What Makes Your Business A Winner: Empirical Analysis Using the Department of Defense Contracts with Small Manufacturing Firms

by

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Abstract

Strengthening small businesses in any economy remains a key pillar of economic growth, technological breakthrough, and national security. The Federal Government has always sought to support its large base of small businesses through its various socio-economic policies and targeted initiatives to increase opportunities of small businesses. However the latter still face numerous challenges when it comes to securing government contracts and building manufacturing capabilities. Focusing on small manufacturing firms contracting with the Department of Defense(DoD), this study sought to empirically evaluate the effects of certain attributes on the probability of winning contracts.
My findings suggest that manufacturing small enterprises are mainly found in manufacturing hubs, belong to an R&D ecosystem, meet certain quality standards, and are domestically focused. The latter finding may be of concern for the DoD as the literature has shown that export-focused firms tend to be more competitive and innovative than non-exporting firms. As the U.S. aims to regain its place as a manufacturing power, its small business strategy may need a closer look to ensure that they attract and retain small innovative firms as key parts of their supply chain.

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1 Introduction

Small businesses in the U.S. play a significant role in the economy as innovation enablers, job creators, and contributors to national security, among many of their roles. The U.S. has strived to ensure that despite challenges small businesses face, concerning their size, and lack of access to adequate capital, policies have been put in place to ensure that they continue to grow. These policies include deliberate federal contracting dollars being set aside for small businesses to ensure fair competition when bidding for government contracts. However, over the last decade, between 2011 and 2021, the U.S. Department of Defence's (DoD) contract obligations to small businesses have significantly decreased despite an overall increase in the contracting dollars allocated for small businesses, a trend that has also been observed among large firms. In other words, the DoD's contracting dollars have increasingly gone to a select few firms, while the DoD's budget has continuously grown. This may amount to an issue for the U.S. economy in terms of the reduced capacity to ensure national security through the resilience of its industrial base. A continuously small pool of contractors poses a threat to the supply chain of the DoD. Research has been done to understand this trend and findings have highlighted factors such as decreased manufacturing capabilities of the United States and the complex federal contracting process as some of the drivers of the decline.

This thesis aims to contribute to the literature through an empirical evaluation of key attributes of small manufacturing firms which have continuously succeeded in securing DoD contracts using a combination of the DoD's spending data, the Small Business Administration Data (SBA), and Compustat data, through a new success framework and regression model approach. The combination of these datasets allowed me to get firm-level data necessary to assess the effect attributes such as geographical location, competitiveness through export orientation, quality standardization, and research and development(R&D) have on the successful acquisition of contracts by small manufacturing firms.

1.1 Small businesses in the U.S.

The U.S. SBA table of size and standards defines small businesses by their North American Industry Classification (NAICS) codes, thus varying by industry, revenue, and employment. Small businesses in the manufacturing sector, depending on the industry, are defined as businesses with employee numbers ranging between 500 and 1500 employees (SBA). In this thesis, I focused on small businesses with at most 500 employees.

In the section below, I will provide context on small businesses in the U.S. and their various contributions to the economy with an added focus on the manufacturing industry. As previously mentioned, the latter plays an important role in the sustained growth of the economy. I will highlight various benefits associated with working with small businesses compared to larger businesses. The subsequent section will also focus on giving a picture of the federal contracting trends with small businesses as well as insights into potential drivers of the declining trend. This is followed by an in-depth view into the federal contracting process along with the importance of defense procurement to the economy, the manufacturing industry, and small businesses.

The importance of small businesses and contributions to the economy

Small businesses play a significant role in the U.S. economy as important engines of growth for the nation but also contribute to their local economy's growth. There are approximately 32.5 million small businesses in the U.S., making up 99.9 percent of all U.S businesses. Further, small businesses held 46.8% of the total U.S. employment share, grew by 20.1 percent between 1994 and 2018, and within the manufacturing sector, employed 43% of the total private employment and held 43% of all high-tech jobs in the country (U.S. Census Bureau,2018, DoD report,2022).

Small businesses also contribute to the growth of the economy through exports on the global market. In 2019, small and medium enterprises (SME) contributed $460 billion to the $1,455 billion in export value, and of these, small manufacturers contributed $148 billion. Of the 288,063 identified exporters, 97.3% were small businesses (U.S. Census Bureau) which attests to their value in the economy. Therefore, the government's support of small businesses advances the country's priorities- supply chain resilience, job creation, and enhanced competitiveness.

Small businesses also tend to be more innovative than large businesses, producing 16.5 times more patents than large firms (DoD, 2022). A study by Breitzman & Hicks (2008) focused on small and large technology firms designated as innovative firms, showed that between the 2002- and 2006-year period, small businesses with less than 500 employees, developed more patents per employee than large businesses. Additionally, the study found that patents filed by small businesses outperform those filed by larger businesses in terms of citation impact, originality, and growth.

With the rise of emerging technologies, small and medium enterprises may be able to significantly improve their productivity through the introduction of advanced technologies. Through research conducted by MIT researchers, SME manufacturers revealed that the adoption of automated technologies improved the quality and reliability of their work (Berger et al, 2021,21). This indicates that through continued support for access to required resources, both physical capital and skilled labor, small businesses, and especially small manufacturers, can continue to contribute to the nation's growth. Additionally, the military relies heavily on small manufacturers, with roughly half of the plants in the defense supply chains having revenues below $25million (Gholz et al,2018).

Benefits of dealing with small businesses

Small firms have for long garnered interest from the government due to their perceived ability to generate employment and to produce technological innovations and various research. Rothwell (1983) conducted research with a focus on SMEs' role in the dynamics of the introduction and diffusion of new technologies specifically in the semiconductors and computer-aided designs. The study found that while initial developments were made in the R&D laboratories of large companies where components and equipment were made for their use, new technology-based firms played a significant role in their diffusion into more general use.

In addition to diffusing new technologies, small businesses are also key contributors to the success of large businesses. They supply an important number of the components needed by big companies. Canis & Yacobucci's (2011) research showed that while many of the 1,700 suppliers needed by U.S. automakers to provide them with parts needed to make their cars, hundreds of smaller companies provide a substantial portion of the 8000 to 12000 parts needed for each vehicle.

Further, small businesses also play a fundamental role as suppliers of goods and services to the federal government. Federal purchasing from small businesses, which totals approximately $130 billion each year, is a key component of the country's competitiveness and innovation, diversity, resilience in the supply chain, and national security. Small businesses compared to big businesses present further advantages for government procurement such as decreased bureaucracy and faster deliveries and they can also be more accommodating and flexible to the government's sometimes complex requirements (Stangler,2021).

The declining trend in small businesses contracting with the government

However, despite the advantages of contracting with small businesses, over the past 2 decades, the number of small businesses contracting with the government has declined (Bresler A & Bresler A,2020, GAO,2021). Stangler (2021) found that the pool of new small businesses procuring for the federal government has seen a 79% decline between 2005 and 2019.Robert Burton, former acting administrator of the Office of Federal procurement stated:

"Indeed, despite the fact that the federal government continues to channel procurement dollars (and perhaps even an increasing amount) to small businesses, the use of small businesses and the number

of small business contract actions actually, have declined. Consequently, it appears that federal procurement dollars are increasingly concentrated in a smaller number of small businesses" (2015 p.7—emphasis added) (Hawkins T et al,2018).

In July 2021, the U.S. SBA reported that the federal government exceeded its small business contracting goal of 23%, awarding $145.7 billion (26%) in prime federal contracts to small businesses, a $13 billion increase from the financial year 2020. Further, they also exceeded their subcontracting goals, awarding $82.8 billion in subcontracts to small businesses. Despite this overall increase, the number of small businesses receiving prime contracts with the federal government decreased (GAO,2021).

The DoD also faced a similar downward trend. In October of 2021, the United States Government Accountability Office (GAO)reported that the DoD contract obligations to small businesses increased from the fiscal year 2011 to 2020 while the number of small businesses contracting with the DoD has significantly declined since 2011, awarding contracts to almost 25,000 fewer businesses in 2020 than it did in 2011(GAO,2021). This trend was also observed within larger businesses.

In 2011, the DoD had challenges meeting its small business goals but by 2020, this had been rectified. In 2011, the department exceeded its 23% goal for small business utilization in some categories of expenditures and not others due to the industry consolidation being concentrated among larger firms. Consequently, due to customer news for economies of scale as well as scope, flexibility, innovation, and agility, certain industries were better suited to businesses of a particular size and many of the goods and services procured by the DoD fell in these categories (Grammich C. et al, 2011). Further, government procurement was found to be a low priority for many small businesses. Therefore, all these factors contributed to the difficulty for the DoD meeting its small business goals, a situation which has since been reversed with the DoD meeting its small business goals for the last seven consecutive years. This was achieved through continued efforts to train small business professionals and a deliberate identification of opportunities for small businesses through market research, competition, and subcontracting. The challenge remains where there needs to be a strategy for the DoD's contracting dollars to go to a wider variety of small manufacturing firms.

Drivers of the decline and challenges faced by small businesses as they do business with the government

Federal contracting practices

Small businesses face various challenges in their business dealings with the federal government. A report to former President Donald Trump highlights some key challenges negatively impacting America's industrial base. These include but are not limited to, sequestration and uncertainty in government spending, and harmful U.S. government business and procurement practices, as well as a shortage of skilled labor and a will among the largest prime contractors to achieve economies of scale (Tirpak, 2008 as cited by Bresler A & Bresler A, 2020). These challenges may be at the core of why fewer small businesses have joined the pool of DoD contractors.

A federal contracting practice that has harmed small businesses' dealings with the government includes category management-a government-wide contracting initiative where agencies have been encouraged to consolidate and coordinate their common goods/services purchases. A report by the GAO found category management to be a potential factor contributing to the decline. This initiative, by the Office of Management and Budget, aimed to encourage efficiency and cost savings through the reduction of duplicative contracts, multiple purchase orders of similar goods/services, and better contracting agency coordination. The initiative achieved its cost-saving goal by saving $27billion in its first three years for the federal government (Stangler,2021,7). However, according to the GAO, of the contracts eliminated due to category management since 2016, 53% had been previously awarded to small businesses (Stangler,2021). DoD officials and small business executives reported that said initiative reduces

opportunities for small businesses where they face difficulty participating in large government-wide contracts such as the initiative's Best in Class contracts (GAO,2021, Stangler,2021).

The GAO also reported administrative difficulty in working with federal agencies, namely the DoD. According to small business executives, contracting with the DoD often is associated with unforeseeable and onerous delays in the award selection process and decision, security clearances, the start of work, and payment dates. The DoD also highlighted in their 2019 Small Business Strategy that other business practices such as the multiple entries into the defense markets and long contracting timeframes have strained their relationships with small businesses. Further, the DoD's new cybersecurity requirements have been both difficult to understand and implement and expensive for small businesses. (GAO,12,2021). Snyder 2021, states that several commercial vendors, both large and small ' refuse to sell goods to the federal government based on the significant additional costs and risks associated with the government-unique specifications, audition requirements, and other onerous terms and conditions (Snyder,2021).Further strategic sourcing by the government leads to supplier rationalization and a lack of accountability for federal agencies to achieve their socio-economic goals further erodes their efforts(Grammich et al,2011 as cited by Hawkins T,2018).

A survey by the Goldman Sachs 10,000 Small Business Voices program found that among small businesses who had applied for state or local government contacts, 54% found the 'federal procurement process too time-consuming'(Stangler,2021,6). Further, the survey also found that, among small businesses which had already applied for state and local governments contracts, 4 in 10 would decline to apply to a contract with the federal government because 'success is unlikely because small businesses are not adequately prioritized' (Stangler 2021,7).

There also exists federal contracting practices which allow small businesses to appear as new entrants while being existing DoD suppliers. Bresler & Bresler (2020) investigated the composition of new DoD vendors and found that an existing supplier, through a Joint Venture or Special Purpose Vehicle (SPV), can be registered as a new entity, giving the appearance of a new entity entering the supply chain. The Federal government always seeks to diversify its supplier base by contracting more small businesses to enhance the resilience of their supply chains. However, the challenges discussed above reduce interest from businesses to work with the government.

Market concentration

Additionally, other factors not related to the federal contracting process such as market concentration might be at the root of the declining trend. Market concentration refers to the level to which market shares may be concentrated among a limited number of firms. Typically, a less concentrated market will have more competitors which may lead to increased efficiencies and reduced markups. High concentration may facilitate economies of scale leading to superior quality products at lower prices. A study by Carril and Duggan (2018), investigated whether and to what extent consolidation-driven increases in industry concentration between 1985 through 2001 can affect the way the government procures its goods and services. The study, focused on the DoD, found that market concentration caused the procurement process to become less competitive, causing an increased amount of spending to be awarded without competition or via single bid solicitations. This has great implications for the present given the expansive literature highlighting the potentially present market concentration which raises concerns about increasing market power.

Autor et al (2019) hypothesized that as a result of globalization or technological changes, industry sales had been pushed towards the most productive firms, 'superstar firms' in each industry, leading to product market concentration. They further argue that this growth in concentration is more apparent in industries experiencing faster technical changes which suggest a level of technological dynamism and not anti-competitive behavior as a driver of the trend. Technological changes, which increase barriers to entry, are also cited as a reason for increased concentration by Grullon et al (2019). Therefore, existing firms, through technological advancements, create advantageous economies of scale, changing the industry landscape and thus creating barriers to entry for new firms.

However, a study by Amiti and Heise (2021), shows that typical measures of concentration, when adjusted for sales by foreign exporters, have stayed constant between 1992 and 2012 in the manufacturing sector. The study provides evidence based on standard international trade models which posit that rising import competition would lead to a reallocation of market share from small inefficient firms to large firms leading to the rise in domestic concentration coinciding with tougher product market competition. In other words, the higher import competition led to a decline in the market shares of the top twenty U.S. firms.

Atkinson and De Sousa (2021) argue against claims of an industry-wide increase in concentration. Based on the economic census data, they assert that more than 80% of business output in 2017 was in sectors with low concentration ratios including multiple advanced technology industries, and the share of industries that have low levels of concentration grew by around 25% from 2002 to 2017. Their report also found that just 4% of U.S. industries are highly concentrated. Further, they also show that there was no relationship between industry concentration and profitability during that period.

While this industry-wide concentration may be overstated, certain manufacturing industries (particularly in the defense industrial base) belonged to the 4% of highly concentrated U.S. industries in 2017. For example, the Ammunition (Except small Arms) Manufacturing which became highly concentrated in 2017, showed a 29.9 percentage point increase from 2002 to 2017 from 52.9% to 82.8%. Others, such as all other miscellaneous and non-metallic mineral product manufacturing became moderately concentrated in 2017 growing from 29.7% in 2002 to 55.6% in 2017. Others, within concentrated industries, also increased in a concentration such as Aircraft Manufacturing increasing from 81% to 90%, and the Guided Missile, Space Vehicle Propulsion Unit, and Part Manufacturing growing from 90% to 96%. However, census data does not account for imports, which do take market share from domestic producers as exemplified by Amiti and Heise's (2021) study and therefore, industry concentration ratios may be overstated due to this omission. Concerning the manufacturing sector, even if concentration ratios are overstated, the industry is still concentrated, at lower ratios which may affect the number of contractors available to the DoD for its procurement needs.

As seen with the statistics provided by Atkinson and De Sousa (2021) the manufacturing sector is facing high levels of concentration, specifically industries comprising DoD contractors. Even if statistics only focused on the share of sales that the top four firms capture in an industry, one can safely assume that these dynamics may also have a ripple effect on small manufacturing firms within the same sectors. As previously mentioned, industries with high levels of concentration may not be conducive for new firms due to high barriers to entry (Grullo et al,2019) and may be unsustainable for existing inefficient small firms (Amiti and Heise,2021) therefore reducing the overall number of small firms existing in the sector.

Therefore, small businesses, despite their proven record of strong contribution to the nations and local economies, still face numerous challenges. Additionally, a combination of federal contracting complexities and continued market concentration in the manufacturing sector may continuously shrink the pool of available contractors for the DoD which may be detrimental to the continued advancements in technology and innovation.

Consequently, in this thesis, I will focus on specific factors at the firm level that might differentiate successful small firms; those with under 500 employees in the manufacturing sectors from others in their ability to win DoD contracts. These factors have been shown in the literature to increase the efficiency, productivity, and competitiveness of small firms thus giving them an edge over others in the market. The factors of interest investigated in this thesis are geographical location, export status, innovation capacity, and quality standardization and their significance in reinforcing the winner or loser framework.

The remainder of this paper is organized as follows. Chapter 2 elaborates on why manufacturing is of great importance to the nation’s economy, the meaning of loss in manufacturing capabilities, and what led to this loss as well as how the capabilities are linked to the nation's defense. Chapter 3 provides in-depth information based on existing literature on attributes of small businesses that I will further investigate through my empirical analysis. Chapter 4 presents the data used for the analysis and empirical

strategy as well as the new success framework. Afterward, the main results and a discussion of the findings are presented in Chapter 5. Finally, I draw the central conclusions and provide policy recommendations.

2. Context

In this chapter, I will provide context on manufacturing in the U.S., why I chose to focus on this sector, and the role it plays as a pillar of the nation's economy. I will also dive into different factors that have led to the significant loss in manufacturing capabilities and how these led to the U.S. losing its place as a manufacturing power on the global stage. Lastly, I focus on the link between the nation's manufacturing capabilities and the defense sector.

2.1 Why manufacturing?

Why should we care about manufacturing? In the words of Robert Atkinson (2013) 'Manufacturing matters because it's simply impossible to have a vibrant national economy without a healthy globally traded sector, and manufacturing is America's most important trade sector'.

America's manufacturing and defense industrial base supports economic prosperity, and global competitiveness and equips the military with the ability to defend the nation. However, the U.S. manufacturing sector has experienced shifts that, in the long run, may jeopardize the U.S. national security, and further erode its capacity to innovate and produce emerging hardware technologies on a large scale.

In 1978, manufacturing establishments employed 26% of the U.S. private sector workforce, and by 2019, this rate had fallen to 9%. Additionally, the manufacturing sector is an important factor in the US economy contributing 12% of GDP, 60% of exports, 55% of all patents, and 70% of U.S. R&D. (Force, I. T. 2018).

Additionally, in 1973, manufacturing made up more than 86% of U.S industrial production. By 1982, that figure had decreased to 71% and in 2014, it had further decreased to 68%, before going back up to about 75% in 2019. (Kota S., Mahoney T). However, despite this apparent growth in manufacturing, total factor productivity between 2011 and 2015 fell 5.8 percent. Additionally, the growth experienced was largely found in only three industries; transportation equipment, petroleum products and food, where advanced industries such as pharmaceuticals, communications equipment and computers stagnated (Kota,S, Mahoney T, 2019).

The share of employment attributed to manufacturing has fallen from over 30% in the 1950s to less than 19% in 2017, with 7.1 million manufacturing jobs lost between 1979 and 2017, and 5 million jobs lost since 2000 alone, a rate which exceeds the rate of loss in the Great Depression (Force, I. T. 2018; Atkinson,2012). Additionally, Atkinson et al, (2012) also shows that for every job lost in manufacturing, two and a half additional jobs are lost throughout the economy. Moreover, a report by the Information Technology and innovation Foundation (ITIF) found that from 2000 to 2010, U.S. manufacturing labor productivity growth was overstated by 122% (Atkinson et al,2012). The ITIF reports also posit that if manufacturing output had grown at the same rate as that of the business sector between 2000 and 2010, by 2012, the U.S. would have had approximately 13.8 million jobs added to the economy (Atkinson et al,2012).

Further, the U.S. capacity to produce advanced technology products also suffered from exports of said products surpassing imports in 2000. By 2019, the U.S. faced a trade deficit of more than $130 billion in advanced technology products, a figure that has grown since 2002. (Armstrong,2021). Other metrics also tell similar stories where the fixed capital investment of manufacturing declined in the 2000s and manufacturing's share of GDP has shrunk from 27% to 12% in the last 50 years.

2.2 The significance of loss in manufacturing capabilities

The loss in manufacturing bears negative consequences to both the economy and the defense industrial base. In many industries, the U.S. no longer controls the means of production, the machine tools, and advanced processing equipment are at the core of innovation in manufacturing processes. The semiconductor processing equipment remains the only sector in which the U.S. maintains approximately 50% of the global market share however, even in this instance, the most advanced extreme ultraviolet photolithography machines used in production are produced by ASML, a Dutch firm (Kota S & Mahoney T).

The Covid19 pandemic further highlighted the U.S.' foreign dependency on critical sectors such as the pharmaceutical industry. Statistics showed that over 70% of the active pharmaceutical ingredients (APIs) used in the U.S market were produced overseas; over half of the factories producing final dosage form medicines for the U.S. market are foreign and three commonly used antibiotics depend on ingredients manufactured only in China (Kota S., Mahoney T). This is concerning especially considering that the pharmaceutical industry is knowledge-intensive and receives a substantial financial benefit from federal R&D spending by the National Institutes of Health.

However, in the early months of the Covid19 pandemic, manufacturing handled the shock relatively better than other sectors. In September of 2020, the National Association of Manufacturers' Third Quarter Outlook Survey reported that 72.5% of all manufacturing companies predicted there will be no employment losses, and instead they would experience an increase in 2021.MIT researchers found that while suppliers in the automotive and aeronautical industry's remand shrunk, their production remained fairly stable. (Berger et al, 2021).

In addition to foreign dependence on pharmaceuticals, the U.S. also depends on foreign suppliers for defense supplies and technology. A 2019 study by the council of foreign relations noted that 'Many advanced technologies necessary for national security are developed in the private sector by firms that design and build them via complex supply chains that span the globe; these technologies are then deployed in global markets. The capacities and vulnerabilities of the manufacturing base are far more complex than in previous eras, and the ability of the U.S. DoD to control manufacturing-base activity using traditional policy means has been greatly reduced." (Kota S & Mahoney T,)

A frequent source of new products is entrepreneurial start-up firms with new hardware inventions. MIT's study, *Production in the Innovation Economy*, examined 150 hardware start-ups emerging from MIT research and found that while these startups had access to sufficient skills, financing for R&D, and initial product demonstration, issues arose at the scaling stage. When it came time to scale production to commercialize, the additional need for capital, production capabilities, and lead customers drove these firms to transfer production abroad which usually meant to China. ((Kota S & Mahoney T). The long-term implications of such segmentation are that eventually, innovation may also be transferred to places where companies have experience in scale-up and commercialization (Berger,2014).

The strong industrial ecosystem built in China has made production in China too compelling, comprehensive, and easy that the U.S. and other countries do not have the capacity or suppliers to match. Therefore, restoration of the U.S. industrial commons and rebuilding of manufacturing industries is imperative to avoid a continued erosion of innovative capacity and production capabilities. These would result in a second-tier economy unable to support the first-tier military.

2.3 What has led to the decline in manufacturing capabilities?

As a result of five decades of production offshoring and the perception of manufacturing as a less valuable activity that ignores its close links with product innovation, the U.S. is now dependent on foreign production across almost every advanced manufacturing industry. Industries include medical equipment and pharmaceuticals which are critical to the country's national security and health. This has resulted in the U.S losing its industrial commons, 'the collective R&D engineering and manufacturing capabilities that sustain innovation in physical products' as first noted in Gary Pisano and Will Shih, 'Restoring American Competitiveness,2009' (Kota S., Mahoney T). Outsourcing production and the loss of

suppliers, skilled trades, and the product and process design, the knowledge in engineering has left the U.S unable to produce the next generation of high-technology products. This has also resulted in a smaller and less innovative manufacturing sector lacking in capacity or resiliency to face the national health crisis that was the pandemic and unable to support the needs of the nation's defense.

Another less explored factor that has played a role in the collapse of the manufacturing sectors before China became a leading force, includes pressure from the financial markets (Berger et al, 2021). Since the 1980s, financial markets have transformed the structure of corporations in the U.S. Previously, the system was dominated by a few large, vertically integrated firms which contained all functions needed to bring a product or idea to the market were contained within the corporations. Operations starting from research and development, design, manufacturing, testing, and logistics to sales and aftermarket services were all found in the same location. After the rise of financial shareholders who wanted to secure a more immediate profit, such shareholders began to favor splitting such a large company to focus on core competencies to increase share price (Berger,2014). In the 1980s about two-dozen large vertically integrated companies including Motorola, Dupont and IBM were the main players in the American economy but due to pressures from the financial markets, activities deemed by investors as peripheral were foregone. Further, this fragmentation was also made possible due to the rise of the internet and digitization and has led to a globally linked value chain of designers, researchers, manufacturers, and distributors which has yielded considerable benefits to the U.S. and its partners. However, these moves have exacerbated the erosion of the industrial ecosystem in the U.S. (Berger,2014).

These large companies used to provide semi-public goods often through training and apprenticeships, basic research opportunities, funding to bring innovation to scale, and through the diffusion of technologies to suppliers. As Berger (2014) states, they were also extremely important to communities and the economy in that they subsidized community college education, availed job training, and created an industry ecosystem that spurred innovation and job growth. With the continued shrinking of aforementioned publicly available resources coupled with the offshoring of production which has driven suppliers out, it has increasingly been more difficult for manufacturers to commercialize new products and processes. These drastic changes in employment share, loss of capacity, and increasing trade deficit have significantly impacted the United States' goal to remain the leading manufacturing power it once was.

2.4 How U.S. manufacturing capabilities are linked to defense

The manufacturing sector is a pillar for both the U.S Economy and the maintenance of U.S military advantage, therefore its declining capabilities and capacity present a threat to National Security. This decline in capacity harms the ability of the DoD to support the U.S. defense with risks associated including greater reliance on single sources, sole sources, and foreign providers to fill in the gaps, and other risks such as lack of qualified workforce, and product insecurity and loss of innovation. These losses were more pronounced in sectors facing import competition, such as primary metals, electronics, chemicals, and machinery exacerbating the reliance on foreign partners to fill the gaps. The loss of innovation, attributed to the decreased focus on domestic manufacturing capabilities, affects America's capacity to capture emerging technologies (Force, I. T.,2018).

A large share of small and medium manufacturers in the U.S. work with the DoD. According to a study by Ben Armstrong (2021), 40% of small and medium manufacturers in the Ohio and New England regions, registered in the SBA database, have had at least one DoD prime contract since 2008. Additionally, this might be an undervaluation of the real share of small and medium manufacturers present in the defense supply chains, given that the database does not account for firms at all tiers of the defense supply chain.

Therefore, my thesis can help the DoD streamline their small business policies by targeting attributes contributing to the success of small firms and encouraging said attributes to be reinforced by other small manufacturing firms wishing to pursue contracts with them.

2.5 Understanding federal contracting

The Federal Acquisition Regulation (FAR) is the primary contract regulation for use by all Federal Executive agencies for their acquisition of supplies and services with funds appropriated by Congress. Each agency also supplements the FAR with its specific regulations and policies, waivers to the FAR, and other regulations such as the Code of Federal Regulations (CFR) which implement policies such as the SBA or the Defense Federal Acquisition Regulation (DFAR) supplement (Snyder,2021).

The acquisition process begins with an agency's specifying requirements for goods and/or services and planning the adequate acquisition method or contracting plan. After the contracting officer determines the appropriate method to acquire the goods and/or services through a contract, the agency issues a solicitation. If the agency anticipates an amount greater than $25,000, the solicitation is posted on the government-wide electronic posting Federal Business Opportunities(FedBizOpps) website (Halchin, 2006 as cited by Snyder,2021). Further, depending on the dollar value, the solicitation may also be posted on the agency's website or commercial government bid sites- Fed Bid, Fed Connect. (Snyder 2021; Dahlstrom,2021)

The minimum information required on the solicitation includes what the government wants to buy, instructions on ways to respond to the solicitation, the source selection method used to evaluate offers, the deadlines for the submission of bids and proposals, and the small business size category for the acquisition. Most of the solicitations and contracts are required to have a small business size category as defined by the North American Industry Classification System (NAICS) code for the industry of the main items being acquired through the contract (Snyder, 2021).

The NAICS code is determined by the US Department of Labor based on U.S. census data describing 1000 business categories and the SBA assigns the small business status to businesses in the services industries based on average annual revenues and in the manufacturing and supply industries, based on average total annual employee count (Snyder,2021).

Within the DoD, multiple offices oversee and execute the department's small business contracting efforts. Specifically, the DoD's Office of Small Business Programs (OSBP), housed under the DoD office of Industrial Policy, aims to maximize small business participation, monitor progress toward SBA goals, conduct outreach to small businesses, and advise on small business policy. There are also OSBPs for the Army, Navy, and Air Force and a variety of agencies throughout the DoD including the Defense Logistics Agency (DLA).

Currently, the Office of the Under Secretary of Defense for Acquisition and Sustainment issues all Defense Federal Acquisition Regulation Supplement guidance; however, in the late 1970s, DoD had 79 offices issuing procurement regulations over 30,000 pages (Force, I. T.,2018). This consolidation coupled with ongoing efforts supporting regulation reform such as the 'Section 809 panel'- an outline showing the DOD's pursuit to streamline acquisition policy and processes to make it easier for contractors to do business with the DoD (Force, I. T.,2018). However, this consolidation of the acquisition authority did not overcome challenges faced by businesses seeking to conduct business with the DoD. According to the GAO, commercial businesses are mostly unaware of the best channels to propose business solutions to the DOD. Additionally, non-traditional companies also highlight the complexity of the acquisition process, lengthy contract timelines, an unstable budget environment, and inexperienced DoD contracting officials as additional challenges associated with doing business with the DOD (Force, I. T.,2018).

2.6 The defining importance of Defense Procurement to the economy and the manufacturing sector.

As a large customer

For the fiscal year 2021, the DoD spent a total of $1.1 trillion as of August 2021, 11.4% of the $9.2 trillion federal budget according to its reported spending budget. The DoD fiscal year 2021 goal for

small business prime contracting was 21.95% of all contract obligations where small businesses are eligible to participate, and the DoD has exceeded its SBA goal each year from 2014 to 2020 (SBA,2021). A key feature of U.S. defense spending is that it is contracted out where procurement contract obligations between the DoD and the private sector roughly represent half of the national budget. (Carril and Duggan,2018). Lastly, The DoD disburses approximately $350 to $500 billion in contracts annually. It is also the largest U.S Government agency with 2.91 million service members and civilians (Bowne,2021)

Importance to small businesses

Contracting with the federal government can be a valuable opportunity for small businesses as will be highlighted in the subsequent section. The SBA of 1953 requires federal agencies to establish annual business contracting goals for small businesses to access federal contracting opportunities (SBA).

The Business Opportunity Development Act of 1988 (Public law 100-656, Section 502) formalized the goal that no less than 20% of overall direct federal procurement contract awards go to firms that the SBA has certified as small businesses. As part of the Small Business Reauthorization Act of 1997(Section 603), the goal was raised to 23% (Reardon & Moore,2005). The established goals allow small businesses to be awarded both prime contracts and subcontracts. In addition, goals are also established for various socioeconomic sub-categories such as small disadvantaged businesses, women-owned small businesses, service-disabled veteran-owned small businesses, and businesses located in Historically Underutilized Business Zones (HUBZone) (3%) .Federal procurement has met or exceeded its procurement goals with small businesses for the last 7 consecutive years. This represents a substantial opportunity for small businesses given that the public sector constitutes a market of approximately $2.7 trillion annually (Bureau of Economic Analysis,2017 as cited by Hawkins et al, 2018) and that a significant amount is deliberately attributed to small businesses at all levels as a matter of public policy to achieve socio-economic benefits. In addition to increased revenues, additional reasons why firms would choose to do business with the DoD include their business gaining credibility, the opportunity to increase one's market's reach and to work on challenging problems, and the ability to contribute to national security.

Further, small businesses can also secure R&D funding through federal procurement. Federal agencies use programs such as the Small Businesses Innovation Research (SBIR) to help small businesses engage in R&D to potentially develop and commercialize emerging and innovative technologies (SBIR). Agencies with over $100M in R&D funding must set aside funding, exactly 3.2%, for U.S based small businesses (with less than 500 employees). The SBA indicates that the mission of the SBIR program is to "support scientific excellence and technological innovation through the investment of Federal research funds in critical American priorities to build a strong national economy" (Bressler, 2020). The program is done through the following phases:

Phase 1: This is the concept and development phase to explore the technical merit and feasibility of the proposed idea or technology. This may usually last for 6 months for $150,000 or less.

Phase 2: This is when the prototype is developed and its commercialization potential is evaluated. This can last approximately 24months for $1M or less.

Phase 3: This is the commercialization phase including the testing and evaluation of products, production contracts, and/or R&D activities. In this phase, there is no limit on the number, duration, type, or dollar value of the award therefore the award cannot be funded by the SBIR program.

The goals of the program are as follows, increasing private sector commercialization of innovations resulting from Federal research and development funding, enhancing the participation in innovation and entrepreneurship of women and socially disadvantaged persons, revitalizing technological innovation, and lastly, meeting federal research and development needs. In short, the SBIR seeks to fill the funding gap that exists which is left by other funding sources. Across federal agencies disbursing SBIR funds, the DoD accounts for close to half of SBIR spending (Chimento III C,2020).

A study was done by a DoD-funded technology transfer center to quantify the economic impact of the DoD's SBIR Phase 2 contracts. The study highlighted that, of the 36 NAICS codes which received 95% of the income between 1995 and 2018, 86% were attributed to firms within the manufacturing

sectors. The study's major findings were that within that time frame, the DoD invested $14.4 billion in small business R&D which resulted in $28 billion in sales of new products to the U.S military, $347 billion in total economic impact nationwide, $121 billion in total sales of new products and services and 1,508,298 jobs.

Another smaller program, the Small Business Technology Transfer (STTR) is different from the SBIR in that it requires a formal collaboration with a research institution. This is motivated by the knowledge that research laboratories are influential in the development of cutting-edge technologies and the entrepreneurial nature of small businesses are the best suited to transform the theories into practical applications. However, coordination costs associated with the STTR make them less popular among small businesses. (Chimento III C,2020)

However, new vendors joining the DoD industry are not leveraging the SBIR/STTR opportunity to join the pool of DoD vendors. A study by Bressler A & Bressler A (2020) found that between 2010-2019, most new entrants were not innovative commercial companies with dual-use potential. Additionally, concerning Phase 1 participants, majority winners had existing DoD business.

OECD countries and the significance of Defense procurement

One aspect of defense procurement in defense R&D according to the earlier research by Draca (2012) as cited by Carril and Duggan (2018) argues that defense procurement increases private contractors' innovations. According to Moretti et al (2019), in many OECD countries, R&D defense expenditures represent the most significant form of public subsidies for innovation. Their study finds evidence that government-funded R&D for an industry or a firm leads to a significant increase in private sector R&D in that industry or firm. They found that on average, a 10% increase in government-financed R&D led to a 5% to 6% additional increase in private R&D. Therefore, estimates found in this study suggest that defense-related R&D is responsible for a significant part of private R&D investment in some industries. As an example, in the U.S. Aerospace Products and Parts industry, defense-related R&D was responsible for $3,026 million in 2002(nominal). However, while defense R&D is a good vehicle for an increase in private R&D, these results are not a direct implication for defense-related R&D as the most efficient way for the government to stimulate private sector innovation and productivity.

Therefore, working with the federal government and specifically, the DoD is a significant opportunity for small businesses in terms of financial gains and the potential increase in innovation capacity. Additionally, small businesses are poised to benefit due to the deliberate will of the federal government to support small business growth. Defense procurement is a key vehicle for economic growth that can be harnessed to enhance the manufacturing and technological capabilities of small manufacturing firms to concurrently strengthen national security.

3. Overview of Hypotheses

As previously mentioned, some firms have stood out as consistent winners of DoD contracts despite an overall decrease in the number of firms joining the pool of contractors for the DoD. In the following section, I will present literature on some key attributes known to play a role in differentiating small firms' efficiency and competitiveness. I will elaborate on the role that geography, export orientation, research and development capability, and quality certification can play in setting small firms apart.

3.1 Geographical distribution of manufacturing job concentrations

Geography plays an important role when it comes to the location of a business, more so for small businesses. Early research in economic geography highlights customer proximity and critical production inputs proximity as key drivers of geographical clustering (Von Thunen (1966), Weber 1928 and Isard 1949 as cited by Sorenson,2018). However, depending on the type of product, or stage of production,

different environments provide different resources. Campi et al (2004) state that in the early stages of the product cycle, firms will tend to locate in diversified environments but as the production process becomes standardized, the internal factors of the firm necessitate a greater geographical dispersion. Hey highlight that external economies' influence plays a role in the distribution of industrial activities in an area. A theory also sustained by early research by Jacobs (1969) who believed that important knowledge was found outside of the core industry (Glaesser, et al,1992). For example, firms engaged in activities requiring higher R&D will be located in large cities offering diversified environments with a small degree of specialization (Feldman and Audretsch,1999 as cited by Campi et al,2004). These cities which are densely populated will have a greater pool of skilled workers, will be less risk-averse, and have a greater ability to learn and create innovations (Glaesser 1999 as cited by Campi et al,2004).

According to Marshall (1890) as cited by Campi et al (2004) the efficiency of firms is increased by externalities such as a shared labor market, firms providing specialized inputs, and the presence of information flows present in medium-sized and small cities. This has been defined as the economies of agglomeration, where firms in similar industries benefit from locating near their competition to benefit for example from shared specialized suppliers (Piore and Sabel,1984: Porter 2000 as cited by Sorenson 2018), and also allows the sharing of innovation costs and a more rapid innovation adoption (Romer 1986, Saxenian 1994, Audretsch and Feldman as cited by Sorenson, 2018). This leads to a less diverse industrial mix given the high importance of externalities between agents of the same industrial sector. Ames, Iowa as found by Armstrong and Traficonte(2021) is an example of successful manufacturing due to its strong labor force and existing strong ties between the Iowa State University and local manufacturers which reinforced findings by Marshall (1890).

With respect to industries, where knowledge spillovers are important, early research by Audretsch and Feldman (1996) suggests that innovative activity tends to cluster even after controlling for production. Knowledge spillovers in this respect refer to new economic knowledge gained from industry R&D, university R&D, and skilled labor. This can be applied to the manufacturing sector where knowledge spillovers in terms of R&D and skilled labor are key to continued innovation. A study by Armstrong and Traficonte(2021) found that despite the downward trend in manufacturing capabilities, firms that operate in a high-technology, high-wage equilibrium and regions with supportive manufacturing ecosystems have excelled.

However, research has also shown that some industries which do benefit from the economies of agglomeration may experience something different where companies located further from other similar companies experienced higher success rates. The biotechnology industry exhibited this pattern (Stuart and Sorenson, 2003 as cited by Sorenson, 2018) where biotechnology companies located further from other biotechnology companies were more successful in that they had a higher probability of being acquired or of going public. However, an entry into the industry occurred in the most concentrated regions. Other industries which have shown the same pattern include metalworking plants (Appold, 1995, as cited by Sorenson, 2018) and the computer industry (Sorenson 2005, as cited by Sorenson, 2018). Therefore, with respect to the manufacturing industry, industry concentration in an area plays a key role in the growth of a specific firm through the provision of external resources.

Hypothesis 1: Firms located in areas with higher levels of manufacturing have a higher probability of winning contracts than others located in areas of low manufacturing concentration

3.2 Competitiveness through export orientation

A competitive firm is one able to overcome new markets, compete against other actors in the market, attract new investments and grow. Research shows that exporting firms tend to be more competitive, experience firm growth, and increase their R&D spending. A study by Kalafsky ad Macpherson (2002) on the Machine Tool industry showed that the revival of this industry had been driven by a combination of factors such as export involvement, improved customer support, and improved product design. To be able to compete in this market where major foreign products benefited from

economies of scale, better pricing, and higher quality products, U.S firms opted for specialized niche markets, a strategy that also benefited small firms. The study also found that this export-focused approach led successful U.S producers in this industry to resemble foreign competitors in terms of different characteristics including R&D spending. Additionally, this study found a major distinction between exporters and non-exporters in that the former had been creating new jobs at faster rates than the latter. However, a study by Bernard and Jensen (2004) found that while exporting strengthens a firm's productivity, this trend predates its entry into exporting. It was found that while exporting firms showed higher productivity and technological sophistication than other plants in the same industry, exporting itself did not seem to confer any observable benefits (Clerides et al, 1998: Bernard and Jensen 1999, Delgado et al, 2002 as cited by Bernard and Jensen 2004). This finding is also confirmed by Love and Roper (2015) and Cassiman et al, (2015) who suggest that innovative firms with higher levels of productivity and economic growth will also likely be successful exporters. The previous study also found that exporting is associated with a reallocation of both labor and capital inputs to more efficient plants (Clerides et al, 1998: Bernard and Jensen 1999, Delgado et al, 2002 as cited by Bernard and Jensen 2004). Therefore, trade served to facilitate the growth of high-productivity plants (at the expense of less productive plants) but not to increase productivity at said plants.

Further, firms competing in rapidly changing global markets must be able to decrease their product development time and respond quickly to demands requiring product changeover (Mechling et al,1995). Other costs associated with exporting include information exporting opportunities(Bachetta and Jensen, 2003 as cited by Falciola,2020) Therefore exporters may be more apt to respond to the stringent requirements of the DoD and may be more willing to get into a contract agreement with them.

Exporting can be a costly endeavor. Entering export markets requires capital-intensive efforts which include high up-front costs and high variable costs. (Bellone et al,2010; Berman & Hericourt, 2010 as cited by Falciola, 2020). Therefore, due to financial constraints experienced by small firms, most might not enter into international markets due to the high costs associated with doing so.

Hypothesis 2: Exporting firms have a higher probability of winning contracts than non-exporting firms.

3.3 Quality standards

The emergence of global supply chains, where suppliers from one country produce input shipped to a multitude of other countries has been followed by the global diffusion of international management standards such as ISO 9000. This quality certification is considered the basis for quality management and through standardization of procedures ensures consistency in the quality of products or services (Rao et al,1997). This type of voluntary standard contributes to the mitigation of barriers related to information asymmetries existing among different actors in the supply chain (Blind K et al,2020). The ISO 9000 standard, created in 1987 and issued by the International Organization for Standardization (ISO), codifies international management practices and is the foundation for certification. Since its inception, it has been deemed a remarkable quality management system (QMS). (Hussain et al,2020). This standard is used by organizations for improvements and documentation of their systems to increase quality and efficiency.

Companies use ISO 9000 as a signalling tool for their collaborators as their investment in quality upgrading and quality performance (Ferro,2011 as cited by Blind K et al,2020), portraying a positive image to stakeholders, increasing their competitive edge in the marketplace and increased business credibility (Hussain et al,2020). Blind K et al (2020) state that ISO certifications in importing countries lead to the diffusion of ISO 9000 in exporting countries. In other words, firms in exporting countries are incentivized to pursue the ISO 9000 certification in order to access markets with firms in importing countries. According to Corbet (2005), companies actively seek certification to become global supply chain suppliers.

Concerning U.S. firms, studies have shown that ISO 9000 is associated with company growth due to the reduced information asymmetries within the supply chain.(Terlaak and king,2006 as cited by Blind K et al,2020). Further., Bakator and Cockalo's (2018)'s review, found that ISO 9001 certification can

improve operational performance, financial performance, customer satisfaction, and business performance. However, their review also found that some papers did find no difference between certified and non-certified businesses in terms of business performance with some papers' findings stating no clear benefits before and after an ISO 9001 certification. The results of an ISO 9001 certification were found to be highly contingent upon the type of organization, size, industry, market, customers, and culture of the organization.

Hypothesis 3: Small ISO 9000 certified firms have a higher probability of being contract winners than non-certified firms

3.4 Research and Development(R&D)

There exists a large body of literature that has argued that R&D is a key driver of firm productivity growth, therefore serving as a motivation for small manufacturing firms to pursue R&D funds both public and private. Other motivating factors to pursue R&D funding are that firms benefiting from government R&D subsidies will undertake even further private R&D (Moretti et al,2019) which in turn also results in productivity gains. Earlier in research, Wallsten (2000) took a closer look at government and industry R&D programs' effect on private R&D with a focus on the DoD SBIR program. The study found that firms with more employees and appeared to do more research won more SBIR grants. However, the study also found that these funds did not allow firms to engage in more R&D. The latter finding may also be interpreted as the government grants allowing firms to not discontinue existing R&D efforts and by reducing the cost to the firms, the subsidy may make the projects also privately profitable. These early findings highlight the importance of accounting for the firm's existing R&D activity for government subsidies when the government decides what firm to subsidize. Consequently, firms already investing in R&D are more likely to win government subsidies, over those who do not which may also lead to further engagement in private R&D.

An R&D strategy that may yield significant results for small firms may be the adoption of a 'deep niche' strategy for product diversification. As Qian (1999) posits, small firms generally lack resources to sustain large-scale R&D operations and thus should carve out well-defined niche markets, for example with the DoD which often requires specialized products, and by also creating cooperative relations to maximize opportunities. The study found that the profitability of a firm tended to increase as product diversification increased when the firm expanded into lines of business related to its original products. This strategy may be facilitated by programs such as the SBIR.

Hypothesis 4: Firms winning SBIR grants have a higher probability of being categorized as contract winners.

4. Data and Empirical Strategy

4.1 Data

In this research, I aimed to identify factors that differentiate small business awardees of DoD contracts from those who are not, given the declining trend of small business awardees.

Based on previous literature, evidence has shown that small businesses have adopted key practices which have allowed them to remain competitive in an increasingly global and challenging market. I relied on several data sources whereby the DoD's spending data (2011-2021) represents the primary data source. Data for treatment assignment was retrieved from research conducted by Armstrong and Traficonte (2021), the SBA, and Compustat. I used these data to create the winner and loser framework where I define winners as first who, following their first contract, consistently secure more contracts over a period of at least 4 years, and losers as those firms who fail to do so.

Federal Spending data

To perform the analysis, I relied on federal spending data found at USAspending.gov, which is the official source of data on federal spending as my primary data source. The site is run by the Department of the Treasury. I retrieved all data specific to all contracts awarded to small businesses by the DoD for the period from 2011 to 2021 and further shrunk the data to only small businesses in the manufacturing sector. I had a dataset of 58,559 unique small firms which have been contracted by the DoD in the last decade. This data was chosen due to its reliability but also the firm-level information such as the firm's unique identifier and SBIR grantee status, industries in which the firm operates, and the availability of the data necessary to construct the outcome variable of interest.
In terms of data quality, a 2021 review by the GAO found that the timeliness, completeness, and accuracy of the data have continuously improved. However, limitations still persist in terms of consistency of award data with agency records, business process controls with respect to detecting and preventing inaccurate data displays, and the data limitations disclosures from agencies (GAO-22-104702).

Small business data

I also relied on data on small businesses provided and maintained by the Small Business Administration. Small businesses were defined as businesses with at most 500 employees. This data provided information on the small businesses exporter status which I used as a proxy for the competitiveness of firms and separate data on quality standards certifications the firms possess, with a specific focus on ISO status. I also narrowed that data to the five states where the DoD's contract values have been the highest in the last decade.

Geographical Data

Data to analyze the significance of manufacturing concentration on success was based on the manufacturing performance of 300 U.S. metro areas provided through research by Ben Armstrong and Dan Traficonte (2021). The aggregated data include manufacturing job share which indicates high and low-performance manufacturing regions, population, earnings, and jobs between 2001 and 2019. The data also includes the density of start-up firms. The goal was to use some of these region variables as controls for manufacturing performance.

Compustat data

I relied on Compustat data and downloaded capital expenditures by NAICS codes between 2011 and 2021. Capital expenditures represent cash outflow or funds used for additions to the company's property, plant, and equipment such as capital leases and construction funds.

4.2 Empirical strategy

Over the last decade, despite the declining trend of contracting dollars awarded to small businesses, some firms managed to consistently win contracts with the DoD. As I sought to understand the factors which made these firms stand out and continuously win contracts, I used a collection of conditional statements to create winners and losers' framework to categorize firms into 2 groups forming my outcome variable. This final dataset was later used as the foundation of my analysis to estimate the significance of factors necessary to test my hypotheses.

Creating the variables

The data was first reduced to the most relevant indicators which included the DUNS number of the recipient firms, the unique award identifier, the action date fiscal year and action date (The date the binding agreement was reached), the period of the performance start date, the period of the performance end date and the current total value of the award. These indicators were the foundation of my framework as they are key in determining which firms consistently won contracts. Using the Python programming language, I transformed the data and created new columns including contract days and action years. I then aggregated the data for each unique firm's DUNS to create new columns including the count of contract

days, total amount awarded, number of contracts, number of active fiscal years, and the longest contract length to better understand the data of each firm's outcome over the last decade. I further create new columns including the total number of days during which a firm was under a contract which is then used to measure the percentage of time the firm was under contract. Lastly, I consider the last year a firm was under contract. This last column was helpful to differentiate between two types of firms. There are firms that may have had a high number of contract days; days between the first day of their first contract signing and the last day of their last contract signing, in which they were contracted; but appeared to only be under contract for less than 50% of those days. This implies that a firm might have secured contracts sporadically over an extended amount of time. All these transformations were necessary for the later categorization of firms as winners or losers. Therefore, winners are firms that managed to secure subsequent contracts after their first contract and managed to do so for a period of over 4 years.

Dealing with outliers

Following the aggregation to calculate the total amount awarded per firm, the statistical distribution of this variable highlighted the presence of outliers. To ensure the results are not skewed by the outliers, it is customary to either drop or winsorize them. I first used the interquartile method to identify the outliers and of the 50,324 non-zero contracts awarded, 8,496 stood out as outliers. The alternative to dropping the outliers and losing the information of 8,496 firms, is to winsorize them. We winsorize the upper tail at 95% as it is recommended. With this method, 2,517 firms on the right tail are assigned the same maximum value. To proceed with the analysis, I opted to consolidate the data to ensure that I lost the minimum amount of information on the firms.

4.2.1 The framework

The framework was created as a succession of conditional statements to identify winners based on their last year of the contract, their number of contracts, their number of active fiscal years, the total number of days they were under contract, and the percentage of time they were under contract. The conditions for the categorization first considered firms whose last contract year was after 2016. With this, I assumed that a firm that had not been awarded a contract since 2016 was not a winner. I chose 2016 as a cut-off to remove firms who haven't contracted with the DoD in over 5 years. This was followed by an exclusion of firms with less than 1 contract and who were active for less than 2 fiscal years and those, who had more than one contract but were still only active for less than 2 fiscal years. I then identified firms with over 2 active fiscal years, at least over 1460 total contract days (4 years' worth of contract days), and over 50% time under contract as winners. I chose to include the 4 years' worth of contract days as a condition to create a lower bound for the longevity among winning firms. The rest were categorized as losers. With this framework, ~19% of firms were categorized as winners which is reasonable with respect to the declining trend of small firms winning contracts over the last decade.

Table 1. Summary Statistics of the Framework's Outcome

Success	count	mean	Std-dev	min	25%	50%	75%	max
N	40917	3.92E+06	6.03E+08	0.01	12757.16	43150.08	167473.8	1.22E+11
Y	9407	6.15E+07	7.12E+08	0.06	728085.495	2476809.37	9902170.58	4.95E+10

4.2.2. The models

The logistic regression models

The logistic regression model or the logit model is a case of a generalized linear model used to model data with a nominal outcome variable. The analysis for the logistic regression model assumes the outcome variable is a categorical variable, with this variable being dichotomous having either a success or failure as the outcome. For this analysis, the model parameter estimates' fit should be assessed. In all 4 analyses which used a logistic model, the models obtained contained the main categorical variable of interest as well as control which may be affecting our results to account for a potential omitted variable bias. This model does not assume a linear relationship between the dependent variable and the independent variables and the latter do not need to be normally distributed, no variance homogeneity, error terms do not need to be normally distributed and the independent variables need not be unbounded. (Wright 1995 as cited by Maxwell, 2009).

The negative binomial regression model

Given that the number of contracts awarded to unique firms is strictly positive and constitutes a count, I used a negative binomial regression model. I opted for a Negative Binomial rather than a Poisson regression model since the dependent was strongly over dispersed; the variance of the count variable was significantly greater than its mean.

4.2.3 Defining variables for the hypotheses

Geographical concentration effects

To assess the significance of the geographical factor on the probability to be categorized as a winner or a loser, I combined the winsorized data created based on the federal spending data and a dataset capturing metropolitan statistical areas and manufacturing jobs created by Ben Armstrong. I used a logistic regression model because my outcome variable, success, is a binary variable. The main independent variables are manufacturing job share by metropolitan statistical area (MSA) and I controlled for location-specific variables such as population (logged values to reduce the effect of outliers) and the share of young firms as a percentage of overall firms. These were selected due to the potential effect on manufacturing jobs share within an MSA. I also assessed the significance of manufacturing jobs on the number of contracts awarded and the total value of contracts awarded with similar controls as in the previous model.

Table 2. Descriptive statistics on location level data

		N	Mean	Std.Dev	Min	Max
manufacturing_job_share	Share of jobs by MSA in manufacturing	35348.00	0.07	0.03	0.01	0.37
log_population_size	Natural Logarithm of the total population by MSA	35348.00	14.51	1.24	11.01	16.40
young firms	Portion of firms by MSA that are young firms	35348.00	0.44	0.12	0.00	0.88

Table 3. Descriptive statistics for firm level data

		N	Mean	Standard Deviation	Min	Max
Success	1 = firm categorized as successful based on the framework 0= otherwise	35348.00	0.19	0.39	0.00	1.00
log_amount_won	Natural logarithms of total amount awarded per firm	35348.00	11.54	2.39	-4.61	16.24
number_contracts	Total number of contracts per firm	35348.00	112.97	1751.49	1.00	111996.00

The figures below show the potential association between manufacturing job share and population and the share of young firms. Across both factors, winning firms seem to behave similarly, therefore, accounting for omitted variables in their association with a manufacturing job share. However, there seems to be no difference between successful and unsuccessful firms.

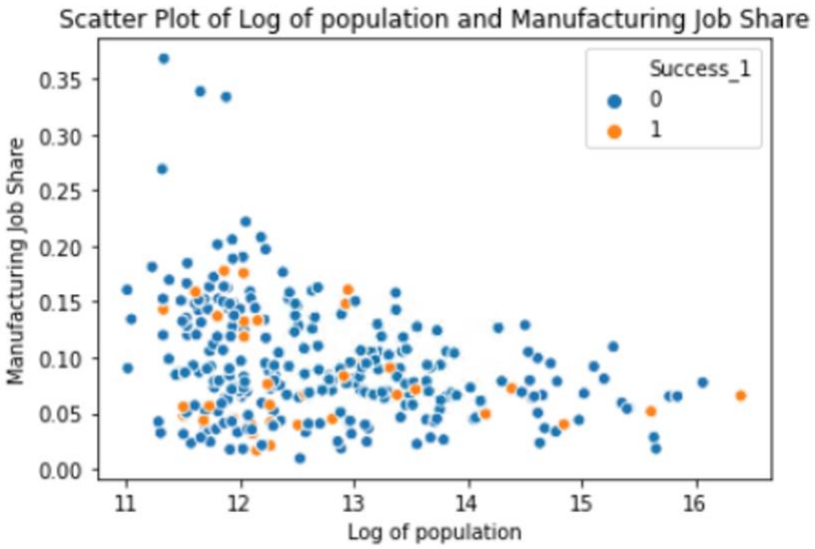

Figure 1. The points represent successful and unsuccessful small firms for manufacturing job share by population size by MSA

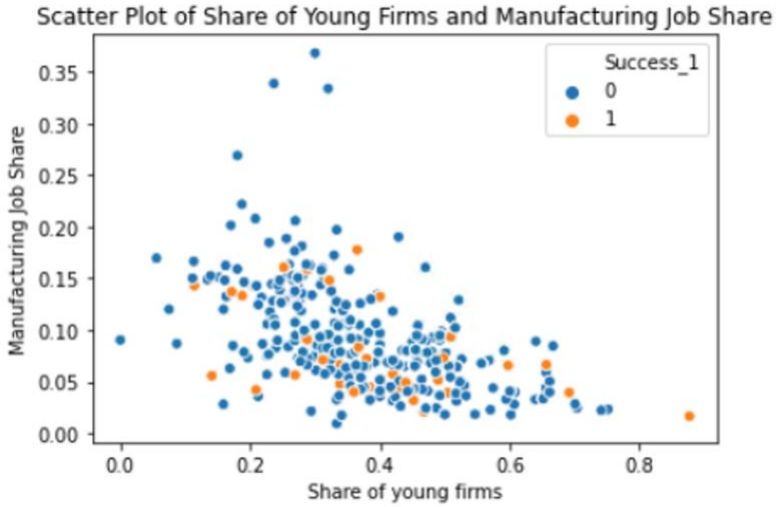

Figure 2. The points represent successful and unsuccessful small firms for manufacturing job share by share of young firms by MSA

R&D effects

To assess the significance that being awarded an SBIR grant has on the probability of success, I isolated firms that have been awarded SBIR grants for different phases and looked for the significance of their coefficients. I then used a logistic regression model to assess the significance of award phases on the probability of success. Additionally, I used an OLS regression to assess whether firms gaining SBIR grants were associated with higher valued awards. I also used a negative binomial regression to assess whether firms awarded SBIR grants were awarded more contracts on average.

I created an indicator variable for the 3 stages of SBIR phases (1-3) and the next 3 stages of STTR phases (3-6) and the table below illustrates descriptive statistics. Table 3 below shows that the vast majority of the firms in our sample show no record of being granted research and development funds. Table 4 shows that within successful companies' rates, 96% are non-grantees and within non-successful firms, the majority remain non-grantees at 98%. This is to be expected given the vast difference in number between the categories and the limited sample of grantees.

Table 4: Summary statistics for each research code

Research_Code	Freq.	Percent
0	10702	97.23
1	60	0.55
2	53	0.48
3	125	1.14
4	7	0.06
5	7	0.06
6	53	0.48
Total	11,007	100

Table 5. Descriptive statistics success levels within grantees and non-grantees

	Granted		
Success	0	1	total
0	7,155	155	7,310
1	3,547	150	3,697
Total	10,702	305	11,007

Competitiveness effects through export orientation

I used exporter status as a proxy for the competitiveness of a firm. To assess the significance that different exporter status has on the probability of success, I once again focused on the top 5 states which received the highest number of awards from the DoD in the last decade; California, Florida, New York, Virginia, and Pennsylvania. I retrieved data from the SBA on firms within those states and their exporter status. The exporter status was expressed in 3 values- Yes, No, and Wants to Be. I also combined this data with the acquired Compustat data and controlled for capital expenditures within industries to which these firms belong.
Following this categorization, I used a logit model to assess the significance of these factors on the probability of success. Additionally, I used an OLS regression to assess whether exporting firms were associated with higher valued awards. I also used a negative binomial regression to assess whether exporting firms were awarded more contracts on average

To assess the significance of exporter status, I created an indicator variable exporter for each exporter status 0-3 for Non-Exporter, Wants To Be an Exporter, and Exporter respectively. I also included those whose exporter status was unknown with indicator variable 99. I assessed the significance of the exporter status by controlling for average capital expenditures The distribution of the three categories is shown below.

Table 6.1 shows that among the companies whose export status is known, exporters are the majority, however, 93% of the companies within the 5 states of interest do not have a declared export status. Table 6.2 shows the distribution of winners within companies of varying exporting statuses. Within non-exporters, winners are evenly distributed; within companies that want to become exporters, a slight majority,55% were classified as losers and within exporters, 66.4% are losers. Lastly, within companies whose export status is unknown, 77.6% were classified as losers. For my analysis, I focused on companies whose exporter status was known and assessed the effect of their status on their success likelihood.

Table 6. Summary Statistics for exporter status

Exporter?	Freq.	Percent
0	55	0.34
1	228	1.43
2	841	5.26
99	14,857	92.97
Total	15,981	100

Table 7. Success by exporter status

	Success_1		
Exporter?	0	1	Total
0	27	28	55
1	126	102	228
2	559	282	841
99	11,535	3,322	14,857
Total	12,247	3,734	15,981

Quality effects

To assess the significance of quality standards on the probability of success, I combined data from the SBA with the winsorized federal data. I first identified the top five states where the DoD had spent the highest contract amounts. The states identified were California, Florida, New York, Virginia, and Pennsylvania. While retrieving data from the SBA, I focused on the states stated above and I retrieved it in two parts. The first dataset contained firms that had the ISO 9000 voluntary certification, which yielded 2067 firms, and in the second run, I retrieved firms that had at least one certification among the following: ISO 10012_1, ISO 9000, MIL-STD-45662A, MIL-Q-9858, and ANSI/ASQ Z1.4. This second search yielded 2527 firms. I then created a categorical variable where firms whose certifications included the ISO 9000 series were given a value of 2, those with other certifications which did not include the ISO-9000 series a value of 1. This combination also highlighted a large number of firms whose certification standards were not specified in the federal spending data. This may be due to them not being registered with the SBA or them not having reported their registration standards to the SBA. The latter was given a value of zero. These results are shown in Table 7. This may be a source of error given the quality certification status of 93% of the firms in the sample was unknown as shown in Table 8. I then

used a logit model to assess the significance of the quality assurance standards on the probability of success due to the outcome variable being binary. Additionally, I used an OLS regression to assess the significance of different quality standards' association with higher valued awards. I also used a negative binomial regression to assess whether firms associated with certain quality standards were awarded more or fewer contracts on average compared to others.

Table 8. Summary statistics by firm's certification status

Certs	Freq.	Percent
0	16,089	92.9
1	244	1.41
2	986	5.69
Total	17,319	100

Table 9. Summary statistics of successful firms by certification

	Success_1		
Certs	0	1	Total
0	12,896	3,193	16,089
1	132	112	244
2	496	490	986
Total	13,524	3,795	17,319

5 Results and Discussion

5.1. Impact of attributes on probability of success

Manufacturing concentration

Using the logistic model, we regress success over manufacturing job share in the metropolitan service area (MSA) including controls such as the population and the share of young firms as a percentage of overall firms. These control variables were chosen due to their significant impact on our main dependent variable, the manufacturing job share whose effect on success we are measuring. Table 9 presents the main results.

Table 10. Main Regression Results for location effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	success outcome	success outcome	success outcome	number of contracts	number of contracts	Log amount awarded	Log amount awarded	Log amount awarded
mfjobshare19	-0.396	1.655***	14.89**	-1.088	-1.020	-1.689***	0.217	9.122**
	(0.413)	(0.499)	(5.900)	(1.908)	(2.260)	(0.389)	(0.461)	(4.564)
ln_pop19		0.120***	0.627		-0.0810		0.0645***	0.357
		(0.0126)	(0.520)		(0.0736)		(0.0114)	(0.367)
Youngfirms		0.145	1.334		0.580		0.489***	-7.395
		(0.136)	(8.371)		(0.825)		(0.125)	(4.907)
Constant	-1.405***	-3.365***	-11.77	4.804***	5.716***	11.66***	10.38***	7.630
	(0.0322)	(0.192)	(8.038)	(0.168)	(1.065)	(0.0307)	(0.173)	(5.088)
Observations	35,348	35,348	35,107	35,348	35,348	35,348	35,348	35,348
R-squared						0.001	0.002	0.026
MSA FE	No	No	Yes	No	No	No	No	Yes

Notes: This table presents results from the logistic regression, negative binomial and log-linear regression for the successful contracting, number of contracts and amounts awarded respectively. Controls include total population across metropolitan state areas and share of young firms across metro state areas. The analysis is on the DoD spending data over the period of 2011-2021, combined with geographical location data disaggregated at metropolitan state area level at the 2019 levels. Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1

After including controls that take into consideration population and other statistics as shown in column (2), the model gains significance from its insignificant result in column (1). The model indicates that an increase in MSA manufacturing job share is associated with an increased log odds of success of 1.655. In column (3) when we include location fixed effects, the log odds of success associated with an increase in manufacturing job share increase by 14.89. This indicates that being in an area of high manufacturing concentration increases a firm's log odds of success. This finding aligns itself with the literature which highlights the benefits for small firms of being in environments with a high manufacturing industry concentration.

I followed the analysis with a regression of the number of contracts won by firms on the previous predictors to understand the relationship between firms and the DoD further. Since the number of contracts was part of the variables used to construct the success/failure framework, for these analyses, I also analyzed whether location had any effect on these firm variables.Given that the number of contracts won is a count variable and that it is over-dispersed, I used a negative binomial regression model to estimate the significance of the location of the firm on the number of contracts it wins. The negative binomial regression model here was chosen because the variance of the number of contracts exceeded the mean of the number of contracts, which indicates overdispersion. I further analyzed these differences for

the amount awarded to each firm holding fixed population and labor statistics. As can be seen in the table of results above, columns (4) and (5) do not produce significant results for the potential effect of location on the number of contracts. However, the analysis of the amount awarded, with location fixed effects as shown in column (8), produces significant results. An increase in manufacturing job share is associated with an increase in the amount awarded controlling for population, and the share of young firms found in the area and including MSA fixed effects. Therefore, the DoD is more likely to contract small manufacturing firms belonging to manufacturing ecosystems over those that are isolated.

R&D

I sampled firms who have been awarded SBIR ad STTR grants. Using this initial sample's MSA information, their NAICS industries, and the sub_agencies from which these grants were received, I found similar companies, that were non-grantees but resided in the same metropolitan areas, same NAICS Industries, and who had won contracts with the DoD sub_agencies who disbursed the SBIR and STTR grants. This created a sample of 11,007 unique firms.

Table 11. Main Regression Results for R&D effects

	(1)	(2)	(3)	(4)
VARIABLES	success_outcome	number_contracts	log_amount_awarded	success_outcome
1.granted	0.669***	0.860*	2.092***	
	(0.116)	(0.452)	(0.115)	
SBIR_3				1.101***
				(0.184)
Constant	-0.702***	5.061***	12.40***	-0.695***
	(0.0205)	(0.0915)	(0.0236)	(0.0203)
Observations	11,007	11,007	11,007	11,007
R-squared			0.020	

Notes: This table presents results from the logistic regression, negative binomial and log-linear regression for the successful contracting, number of contracts and amounts awarded respectively. Controls include the log of counts of industries across which a firm operates. The analysis is on the DoD spending data over the period of 2011-2021. Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1

Results show in column (1) that firms that have been awarded an SBIR grant show a higher likelihood of success. The log odds of success increase by 0.669 between a granted and non-granted firm. Further, I analysed specific firms which have won SBIR phase 3 grants, and column (4) results show that firms in this category have a higher log-likelihood of winning DoD contracts. These findings imply that being part of an R&D ecosystem such as the SBIR improves the likelihood of firms successfully contracting with the DoD.
This finding confirms the hypothesis that firms with higher levels of R&D activities are on average more likely to win contracts than other firms.

Further, I assess the significance of different grant statuses in their effects on the number of contracts won by firms and their effects on the values of the awards. Findings show that being awarded a grant positively significantly affects the number of contracts awarded however at a 10% significance level. The expected log count of the number of contracts awarded increases by 86 percentage points for a firm in the SBIR or STTR program. Additionally, being a grantee significantly affects the total value of the amount awarded. Being granted SBIR or STTR funds is significantly positively associated with an increase in the amount awarded. Therefore, companies who appear to have received SBIR and STTR funds from the DoD, seem to have higher probabilities of success than those who have not. This may imply a tendency of the DoD to work with companies involved in R&D at different levels and most especially companies whose capabilities lead to the commercialization of novel products.

Competitiveness through export orientation

I assess the significance of the exporter status on the success probability of firms. I controlled for average capital expenditures per NAICS codes.

Table 12. Main table of results for exporter effects

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	success_outcome	success_outcome	number_contracts	number_contracts	log_amount_awarded	log_amount_awarded
1.exporter_yes	-0.521***	-0.588***	-1.728**	-1.909***	-0.425**	-0.332**
	(0.140)	(0.169)	(0.701)	(0.720)	(0.173)	(0.148)
ln_capx_mean		0.910***		0.506***		0.632***
		(0.0620)		(0.0676)		(0.0358)
Constant	-0.163	-5.261***	6.315***	3.042***	12.88***	9.451***
	(0.119)	(0.397)	(0.668)	(0.933)	(0.151)	(0.239)
Observations	1,124	1,124	1,124	1,124	1,124	1,124
R-squared					0.006	0.234

Notes: This table presents results from the logistic regression for successful contracting. Controls include the log of counts of industries across which a firm operates and the log of capital expenditures averaged across NAICS industries. The analysis is on the DoD spending data over the period of 2011-2021. Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1

Using a logistic regression model column (1) shows that being an exporter decreases the log odds of success by 0.521 between a non-exporting firm and an exporting firm. These further decreases when we control for capital expenditures where these log odds of success decrease by 0.588. I then assess the significance of exporter status on the value of contracts awarded and on the number of contracts awarded. I used OLS regression and negative binomial regression model respectively. As results show, in columns (3) through column (6), exporter status is significantly associated with the value of contracts awarded and the number of contracts awarded and is robust to the addition of controls.

For the number of contracts awarded, the expected log count of the number of contracts awarded decreases by 1.7 from a non-exporter to an exporter. Further, our results are robust to controls. As shown in column (4), the expected log count of the number of contracts awarded decreases by 1.9 from a non-exporter to an exporter, a slightly bigger decrease than in the previous analysis. For the value of contracts awarded, being an exporter is associated with a 33.2% decrease in the amount awarded holding capital expenditures fixed. Therefore, non-exporter status is on average associated with better performance compared to the exporter status in their dealings with the DoD.

In the table below, I investigated whether there exists a significant difference between exporters and want to be exporters relative to non-exporters and their performance in contracting with the DoD.

Table 13. Secondary results for exporter status

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	success_outcome	success_outcome	number_contracts	number_contracts	log_amount_awarded	log_amount_awarded
1.exporter	-0.248	0.243	-2.236**	0.405	-0.0542	0.307
	(0.301)	(0.382)	(1.033)	(1.156)	(0.388)	(0.347)
2.exporter	-0.721***	-0.394	-2.999***	-1.590*	-0.469	-0.0848
	(0.280)	(0.356)	(0.962)	(0.855)	(0.359)	(0.326)
ln_capx_mean		0.914***		0.519***		0.634***
		(0.0625)		(0.0605)		(0.0361)
Constant	0.0364	-5.474***	7.587***	2.647***	12.92***	9.193***
	(0.270)	(0.535)	(0.938)	(0.956)	(0.349)	(0.392)
Observations	1,124	1,124	1,124	1,124	1,124	1,124
R-squared					0.006	0.235

Notes: This table presents results from the negative binomial and log-linear regression for number of contracts and amounts awarded respectively. Controls include the log of counts of industries across which a firm operates. The analysis is on the DoD spending data over the period of 2011-2021 and SBA data within the main 5 states of interest. Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1

As the results in the table above show, the successful performance of firms who want to become exporters relative to non-exporters is not statistically significant. For the number of contracts, the expected log count of contracts awarded decreases by 1.590. For the amount awarded, the models do not yield significant results. While the differences do not yield significant results, these confirm the findings from the logistic regression model in table 7.1 where non-exporters are more likely to win more contracts than exporters and also win higher valued contracts than non-exporters. Additional data on the export statuses of the over 14,000 firms with no recorded export status would contribute to strengthening the findings in this model. However, despite the significance of my results, the small sample size may not be representative of all contractor firms.

Quality standards

I used a logit model to assess the significance having quality certifications has on the probability of success for firms

Table 14. Main regression results for certification effects

	(1)	(2)	(3)
VARIABLES	success_outcome	number of contracts	log_amount awarded
1.cert	1.354***	0.731**	1.356***
	(0.0604)	(0.362)	(0.0767)
Constant	-1.396***	4.788***	11.56***
	(0.0198)	(0.113)	(0.0191)
Observations	17,319	17,319	17,319
R-squared			0.020

Notes: This table presents results from the logistic regression for the successful contracting. Controls include the log of counts of industries across which a firm operates. The analysis is on the DoD spending data over the period of 2011-2021. Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1

The table above indicates that certification increases the firm's log odds of success, the number of contracts awarded and the amount awarded significantly. The log odds of success increase by 1.354 when a firm is certified as shown in column (1). Further, column (2) shows that the expected log count of the number of contracts awarded is associated with a 73-percentage point increase for certified firms, and as seen in column (3), a change to certified status is associated with a 135.6% increase in the amount awarded for firms.
This finding confirms the hypothesis and suggests that certified firms, on average do better with their contracts with the DoD compared to non-certified firms.

Table 15. Secondary results for certification effects

	(1)	(2)	(3)
VARIABLES	success_outcome	number of contracts	log_amount awarded
1.certs	1.232***	-0.162	1.063***
	(0.130)	(0.239)	(0.173)
2.certs	1.384***	0.868**	1.428***
	(0.0667)	(0.390)	(0.0843)
Constant	-1.396***	4.788***	11.56***
	(0.0198)	(0.113)	(0.0191)
Observations	17,319	17,319	17,319
R-squared			0.020

Notes: This table presents results from the negative binomial and log-linear regression for number of contracts and amounts awarded respectively. Controls include the log of counts of industries across which a firm operates. The analysis is on the DoD spending data over the period of 2011-2021 and SBA data within the main 5 states of interest. Robust standard errors in parenthesis *** p<0.01, ** p<0.05, * p<0.1

As previous results show, certifications are significantly associated with the successful outcome of firms, the value of awards, and the number of contracts awarded to firms. In this section, I specifically investigated the difference in significance in terms of type certifications acquired by firms. Column (1) above shows that firms whose certification does not include the ISO 9000 (1. certs) do slightly worse than firms whose certifications include the ISO 9000 (2. certs) in their log odds of success. Additionally, in terms of the number of contracts awarded, column (2) shows no significance for firms, not ISO 9000 certified. In terms of the value of contracts awarded, similar to success odds, as seen in column (3), whose certifications include the ISO 9000 fair better than those without.
These findings also confirm the previous results which highlight the advantage held by certified firms, with an even further clear advantage of the advantage provided by the ISO 9000 certification.

5.2 Discussion

The previous section presented the results of the main logistic regression results, as well as negative binomial and log-linear regression results for a, renege of attributes related to what may lead a firm to outperform others in terms of securing a contract with the DoD. Across the board, geographical location, quality certification, and export status seem to be significant in predicting the probability impact of winning a contract while exporter status negatively affects winning prospects as measured by these outcomes. Coefficients for a high concentration of manufacturing industry, R&D, and quality certification significantly increase the odds of firms winning DoD contracts, whereas having an exporter status seemed to significantly negatively affect the probability of success. For R&D capabilities, results suggested that firms who were able to secure SBIR phase 3 funding had an increased probability of success compared to others. The obtained results remained consistent when I checked for their specific impact on the number of contracts won and the total value of contracts awarded which served to confirm that the framework used to classify firms into losers and winners captured firms appropriately.

I interpret these impacts in strengthening the DoD's contracting methods with small manufacturing firms in 2 ways. First, my findings point to the importance of existing industrial ecosystems in raising the capability of small manufacturing firms through the increased probability of success of firms located in areas with a high manufacturing concentration. This finding strengthens the current literature that points to the challenges faced by small manufacturing firms who were left without the capabilities to scale their ventures. The importance was further highlighted through the finding that firms whose R&D is advanced tend to win more contracts. Through the development of industrial ecosystems, where spillover effects such as knowledge externalities would take place, more small firms would be able to reach the commercialization phase of product development at faster rates.

Secondly, the negative influence of exporter status may be a consequence of the limited data on the exporter status of small firms contracting with the DoD where over 90% of the firms in our sample, did not have a recorded exporter status in the SBA database. These findings could be interpreted in several ways. It could be that either, non-exporters cannot take their business to the international market as a result of the onerous costs necessary to succeed and therefore have opted to focus on the niche market of being suppliers for the DoD. On the other hand, exporters may have opted to focus on the international market and refrained from working with the DoD due to the numerous challenges involved in doing so. Therefore, either of these alternatives should be studied further to ensure that DoD integrates

into its supply chain exporting firms which as mentioned in chapter 4 are likely more productive and more technologically advanced than non-exporting firms and have the potential to grow at faster rates than non-exporting firms. Further, through this existing network of non-exporting firms, the DoD can devise a strategy to help small manufacturing firms overcome entry barriers on the international market, therefore, increasing the competitiveness of their manufacturing industrial base and contributing to the technological advancements of small firms.

In general, the findings of my thesis add to and corroborate some of the prior empirical work on the different mechanisms and strategies that small firms adopt to stay competitive, grow and contribute to the nation's economy. As highlighted in Armstrong and Traficonte's (2021) study, supportive manufacturing ecosystems lead to growth in manufacturing capabilities, and Audretsch and Feldman (1996) also found that innovative activities tend to cluster both, strengthening the importance of ecosystems. Further, as highlighted by Hussain et al (2020), possessing international certification, globally accepted as a quality management system works as a signalling effect to potential clients of the quality of management of a firm. Further Blind K et al (2020) also emphasized their use to reduce information asymmetries across the supply chain, a quality necessary for a thriving supply chain. Lastly, Moretti et al (2019) indicate that firms benefiting from federal R&D spending may undertake further R&D which is corroborated by the finding that firms who win SBIR phase 3 grants outcompete others in that the latter firms are already at an advanced stage of research and development. Additionally, this may also suggest that firms in the DoD R&D ecosystem consistently secure contracts which suggests that new entrants do not utilize the SBIR/STTR as Bressler (2020) also found.
However, the finding for non-exporting firms was surprising as all research has pointed to exporting firms as being more productive and more competitive than others, which led to the valid assumption that exporting firms may outperform non-exporting firms for government contracts. In terms of the number of contracts and the total value of the amount awarded, the attributes varied in their significance pointing to potential noise in the data.

Finally, the discussion of my analysis must also bring up possible threats to the validity and limitations of the data. First, it should be noted that my framework for winners and losers was based on characteristics I believed ensured the capture of firms that have consistently won contracts with the DoD over the past decade. A different approach to this categorization may yield different results. While winsorization helped get rid of extreme outliers negatively impacting results, some information may have been lost which would have led to more robust findings. Further, for the attributes, there might be some other unaccounted-for strategies that may have played a role in helping some firms stand out over others. These include potential political connections of government contractors with suppliers which lead to continuous contracts (Dahlstrom,2021). For the SBIR grants, data on firms who may have applied for the grants and not received them but continue to work with the DoD under other capacities may have presented more accurate estimates of the effects said grants have on success probabilities. To the best of my knowledge, research into firm differentiating attributes of small manufacturing specifically working with the DoD remains scarce; it is therefore of interest to pursue studies that combine both firm characteristics and federal contracting practices in identifying the best path forward in improving federal contracting practices. Second, the findings of this research would be enhanced by data on supplier relationships of the DoD. Most small firms appear further in extended supply chains(Gholz et al,2018). Unfortunately, data on companies' supply chains can be a key component of a firm's competitive advantage and therefore is not easily accessible (Dyer 2006, Li et al 2006 as cited by Gholz et al,2018). Similar to the study conducted by Gholz et al (2018), which focused on the supply chains for three major weapons systems with access to data up to fifth tier suppliers, similar datasets on different programs run by the DoD, highlighting different suppliers at different tiers of the supply chain would provide better estimates.

6. Conclusion

The Federal Government, through its socio-economic policies, continuously seeks ways to strengthen its large cohort of small businesses to ensure that they continuously grow and strengthen the nation's economy as well as their local economies and ensure the manufacturing industrial base is resilient. This thesis empirically evaluates the impact of four important attributes of small manufacturing firms' ability to secure DoD contracts, a vehicle through which small businesses can be supported to achieve the nation's goal of technological advancements and national security. My study adds in an important way to existing evidence of keys to ensuring sustained manufacturing capabilities.

In the framework, I highlighted several key indicators of successful firms which have led to certain firms consistently winning contracts with the DoD. I focused particularly on the percent days contracted which captured the percentage of the days over which a firm was contracted over the difference between the days from the first day of their contract and the last contract days and the number of active fiscal years starting in 2016. The former indicated consistency while the latter restricted the sample to firms that had been contracted since 2016 and remained in the DoD's database. These were chosen as they ensure firms categorized as winners had not just had a one-off lengthy contract or had a long contract span with a small number of active years. Employing a logistic regression model due to the binary nature of my outcome variable, I assess the impact of the four important attributes on the probability of a firm being categorized as successful. Whereas exporting showed to be negatively significantly associated with the success probability, other attributes, for the most part, showed a significantly positive association with success.

The first general picture suggests most small manufacturing firms winning contracts with the DoD can be found in manufacturing hubs, have an R&D ecosystem (SBIR, etc.), meet certain quality standards, and tend to be more domestically focused. The literature has also indicated that the three former findings play a significant role in the success and growth of manufacturing small firms. However, the finding which suggests that domestically focused firms have secured most of the DoD contracts may be concerning as literature suggests that competitive and innovative firms tend to be export-focused. A further investigation into manufacturing small firms at all tiers of the defense's supply chain may give a better picture of the DoD's contracting practices. Supply chain data would provide insights on the firms securing prime contracts and subcontracts and investigate their attributes to contribute to the DoD's small business strategy.

As the DoD continuously tries to devise strategies to strengthen its manufacturing industrial base, this topic offers interesting possibilities for future research. Some of them have been mentioned in previous chapters and include a combination of federal contracting practices as well as small firm attributes to highlight which have played a key role in the success of some firms and not others. The DoD remains an important enabler of small business innovation and growth, it is of great importance to research how the DoD can further contribute to the restoration of the manufacturing capabilities of the nation. In conjunction with the SBA and networks such as the Manufacturing Extension Partnership (MEP)- a network that seeks to strengthen and enable U.S. manufacturers, the DoD may streamline the Small Business Strategy. Resources can be focused on small manufacturers outside of manufacturing hubs to create or strengthen an ecosystem, incentivize and help them achieve required quality standards, strengthen their R&D capabilities and help them become competitive in the international market. These specialized interventions would help strengthen both the nation's manufacturing capabilities and the defense industrial base for a stronger economy and sustained national security.

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