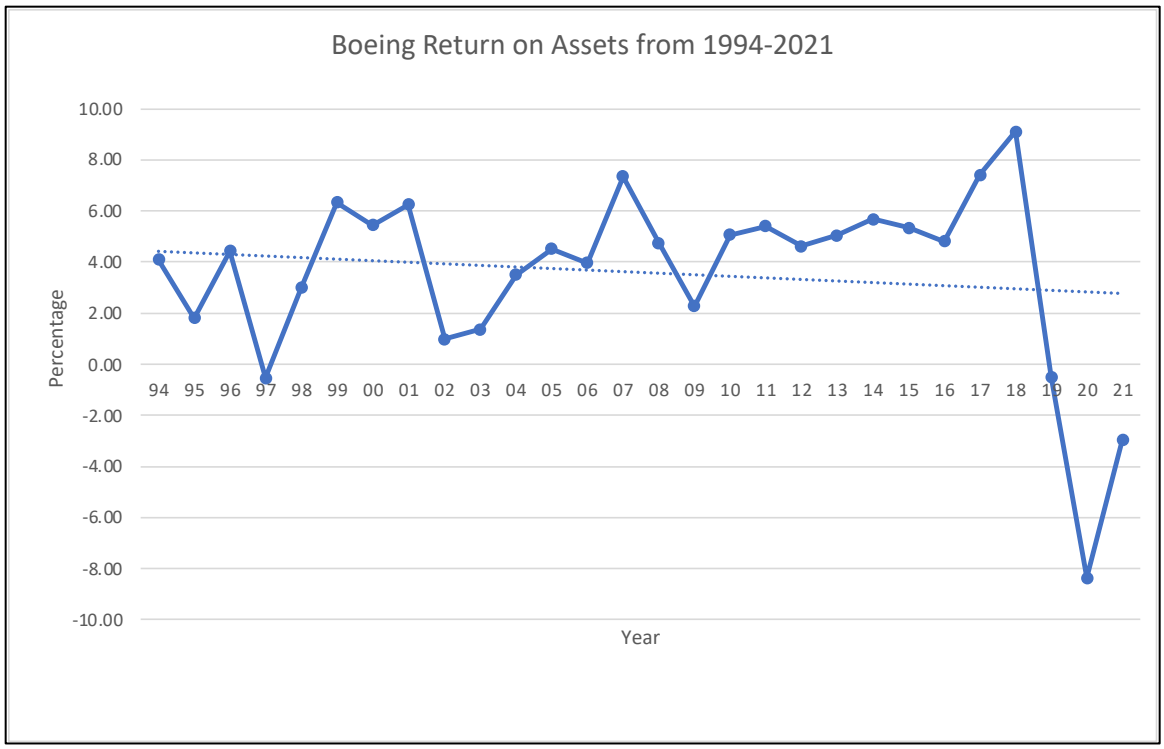


Figure 33: Return on Assets - Boeing

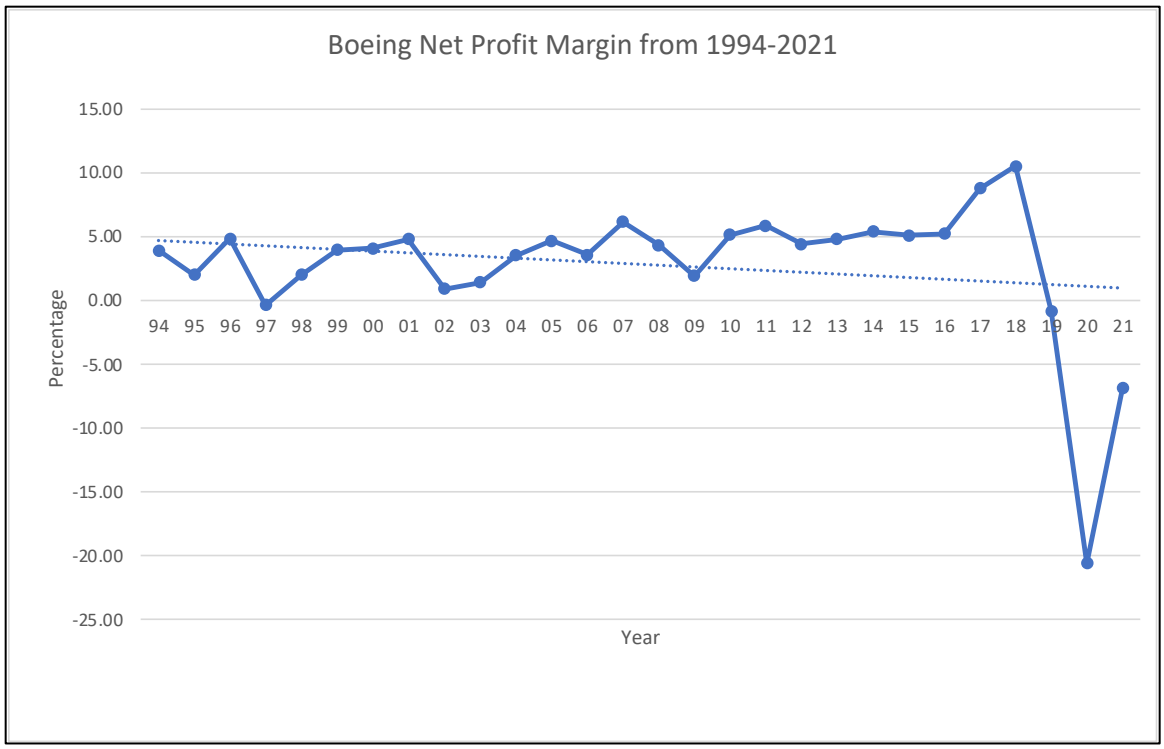


Figure 34: Net Profit Margin - Boeing

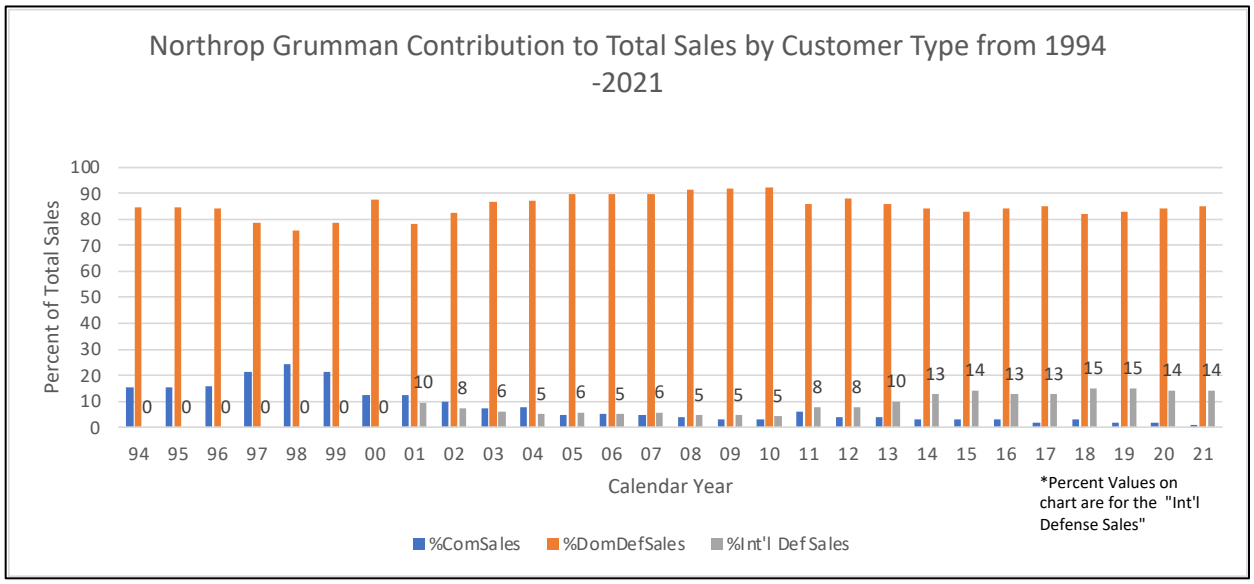


Figure 35: Revenue Mix by Customer Type - Northrop Grumman

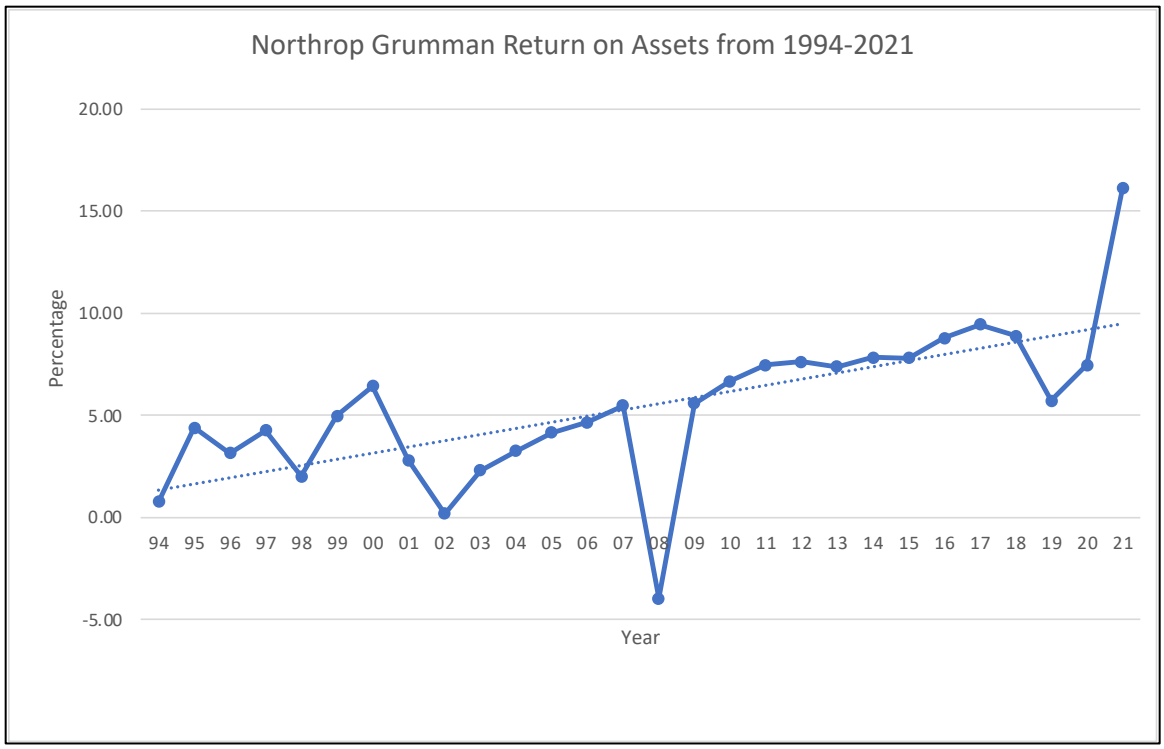


Figure 36: Return on Assets - Northrop Grumman

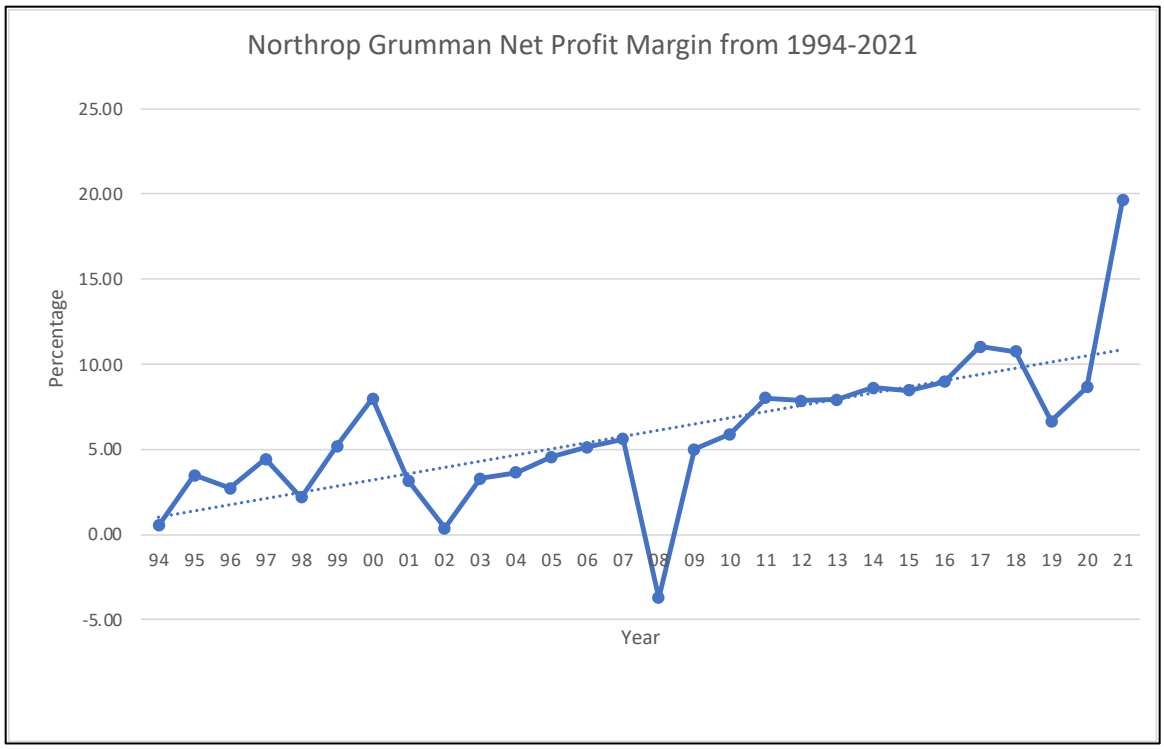


Figure 37: Net Profit Margin - Northrop Grumman

How was Figure 2. Total Worldwide FMS Agreements from FY1993-FY2021 created?

The nominal values for FMS agreements were recorded from the DSCA historical fact books in the respective years. To consider inflation, the GDP Price Indexes were used from *Table 10.1—Gross Domestic Product and Deflators Used in the Historical Tables: 1940–2027* found on white house.gov. Because the base year for the table was FY2012, the GDP Price indexes were rebased to FY2022 for the years 1993-2021 by dividing each value by 1.22 (the GDP Price index in FY2022). The new constant year FY2022 GDP price indexes were multiplied by the value of FMS agreements in their respective years to capture the "Total Worldwide FMS Agreements from FY93-FY2021 in constant FY2022 dollars.

How were the percentages allocated to international defense sales, commercial, and domestic defense sales calculated?

It is important to discuss how the percentages allocated to international defense sales (combination of FMS and DCS), domestic defense sales (sales to US government), and commercial sales (foreign and domestic) by each specific contractor were calculated. In the 10-Ks, each contractor categorized their sales by customer type in varying methods which also changed over the years. This section will also highlight the assumptions about how the data was presented by each contractor and discuss the limitations of the assumptions made. The conceptual formula for each category divided all revenue comprising each category by total annual sales. This created the percentage of revenue added to that specific category. The focus of this section is to highlight the data and language in the 10-Ks to determine what revenue fell in each category. The best attempt was made in making sure the revenue comprising each of the three categories was revenue that belonged in that category. For example, for the percentage of international defense sales, every attempt was made to ensure commercial revenue was not included in this calculation. There were some scenarios where some of the revenue could not be separated out into its appropriate category and assumptions had to be made.

Lockheed Martin

For the entire period analyzed, Lockheed Martin had a section in the 10-K covering total sales by customer category. The categories were US Government sales, Foreign Government sales (international defense sales), and Commercial sales. There was a note included with this section stating that FMS were included in the calculation of total sales for the Foreign Government category. The remainder of the sales in the Foreign

Government category were assumed to be through DCS because that is the only other type of international defense sale made by the United States. To capture the percentage of international defense sales in a certain year, the total sales listed in the Foreign Government category was divided by the annual total sales listed for that year in the 10-K. The same process was done to obtain the percentage of domestic defense sales (US Government sales) and commercial sales. There also was a note in this section indicating that the calculation of the Commercial sales category included foreign commercial sales. The rest of the sales comprising the Commercial sales category were assumed to be domestic.

General Dynamics

1994-1998

FMS and Sales to the US Government figures were provided in the 10-Ks. DCS were assumed to be what was classified as "Direct Foreign Sales" in the 10-Ks for these years. The Direct Foreign Sales category was assumed to contain only defense revenue from products and services.

How was it determined that international commercial sales did not exist in "Direct Foreign Sales"?

Throughout the early 1990's, General Dynamics' portion of revenues allocated to defense was 92%. General Dynamics also listed what their commercial businesses were in those years, and the sales figures for those businesses were significantly different from the sales figures listed as Direct Foreign Sales. This supported the assumption that the revenue in the "Direct Foreign Sales" category was more than likely majority defense items. Additionally, the 10-K also mentioned General Dynamics' involvement with

offsets, which typically only refer to sales of US defense articles and services through FMS and DCS. This finding further shows that the Direct Foreign Sales category is more than likely only reporting figures for defense items.

Additionally, in 1998, operations from revenues of international defense companies that General Dynamics acquired in 1997 were included in the revenues of Direct Foreign Sales for the previous three years. These updated figures were used for the Direct Foreign Sales total in the years 1995-1998. Although this revenue was ultimately included, it is not revenue from sales of US defense articles and services and can be viewed as an outsourced method to obtain revenue from the sales of defense articles and services internationally. General Dynamics took advantage of gaining revenue from the defense dollars of foreign countries by acquiring those defense companies in 1997. The percentage of international defense sales became FMS revenue plus revenue from Direct Foreign Sales divided by total annual sales specified in that given year.

The percentage of domestic defense sales was the Sales to the US Government figure listed in the 10-K divided by total annual sales specified in that year. The total amount of revenue allocated to commercial sales became what was left over to make up the rest of the total annual revenue listed in the 10-K after international defense sales, and sales to the US government were accounted for. Then, this total was divided by the total annual sales specified in that year to obtain its percentage. This was sufficient because the only revenues unaccounted for using this method were revenues from the "Other" category listed in the 10-Ks for these years. Moreover, the revenues that comprised this category were General Dynamics' commercial segment according to language found in the 10-Ks.

1999-2021

From 1999 to 2021, General Dynamics included a pie chart in the 10-Ks that displayed percentages of revenues by customer category. The percentages from international defense, domestic defense (sales to the US Government), and commercial (foreign and domestic) sales were copied directly from the pie chart from each respective year. In 2007, international defense sales were renamed "non-US government sales" in the pie chart.

Raytheon

1994-2012

The 10-Ks in these years directly listed the total percentage of sales to customers outside the United States. This percentage was used as the percentage of international defense sales and was assumed to contain only revenue from international defense sales (FMS and DCS).

How was it determined that the percentage of "sales to customers outside the United States" did not include commercial sales?

The 1999 10-K explicitly stated that the percentage of "sales to customers outside the United States" included FMS. The remainder of the sales that comprised this percentage were assumed to be from DCS. The assumption about DCS may have been correct because where the "sales to customers outside the United States" percentage was located added new language in 2008 referencing the International Traffic in Arms Regulation (ITAR). As defined by DDTC, ITAR "governs the manufacture, export, and temporary import of defense articles and the furnishing of defense services" (DDTC, 2022). The 10-Ks in these years have explicit language stating that foreign sales are

mainly in the department of defense systems and reference the use of DCS licenses to export certain goods in the same section where the "sales to customers outside the United States" percentages were located. DCS licenses only refer to the transfer of defense articles and services internationally.

FMS were included in the calculation of the total sales to the US Government in the 10-Ks for all years analyzed. However, the amount of FMS revenue included in sales to the US Government was provided. Therefore, to get the true value of domestic defense sales in these years, the revenue from FMS was subtracted from the total sales to the US Government listed in that respective year. To obtain the percentage of domestic defense sales, the value of sales to the US Government was divided by the total sales figure listed in the 10-K for each of the years. Once the percentages for international defense sales, and domestic defense sales were accounted for in that respective year, the percentage of commercial sales became what was needed to comprise 100% of the annual total sales. Raytheon did have domestic and foreign commercial customers but did not provide any specific figures in these years accounting for commercial sales.

There are some limitations to note for this particular method. First, it was not known if the "sales to customers outside the United States" percentage included international commercial sales. It is very well possible that it did, but there was no way to tell. Even if this percentage did contain some international commercial sales, the language in the 10-K suggests that this figure is small considering that the majority of international sales were sales of defense systems. Because the percentage of commercial sales became what was left over to make up 100% of the annual revenue after accounting for both international defense and domestic defense sales, the percentage of commercial

sales had the potential to capture revenue that may have not been sales of commercial goods. However, there was high confidence that this percentage of commercial sales did not contain any revenues from defense.

2013-2016

The 2014 10-K provided the first detailed breakouts by customer base. Sales were now broken out into “Sales to the US Government”, “Sales to the Department of Defense”, “Foreign Direct Commercial Sales (DCS)”, and “FMS”. This new breakout out also listed the percentage of total revenue allocated to each category. The percentage of international defense sales became the combined percentages of “Foreign DCS” and “FMS”. Additionally, this combined percentage was also stated in the 10-Ks in these respective years. The percentage of domestic defense sales became the percentage of total revenue listed from “Sales to the US Government”. The percentage of revenue making up commercial sales became what was needed to make up 100% of the revenue after the percentages of sales to the US Government and international defense were accounted for.

2017-2019

The 2018 10-K updated the customer categories again and also included a new breakout of sales to major customers by business segment. A new category, “U.S Direct Commercial sales and other U.S Sales”, was introduced and the previous Foreign DCS category was updated to “Foreign DCS and other foreign sales” but still excluded sales through FMS, as FMS maintained its own category. The previous Foreign DCS category was assumed to only contain revenue from sales of defense articles and services through DCS. Now, for the DCS category what comprised the “other foreign sales” portion had to be determined because these sales could have potentially contained commercial and/or

defense sales. It was crucial to limit revenue spill over into other customer categories in order to accurately express the percentages allocated to international defense sales, domestic defense sales, and commercial sales. It was assumed that the inclusion of the "other foreign sales" language into the "Foreign DCS and other foreign sales" category happened because of the foreign commercial sales provided by Raytheon's information and services (IIS) business segment and by Forcepoint, a cybersecurity joint venture business segment. This was assumed because articles and services sold through DCS are defense only. In addition, the description of the IIS and Forcepoint business segments depicted that both segments offer defense and commercial products and services. The figures for total revenue contributing to the "Foreign DCS and other foreign sales" by IIS and Forcepoint are provided for these years. However, it could not be determined whether these revenues were from defense or commercial sales. It is assumed that there is a combination of both types of sales, otherwise Raytheon may not have included "other foreign sales" to the Foreign DCS categories since DCS primarily involves sales of defense articles and services. If IIS and Forcepoint only had defense sales in the years analyzed, those sales would have been included in the Sales to the US Government, FMS, and Foreign DCS categories. The combined revenue from the IIS and Forcepoint business segments making up the "Foreign DCS and other foreign sales" category was only 14%, 16%, 17% in 2017, 2018, and 2019 respectively.

Even if these percentages were made up of all commercial revenues, the overwhelming majority of the rest of the sales were defense. The remainder of the revenue in "Foreign DCS and other foreign sales" in these years were from Raytheon's other business segments, which were all defense (Integrated defense systems, Missile

systems, Space and Airbourne systems). So, it is assumed that all the defense sales in these business segments were processed through DCS. Because it could not be determined whether the contributions to "Foreign DCS and other foreign sales" were commercial or defense sales by the IIS segment and Forcepoint, the revenue from both segments were assumed to be defense and were included in the make-up of the percentage of international defense sales for each of the years. While there is potential for the inclusion of international commercial revenues in the calculations of international defense sales, revenue from the "Foreign DCS and other foreign sales" category is a sufficient proxy for international defense sales considering that over 82% of the revenues comprising this category in each of the years were from defense.

To acquire the percentages allocated to international defense, domestic defense, and commercial sales, the same methodology was used from the 2013-2016 Raytheon section of the 10-K. However, there are some minor changes that were made. First, the "Foreign DCS" category was updated to "Foreign DCS and other foreign sales" for these years. Secondly, what became the percentage of commercial sales was the revenue from the new "U.S Direct Commercial sales and other U.S Sales" category expressed as a percentage of total revenue as Raytheon did not generate much revenue through international commercial sales.

2020-2021

On April 3, 2020, the merger between United Technologies and Raytheon Company was solidified and formed a new company, Raytheon Technologies Corporation. The ticker symbol transitioned from RTN to now operating under RTX. The data from the 10-Ks of Raytheon Technologies was used to acquire data for the years

2020 and 2021. The percentage of international defense sales became the combined percentages from the FMS and Foreign DCS customer categories. The percentage of domestic defense sales became the percentage of total revenue listed from "Sales to the U.S Government". The percentage of commercial sales was the percentage listed in the "Commercial aerospace and other commercial sales" category which was comprised of international and domestic revenue.

Boeing

1994-2011

In the 10-Ks, Boeing organizes its industry primarily into two segments: Commercial Aircraft and Defense. The defense segment changed names many times over the period assessed: Defense and Space-1994; Information, Space and Defense Systems-1997; Military Aircraft and Missiles Segment and Space and Communications segment-1998; Integrated Defense Systems (IDS)-2003; and Boeing Defense, Space & Security (BDS)-2009.

There were no sales figures for FMS or DCS listed in these years in the 10-Ks. However, the percentage of sales from the defense segment to two foreign regions was listed and was used to produce the percentage of international defense sales. For the years in this period, Boeing listed the percentage of defense sales to "Asia, other than China" and "Europe". All of these sales were assumed to be processed through a combination of FMS and DCS. It was also assumed that Boeing only highlighted the defense sales in these regions because these countries were the largest customers of international defense items. To obtain the percentage of international defense sales, the defense revenue was combined from the two international regions and divided by the total annual revenue in

that respective year. To obtain the percentage of domestic defense sales from 1994-2011, the defense revenue from the two international regions was subtracted from the total revenue of the defense segment. Then, the remaining revenue was divided by the total revenue listed in that respective year. The remaining revenue was assumed to be majority domestic because language in the 10-K explicitly stated that the principal customer of the defense segment was the United States Government. Beginning in 2000, the percentage of sales from the defense segment to the United States Government was explicitly stated in the 10-K going forward.

"Other" Business segment and Boeing Capital Corporation inclusion with Commercial Sales

Boeing's commercial sales consisted mainly of revenue (domestic and foreign) from the Commercial Aircraft business segment. Some of the years within this period included a business segment called "Other". In any of the years where the "Other" business segment was present, it was determined that revenues which made up this category came from commercial sales, according to explicit language stated in the 10-K. Therefore, revenue from the "Other" business segment was included in the calculation of commercial revenues in that respective year. Additionally, Boeing Capital Corporation (BCC) was introduced as an additional business segment in the year 2003, so all revenues from this segment were included in the calculation of commercial revenues going forward. According to Boeing's 10-K, the BCC's primary business revolved around the financing of commercial equipment and aircrafts. To obtain the percentage of commercial sales, revenue from the commercial aircraft, other (where applicable), and BCC business segments were totaled and divided by the total revenue in that respective year.

2012-2015

For the years in this period, the Boeing Defense, and Security (BDS) segment's revenue was organized into two categories: DoD and non-DoD. Only the percentage of sales to the DoD (synonymous with sales to the US Government) from the BDS segment was provided for the years in this range. The percentage of non-DoD revenue within the BDS segment became what was needed to make up 100% of the BDS's segment's total revenue. The 10-Ks in these years explicitly stated that the non-DoD BDS revenue was composed of sales to National Aeronautics and Space Administration (NASA), international defense customers, and commercial satellite markets. It was assumed that the majority of non-DoD defense revenue was from international defense sales, given that the primary source of revenue in this segment is defense. Therefore, non-DoD BDS revenue was used to represent the entire international defense sales category.

The percentage of domestic defense sales became DoD BDS revenue divided by total sales for each year. To obtain the value of DoD BDS revenue, the percentage of sales to the DoD within the BDS segment was multiplied by the total BDS revenue figure provided in the 10-Ks. The percentage of international defense sales became non-DoD BDS revenue divided by total sales for each year. To obtain the value of non-DoD BDS revenue, the percentage of non-DoD BDS revenue was multiplied by the total BDS revenue figure provided in the 10-Ks. To obtain the percentage of commercial sales, the same methodology from the 1994-2011 section was used.

There was one primary limitation with this method. For the years analyzed, international defense sales (non-DoD BDS revenue) include some revenue that came from sales to NASA and to commercial satellites markets. NASA is a US government

space agency and sales to them ideally should be included in sales to the US Government. Sales to commercial satellite markets would ideally be included in the percentage of commercial sales. However, there is no way to determine the magnitude of these sales comprising the total non-DoD BDS revenue so they cannot be separated out. It could be possible that one of these two categories is responsible for majority of the sales comprising non-DoD BDS revenue. However, if that was the case it is not believed that this would drastically change the results of the model considering this nuance is only present in four years of data.

2016-2021

The 2019 10-K, and the rest of the annual reports thereafter provided the first detailed breakout by customer on Boeing's defense segment since 2011. Not only did it contain the total revenue of defense items sold to all its foreign customers (non-US BDS revenue), but this total was also inclusive of FMS. This report had this data available for the years 2016-2018. A breakout was provided for, Global Services (BGS), one of Boeing's new business segments who provided services to government and commercial customers worldwide. Both government and commercial revenues were a combination of domestic and foreign revenues. As with other contractors reviewed, sales to the US Government included FMS. Essentially, it was impossible to extract FMS contributions from the total domestic revenue. Ultimately, it was decided that this portion of the BGS segment would be included with the domestic defense sales revenue with the understanding that a small portion of revenue was coming from FMS. The revenue from FMS was more than likely small and would have little effect on the true percentage of domestic defense sales considering Boeing is a US based company, with the United

States Government as its primary customer. The rest of the revenue comprising the BGS government segment was from international defense sales through DCS and was the majority of sales in this segment in each of the years in this period with the lowest percentage being 59% in 2016 and 2020.

To obtain the percentage of international defense sales, total revenue from non-US BDS was combined with total revenue from foreign government sales in the BGS segment and divided by the total annual revenue in each respective year. To obtain the percentage of domestic defense sales, total revenue from US BDS sales was combined with total revenue from US government sales in the BGS segment and divided by the total annual revenue in each respective year. To obtain the percentage of commercial sales, total revenue from the commercial aircraft segment, BCC, and total commercial revenue from the BGS segment was combined and divided by the total annual revenue in each respective year.

Northrop Grumman

1994-1999

International defense sales were considered immaterial in these years. For this reason, the percentage of international defense sales were zero. Immaterial means that the values were not relevant enough to report. It was assumed that international defense sales were immaterial because there were no direct figures provided for FMS or DCS in these years. However, it was stated that the "sales to the U.S government" figures included revenue from FMS. It was believed that the FMS value was insignificant and, as such, its revenue is included with sales to the US government. Also, the 10-Ks spanning this timeframe explicitly state that Northrop did not conduct a "significant volume of activity

in foreign currencies." This was interpreted to mean that there was not a large portion of sales going through the DCS program. US defense contractors negotiate directly with the foreign countries when a sale is made through DCS. Typically, there is some type of exchange rate in dealing with foreign currencies when it is time for the foreign country to pay. There were only two other categories of revenue listed in the 10-Ks for these years: "The Boeing Company" and "Other Customers". The revenue from sales to the Boeing Company came from sales of commercial aircraft equipment in support of Northrop's role as a subcontractor for Boeing's 747 commercial aircraft. Until 2011, there was no description of what revenue from "Other Customers" consisted of. Therefore, it was assumed that this category was composed of mainly commercial sales since all of the defense sales were already accounted for by the method above. The percentage of domestic defense sales became sales to the US Government divided by total annual sales for each year. The percentage of commercial sales became total revenue from sales to "The Boeing Company" and "Other Customers" divided by total annual sales for each year.

This method has two limitations. First, a portion of international defense sales (FMS) were included with sales to the US Government. FMS could not be removed from sales to the US Government because there were no direct figures reported for this category. However, considering that this analysis is on the Big Five US defense contractors, it is safe to assume that the majority of the sales in the "sales to the U.S government" category are to the DoD and not to foreign entities. Additionally, no description was found regarding where the revenue in "Other Customers" category

originated. This category could have contained some portion of international defense sales through DCS as FMS was already accounted for in sales to the US government.

2000

In 2000, Northrop Grumman sold its commercial aerostructure business, so "The Boeing Company" revenue category disappeared. Northrop Grumman no longer had any commercial items to sale to Boeing in support of their 747 commercial airline. To obtain the percentage of revenues of the three categories (international defense, commercial, domestic defense) the same methodology was used above except commercial sales no longer included revenue from "The Boeing Company".

2001-2010

2001 was the first year where annual sales figures were provided for what was assumed to be DCS. This value was represented by the "Foreign sales" figure listed in the 10-Ks of these years.

How was it assumed that "Foreign sales" did not include international commercial sales?

The category's name was changed to "Direct Foreign Sales" in 2007 which typically refers to DCS. There were still only two categories of revenue in the 10-Ks in these years: "Sales to the U.S Government" and "Other Customers". FMS were still included in sales to the US Government figure for all of these years. To get the percentage of international defense sales, the "Foreign Sales" total was divided by total annual sales for each year. To get the percentage of domestic defense sales, "Sales to the U.S Government (inclusive of FMS)" was divided by total annual sales for each year. To get the percentage of commercial sales, the value of "Foreign Sales" was first subtracted

from “Other Customers” to remove the portion of revenue allocated to international defense out of this category. The value of “Other Customers” after this was then divided by total annual sales for each year to get the true percentage of commercial sales. One limitation of this method is that FMS were not able to be removed from sales to the US government. The true percentage of international defense sales would be higher if FMS was able to be included.

2011-2014

The 2014 10-K was used to obtain data for the years 2011-2013. Reason being, the 2014 10-K was the first instance where FMS were excluded from the calculation of sales to the US Government. Additionally, the 2014 10-K listed the percentages of “sales to the U.S Government (excluding FMS)” and “international sales” from 2011-2013. The percentage of international sales listed in the 10-K was assumed to be composed of only FMS and DCS based off language in the document. The document made a reference to pursuing “international opportunities” in which they only referred to as “direct and foreign military sales”. The percentages of sales to the US Government were used to represent the data for domestic defense sales for 2011-2013. The percentages listed for “international sales” were used to represent data for international defense sales from 2011-2013. The percentage of commercial sales became what was needed to add up to 100% after the percentages of domestic and international defense sales were calculated for 2011-2013. This was done because Northrop Grumman had commercial sales in these years but there were not any direct figures specifying an exact amount. The two revenue categories in the 10-K were “Sales to the U.S Government” and “Other Customers”. For the 2014 data, the same method was used to calculate the three different categories of

sales, but the data came from the 2015 10-K. The limitation with this method is that it is not known whether international commercial sales was included in Northrop Grumman's "international sales" figure listed for the respective years. However, once again it was a safe assumption that majority of the sales in this category were international defense given that defense sales was the company's primary business.

2015-2021

"International Sales" was added as a revenue category in the 2016 10-K. There were now three revenue categories within the 10-Ks for the years in this time period: "Sales to the U.S Government", "International Sales", and "Other Customers". The 10-Ks also finally provided a description of what type of sales comprised each category. The 10-Ks stated that "International Sales" was comprised of FMS, DCS, and international commercial sales. Revenue from "Other Customers" was comprised of sales to US State and local governments and domestic commercial sales. The percentages of revenue comprising each category were also listed in the10-Ks and these percentages were used for the data in the analysis. The percentage of "Sales to the U.S Government" was used to represent domestic defense sales. The percentage of "International Sales" was used to represent international defense sales. The percentage of revenue from "Other Customers" was used to represent commercial sales.

No assumptions had to be made about what comprised "International Sales" for the data in these years since a description was finally provided by Northrop Grumman. However, the limitation of this method was that international commercial sales were being included in the calculation of the percentage of international defense sales. There was still no way to determine how much international commercial sales were being

included in “International Sales”. Therefore, the assumption that majority of the sales comprising this category were primarily international defense (FMS and DCS) was made for these years as well.

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