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VITAL SIGNS 2021

THE HEALTH AND READINESS OF THE DEFENSE INDUSTRIAL BASE

TABLE OF CONTENTS

FOREWORDS

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America is at a crossroads with an increasingly dangerous and complex international security environment coupled with internal divisions exacerbated by the reckless rhetoric that led to a violent attack on our nation's temple of democracy, the United States Capitol.

Thankfully, as shown by the recent passing of the Fiscal Year 2021 National Defense Authorization Act via an override of a presidential veto, providing for the common defense remains a unifying, bipartisan value. The provision of that defense is predicated on a vibrant and productive defense industrial base.

That base is facing multiple headwinds in its efforts to keep American and allied warfighters advantaged in all domains of conflict. These challenges include but are not limited to intense industrial security threats highlighted by the recent SolarWinds hack attributed to Russia, along with myriad breaches attributed to China; expected flat budgets going forward; decreased investments in the basic science that fuels U.S. innovation; skilled, cleared workforce shortages; and increased regulatory burdens and barriers to entry for those seeking defense contracts.

Put those challenges together with the COVID-19 crisis and you get a defense industrial base—especially the critical small businesses within it—struggling today to survive in order to produce in the future for our nation's military and our nation's security.

Vital Signs 2021, our second annual edition of our study on the health and readiness of the defense industrial base, is uniquely timely. Those who read last year's report will understand that the report is based on data gathered through the previous year. As a result, what readers will see here is the state of the base at the precipice of the pandemic with several scores declining, a halving of new entrants each year between 2018 and 2019, and a defense budget set to rise at a meek 0.05% pre-inflationary rate.

Accordingly, policymakers on Capitol Hill, in the executive branch, and in academia as well as our think tanks should take notice. As I stated last year, our warfighters' capability superiority is not a birthright; rather, it is earned through hard work, investments, and good policies driven by good strategy.

We hope and expect this report to drive a much-needed discussion on industrial base issues as the greater international strategic competition heats up despite, and a bit because of, the pandemic.

Gen Hawk Carlisle, USAF (Ret)
President and Chief Executive Officer, NDIA

GOVINI

The intensity of great-power rivalry between the United States and its principal strategic competitors, China and Russia, is increasing and, with it, the imperative for a healthy defense industrial base to ensure U.S. military-technical advantage. Yet, the health of the defense industrial base—like its potential to improve—is subject to a host of economic, political, societal, technological, fiscal, and regulatory forces that often move at cross-purposes.

Cognizant of these facts, the U.S. Defense Department, the Congress, and industry are each conducting a range of initiatives to improve the health of the defense industrial base. From acquisition reform to supply chain assurance and cybersecurity to improved design and manufacturing processes, there is a flurry of activity underway to enhance the defense industrial base's resilience and innovativeness. The focus is high, but progress is slow. Moreover, the scale and complexity of the defense industrial base can make it hard to determine where progress is occurring, where it is not, and where, therefore, to focus greater attention. The answer lies in data.

As originally conceived, the goal of *Vital Signs* is to persistently monitor a set of key metrics to measure the health of the defense industrial base over time. With this second edition, *Vital Signs* has realized this vision. By providing a relative comparison to last year's assessment, it applies data-driven insights to unearth the key trends at play and points to the primary areas that need focused government and industry action.

Great-power competitors, global market forces, and exogenous shocks such as the COVID-19 pandemic will continually test the resilience and innovativeness of the defense industrial base. The *Vital Signs* report's ability to regularly diagnose the defense industrial base and determine where it is healthy and where it is ill is essential to finetune the nation's efforts to maintain an effective military-technical advantage.

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EXECUTIVE SUMMARY

In 2018, the Department of Defense (DoD) released "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States" (13806 Report), a report focused on the production risks to critical defense industrial supply chains. The report starkly framed the health of the U.S. defense industrial base (DIB) as key to the readiness of the United States in an age of great-power competition. Despite the 13806 Report's high-resolution snapshot of the defense industrial base's "unprecedented set of challenges," the report did not provide the American public or the defense policy community a publicly available summary measurement of the health and readiness of the defense industrial base or an accessible way of monitoring the DIB's "pulse" and key "vital signs" to track the health of the defense industrial base over time.[1]

To fill this gap, last year, the National Defense Industrial Association (NDIA) published *Vital Signs 2020*, which provided an unclassified summary of the health and readiness of the defense industrial base that was accessible by both the American public and the defense policy community. *Vital Signs 2021* is the second annual installment of our *Vital Signs* publication. In order to provide a comprehensive assessment of the defense industrial base, our procedure involves standardizing and integrating different elements that impact the performance of the defense industrial base and the overall business environment.

Like *Vital Signs 2020, Vital Signs 2021*'s final grade for the health and readiness of the defense industrial base is a "C." While passing, the "C" grade reflects a business environment that is characterized by contrasting areas of concern and confidence. It also reflects the state in which the defense industrial base entered the novel coronavirus (COVID-19) pandemic, which dramatically disrupted the daily lives of every American as well as the flow of American and global commerce. Continued deterioration in industrial security and the availability of skilled labor and materials emerged from the analysis as areas of clear concern. Favorable conditions for competition in the defense contracting market and a rising pre-pandemic demand for defense goods and services reflect growth in the defense budget. NDIA intends *Vital Signs 2021* to be a reference document that sets the conditions for an annual discussion on DIB issues and contributes to the debate about national defense acquisition strategy by offering a common set of indicators—"Vital Signs"—of the defense industrial base partners that give our men and women in uniform an advantage in all warfare domains.

SCORE DETERMINATION

In order to complete *Vital Signs 2021*, we conducted a study of data related to eight conditions that shape the performance of defense contractors: demand, production inputs, innovation, supply chain, competition, industrial security, political and regulatory, and productive capacity and surge readiness. Categorized by factor, we analyzed over 40 publicly available longitudinal statistical indicators, converted each of them into an index score on a scale of 0 to 100, and evaluated three years of scores for each indicator. With the exception of our *Vital Signs 2021* Survey of NDIA members that was fielded in August 2020, our datasets are lagging indicators that were published before the nationwide lockdowns that began in March 2020 at the beginning of the COVID-19 pandemic in the United States. These lagging indicators provide insight into how the defense industrial base entered the pandemic and will give future policymakers a baseline for evaluating the defense industrial base's ability to cope with a crisis.

OVERALL SCORES

Condition	2018	2019	2020	Change, 2018 – 2020
Demand	77	85	93	+16
Production Inputs	68	68	68	0
Innovation	73	70	71	-2
Supply Chain	83	68	77	-6
Competition	89	92	91	+2
Industrial Security	57	56	56	-1
Political & Regulatory	82	76	72	-10
Productive Capacity & Surge Readiness	54	81	66	+12
Overall Health and Readiness	***73***	***75***	***74***	***+1***

Figure 0.1, Source: NDIA

Factor Score Key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

AREAS OF CONCERN

Vital Signs 2021 reveals a defense industrial base that entered the COVID-19 pandemic in a weakened state. The final grades are based solely on data from before the COVID-19 pandemic. Six conditions earned composite scores lower than 80, three of which earned scores lower than 70, which we consider failing grades—the same as in last year's report. These scores suggest that the defense industrial base is increasingly struggling to meet the unprecedented challenges it faces. Industrial security scored the lowest among the eight conditions with a 56 for 2020. Industrial security has gained prominence as massive data breaches and brazen acts of economic espionage by state and non-state actors plagued defense contractors and the entire U.S. economy in recent years. To assess industrial security conditions, we analyzed indicators of threats to information security and to intellectual property (IP) rights. The score

1 Department of Defense, "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806, September 2018. https://media.defense.gov/2018/Oct/05/2002048904/-1/-1/1/ASSESSING-AND-STRENGTHENING-THE-MANUFACTURING-AND%20 DEFENSE-INDUSTRIAL-BASE-AND-SUPPLY-CHAIN-RESILIENCY.PDF

incorporates MITRE's annual average of the threat severity of new cyber vulnerabilities, which improved slightly from our 2018 score of 17 to a similarly dismal score of 18 in 2020. In contrast, threats to IP rights scored an all-time high of 89 for 2020 as the number of new Federal Bureau of Investigation (FBI) investigations into IP rights violations declined to 47 as part of a steady decline since reaching an all-time high of 235 in 2011. Defense industry production inputs also scored poorly in 2020 with a score of 68, a steady score since 2018. Major production inputs include the skilled labor, intermediate goods and services, and raw materials used to manufacture or develop end-products and services for DoD consumption. Our estimate of the size of the defense industry workforce, currently about 1.1 million people, falls substantially below its mid-1980s peak size of 3.2 million. The indicators for security clearance processing also contributed to the low overall score for production inputs as on-boarding backlogs continue to persist.

AREAS OF CONFIDENCE

The competitive environment and the state of demand for defense goods and services are areas of confidence. Over the past few years, DoD has averaged about 701,000 prime contracts each year and had over $394 billion in prime contract obligations in 2019, according to an analysis conducted by our research partner, Govini, a decision science company. An analysis of the top 100 publicly traded DoD contractors produced a competition score of 91 for 2020. Several high-scoring indicators drove the strength of market competition conditions, including the low level of market concentration of total contract award dollars, the relatively low share of total contract award dollars received by foreign contractors, and the high level of capital expenditures in the defense industrial base. Additionally, the defense industrial base earned a score of 77 for profitability for 2020 based on a new methodology for this edition of our annual report. Demand for defense goods and services received a score of 93 for 2020, which is a 16-point increase over the 2018 score. This high score for demand is a result of the recent increase in contract obligations issued by DoD. Total contract obligations issued by DoD grew from $329 billion in Fiscal Year (FY) 2017 to $394 billion in FY19, marking a 20% increase. Foreign military sales (FMS) also grew by nearly 20% over the same time period.

OTHER TAKEAWAYS

Innovation conditions within the defense industrial base received a score of 71 for 2020, two points down from its 2018 score. Notably, the U.S. share of global investment in research and development (R&D) was only 28%, which is down from a peak of 38% in 2001.

Scores also dropped for political and regulatory conditions. In early 2020 before the pandemic took hold, the percentage of Americans that thought the United States was spending "too little" on national defense was nearly half as many as in 2018, the largest two-year drop since 1983, which may indicate a decrease in the American public's appetite for major increases in defense spending.

Acquisition reform and budget stability, two of NDIA's strategic priorities, continue to be top of mind for the defense industrial base. In our *Vital Signs* Survey, when asked about the most important thing that the government can do to help the defense industrial base, respondents said that streamlining the acquisition process (35.3%) and budget stability (31.7%) were the most important. When asked what conditions would limit their firms' willingness or ability to devote larger amounts of productive capacity to military production, 47.8% of our respondents said that uncertain prospects of continuing volumes of business were a moderate deterrent while 41.5% of respondents said that the burden of government paperwork was a moderate deterrent. Both findings underscore the continued importance of reforming and streamlining the acquisition process and of the need for budget stability.

CAN THE DEFENSE INDUSTRIAL BASE MEET SURGE DEMAND DURING A CRISIS?

The capacity of the defense industrial base to grow its output and fulfill a surge in military demand stands as a key test of its health and readiness. Productive capacity and surge readiness earned a score of 66 for 2020, a 15-point decrease since 2019. Declines in output efficiency contributed to this downward trend. Importantly, this score is not based upon an economy undergoing a full mobilization to war like in World War II. Instead, the productive capacity and surge readiness condition is baselined against the defense buildup that began under the Carter Administration and that accelerated throughout the Reagan Administration. The Carter-Reagan buildup involved a 31% surge in DoD expenditures.

The health and readiness of the defense industrial base pose a challenge to the defense acquisitions community. With the growing expectation for the defense industrial base to meet the challenges faced during an era of great-power competition, *Vital Signs 2021* highlights several hurdles that the DIB must overcome when emerging from the COVID-19 pandemic. The overall defense industrial base's health and readiness grade of "C" suggests a satisfactory ability to meet current industrial requirements. We hope that *Vital Signs 2021* will help to inform the discussion that leads to an improved overall grade for *Vital Signs 2022* and beyond.

INTRODUCTION

President George Washington's farewell address famously warned against "the necessity of those overgrown military establishments."[2] Yet, he also praised the importance of being prepared in his first annual address to Congress, saying that "providing for the common defense will merit particular regard. To be prepared for war is one of the most effectual means of preserving peace."[3] Since our beginning, the defense industrial base has provided the United States with a strategic advantage. America's success on the battlefield and ability to deter conflict have always relied upon deliberate planning between government policymakers and industry.

Despite the vital and historical role of the defense industrial base in supporting America's armed forces during wartime, U.S. defense policy has not always recognized that vital role. For example, congressional panels on the defense industrial base convened by the House Armed Services Committee in 1980, 1992, and 2011 called attention to U.S. defense policy's persistent neglect of the defense industrial base and the potential tactical and strategic ramifications for the nation in a conflict against a near-peer adversary.[4] In 2017, Executive Order 13806 identified important structural changes to the U.S. manufacturing sector that "raise[d] concerns about the health of the manufacturing and defense industrial base" and called for a "comprehensive evaluation" to help guide future remedial policy actions.[5] As the executive order suggests, a key obstacle to a sound defense industrial base strategy is a common baseline understanding of the overall health and readiness of the defense industrial base.

Despite the 13806 Report's high-resolution snapshot of the challenges that face the defense industrial base, it failed to provide the public and the defense policy community either an unclassified summary measurement of the health and readiness of the defense industrial base or a simple way of tracking such a measurement over time. The National Defense Industrial Association, in partnership with Govini, has completed a second annual, months-long assessment of the health and readiness of the defense industrial base to address this gap. By analyzing select statistical indicators, NDIA developed a composite indicator consisting of a set of eight conditions, providing an integrated measure of the health and readiness of the U.S. defense industrial base to meet the demands of the National Defense Strategy (NDS) and the needs of our servicemen and women in uniform. Given that this synoptic indicator brings together data on multiple sets of factors affecting the defense industry, it facilitates a common, holistic understanding of the state of the defense industrial base and its "Vital Signs." This annual report is the defense industrial base's yearly health check-up; accordingly, it aims to encourage conversations at all levels about how to adjust policies and make investments that maintain the superior readiness of the American defense industrial base while providing the advantages our nation and its warfighters have come to expect.

WHAT IS THE DEFENSE INDUSTRIAL BASE?

The U.S. defense industrial base partners with the Department of Defense to ensure that the United States enjoys decisive advantages in any conflict. The defense industrial base encompasses manufacturers, systems integrators, service providers, technology innovators, labs and research organizations, and other suppliers linked to one another by contracts into regional, national, and global supply chains to provide America's warfighters with superior tools, capabilities, and resources.[6] The defense industrial base includes more than just the producers of major capabilities vital for national defense. In recent years, the U.S. domestic defense industrial base has declined in size despite growing demand for its output. DoD is the largest contracting agency in the federal government. Total contract obligations issued by DoD grew from $329 billion in 2017 to $394 billion in 2019—a 20% increase.

Defense supply chains touch every state in the Union. According to data from DoD's Office of Economic Adjustment, defense contract spending in FY18 averaged over $7 billion per state and in the District of Columbia, although spending levels varied widely.[7] For example, California received the most of all states with $42 billion in defense contract spending while Wyoming received the least of all states

2 Washington, George, "Farewell Address," Transcript of remarks as delivered, 1796, The National Archives, OurDocuments.gov, https://www.ourdocuments.gov/doc.php?flash=false&doc=15&page=transcript

3 Washington, George, "Farewell Address," January 08, 1790 , University of California at Santa Barbara, https://www.presidency.ucsb.edu/documents/first-annual-address-congress-0

4 United States House Committee on Armed Services. (1980). The ailing defense industrial base: unready for crisis. Report of the Defense Industrial Base Panel of the Committee on Armed Services, House of Representatives. Ninety-sixth Congress, Second Session. Washington: U.S. G.P.O.; United States House Committee on Armed Services. (1992). "Defense industrial base: hearings before the Structure of U.S. Defense Industrial Base Panel of the Committee on Armed Services," House of Representatives, One Hundred Second Congress. Washington: U.S. G.P.O.; United States House Committee on Armed Services. (2012). "The defense industrial base: a national security imperative: hearing before the Panel on Business Challenges within the Defense Industry of the Committee on Armed Services," House of Representatives

5 Trump, President Donald J., "Presidential Executive Order on Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," July 21, 2017; Available at: https://www.whitehouse.gov/presidential-actions/ presidential-executive-order-assessing-strengthening-manufacturing-defense-industrial-base-supply-chain-resiliency-united-states/

6 Definitions of the "defense industrial base" vary in their inclusiveness. We adopt a broad definition of the defense industrial base in recognition of the growing size, diversity, and complexity of the supply networks that support America's warfighters.

7 U.S. Department of Defense, Office of Economic Adjustment Defense Spending by State - Fiscal Year 2018 https://www.oea.gov/dsbs-fy2018

New Vendors By Place of Performance, FY19

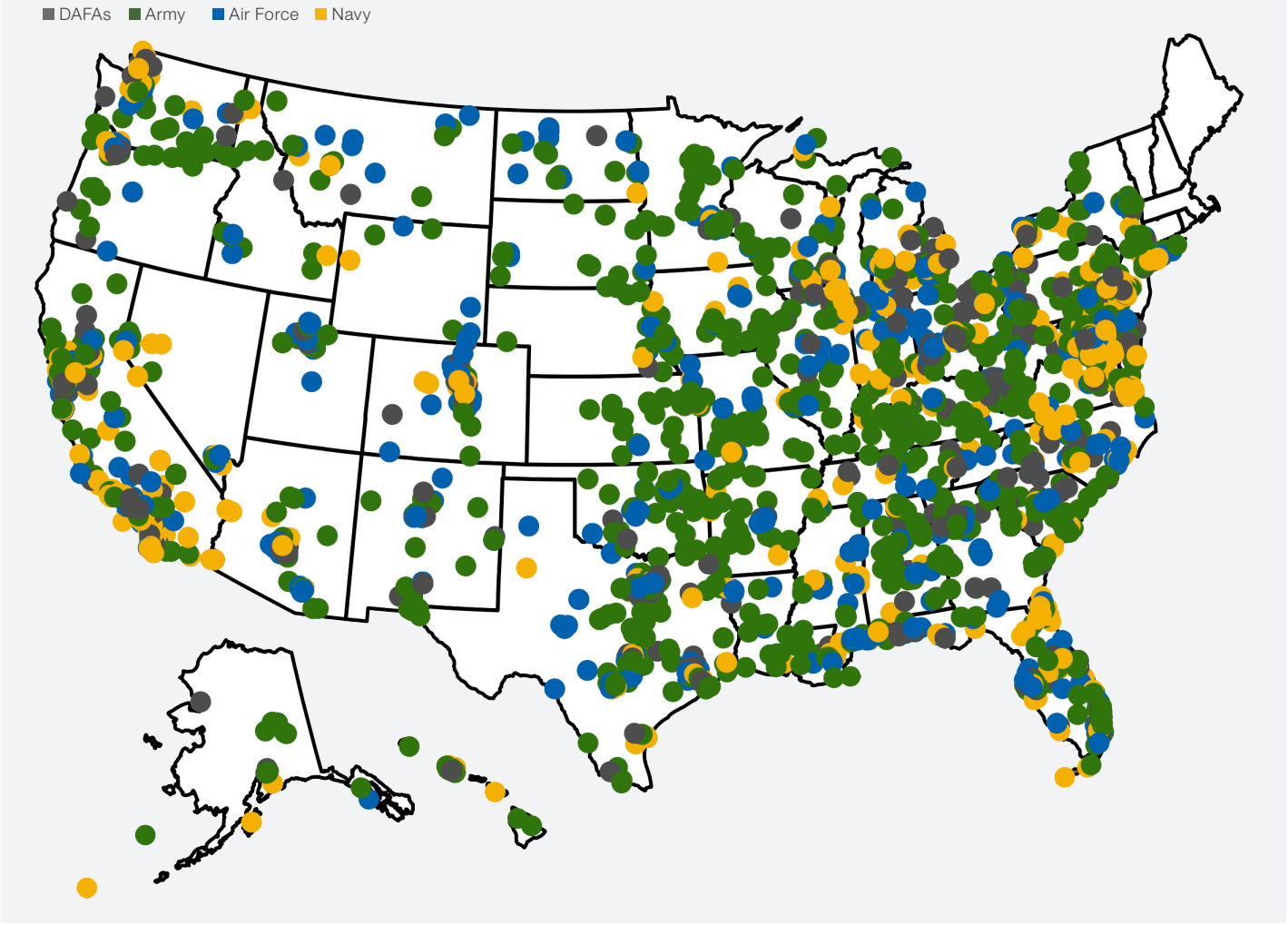


Figure 0.2, Source: Govini

with $154 million.[8] The concentration of defense contract spending in major metropolitan areas supports clusters of defense industry production, investment, and employment. The metropolitan areas of Washington-Baltimore, Dallas-Fort Worth, San Diego, Seattle, St. Louis, Los Angeles, Huntsville, and Boston host the country's largest defense contracting clusters.[9] Historically, defense procurement has followed a decadal cyclical pattern, driven by events and policy changes.[10] The breakout of major military conflicts has prompted defense spending peaks with a typical concentration in the high-volume procurement of major defense acquisition programs (MDAPs). Spending troughs have followed such peaks when military conflicts and tensions have deescalated, driving industry consolidation. For the U.S. defense industrial base, these cyclical changes reflect the challenges defense contractors have when maintaining thriving companies while also making critical investments in future capabilities. The globalization and internationalization of supply chains have only served to exacerbate those challenges.

THE EVOLVING DEFENSE INDUSTRIAL BASE: FROM THE COLD WAR TO TODAY

The 2018 National Defense Strategy's declaration of the re-emergence of an era of great-power competition has held significant implications for the defense industrial base. The NDS called for reforms to defense acquisition systems to ensure the prompt delivery of important capabilities, services, and materials to U.S. warfighters in step with the changing strategic environment. This era of great-power competition presents the challenge of a multi-domain competition with near-peer competitors, specifically China and Russia. Achieving decisive national advantages across emerging technologies—artificial intelligence, hypersonic aviation, quantum computing, autonomy, and human-machine teaming systems, among others—will have significant implications for the future of economic and strategic balances of power. This new era also challenges industry to achieve high levels of readiness to rapidly

8 *Id.*

9 *Id.*

10 Watts, Barry D. The US defense industrial base: Past, present, and future. CENTER FOR STRATEGIC AND BUDGETARY ASSESSMENTS WASHINGTON DC, 2008.

grow the production and deployment of military hardware during a conflict against a near-peer competitor. Nevertheless, trends from previous eras will continue to affect the defense industrial base. Consolidation among prime contractors can be expected to continue as risks of budget instability and the pressure to deliver favorable quarterly returns lead companies to seek synergies with other firms. The pressure to reduce costs and exploit international talent will encourage a more comprehensive globalization of supply chains. Growing dangers to industrial security from cybersecurity threats and traditional economic espionage will require defense contractors to implement new and often costly security procedures and systems. Such dynamic and uncertain business conditions of this emerging era will undoubtedly bring changes to both the organization and behavior of the defense industrial base.

UNDERSTANDING THE HEALTH OF THE DEFENSE INDUSTRIAL BASE

Despite the defense industrial base's importance to America's national security and ability to achieve policy goals, many assessments of national defense capacities, capabilities, and needs lack a broad consideration of the strengths and weaknesses of the defense industrial base. The FY17 Annual Industrial Capabilities Report, authored by the Office of the Under Secretary of Defense for Acquisition & Sustainment, focused on cataloging defense-related private manufacturing capabilities.[11] Separately, the 2018 report entitled "Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States," initiated by Executive Order 13806, highlighted emergent risks to industrial capabilities in various defense sub-sectors and weapons systems categories.[12] Influential non-governmental analyses like the Center for Strategic and International Studies' annual "Acquisition Trends" reports tend to address the defense industrial base health question from the perspective of trends in demand-side defense contracting flows.[13] Although these studies provide valuable insights into specific aspects of the health of the defense industrial base, they lack the breadth necessary to develop a holistic understanding of the position of the defense industrial base with respect to peak performance standards. To understand the current business environment of the defense industrial base in empirical terms, NDIA has developed a set of eight conditions based on a diverse array of select statistical indicators. If the report is a health exam, then our eight conditions are the four traditional vital signs that physicians use to assess the status of their patients' life-sustaining functions (temperature, pulse, respiratory rate, and blood pressure).

In general, statistical indicators provide summary representations of statistical data and typically reveal directional trends or relative positions. Statistical indicators also provide a structured and longitudinal way of understanding the relative performance of the defense industrial base. The complexity and scale of the defense industrial base mean that an array of statistical indicators may be useful for performance analysis and interpretation. The conditions simplify the challenge of interpreting multiple statistical indicators by combining and integrating various statistical indicators into "a single index on the basis of an underlying model."[14] As a result, they offer a better value for capturing multi-dimensional concepts, like the health of the defense industrial base, for which single indicators prove inadequate as means of measurement. By tracking changes over time, our conditions make modeling and other forms of advanced statistical values easier to analyze. Beyond their analytical benefits, they facilitate more inclusive and broader communication with the public.

Descriptions of each of the eight conditions follow. The remainder of *Vital Signs 2021* presents the overall composite index score and the underlying analysis for each condition.

Demand

The scale of defense contracting opportunities available to firms shapes the defense industrial base's health. The stability of this demand affects the ability of companies to commit to and plan for defense-related production and their investment in research and development. This section of the report shows trends in aggregate defense procurement and the distribution of contracting awards among different product categories.

Production Inputs

The cost and availability of the inputs used in the production of goods and services also shape the performance of the defense industrial base. Defense industry production relies heavily on intermediate goods and services, highly skilled labor, and raw materials. Trends in the cost and availability of these resources shed light on the ability of defense contractors to acquire the inputs necessary for production.

Innovation

For decades, the U.S. National Defense Strategy has looked to the defense industrial base as an important source of technological innovation. The manufacturing and services industries associated with the most technology-intensive goods and services acquired by DoD are the source of significant amounts of capital for research and development. Trends in industrial R&D investment and patent activity help form a picture of the state of private sector defense innovation.

11 Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States Report to President Donald J. Trump by the Interagency Task Force in Fulfillment of Executive Order 13806. September 2018.https://media.defense.gov/2018/Oct/05/2002048904/-1/-1/1/ASSESSING-AND-STRENGTHENING-THE-MANUFACTURING-AND%20DEFENSE-INDUSTRIAL-BASE-AND-SUPPLY-CHAIN-RESILIENCY.PDF

12 *Id*.

13 Defense Acquisition Trends 2020: Topline DoD Trends, October 2020. https://www.csis.org/analysis/defense-acquisition-trends-2020-topline-dod-trends

14 OECD, "The OECD-JRC Handbook on Practices for Developing Composite Indicators", paper presented at the OECD Committee on Statistics, 7-8 June 2004, OECD, Paris. Available at: https://www. oecd.org/els/soc/handbookonconstructingcompositeindicatorsmethodologyanduserguide.htm

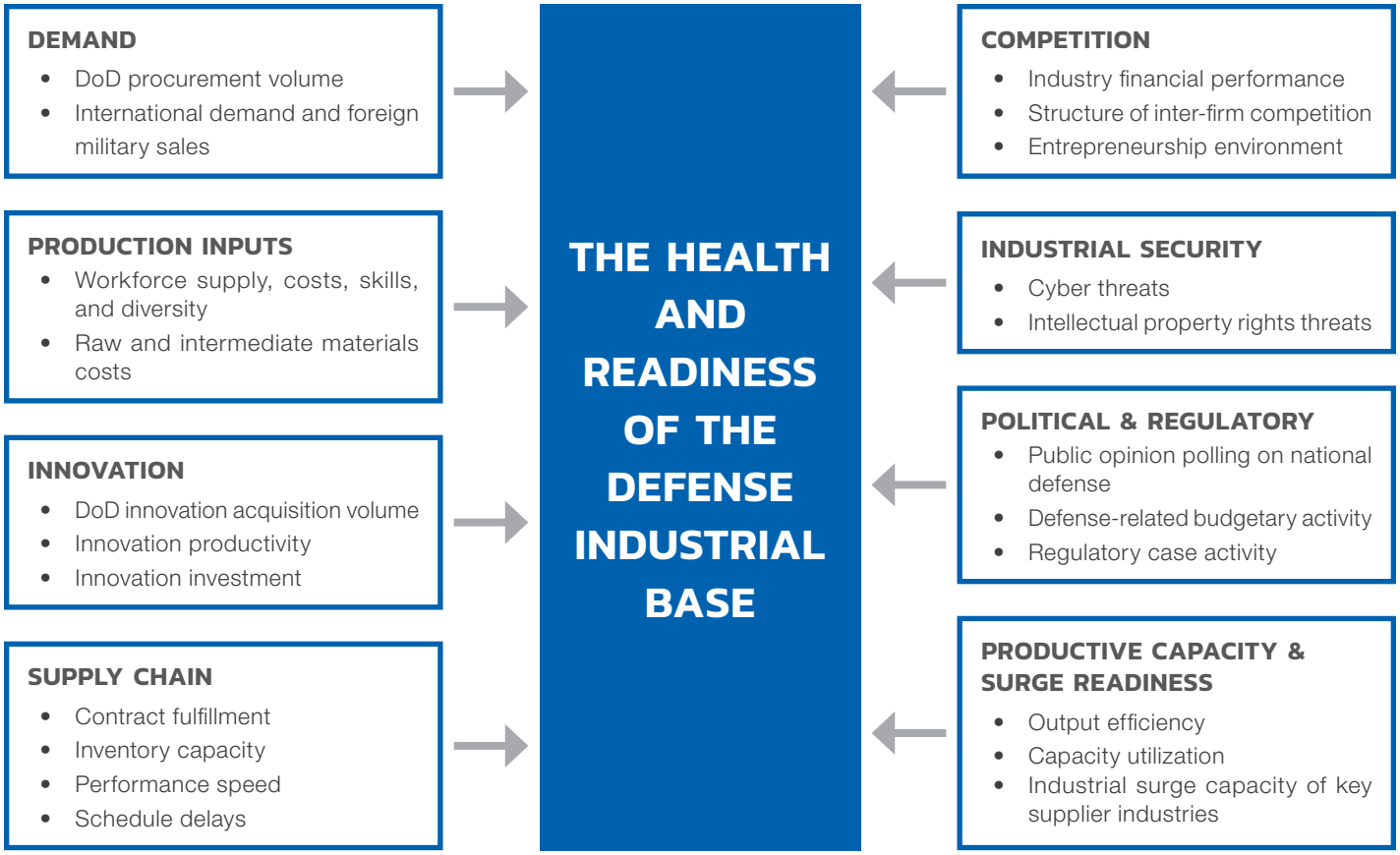


Figure 0.3, Source: NDIA

Supply Chain

The performance of the corporate supply chains that support industry's supplier networks factors into assessments of the health of the defense industrial base. Defense supplier networks rely on well-functioning relationships among companies to deliver products and services to fulfill their government contracts. The overall competency of these networks comes from the combination of their track record of contract delivery, product flow, and speed of operation. This section of the report studies trends in industry's contract performance failures, inventory assets, program schedule integrity, and speed of operation.

Competition

The state of competition between firms exerts a powerful influence on the productive performance of firms within industry. Many firms of varying sizes, product and service specializations, and even national origin compete for the same contracts within the defense industrial base. While such competition occurs, trends in financial performance indicate the financial health of the involved firms. The competition between firms for contracts results in patterns of market concentration that illustrate the extent to which relatively few firms dominate defense contracting dollars. The entry of firms into defense contracting provides insight into the openness of the defense contracting market to new sources of competition. This section of the report informs our understanding of the health of competitive dynamics within the defense industrial base. We relied on publicly available Securities and Exchange Commission (SEC) filings from the top 100 publicly traded recipients of defense contracts to complete our analysis.

Industrial Security

The security of industrial operations against threats to information systems and intellectual property rights contributes to a comprehensive portrait of the health of the defense industrial base. American industry faces persistent, increasing threats of intellectual property theft, economic espionage, cyber crime, and other forms of attacks. This section of the report examines new FBI intellectual property rights violation investigations, the average annual newly reported common IT cyber vulnerabilities, and the severity of newly reported common IT vulnerabilities.

Political & Regulatory

More than most industries, legislative and regulatory processes have a direct impact on defense industry productivity. The public's attitudes toward defense spending shape congressional interest in defense acquisition, ultimately affecting congressional budgets. The time that Congress takes to authorize a budget for national defense programs affects capital availability and the product delivery schedule of defense supply chains. Similarly, changes to defense acquisition regulations affect defense contractors' eligibility and administrative costs. In this way, policymakers can have a significant impact on the defense industry in terms of the demand

for goods and services, availability of inputs, conditions in related and supporting industries, and structure of industry competition. This section of the report assesses political and regulatory trends that shape defense industrial productivity.

Productive Capacity & Surge Readiness

The need for an increase in defense production often appears suddenly, leaving little time for defense suppliers to ramp up production to fulfill a surge in demand for their goods, services, or materials. Meeting surge demand requires leveraging the latent excess productive industrial capacity in the national economy. In manufacturing industries, firms must activate unused industrial capital assets to reach necessary levels of productivity. However, the complex structure of industrial supply chains means that the flows of goods and services between industries will limit the extent to which an increase in demand for industrial end-products translates into an increase in industrial output. This section analyzes the output efficiency and the capacity utilization of the economy.

Survey Results

For *Vital Signs 2021*, NDIA fielded a 42-question survey to our members. This year's survey focused on questions that will be relevant every year (i.e. related to the DIB's capacity to surge) and questions that are relevant to this year (i.e. related to the impacts of COVID-19). The survey results are used throughout *Vital Signs 2021* while key results are presented in a single, dedicated section of the report. Though this year's survey was the first of its kind, we intend to field this survey every year to track results over time.

HOW TO READ THIS REPORT

In the succeeding sections of this report, we present composite scores for each of the defense industrial base conditions described herein. Our scores follow a nested approach, combining quantitative scores for each condition's factors and indicators into an overall health score on a 0-to-100 scale. The score for each set of conditions is itself a composite of scores for variables that contribute to health and readiness in that area. To score each variable, we analyzed statistical indicators that serve as empirical proxies. Indicator scores are calculated by comparing a three-year average of the indicator to a baseline value. Baseline values are either historical peak values (a prior value of the indicator that represents the best recent performance given available data) or, when conceptually appropriate, ideal standards. As a result, baseline values are chosen on a case-by-case basis, further depending on data availability. For each indicator, we provide an analysis that incorporates the influence of contemporary contextual events and forces that drive the indicator's performance. In each section of *Vital Signs 2021,* graphics depicting the recent trend in the scores accentuate the discussion of variables and indicators. Each section also includes a table detailing the current scores for each variable and indicator in addition to their net change over the two previous years. The indicators that form the basis of our analysis were constructed from multiple data sources. Furthermore, we developed many indicators from public data sources. Our financial indicators are based on publicly available SEC filings that were obtained through FTSE Russell's Mergent Online database. Several indicators, including those presented within the section on demand conditions, are derived from custom data provided by our research partner, Govini. Some indicators are based on estimates generated by NDIA. We reference indicator data sources throughout the report.

FOR THE FUTURE

Vital Signs 2021: The Health and Readiness of the Defense Industrial Base is the second installment of *Vital Signs*. This report makes conclusions on the overall health and readiness of the defense industrial base. We purposely do not make any policy recommendations, support any specific legislative or regulatory changes, or advocate for any targeted investments. Our goal is to provide a baseline reference for the defense policy community and the citizens interested in defense policy. We believe an unclassified report, like this one, will serve as an important annual touchpoint at the beginning of the policy cycle by providing trend analyses that demonstrate the results of changes in the strategic environment, economy, policies, and investments while ensuring a discussion of industrial base issues at the national level. In this way, we will be able to identify what actions or decisions were successful and which ones were not. It will then be up to various stakeholders, organizations, and policymakers to interpret and advocate for policies they believe are in the best interest of the defense industrial base and our national security posture. The National Defense Industrial Association looks forward to feedback from across the spectrum of thought leaders on our study model, its methods and measures, and ways of ensuring its usefulness to the defense policy community.

DEMAND

Change, 2018 – 2020

+16

DEMAND SCORES		
Overall Factor	**2020**	**Change, 2018 – 2020**
Demand	93	+16
Overall Demand Score	***93***	***+16***

Figure 1.1, Source: Govini

Factor Score Key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

OVERVIEW

The scale of defense contracting opportunities available to firms shapes the defense industrial base's health. The stability of this demand affects the ability of companies to commit to and plan for defense-related production and their investment in research and development. This section of the report shows trends in aggregate defense procurement and the distribution of contracting awards among different product categories.

Likewise, it presents an analysis of the major trends in DoD's contract demand and its impact on industry while offering scores for the demand for defense goods and services. The Department of Defense's demand for defense goods and services drives industry's production and investment in the defense industrial base. As recent history has shown, changes in the volume and composition of DoD purchases impact which firms choose to participate in the defense industrial base, what goods and services they produce, and their role in supply chains.

As the nation's sole buyer of defense goods and services, and as the largest buyer in the world, DoD's annual level of contract obligations provides the best view into the demand for defense goods and services. The defense industry relies on stable defense budgets, which drive stable demand signals, to justify investments in the productive capacity required to fulfill contracts and to make the investments required to compete for future awards. Large downward budget fluctuations, like across-the-board budget cuts, could deter potential new entrants from participating in defense markets and, thereby, slow down the defense modernization process.

Overall, the demand for defense goods and services has improved despite recent DoD budget adjustments driven by the 2019 Bipartisan Budget Act. Acknowledgment of the possible limitations to defense spending has resulted in the reprioritization of resources and the shifting of investments to prepare for, deter, and win a high-end fight against a near-peer competitor in order to maintain alignment with the National Defense Strategy.

Before the COVID-19 pandemic, the combined demand signal on the defense industrial base—in terms of foreign military sales and direct commercial sales—was strong. Even now, the U.S. defense industrial base remains the global supplier of choice for defense goods and services. Besides the geopolitical benefits like interoperability and influence, sales to foreign customers provide the defense industrial base with greater economies of scale and additional resources to invest in new capabilities.

> **"Demand for industrial output has improved despite recent DoD budget adjustments driven by the 2019 Bipartisan Budget Act.**

KEY TAKEAWAYS

- Overall DoD contract obligation volume has surged
- Among all categories, major defense platforms (aircraft, ships/submarines, and land vehicles) were awarded the largest share of total contract obligation value
- Growth in total contract obligation value for electronics & communication services (89%) led all service categories while growth in total contract obligation value for sustainment (79%) led all product categories
- Combined foreign military sales for knowledge-based services (35.33%) and equipment-based services (30.95%) constituted two-thirds of awarded service obligations between FY15 and FY19
- Foreign military sales for aircraft, ships/submarines, and land vehicles amounted to 48% of awarded product obligations between FY15 and FY19

DEMAND SCORES			
Factor	**Indicator**	**2020**	**Change, 2018 – 2020**
Demand	Department of Defense Contract Obligations	93	● +16
Overall Demand Score		***93***	● ***+16***

Figure 1.2, Source: Govini

Factor Score Key	● -6 and worse	● -1 – -5	● 0	● +1 – +5	● +6 and better

INTRODUCTION

The Department of Defense's demand for defense goods and services powers production and investment in the defense industrial base. As recent history has shown, changes in the volume and composition of DoD's purchasing of goods and services drive corresponding changes in firms' participation in the defense industrial base, what they produce, and their role in supply chains. This section of *Vital Signs 2021* presents an analysis of major trends in DoD's contract demand and its impact on industry while offering scores for indicators of government demand for defense goods and services.

METHODOLOGY

Indicator scores are determined by the ratio of an indicator's average value to a baseline value. Baseline values reflect historical peak values or ideal standard values, which means that they are unique for each indicator. Ultimately, the availability of data in the public domain constrained the selection of baseline values. The overall section score averages variable scores that consist of averages of indicator scores, which are capped at 100 to allow for a 0-to-100 scoring scale.

Overall, the annual total amount of DoD contract obligations serves as the main indicator of demand. This indicator combines the total value of new DoD procurement contract awards; research, development, testing, and evaluation (RDT&E) contracts; and FMS contracts. This analysis was provided by Govini, our research partner, who calculated total contract obligation values based on a custom federal contracting dataset.

DEPARTMENT OF DEFENSE CONTRACT OBLIGATIONS

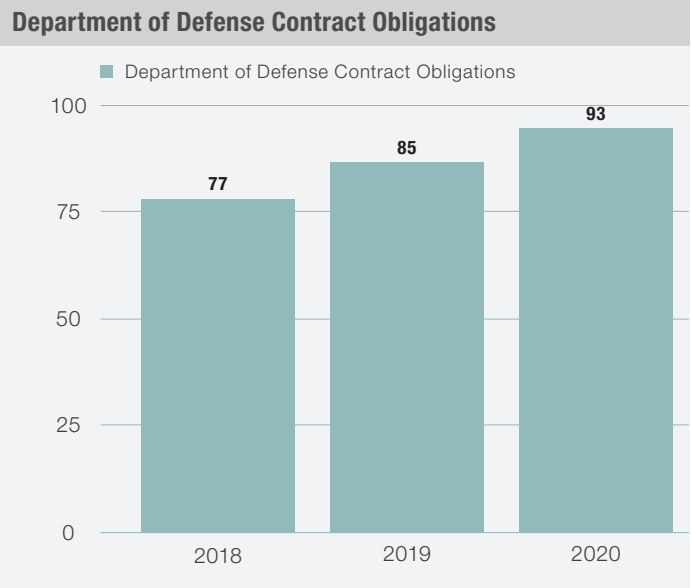


Figure 1.3, Source: NDIA

DoD's contract obligation volume scored a 93 for 2020, trending upward by 16 points over the 2018 score of 77. This score is based on the rise of DoD contract obligations to $394.7 billion in FY19—which is an increase of $65.4 billion over FY17.

As the nation's sole buyer of defense goods and services, and as the largest buyer in the world, the Department of Defense and its annual total of contract obligations provide the best indication of the demand for defense goods and services. Contract awards drive production activity throughout industry as the defense industrial base relies on consistent demand from DoD to justify investments in the productive capacity required to fulfill contracts and compete for future awards. Due to a limited amount of data available from the Carter-Reagan buildup era, annual DoD contract obligations were scored against 2008's baseline value of $392.6 billion—the highest peak in contract obligation volume within our dataset.

DoD's recent budget limitation has not affected its increasing contract obligation volume. In fact, DoD's budget authority increased over five consecutive fiscal years—FY16 to FY20—from $596 billion to $713 billion in current dollars and including Overseas Contingency Operations funding.[1] However, DoD's contract obligations sharply increased from $306.7 billion in FY16 to $394.7 billion in FY19. We expect budget levels to likely flatten over the next few

1 Office of the Undersecretary of Defense (Comptroller)/Chief Financial Officer, "Defense Budget Overview" May 2020. https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/fy2021_Budget_Request_Overview_Book.pdf

DoD Awards By Obligation Amount & Percentage of Total, By Level-One Category Management Group, FY15 – FY19

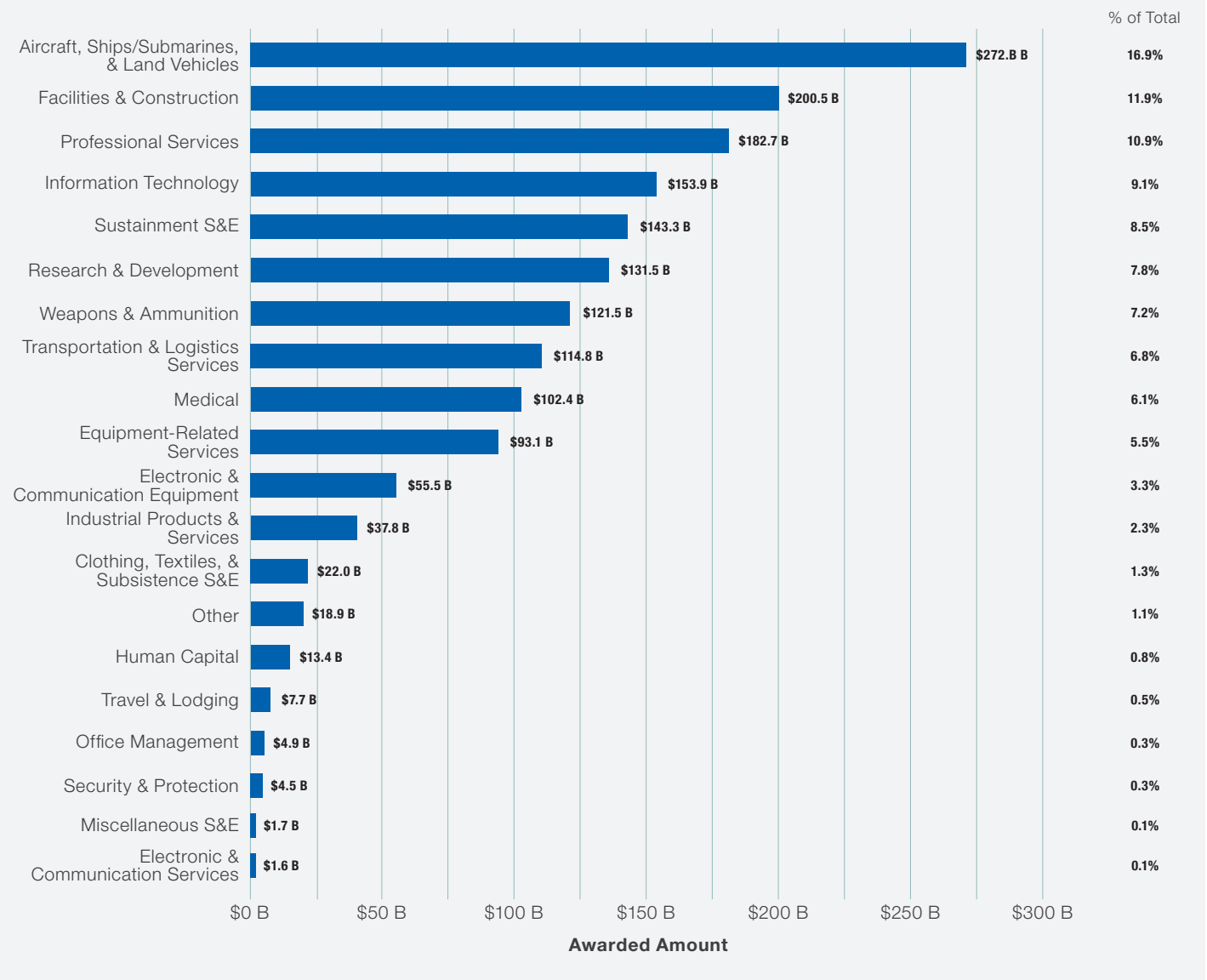


Figure 1.4, Source: Govini

years, affecting DoD's purchasing power. As a result, defense contract obligations warrant close attention in the future.[2]

In its FY21 budget proposal, DoD addressed the spending limits established in the Bipartisan Budget Act of 2019 as well as the tough choices the Department made to realign resources to sustain and advance the recent gains in readiness and effectiveness.[3] While DoD states that the sequestration-driven decline in military readiness has been overcome with past budgets, it acknowledges that a high level of funding is not guaranteed in the future.

From FY19 to FY20, DoD emphasized great-power competition and the prioritization of innovation and modernization to strengthen the U.S. competitive advantage across all warfighting domains. For FY21, DoD proposes strengthened military readiness, the modernization of lethality, dominance across all domains, nuclear deterrence recapitalization, strengthened homeland missile defense, and the development of critical technologies.[4] According to an analysis by Govini, the FY21 defense budget request reflected the necessary adjustments for those emphasized areas identified by the National Defense Strategy.

Among all categories, major defense platforms—aircraft, ships/submarines, and land vehicles—were awarded the most total contract obligations, valued at $272.6 billion. Although these platforms accounted for a combined 16% of total contract obligation awarded between FY15 and FY19, professional services and information technology spending outpaced aircraft, ships/submarines, and land vehicles with 20% of total contract obligation.

2 Rhys McCormick, "Defense Acquisition Trends 2020." October 8, 2020. https://www.csis.org/analysis/defense-acquisition-trends-2020-topline-dod-trends

3 Office of the Undersecretary of Defense (Comptroller)/Chief Financial Officer, "Defense Budget Overview" May 2020. https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/fy2021_Budget_Request_Overview_Book.pdf

4 *Id.*

Percent Change in Total Obligation Value, By Service Category, FY15 – FY19

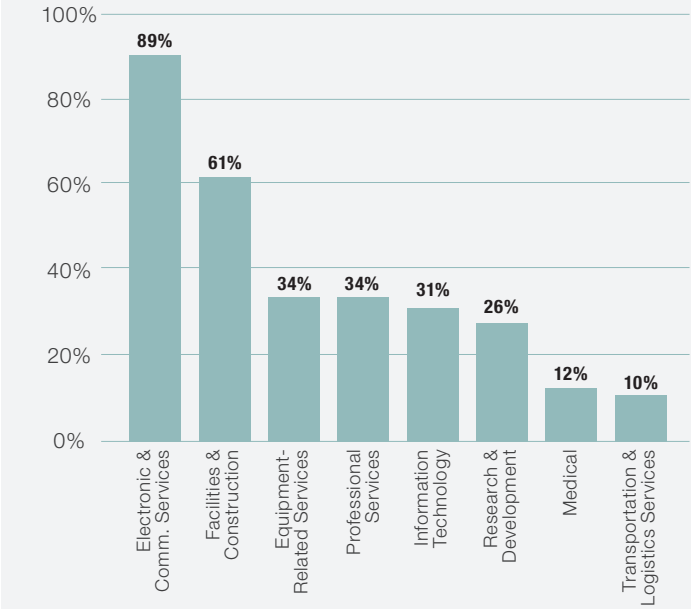


Figure 1.5, Source: Govini

Among service contract categories, between FY15 and FY19, the largest increases occurred for electronics and communication services (89%); facilities and construction (61%); and equipment-related services (34%). Professional services, which is the second largest service contract category, accounted for 18% of all service contract obligation awards and received a 34% increase in contract obligation value. At 10%, transportation and logistics services attracted the lowest increase in total contract obligation value despite holding 11.4% of all service contract obligation.

Percent Change in Total Obligation Value, By Product Category, FY15 – FY19

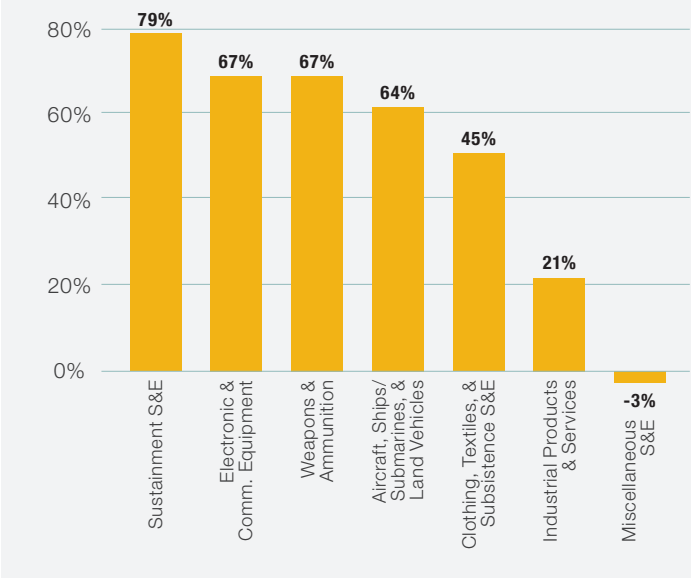


Figure 1.6, Source: Govini

Among product categories, sustainment (79%), electronic and communication equipment (67%), weapons and ammunition (67%), and major defense platforms—aircraft, ships/submarines, and land vehicles—(64%) gained the most in terms of total contract obligation value between FY15 and FY19. While clothing, textiles, and subsistence only hold 3.4% of all product contract obligation, their category experienced a 45% increase in contract obligation value.

For FMS, two major service categories stood out. FMS involving knowledge-based services (35.3%) and equipment-related services (30.9%) constituted two-thirds of contract obligation awards made between FY15 and FY19. Meanwhile, FMS involving transportation services and medical services were negligible, amounting to only 0.05% of contract obligation awards.

Foreign Military Sales Obligations & Percentage of Total, By Service Category, FY15 – FY19

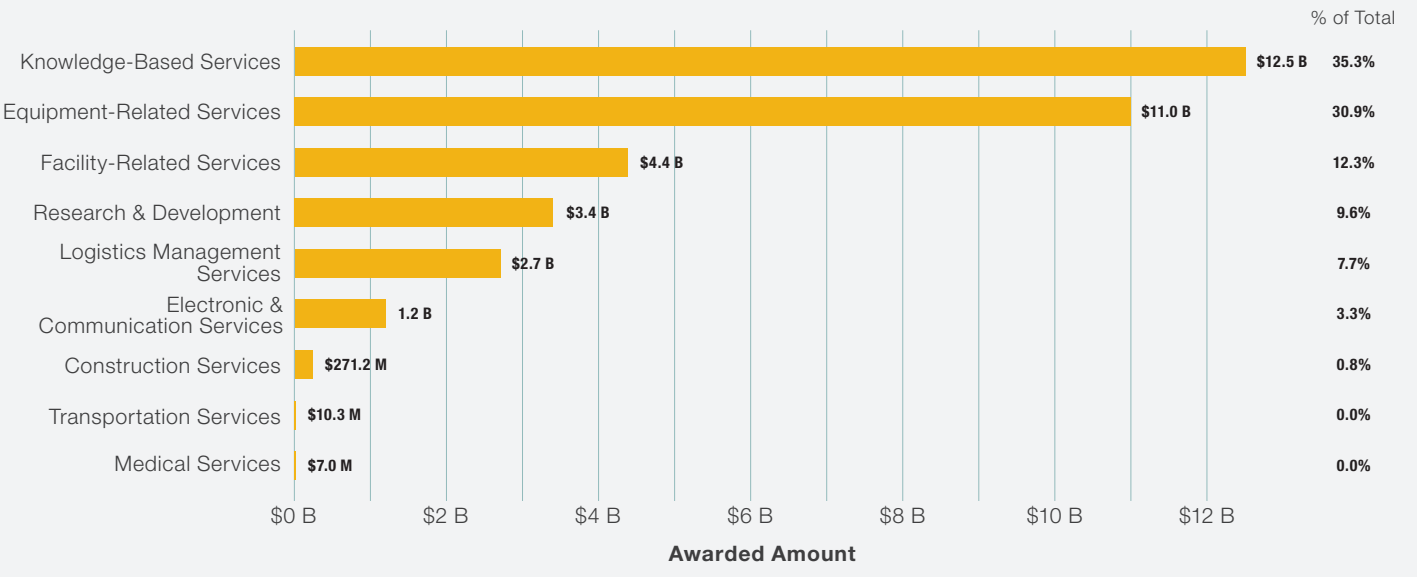


Figure 1.7, Source: Govini

Foreign Military Sales Obligations & Percentage of Total, By Product Category, FY15 – FY19

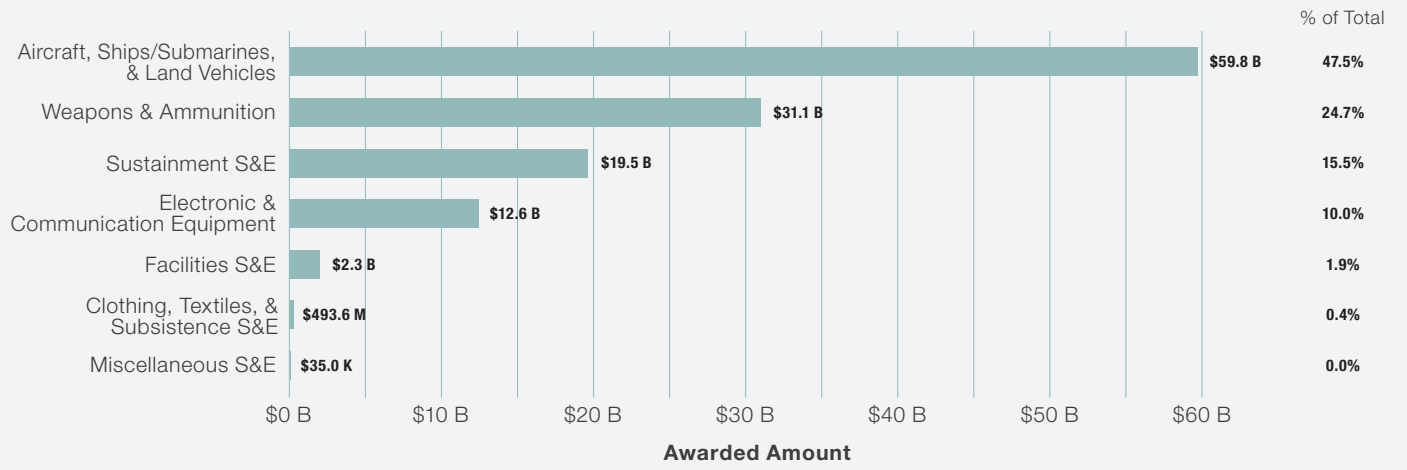


Figure 1.8, Source: Govini

Aircraft, ships/submarines, and land vehicles led all product categories in FMS from FY15 to FY19 with approximately 48% of sales, just about doubling the FMS of weapons and ammunition and more than doubling the FMS of sustainment supplies and equipment. On the other hand, FMS contracts for clothing, textiles, and subsistence supplies and equipment resulted in a mere 0.4% of sales.

Growth in Foreign Military Sales of Aircraft, Ships/Submarines, & Land Vehicles, FY15 – FY19

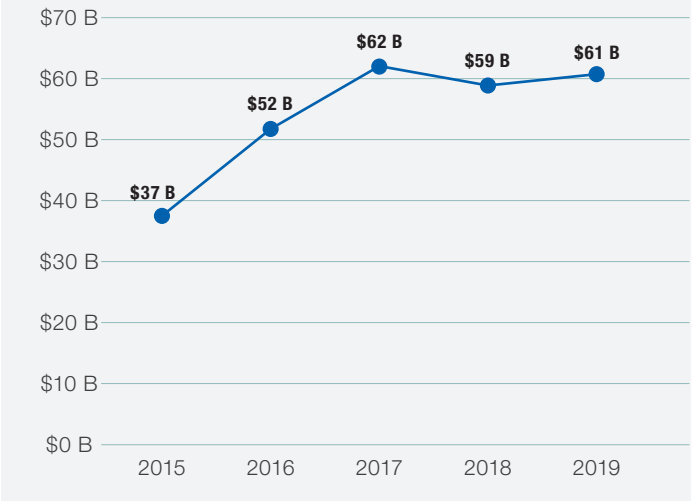


Figure 1.9, Source: Govini

While FMS of major defense platforms received a majority of overall sales for the period between FY18 and FY19, there was only a slight increase from $59 billion to $61 billion (net $2 billion) when compared to the steep rise in sales from previous years.

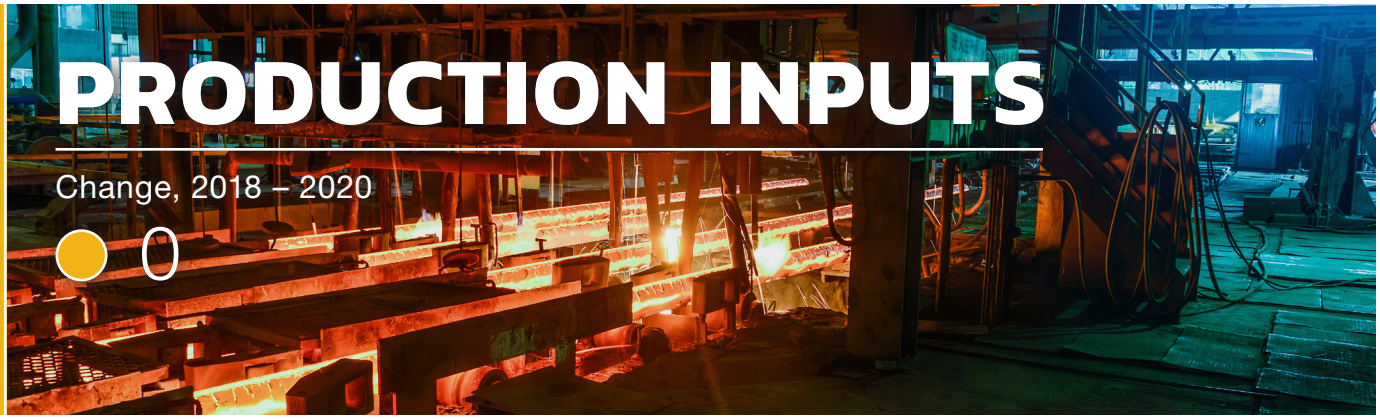
CONCLUSION

DoD's demand for defense goods and services has trended sharply upward since 2018, rising by 16 points to a score of 93 for 2020. Overall, demand for industrial output has improved despite recent DoD budget adjustments driven by the 2019 Bipartisan Budget Act. Acknowledgment of the possible limitations to defense spending has resulted in both the reprioritization of resources and the shifting of investments to prepare for a potential high-end future fight to adhere to the National Defense Strategy.[5] Future DoD purchasing power looks to be challenged by flattening budgets, forcing prioritization between current readiness and capacity versus modernization and recapitalization.

Among service procurement categories, electronic and communication services grew by 89% in contract value while sustainment increased the most among product categories at 79%. FMS boomed among knowledge-based and equipment-related services (~66%) in addition to major defense platforms such as aircraft, ships/submarines, and land vehicles (~48%).

The combined demand signal on the defense industrial base from FMS and direct commercial sales (DCS) remains a bright spot. Foreign sales also provide the defense industrial base with economies of scale and the resources to invest in new capabilities. The United States remains the supplier of choice for defense capabilities.

5 Office of the Undersecretary of Defense (Comptroller)/Chief Financial Officer, "Defense Budget Overview" May 2020. https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2021/fy2021_Budget_Request_Overview_Book.pdf



PRODUCTION INPUTS

Change, 2018 – 2020

0

PRODUCTION INPUTS SCORES

Overall Factor	2020	Change, 2018 – 2020
Costs of Goods, Services, and Strategic Materials	89	-5
Access to Strategic Materials	43	+5
Productivity	99	0
Workforce Size	34	+2
Workforce Compensation	78	+3
Workforce Diversity	76	+2
STEM Talent Pool	98	+3
Security On-Boarding	28	-7
Overall Production Inputs Scores	***68***	***0***

Figure 2.1, Source: NDIA

Factor Score Key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

OVERVIEW

The cost and availability of the inputs used in the production of goods and services also shape the performance of the defense industrial base. Defense industry production relies heavily on intermediate goods and services, highly skilled labor, and raw materials. Trends in the cost and availability of these resources shed light on the ability of defense contractors to acquire the inputs necessary for production.

Overall, production inputs have remained constant over the past two years. Within production inputs, the performance of the security clearance system is the only factor that had a change greater than five points. A decrease in the performance of the security clearance system can become a pain-point of the defense industry's ability to access skilled labor.

Another area of concern is strategic materials; this indicator represents America's ability to produce and procure rare earth metals that are critical to the manufacturing of magnets, microelectronics, LEDs, and batteries. Though this indicator was not included as a stand-alone factor in *Vital Signs 2020*, the importance of rare earths called for the inclusion of new data as well as the treatment of strategic materials as a separate factor in *Vital Signs 2021*. This factor continues to score poorly given the low levels of U.S. rare earth production.

This section also illustrates the reasons for which *Vital Signs 2021* uses a three-year trailing average for all the indicators. This year, the underlying data for diversity indicated a small single-year decrease for each indicator. Nevertheless, there were overall increases across the board for diversity indicators because previous years' increases pushed up the three-year average. Conversely, the underlying data for security indicators saw a year-over-year increase. However, their overall score has decreased due to the three-year average being driven down by prior years' performances.

> **"There were overall increases across the board for diversity indicators.**

KEY TAKEAWAYS

- Overall production inputs conditions scored a 68 for 2020
- Well-performing factors: Costs of goods, services, and strategic materials; workforce compensation; and STEM talent pool
- Poor-performing factors: Workforce size and security on-boarding capacity

PRODUCTION INPUTS SCORES

Factor	Indicator	2020	Change, 2018 – 2020
Costs of Goods, Services, and Strategic Materials	Producer Price Index of Services for Intermediate Demand	85	-5
	Producer Price Index of Processed Goods for Intermediate Demand	93	-5
Overall Costs of Goods, Services, and Strategic Materials		***89***	***-5***
Access to Strategic Materials	Average Rare Earths Minerals (REMX) ETF Prices	100	0
	U.S. Share of World Rare Earths Mine Production	23	+18
	Net Import Reliance as a Percentage of Domestic Consumption	6	-2
Overall Access to Strategic Materials		***43***	***+5***
Productivity	Total Factor Productivity	99	0
Overall Productivity		***99***	***0***
Workforce Size	Estimated Total Defense-Related Direct Employment	34	+2
Overall Workforce Size		***34***	***+2***
Workforce Compensation	Estimated Average Annual Per-Worker Pay for Defense-Related Employment	78	+3
Overall Workforce Compensation		***78***	***+3***
Workforce Diversity	Gender Diversity in Employment in Defense Supplier Industries	85	0
	Racial Diversity in Employment in Defense Supplier Industries	79	+8
	Latino Ethnicity Diversity in Employment in Defense Supplier Industries	41	+2
	Age Diversity in Employment in Defense Supplier Industries	100	0
Overall Workforce Diversity		***76***	***+2***
STEM Talent Pool	STEM Percentage of Total U.S. Occupational Employment	98	+3
Overall STEM Talent Pool		***98***	***+3***
Security On-Boarding	Annual Inventory of Security Clearance Investigation Cases	28	-2
	Duration of Initial Top Secret Reviews (days)	23	-9
	Duration of Top Secret Periodic Reinvestigations (days)	33	-11
Overall Security On-Boarding		***28***	***-7***
Overall Production Inputs Score		***68***	***0***

Figure 2.2, Source: NDIA

Factor Score Key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

INTRODUCTION

The production inputs scores are lagging indicators and reflect the state of production inputs before the COVID-19 pandemic. Defense contractors use a variety of goods, services, materials, and security-cleared skilled labor to fulfill the requirements of defense contracts. The cost and availability of these production inputs are subject to institutional forces and changes in the market. Fluctuations in these production inputs affect delivery schedules, the quality of goods and services, as well as the final cost for the government customer. By presenting indicator scores for common defense production inputs, this section analyzes statistical factors that drive the supply side of defense production.

METHODOLOGY

Indicator scores are determined by the ratio of an indicator's average value to a baseline value. Baseline values reflect historical peak values or ideal standard values, which means that they are unique for each indicator. Ultimately, the availability of data in the public domain constrained the selection of baseline values. The overall section score averages variable scores that consist of averages of indicator scores, which are capped at 100 to allow for a 0-to-100 scoring scale.

This section describes key attributes of defense production inputs that include the costs of goods, services, and strategic materials; the size of the defense workforce; compensation; workforce

diversity; workforce STEM talent pool availability; and the security on-boarding process. The indicators for the costs of goods, services, and strategic materials rely on Producer Price Index (PPI) data from the U.S. Bureau of Labor Statistics; data for the rare earth price indicator is based on VanEck Vectors® Rare Earths/Strategic Metals Exchange Traded Fund (REMX ETF). Total employment, average compensation, diversity, and STEM talent data comes from the U.S. Bureau of Labor Statistics and the National Science Foundation. Data for the security on-boarding process is from the National Industrial Security Program Advisory Council.

COSTS OF GOODS, SERVICES, AND STRATEGIC MATERIALS

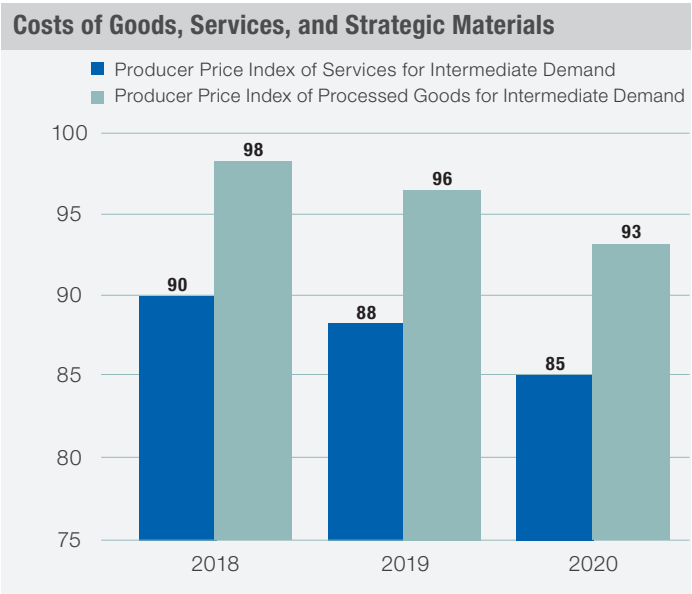


Figure 2.3, Source: NDIA

Although the costs of goods, services, and strategic materials scored well for 2020, its score of 89 marks a decrease of five points from the 2018 score of 94. This downward trend is based on the Bureau of Labor Statistics' PPI scores for intermediate goods and intermediate services, which rose to values of 108 and 120, respectively, due to increased prices for fuel and materials used in manufacturing products such as steel.

Defense contractors consume intermediate goods and intermediate services when fulfilling their defense contracts. In addition, rising costs can negatively affect their productive capacity. Changes in production input costs can force producers to adapt their production plans by changing their per-unit cost structure of final products, altering production volumes, or passing along additional costs to the government customer. The Bureau of Labor Statistics' PPI measures average prices experienced by end-producers of goods and services across a single sector. The PPI of services for intermediate demand captures average prices for services consumed by end-producers that generate final products. The PPI of services for intermediate demand scored an 85 for 2020, which is a five-point decrease from the 2018 score of 90 and a three-point decrease from the 2019 score of 88. The PPI of processed goods for intermediate demand shows average prices for durable and non-durable goods used in the making of other products. In fact, the PPI of processed goods for intermediate demand scored a 93 for 2020, which is a five-point decrease from the 2018 score of 98 and a three-point decrease from the 2019 score of 96. For example, in 2018, steel prices rose 33%, largely due to the impact of tariffs on steel prices.[1]

In recent years, price growth in materials used for durable manufacturing—a category that includes processed materials like textiles, lumber, metals, and cement—has driven a rising trend in prices for processed goods for intermediate demand.[2] Meanwhile, prices for services for intermediate demand have risen as the result of price growth in transportation services. U.S. tariffs on foreign goods, particularly steel, have also helped to push the prices of commodities upward.[3] This trend is in contrast to the Consumer Price Index, which increased by only 1% in FY20.[4]

ACCESS TO STRATEGIC MATERIALS

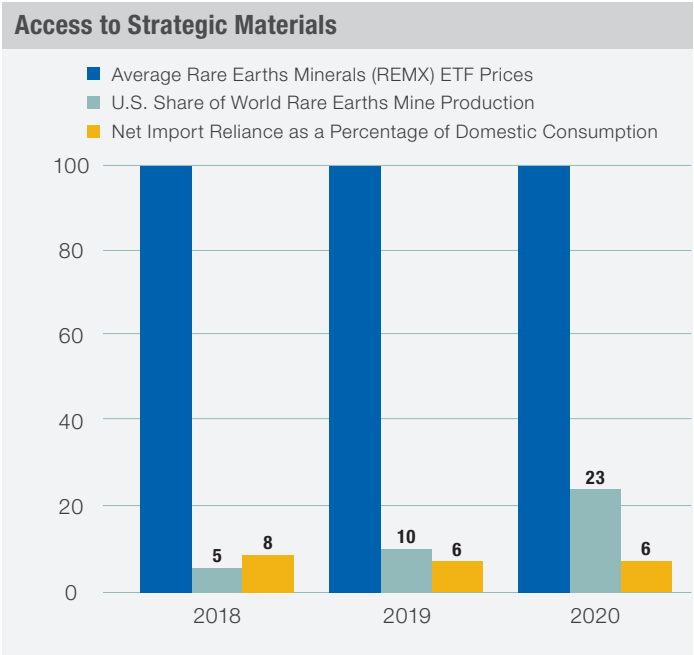


Figure 2.4, Source: NDIA

Many defense companies use rare earth minerals and metals to manufacture defense items. Rare earths are a group of 17 elements that are critical to the manufacture of magnets, microelectronics, LEDs, and batteries. Rare earth minerals are also used in consumer

1 John Packard. "2018 steel year in review." January 16, 2019. https://www.thefabricator.com/thefabricator/blog/metalsmaterials/2018-steel-year-in-review

2 U.S. Bureau of Labor Statistics, "PPI Detailed Report: Data for December 2018," January 2019. https://www.bls.gov/ppi/ppidr201812.pdf

3 Heather Long, "Trump's steel tariffs cost U.S. consumers $900,000 for every job created, experts say," Washington Post, May 7, 2019. https://www.washingtonpost.com/business/2019/05/07/trumps- steel-tariffs-cost-us-consumers-every-job-created-experts-say/

4 CPI Calculator, Bureau of Labor Statistics. https://www.bls.gov/data/inflation_calculator.htm

products like the iPhone, which uses rare earths to run its taptic engine.[5] China has restricted the export of rare earths, prompting concerns for their availability to the DIB.[6] Section 851 of the FY21 National Defense Authorization Act (NDAA) contains a provision that will require a report on strategic and critical materials that will include the gaps and vulnerabilities in their supply chain.[7]

We consulted the REMX ETF measurement of average price activity across all rare earth metals to calculate our strategic materials score. While both PPI indicators were scored against the default value of 100, the cost of rare earths was scored against a baseline annualized REMX ETF price for 2014 of $75. Meanwhile, the U.S. share of global production and the U.S. reliance on foreign production were scored against 32% in 1994 and 6% in 1995, respectively. These years represent peaks within our dataset. Within this metric, the score for the U.S. share of worldwide rare earths mine production increased from a score of five points in 2018 to a score of 23 in 2020. Moreover, net import reliance as a percentage of domestic production stayed the same from the 2019 score of 6 but decreased slightly from the 2018 score of 8. These scores are representative of the low levels of production in the United States as well as our continued reliance on imports. In fact, the United States exports nearly all of the rare earths that it mines while continuing to rely on imports—all despite its increased domestic production.[8]

PRODUCTIVITY

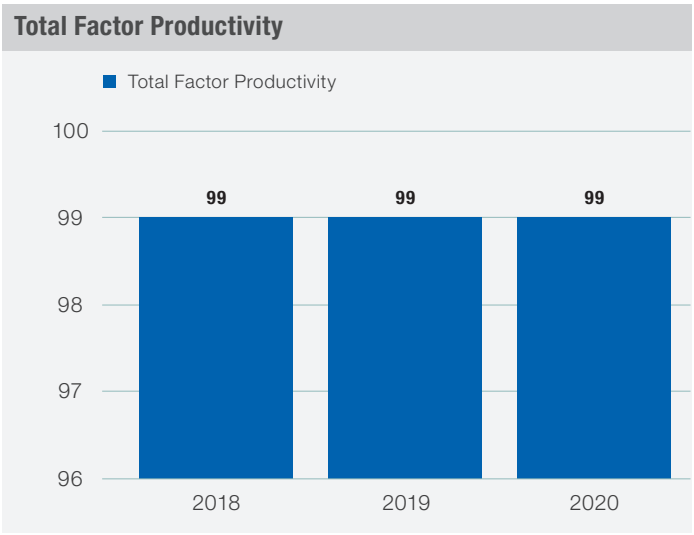


Figure 2.5, Source: NDIA

Total Factor Productivity (TFP), also known as Multifactor Productivity (MFP), is the portion of output that is not accounted for or is unexplained by the number of production inputs used.[9] The unexplained portion of output reflects advances in technologies and processes. TFP is a measure of economic performance that compares output—the amount of goods and services produced—to the amount of combined inputs used to produce those goods and services. Inputs can include labor, capital, energy, materials, and purchased services. In 2020, TFP scored a 99, which is consistent with the score of 99 calculated for both 2018 and 2019.

WORKFORCE SIZE

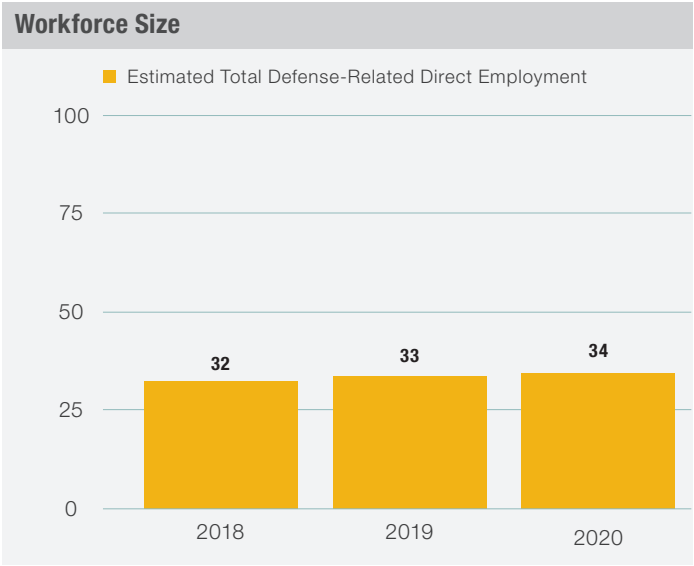


Figure 2.6, Source: NDIA

The size of the defense industrial workforce trended slightly upward for 2020, earning a score of 34, a two-point increase from 32 in 2018 and a one-point increase from 33 in 2019. This score is based on an NDIA estimate of private employment directly related to defense contracts of approximately 1.1 million.[10] Our estimate is based on "Employment and Wages, Annual Averages 2019," produced by the U.S. Bureau of Labor Statistics.[11] The size of the defense industrial workforce was baselined against the defense industry's 1985 employment peak value of 3.2 million workers. Factoring in increases in labor productivity, which grew by 90% since 1985, 2 million workers would be needed to create a defense workforce equivalent to that of 1985.[12]

5 Stephen Nellis, "Apple taps recycled rare earth elements for iPhone parts." Reuters, September 18, 2019 https://www.reuters.com/article/us-apple-rareearths/apple-taps-recycled-rare-earth-elements-for-iphone-parts-idUSKBN1W31JG

6 Iori Kawate "China passes export control law with potential for rare-earths ban." Nikkei Asia, October 19, 2020. https://asia.nikkei.com/Politics/International-relations/US-China-tensions/China-passes-export-control-law-with-potential-for-rare-earths-ban

7 Conference Report, National Defense Authorization Act for Fiscal Year 2021. Section 851.

8 https://pubs.usgs.gov/periodicals/mcs2020/mcs2020-rare-earths.pdf

9 Multifactor Productivity, Bureau of Labor Statistics. https://www.bls.gov/mfp/ https://www.hbs.edu/faculty/Pages/item.aspx?num=30762

10 NDIA's estimate is consistent with a Deloitte LLP's estimate of direct defense industry employment of 1.2 million published in 2016. Employment and Wages, Annual Averages 2019

11 Bureau of Labor Statistics, "Employment and Wages, Annual Averages 2019." https://www.bls.gov/cew/publications/employment-and-wages-annual-averages/2019/home.htm

12 *Id.*

Since the defense industrial base relies on a large labor pool to deliver goods and services for DoD, such trends in defense workforce size provide insight into the evolving availability of workers for the defense industrial base.[13] Since 1985, the defense industrial base has experienced a significant reduction of its ranks—a function of declining federal defense expenditures as a percentage of overall gross domestic product (GDP) as well as budget instability.

WORKFORCE COMPENSATION

Workforce Compensation

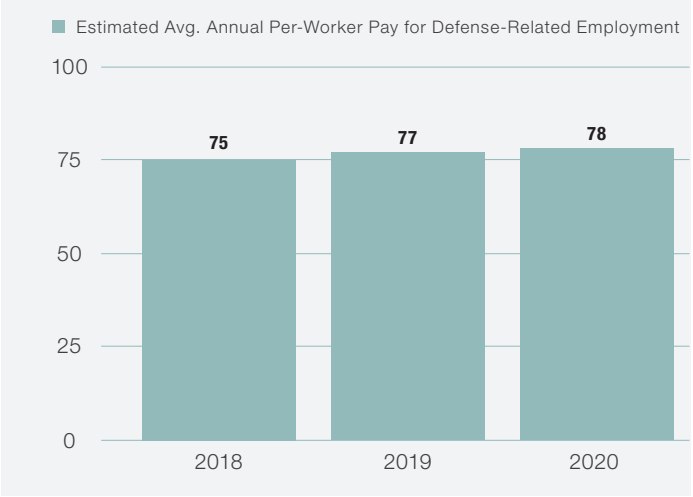


Figure 2.7, Source: NDIA

Workforce compensation scored a 78 for 2020, which increased by three points from a score of 75 in 2018 and one point from a score of 77 in 2019. These scores are based on an NDIA estimate of the average annual per-worker pay in defense-related industries of approximately $80,243.

Workforce compensation strongly influences the defense industry's ability to recruit talented personnel. While skilled workers make essential contributions to the production of goods and services for defense contracts, trends in the average level of pay provided to individual industry workers indicate the evolving valuation of their labor. Increasing wages, which is generally a very positive development for workers, can indicate tight labor markets fueling wage escalation. Using wage data from the Bureau of Labor Statistics, NDIA estimated a weighted average of annual pay per worker in defense-related industries to demonstrate the trend in the valuation of talent within the defense industrial base. Average annual per-worker pay was scored against a baseline value of $100,500, which is the inflation-adjusted level of annual per-worker pay from during the defense buildup peak of 1985.

WORKFORCE DIVERSITY

Workforce Diversity

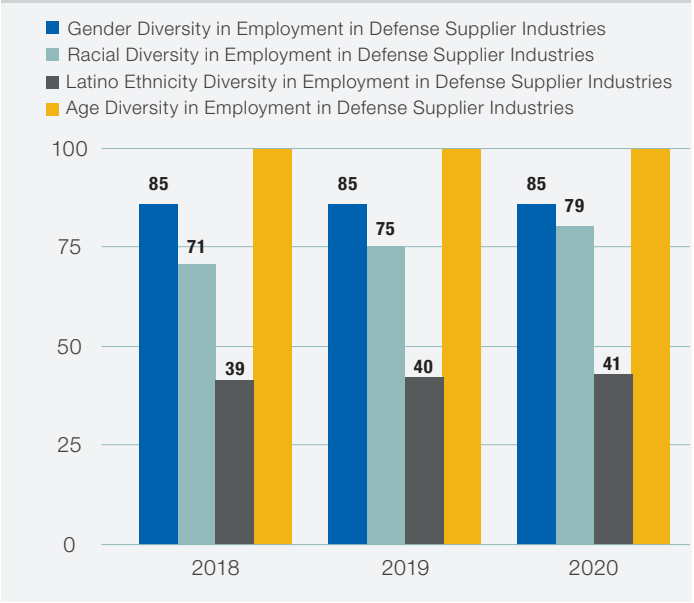


Figure 2.8, Source: NDIA

Workforce diversity scored a 76 for 2020, which marks a two-point increase from 2018. This score is based on NDIA's estimate of the value of Simpson's Diversity Index (SDI) for employment in defense-related industries according to age, gender, race, and ethnicity.

The defense industrial base derives its capabilities from the skills of its workforce and through its ability to attract talent from all parts of American society. Diversity includes differences in age, ethnicity, gender, and race. A diverse workforce enhances the breadth of knowledge, skills, and abilities present in the workforce. Several studies have found that diverse groups make better decisions.

To assess diversity within key supplier industries, an estimate of SDI serves as an indicator of the level of diversity present in the defense industrial base.[14] SDI values measure the probability that any two members of a system, selected randomly, will be the same.[15] Each dimension of diversity was scored against an SDI value of 0.5—the threshold value for a diverse population.

The industry's rising workforce diversity reflects both demographic trends and a growing recognition of diversity and inclusion within the workforce. A 2016 Ernst and Young survey found that 54% of human resource professionals at leading global aerospace and defense companies identified the "lack of diversity at different levels of the organization" as the top talent management challenge for the sector.[16] A 2017 *Aviation Week* survey of top U.S. aerospace and defense companies identified a surge in the percentage of

13 David K. Henry and Richard P. Oliver, "The defense buildup, 1977- 85: effects on production and employment," Monthly Labor Review, 1987, https://www.bls.gov/opub/mlr/1987/08/art1full.pdf

14 Knudsen, Eric, "Simpson's Diversity Index: The Diversity Metric You Aren't Tracking Yet," The Namely Blog, June 21, 2018. Available at: https://blog.namely.com/blog/the-diversity-metric-you-arent-tracking-yet

15 Royal Geographical Society, "A Guide to Simpson's Diversity Index," Available at: https://www.rgs.org/CMSPages/GetFile.aspx?nodeguid=018f17c3-a1af-4c72-abf2-4cb0614da9f8&lang=en-GB

16 Ernst and Young, "Top 10 risks in aerospace and defense," https://www.ey.com/publication/vwluassets/ey-top-10-risks-in-aerospace-and-defense/%24file/ey-top-10-risks-in-a&d.pdf

minorities in the workforce, increasing from 15% to 21%.[17] In 2020, *Aviation Week* reported a sizable increase in the percentage of women and minority executives.[18] Additionally, in 2019, 37.3% of new hires identified themselves as members of a minority group.[19]

Though there were overall increases across the board for diversity indicators, there were also small dips in the SDI score for all categories, which highlights the importance of the way in which *Vital Signs* uses three-year running averages. This one-year small dip could be either anomalous or a leading indicator; however, this small, one-year shift was not enough to change the data.

STEM TALENT POOL

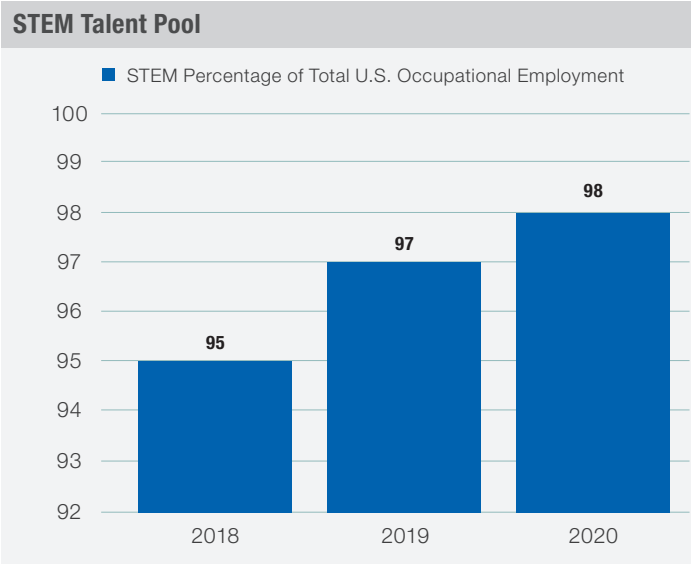


Figure 2.9, Source: NDIA

The size of the industry's technical talent pool scored a 98 for 2020, three points higher than in 2018. This score is derived from the science, technology, engineering, and mathematics (STEM) percentage of total U.S. occupational employment. The 2020 score for the technical talent pool uses NDIA's estimate of the average annual STEM share of total U.S. occupational employment—12.6%.

The availability of STEM workers impacts the productive capabilities of the defense industrial base because such workers offer highly valuable technical skills that are essential for the design, development, and production of complex goods and services. Data from the U.S. Bureau of Labor Statistics on the share of STEM workers that comprise total U.S. occupational employment indicates the amount of STEM-trained talent active within the workforce. This year's average percentage of 12.4% was scored against 12.6%, the single-year peak value that the STEM share of employment reached in 2019.

The upward trend in the size of industry's STEM talent pool reflects the influence of several factors. First, more undergraduate students choose STEM majors today than a decade ago.[20] STEM workers benefit from a wage premium when compared to workers in other industries or groups.[21]

In recent years, a debate has emerged among industry and government leaders about a deficit of STEM skills throughout the U.S. workforce. Depending on the field, both shortages and surpluses exist within the STEM workforce.[22] Thus, STEM employment faces a paradox in which an expanding pool of STEM graduates fails to keep up with the growing demand for skilled labor while the overall STEM workforce is getting older.[23]

Within the defense industrial base, concerns about the skills gap have focused on the availability of STEM workers for both manufacturing and engineering roles.[24] A 2018 study of the skills gap by Deloitte and the Manufacturing Institute estimated that 2.4 million open manufacturing positions would go unfilled between 2018 and 2028 due to a lack of available skilled labor.[25] Many defense leaders have issued calls to action to address this sort of STEM-based skills gap, citing growing shortages of engineers and technicians at a time of technological competition.[26] Many leading defense firms have responded to this trend by helping to grow the pipeline of STEM graduates entering defense engineering and manufacturing fields.[27]

17 Aviation Week, "2017 Aviation Week Workforce Report," November 30, 2017. Available at: https://www.aia-aerospace.org/report/2017-aviation-week-workforce-report/

18 Aviation Week, "The Face of Aerospace & Defense," September 25, 2020. Available at: https://aviationweek.com/aerospace/face-aerospace-defense

19 *Id.*

20 Wright, Joshua, "STEM Majors are accelerating in every state, just as humanities degrees are declining," Emsi, September 1, 2017. https://www.economicmodeling.com/2017/09/01/stem-majors-accelerating-every-state-just-humanities-degrees-declining/; Yadoo, Jordan, "American College Students Are Swapping Shakespeare for STEM," Bloomberg News, September 14, 2018, "https://www.industryweek.com/talent/article/22026345/american-college-students-areswapping-shakespeare-for-stem

21 Graf, Nikki; Fry, Richard; and Cary Funk, "7 facts about the STEM workforce," FACTANK, Pew Research Center, January 9, 2018. Available at: https://www.pewresearch.org/fact-tank/2018/01/09/7-factsabout-the-stem-workforce/

22 Xue, Yi and Richard C. Larson, "STEM crisis or STEM surplus? Yesand yes," Monthly Labor Review, U.S. Bureau of Labor Statistics, May 2015. https://www.bls.gov/opub/mlr/2015/article/stem-crisis-or-stemsurplus-yes-and-yes.htm

23 Kramer, Mark et al. "The Global STEM Paradox," FSG and the New York Academy of Sciences, 2015; https://www.fsg.org/publications/ global-stem-paradox

24 "2016 National Aerospace & Defense Workforce Summit: Proceedings Report & Recommendations," Aerospace Industries Association and the American Institute of Aeronautics and Astronautics, 2016, http://static.politico.com/88/1f/4bdfa7e04063a94044eecf1c7f21/2016-national-aerospace-defense-workforce-summit-proceedings-report-recommendations.pdf

25 Giffi, Craig et al, "2018 Deloitte and the Manufacturing Institute skills gap and the future of work study," Deloitte Insights, 2018. http://www.themanufacturinginstitute.org/~/media/E323C4D8F75A470E8C96D7A07F-0A14FB/DI_2018_Deloitte_MFI_skills_gap_FoW_study.pdf

26 Hewson, Marillyn, "We must close the skills gap to secure our future," FoxNews.com, July 19, 2018. https://www.foxnews.com/opinion/we-must-close-the-skills-gap-to-secure-our-future

27 Censer, Marjorie, "Growing roots for more STEM," Washington Post, April 22, 2012. Available at: https://www.washingtonpost.com/ business/capitalbusiness/growing-roots-for-more-stem/2012/04/20/ gIQA3QzUaT_story.html

SECURITY ON-BOARDING

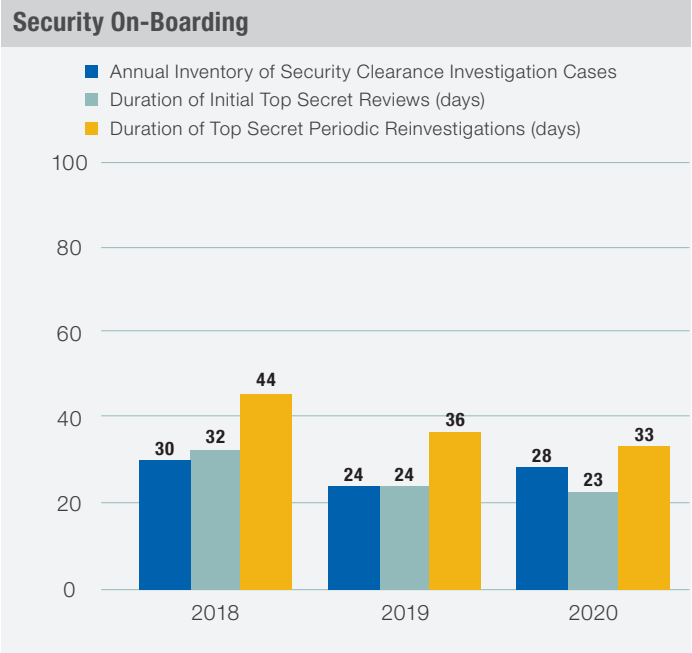


Figure 2.10, Source: NDIA

Overall federal security clearance processes earned an overall score of 28 for 2020, which is down seven points from 2018. The security on-boarding score is a composite of indicators from 2018 to 2020 that include the average annual inventory of security clearance investigation cases (574,667 cases), the duration of initial top secret clearance reviews (437 days); and the duration of periodic top secret clearance reinvestigations (540 days). The average annual inventory of security clearance investigation cases was scored against a baseline from FY10 (162,000 cases); the duration of initial top secret clearance reviews (100 days); and the duration of periodic top secret clearance reinvestigations (180 days).

On-boarding new personnel in the defense industry often requires navigating the security clearance process. Access to security clearances affects the availability of skilled workers for the defense industrial base because national security requires some contract-based defense workers to acquire security clearances to be eligible to perform their assigned duties. Achieving a permanent security clearance requires an extensive background check. The capacity and efficiency of the security clearance investigation process and the issuance process may act as a constraint on the ability of defense contractors to fill defense contracting jobs.

The backlog of security clearances has seen a significant decrease since the release of *Vital Signs 2020*. Though the three-year trailing average is still largely dominated by the massive increase from 2018, the inventory was down from a high of over 700,000 cases to just over 300,000 cases in 2019. The drop in cases has coincided with investigations being handed over from the National Background Investigations Bureau to the Defense Counterintelligence and Security Agency (DCSA). Both new investigation times and reinvestigation times are down on a year-by-year basis. However, it is worth mentioning that DCSA only released the average time for the fastest 90% of investigations in 2019. As mentioned previously, it is unclear if this trend can be continued long enough to show up in our trailing average.

CONCLUSION

While production inputs demonstrated increasingly poor conditions with an overall score of 68 for 2020, the score has remained constant since 2018. The performance of the security clearance system led to a low 2020 score of 28 for security on-boarding, a key limiting factor in the defense industry's access to skilled labor. Though the costs of goods and services scored an 89 for 2020, it did decrease by five points from 2018; meanwhile, access to strategic materials increased by five points from 38 in 2018 to 43 in 2020. By contrast, other factors' scores gained points. Workforce diversity improved by two points—to 76 in 2020 from 74 in 2018—driven primarily by an eight-point improvement in racial diversity. The skilled workforce pool scored a 98, rising as a result of an expansion of STEM-trained graduates and workers drawn to the compensation premium associated with STEM jobs and educational backgrounds. Additionally, there were many data shifts that are just beginning to enter our three-year average and have not yet been translated into trends. How many of these one-year shifts continue will be an interesting point to track in future years.

INNOVATION SCORES		
Overall Factor	**2020**	**Change, 2018 – 2020**
Innovation Inputs	77	-1
Innovation Outputs	59	-8
Innovation Competitiveness	76	+1
Overall Innovation Score	***71***	***-2***

Figure 3.1, Source: NDIA

Factor Score Key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

OVERVIEW

For decades, the U.S. National Defense Strategy has looked to the defense industrial base as an important source of technological innovation. The manufacturing and services industries associated with the most technology-intensive goods and services acquired by DoD are the source of significant amounts of capital for research and development. Trends in industrial R&D investment and patent activity help form a picture of the state of private sector defense innovation.

Many DoD programs require, or are the result of, large investments in research and development. Both the technical research of applied science to solve specific issues and the basic foundational scientific research are key to this effort.

For *Vital Signs 2021*, industrial innovation conditions remained poor and continued a downward trend. The decrease in innovation investments stems from cuts made within the scientific R&D services industries—typically those focused on basic research. This sector is also a poor performer in innovation outputs, which makes scientific R&D services a key driver of the decline in the innovation system. This situation unfolds while the value of R&D investment in technology and manufacturing continues to be strong. In addition, overall investment is showing a slight increase. Interestingly, while manufacturing innovation inputs remain strong, manufacturing innovation outputs saw a large drop over the past two years.

Direct DoD innovation spending patterns provide another way of looking at the innovation landscape. Research, development, test, and evaluation continue to dominate DoD innovation spending. However, obligations made through Other Transaction Authorities have grown quickly in the last few years.

> **"The decreasing level of innovation inputs and outputs coming from scientific R&D services industries, typically focused on basic research, is a key driver of the overall decline in the innovation system.**

KEY TAKEAWAYS

- Innovation conditions scored a 71 for 2020, a two-point decrease from 73 in 2018
- Declining investments in innovation and productivity in basic science R&D have driven innovation conditions downward
- Innovation outputs performed poorly

INNOVATION SCORES

Factor	Indicator	2020	Change, 2018 – 2020
Innovation Inputs	Average Annual Value of Worldwide R&D Paid for by United States-Based Companies (Durable Industrial Goods Manufacturing Industries)	100	0
	Average Annual Value of Worldwide R&D Paid for by United States-Based Companies (Information and Communications Technologies)	100	0
	Average Annual Value of Worldwide R&D Paid for by United States-Based Companies (Scientific R&D Services)	31	-4
Overall Innovation Inputs		***77***	***-1***
Innovation Outputs	Average Annual Patent Applications (Durable Industrial Goods Manufacturing Industries)	46	-29
	Average Annual Patent Applications (Information and Communications Technologies)	94	+14
	Average Annual Patent Applications (Scientific R&D Services)	38	-7
Overall Innovation Outputs		***59***	***-8***
Innovation Competitiveness	U.S. Share of Global R&D Investment	76	+1
Overall Innovation Competitiveness		***76***	***+1***
Overall Innovation Score		***71***	***-2***

Figure 3.2, Source: NDIA

Factor Score Key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

INTRODUCTION

The United States has looked to industry to create innovations that enable our nation's superiority on the battlefield across all domains. Trends in the inputs, outputs, and the competitiveness of our innovation system illuminate the defense industrial base's ability to continue to produce innovations that help to maintain our technological edge.

METHODOLOGY

Indicator scores are determined by the ratio of an indicator's average value to a baseline value. Baseline values reflect historical peak values or ideal standard values, which means that they are unique for each indicator. Ultimately, the availability of data in the public domain constrained the selection of baseline values. The overall section score averages variable scores that consist of averages of indicator scores, which are capped at 100 to allow for a 0-to-100 scoring scale.

This section of the report presents scores for industrial innovation that describe the innovation inputs, innovation outputs, and the international competitiveness of industrial innovation. Scores for innovation inputs and outputs are based on corporate R&D expenditures and annual patent applications obtained from the National Science Foundation. The score for innovation competitiveness uses patent data from the World Intellectual Property Office (WIPO) in addition to comparative international expenditures data from the Organization for Economic Cooperation and Development (OECD).

INNOVATION INPUTS

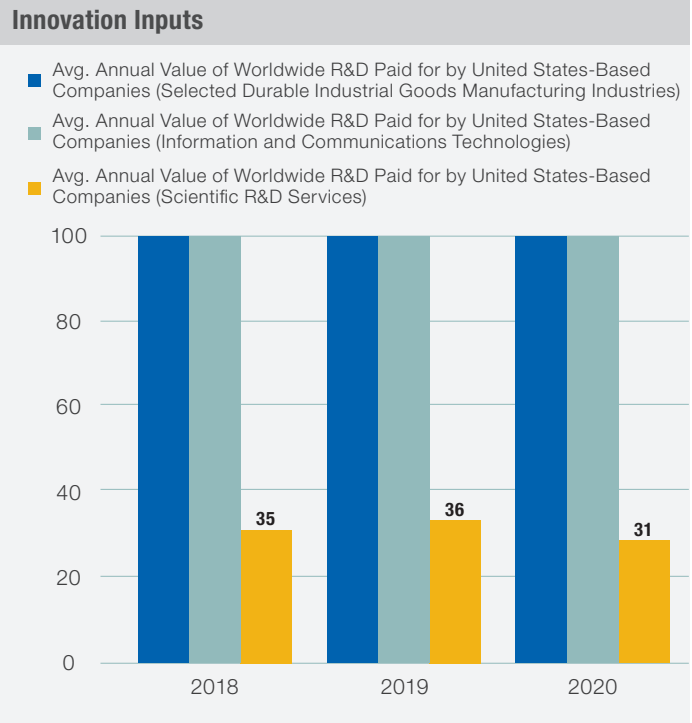


Figure 3.3, Source: NDIA

Private sector investment in innovation is vital to advancing defense technologies. Through internal and external R&D projects, companies can discover and develop new products and services with national security applications.

Innovation inputs scored a 77 for 2020, which is a decline of one point from 78 in 2018. This score is based on the average annual value of worldwide R&D paid for by United States-based companies in 1) durable goods manufacturing, 2) information and communications technologies, and 3) scientific R&D services. According to the National Science Foundation's most current data, American companies in these sectors spent an average of $162.4 billion, $71.9 billion, and $4.7 billion, respectively, between 2014 and 2016.

The trends for innovation inputs suggest that the resourcing of traditional industrial sources of defense technology innovation has diverged. Information and communications technologies and durable goods manufacturing now receive high levels of investment in innovation. In contrast, scientific R&D services received decreased levels of investment. This divergence in investment activity may be caused by the devaluing of investments in basic scientific research for both the public and private sectors in the United States.[1] The scientific R&D services category includes the activities of organizations performing experimental scientific research and not engineering-related research; specifically, universities, independent research institutes, and corporate and private laboratories are part of this group.

A 2019 report by the Task Force on American Innovation declared that the United States "risks falling perilously behind in the basic scientific research that drives innovation" as the result of both declining federal support for basic scientific research and intensifying global competition in basic research.[2] The Task Force also noted that basic research investment in the United States disproportionately favors biotechnology and life sciences over mathematics, computer science, and the physical sciences. The continuing decline of private sector-funded basic scientific research has created an environment in which universities now function as the main centers for innovation-oriented basic research and complex innovation ecosystems.[3] This trend in basic research is just a continuation of the trend reported in Vital Signs 2020. The recent average of $4.1 billion for innovation inputs is well below the 2008 total of $13.1 billion.

INNOVATION OUTPUTS

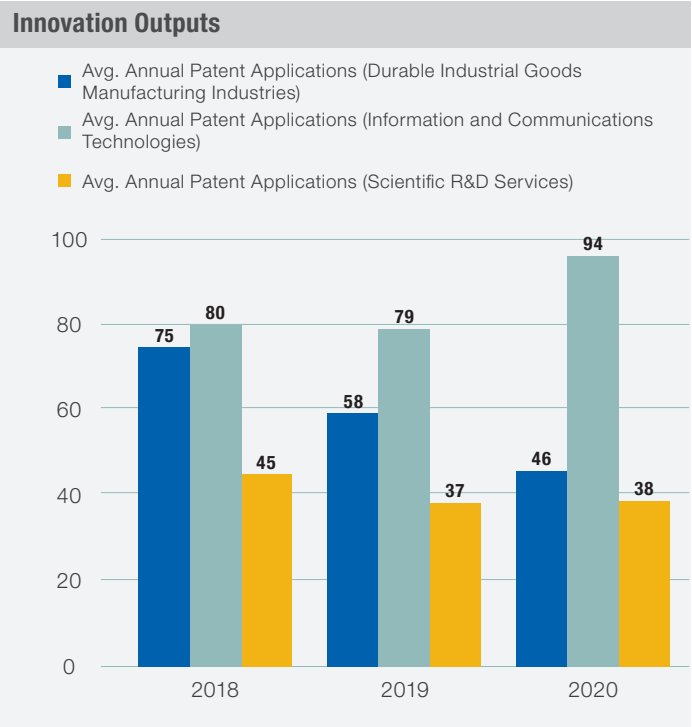


Figure 3.4, Source: NDIA

Innovation outputs scored a 59 for 2020—an eight-point decrease from the 2018 score of 67. This score is based on a combination of three indicators related to annual patent application filings for inventions associated with 1) durable goods manufacturing, 2) information and communications technologies, and 3) scientific R&D services. For the three most recent years of data, the average number of annual patent applications submitted by United States-based companies was 34,732 for durable industrial goods, 65,066 for information and communications technologies, and 2,686 for scientific R&D services.[4]

NDIA defines innovation outputs as "how well the U.S. innovation system generates new inventions." Inventions are new solutions to problems that generate new goods and services. Patent applications provide one standard way to measure innovation productivity and serve as a useful measure of innovation productivity. They also help identify new technical inventions with beneficial commercial uses. By contrast, patent issuances include only those innovations that qualify for a patent. Therefore, they do not effectively represent all productive innovation outputs. Average annual patent application totals were scored against the following baselines: 71,202 from 2013 for durable goods manufacturing; 64,665

1 The MIT Committee to Evaluate the Innovation Deficit, "The Future Postponed: Why Declining Investment in Basic Research Threatens a U.S. Innovation Deficit," M.I.T., April 2015, Cambridge, Massachusetts. https://dc.mit.edu/sites/default/files/Future%20Postponed.pdf; Jonathan Dworin "The Changing Nature of U.S. Basic Research: Trends in Federal Spending," State Science and Technology Institute Blog, May 21, 2015. https://ssti.org/blog/changing-nature-us-ba- sic-research-trends-federal-spending

2 Task Force on American Innovation, "Second Place America? Increasing Challenges to U.S. Scientific Leadership," May 2019. Avail- able at: http://www.innovationtaskforce.org/benchmarks2019/

3 Beryl Lieff Benderly, "The downs and ups of corporate research," Science, May 3, 2017. Available at: https://www.sciencemag.org/ careers/2017/05/downs-and-ups-corporate-research

4 Selected durable industrial goods manufacturing (NAICS codes: 3251, 3252, 3255, 3259, 326, 327, 331, 332, 3336, other 333, 335, 336), Information and Communication Technologies goods and services (NAICS 333242, 334, 5112, 517, 518, 5415), Scientific R&D Services (5417)

from 2008 for information and communications technologies; and 7,072 from 2008 for scientific R&D services.[5] These years represent standout levels of patent applications.

Like the trends for innovation inputs, the trends for average patent applications submitted for inventions in durable goods manufacturing and information and communications technologies diverged from the number of applications submitted for scientific R&D services. The decline in investments for scientific R&D services correlates with the overall decline in innovation outputs.

INNOVATION COMPETITIVENESS

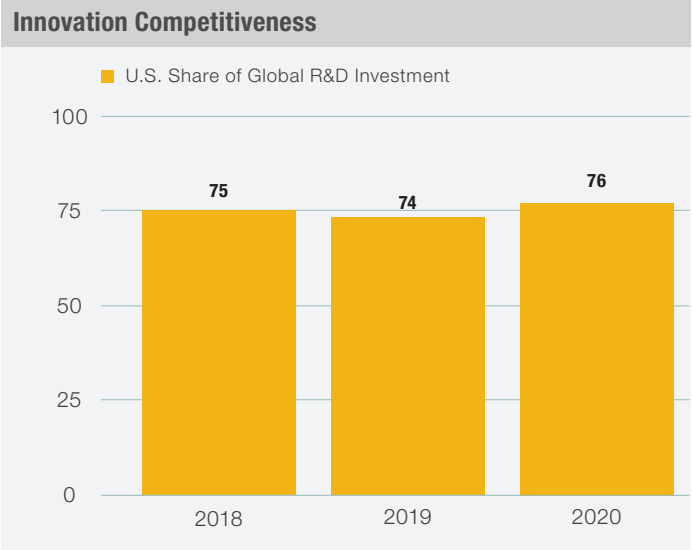


Figure 3.5, Source: NDIA

Innovation competitiveness scored a 76 for 2020, a one-point increase from its 2018 score of 75. Innovation competitiveness is based on the overall U.S. share of global R&D investment, which is currently 28%.

Industrial innovation activity occurs within a global context. Assessing the competitiveness of the U.S. industrial innovation system requires a comparison with international competitors. International innovation activity has dramatically changed over the past decade as China, nations in the European Union, and other dynamic economies challenge the United States in innovation.[6] The scale of U.S. innovation inputs and outputs, with respect to those of competitor nations, provides insight into the capability of U.S. industry to achieve a leading position in innovative technologies. To contextualize America's current position, the U.S. share of global R&D investment was scored against a baseline peak of 38.3%, which was achieved in 2001.[7]

The steady erosion of investment in the government-universities-industry "innovation triangle," pioneered during World War II, has contributed most to America's recent decline in innovation. Walter Isaacson of the Aspen Institute pointed out that U.S. investment in basic research at university and federal laboratories has declined for a generation—all while China has made radical investments in its own "innovation triangle."[8] Further, Robert Atkinson of the Information Technology & Innovation Foundation described America's national innovation system as being in crisis because of the absence of a coordinated innovation policy system.[9] In 2017, federal R&D spending as a share of the GDP fell to its lowest level since 1955.[10] In contrast, between 2011 and 2016, China's public sector investment in R&D increased by over 50% while its R&D expenditures have grown nearly 20% to 2.5% of GDP in 2020.[11] In 2019, the World Economic Forum ranked the United States second in its global competitiveness report.[12] The WIPO Global Innovation Index 2020 rankings placed the United States in third out of 129 countries.[13] In an age of great-power competition, U.S. investments in R&D must be benchmarked against the pacing threat—China—to maintain leadership in innovation.

TRENDS IN DOD INNOVATION SPENDING

The Department of Defense's innovation spending patterns provide another lens for understanding innovation trends. Trends in DoD innovation spending and defense contracting entrepreneurship are consistent with the other innovation trends previously presented herein. Since FY16, DoD's RDT&E budget requests have grown. While FY20 saw the Department's largest budget request in 70 years, the FY21 request marked a very slight increase of 0.1% to

5 *Id.*

6 Dutta, Soumitra et al., "The Global Innovation Index 2019," Chapter 1, World Intellectual Property Organization. https://www.wipo.int/ edocs/pubdocs/en/wipo_pub_gii_2019-chapter1.pdf

7 Based on NDIA calculations. The denominator of global R&D investment included investment from OECD countries, China, Russia, South Africa, Singapore, and Taiwan.

8 Isaacson, Walter, "How America Risks Losing Its Innovation Edge," Time, January 3, 2019. https://time.com/longform/america-innovation/

9 Atkinson, Robert, "Understanding the U.S. National Innovation System," Innovation Files Blog, Information Technology & Innovation Foundation, November 2, 2020. https://itif.org/publications/2020/11/02/understanding-us-national-innovation-system-2020

10 Foote, Caleb and Robert D. Atkinson, "Dwindling Federal Support for R&D Is a Recipe for Economic and Strategic Decline," Innovation Files Blog, Information Technology and Innovation Foundation, December 14, 2018. https://itif.org/publications/2018/12/14/dwindling-federal-support-rd-recipe-economic-and-strategic-decline

11 "Is China a Global Leader in Research and Development?" China Power, https://chinapower.csis.org/china-research-and-development rnd/#:~:text=In%20 2017%2C%20its%20R%26D%20expenditure%20reached%202.1%20percent%20of%20GDP.&text=This%20growth%20is%20even%20more,%2413%20billion%20 to%20%24410%20billion.

12 The Global Competitiveness Report. World Economic Forum, 2019. http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf

13 Global Innovation Index, World Intellectual Property Organization, 2020. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020.pdf

$705.4 billion.[14] The slight decline in budget requests is concentrated in requests related to early-stage activities. Requests for Advanced Component Development and Prototypes (ACD&P) have increased while later-phase RDT&E requests have remained steady.

DoD Innovation Obligations By Year, 3-Year Moving Average, FY17 – FY19

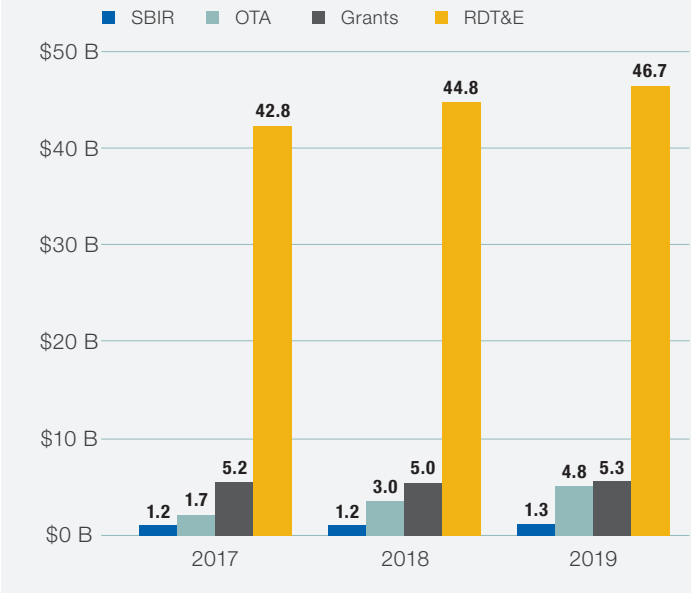


Figure 3.6, Source: Govini

DoD continues to show an increased level of interest in using alternative contracting authorities for its innovation investments. In 2019, RDT&E contracting obligations continued to dominate DoD innovation spending. However, obligations made through Other Transaction Authorities (OTAs) continued on an upward trend. OTAs allow DoD to conduct certain types of prototyping, applied research, and product development activities for non-contract and non-grant agreements. Unlike in the last few years, direct research grants and Small Business Innovation Research (SBIR) awards also increased. *Vital Signs 2021* does not measure the effectiveness of these contracting vehicles in producing tangible capabilities for the warfighter. NDIA will explore methodologies to track that effectiveness for future iterations of this report.

DoD Innovation Obligations Other Than RDT&E, 3-Year Moving Average, FY17 – FY19

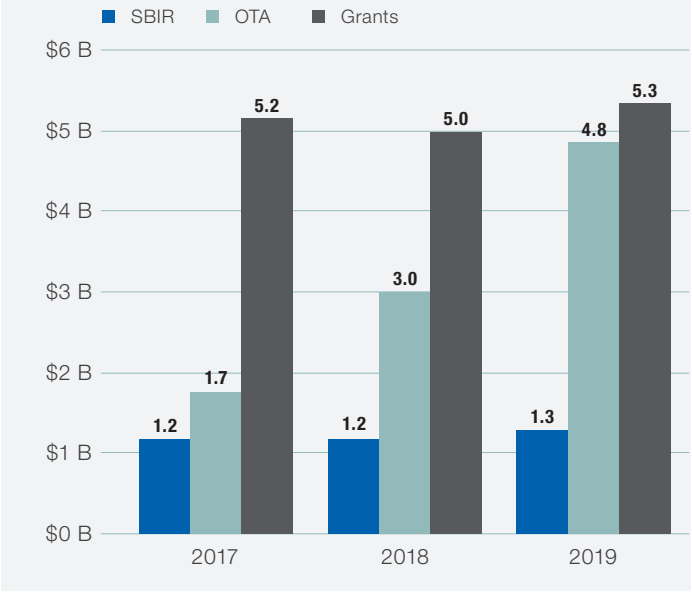


Figure 3.7, Source: Govini

CONCLUSION

Industrial innovation conditions in the United States remain poor and continue a downward trend. The decreasing level of innovation inputs and outputs coming from scientific R&D services industries, typically focused on basic research, is a key driver of the overall decline in the innovation system. Overall innovation conditions scored a 71 for 2020, which represents a two-point decrease from the 2018 score of 73 and a one-point increase from the 2019 score of 70. Corporate investment in industrial research and development in defense-related industries scored a 77, marking a one-point decline since 2018. Innovation outputs regarding patent applications from defense-related industries scored a 59, which is eight points lower than the 2018 score of 67. For 2020, innovation competitiveness scored a 76; this score represents an increase of one point from 2018 and of two points from 2019, marking a reversal in a downward trend and creating a bright spot in an otherwise downward trajectory.

14 "DoD Releases Fiscal Year 2021 Budget Proposal." February 10, 2020. https://www.defense.gov/Newsroom/Releases/Release/Article/2079489/dod-releases-fiscal-year-2021-budget-proposal/

SUPPLY CHAIN

Change, 2018 – 2020

● -6

SUPPLY CHAIN SCORES

Overall Factor	2020	Change, 2018 – 2020
Contract Failure	27	● +5
Financial Performance	74	● -21
Inventory Management	83	● -17
Schedule Management	100	● 0
Cost Management	100	● 0
Overall Supply Chain Score	***77***	● ***-6***

Figure 4.1, Source: NDIA

Factor Score Key				
● -6 and worse	● -1 – -5	● 0	● +1 – +5	● +6 and better

OVERVIEW

The performance of the corporate supply chains that support industry's supplier networks factors into assessments of the health of the defense industrial base. Defense supplier networks rely on well-functioning relationships among companies to deliver products and services to fulfill their government contracts. The overall competency of these networks comes from the combination of their track record of contract delivery, product flow, and speed of operation. This section of the report studies trends in industry's contract performance failures, inventory assets, program schedule integrity, and speed of operation.

The vulnerability and resilience of the overall defense supply chain continue to gain increasing attention, especially amid the COVID-19 crisis. This section assesses the pre-COVID-19 trends in industry's contract performance failures, inventory assets, program schedule integrity, and speed of operation. Defense supply chain performance directly impacts the health of the defense industrial base. Defense supplier networks rely on well-functioning relationships among companies to deliver products and services to fulfill their government contracts. The overall health and readiness of these networks stem from the combination of their track records in contract delivery, product flow, and speed of operation.

The overall industrial supply chain conditions for 2020 are worse than in 2018 but better than in 2019. Regardless, supply chain financial performance declined significantly since 2018. Cash conversion cycles lengthened, which led to a significant drop in supply chain financial performance akin to that of industry's average inventory turnover ratio. While financial performance and average turnover ratio still scored a passing grade, the magnitude and direction of the trends are very concerning. Moreover, the score for contract failure increased, possibly due to an uptick in the management and oversight of contract awards. Whereas this outcome constitutes the only positive change in the section, it represents the worst preforming indicator by far. The pre-COVID-19 score for supply chain conditions continues to be bolstered by maximum scores for both schedule-based cost changes and breaches in overall program cost limits.

The lasting effects of the COVID-19 pandemic on supply chains remain to be seen. However, our *Vital Signs* Survey included questions about supply chain reliability. While not able to be scored, the survey responses provide insight into how the defense industrial base has been impacted by the pandemic.

> **"The lasting effects of COVID-19 remain to be seen on supply chains.**

KEY TAKEAWAYS

- Supply chain conditions scored a 77 for 2020, declining six points from 2018
- Industry supply chains today experience lengthening cash conversion cycles and a declining average rate of inventory turnover as they invest in new inventory to fulfill the rising demand for defense goods and services
- Schedule-based cost changes to MDAPs and Nunn-McCurdy cost breaches continue to fall below baseline values
- Well-performing factors: Schedule management and cost management
- Poor-performing factors: Contract failure, financial performance, and inventory management

SUPPLY CHAIN SCORES

Factor	Indicator	2020	Change, 2018 – 2020
Contract Failure	Average Annual DoD Contracts Terminated for Cause	27	+5
Overall Contract Failure		***27***	***+5***
Financial Performance	Weighted Average Cash Conversion Cycle for Top Defense Contractors	74	-21
Overall Financial Performance		***74***	***-21***
Inventory Management	Weighted Average Inventory Turnover Ratio for Top Defense Contractors	83	-17
***Overall Inventory* Management**		***83***	***-17***
Schedule Management	Average Schedule Performance Index for MDAPs	100	0
Overall Schedule Management		**100**	**0**
Cost Management	Average Nunn-McCurdy Unit Cost Breaches	100	0
Overall Cost Management		***100***	***0***
Overall Supply Chain Score		***77***	***-6***

Figure 4.2, Source: NDIA

Factor Score Key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

INTRODUCTION

The defense industrial base relies on well-functioning supplier networks to ensure that it serves the needs of defense agencies. Consequently, the performance conditions of these networks affects industry's ability to deliver products and services with an acceptable cost, schedule, and quality. These conditions follow trends in factors such as the frequency of contract terminations, financial performance, inventory management, schedule management, and cost management. Thus, these trends indicate how supply chain dynamics may be helping or hindering industry's performance.

METHODOLOGY

Indicator scores are determined by the ratio of an indicator's average value to a baseline value. Baseline values reflect historical peak values or ideal standard values, which means that they are unique for each indicator. Ultimately, the availability of data in the public domain constrained the selection of baseline values. The overall section score averages variable scores that consist of averages of indicator scores, which are capped at 100 to allow for a 0-to-100 scoring scale.

This section of the report presents scores for indicators of the performance of defense supply chains. These indicators describe key attributes such as patterns of contract failure, supply chain financial performance, inventory management, schedule management, and cost management. The indicator of contract failure rates was based on data on contract terminations for cause obtained from the Federal Awardee Performance and Integrity Information System. NDIA calculated industry's cash conversion cycle and inventory turnover ratio—indicators of supply chain financial performance and inventory management, respectively—by using financial data obtained through FTSE Russell's Mergent Online database and from the annual Securities and Exchange Commission filings of the top 100 recipients of defense contracts. Indicators of schedule-based cost changes for MDAPs are based on cost change data from DoD's Selected Acquisition Reports on major platforms and weapons systems. Finally, the indicator for supply chain cost management was calculated based on counts of Nunn-McCurdy cost breaches reported by the DoD Director of Cost Assessment and Program Evaluation.

CONTRACT FAILURE

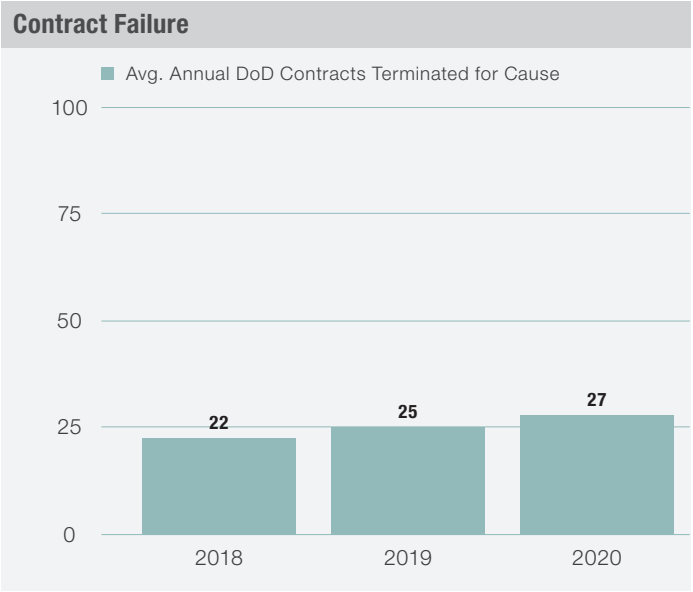


Figure 4.3, Source: NDIA

Industry's contract failure indicator scored a 27 for 2020, marking an increase of five points over its 2018 score. This score is based on the decrease in the average number of contract terminations for cause, which was 394 in 2019.

Contract terminations serve as a useful barometer for systemic challenges within the DoD contract management system. Like all federal agencies, the Department of Defense holds an inherent ability to terminate contract awards for reason of default by the contractor. Contracting officers can only exercise this contract provision after an extended and interactive process of official complaints and responses. Trends in these contract terminations indicate a pattern of contract performance and contract award management, which could then illustrate an increasing or decreasing amount of contractor risk throughout the defense industrial base. Contract terminations were scored against a baseline of 135 for 2014, which is the first year for which a longitudinal dataset for this statistic is available.

Terminations for cause often occur after a contracting officer assesses the ability of the contractor to perform on the contract. This assessment typically revolves around a judgment about the post-award behavior of the contractor in delivering on contract terms. Contractors have a strong incentive to avoid contract terminations because the records of such action are incorporated into their permanent contractor performance record and, thereby, risk their ability to win future contract awards. Although the government has an inherent right to terminate contracts for cause under the Federal Acquisition Regulation (FAR), it could still be liable for a contractor's costs incurred up to the termination.

The increase in score for the contract failure indicator between 2018 and 2020 is mostly due to the number of terminations dropping from 532 in 2018 to 394 in 2019, which is the most recent year for which data is available. The decrease aligns with the observed trend of the past couple of years. However, the size of the drop is much larger. What remains to be seen is if this trend will be a sustained one or if it represents a singular incidence.

FINANCIAL PERFORMANCE

Financial Performance

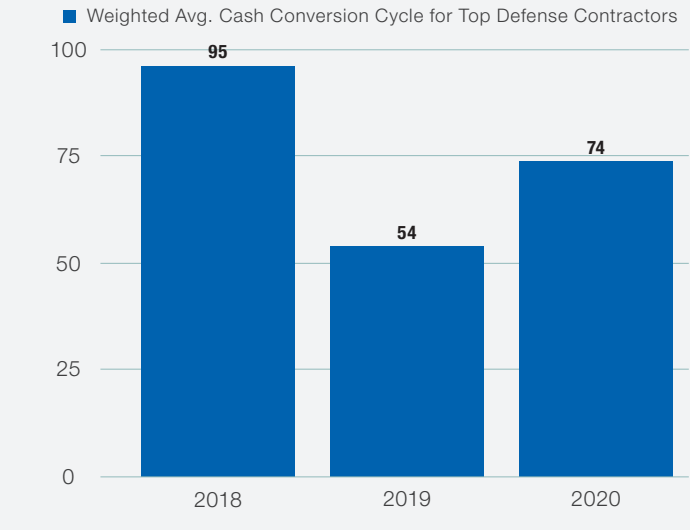


Figure 4.4, Source: NDIA

Industry's supply chain financial performance conversion cycle scored a 74 for 2020, marking a 21-point decrease from 2018 but a 20-point increase from 2019. This score is based on a rebound from the average conversion cycle of 55 days in 2019 that is now down to 34 days.

Industry's cash conversion cycle illustrates how well its supply chains function by indicating the amount of time required for a company to regain a dollar invested in product inventory as cash receipts. The conversion of product investment into cash receipts involves the flow of goods, services, resources, and information through multiple supply chain processes, product stages, and partners. Trends in the length of the cash conversion cycle suggest a pattern of either improvement or deterioration in supply chain performance. In this way, cash conversion cycles also help with understanding supply chain liquidity. Companies rely on cash generated from sales to finance the production of additional goods for sale. While a shorter cash conversion cycle helps companies to fund operations without having to access capital markets, a longer cash conversion cycle indicates that companies face greater difficulty in relying on sales for the liquidity necessary to fund critical operations. NDIA estimated an aggregate cash conversion cycle using financial data for the top 100 publicly traded DoD contractors. Cash conversion estimates were scored against a standard value of 30 days, equivalent to the cash conversion cycle for "best-in-class" companies.[1]

Various factors explain the lengthening cash conversion cycles. The recent growth of the defense budget has increased industry revenues from contract obligations, raising the average number of days of sales outstanding. Additionally, companies may be taking greater advantage of growing revenues than before to nurture their suppliers by reducing their days of payables outstanding. In turn, such companies can leverage suppliers to help build up inventories

1 Ball, Bryan, "The Importance of Working Capital in the Supply Chain," Aberdeen Group, January 2016. https://freight.usbank.com/ download/11890_RR_BB_CFO_tradefinance_capital.pdf

in anticipation of future sales. In the 2019 edition of their annual study of the working capital of the 1,000 largest U.S. public companies, the Hackett Group found that, on average, companies have built up inventories to inefficient levels, trapping lots of potential liquidity. A JP Morgan Chase and Co. study of corporate working capital trends discovered that aerospace and defense industry companies experienced the largest average increase in the length of cash conversion cycles between 2011 and 2018, due in part to a relatively high number of days of inventory outstanding.[2] The decrease in the cash conversion cycle can be viewed as especially positive given the results of other industries.[3]

INVENTORY MANAGEMENT

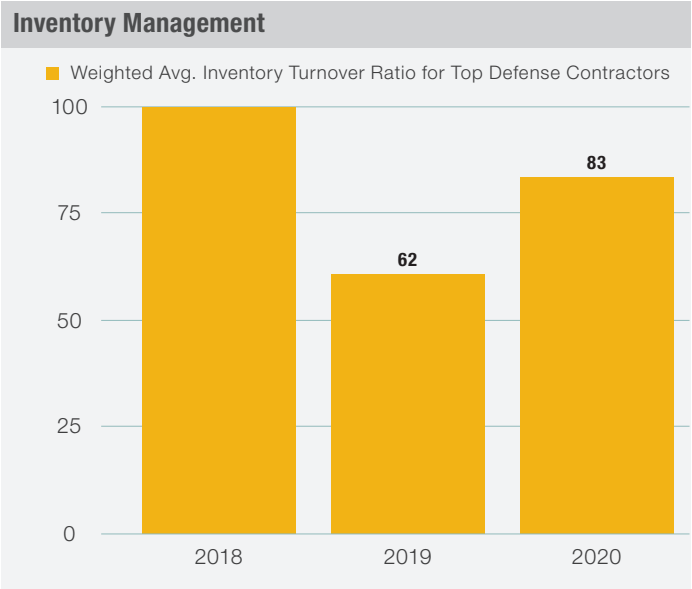


Figure 4.5, Source: NDIA

Industry's inventory turnover ratio scored an 83 for 2020—17 points below its perfect score for 2018. This score for *Vital Signs 2021* is based on the decrease of the average inventory turnover ratio from 14 days to 12 days between 2017 and 2019.

The decreasing inventory turnover ratio indicates a growing inefficiency in inventory management. On average, the inventory turnover ratio calculates the number of times that defense companies exhaust their inventory to fulfill sales. Higher ratios indicate better inventory management that often occurs in the form of lower storage costs and better coordination of sales with supply chain production. Companies seek to ensure that they have enough inventory to facilitate quick sales but not such an excessive inventory that it becomes too costly to sustain existing inventory levels. The inventory turnover ratio was scored against a five-year average inventory turnover ratio for the Standard & Poor's (S&P) 500 companies from Q3 2019 back to Q4 2015.

Industry's growing investment in inventory is likely to have lowered turnover ratios. Historically, defense manufacturing firms maintain extra inventory because of the complexity of their supply chains and long production lead times.[4] As recent defense spending growth increases procurement and lifts industry revenues, industry investment in production will expand inventory valuations. In doing so, industry will help reduce both average production costs and acquisition lead times. While increased inventory can protect against potential sole-source chokepoints among lower-tier suppliers, industry risks a loss of both supply chain flexibility and working capital.[5] These supply chain issues are also demonstrated in the results of our *Vital Signs* Survey. When asked about levels of confidence in their supply chain, only 30% of survey respondents were "very confident."[6]

SCHEDULE MANAGEMENT

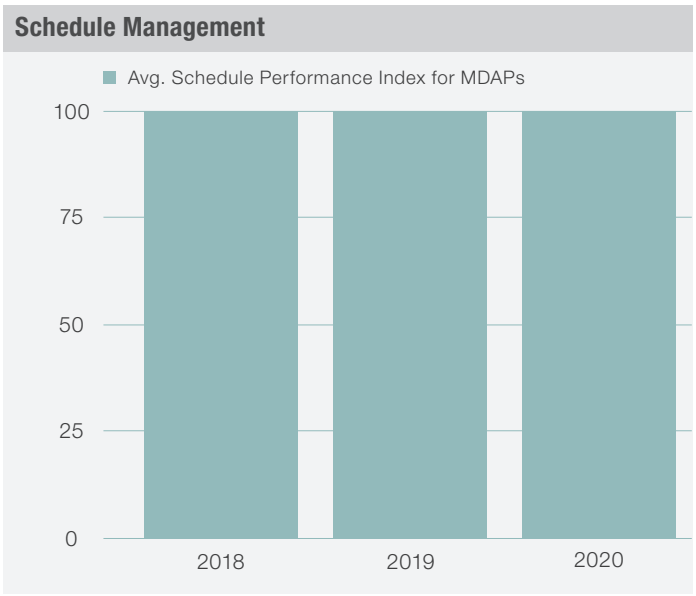


Figure 4.6, Source: NDIA

Schedule-based cost changes to major defense acquisition programs scored at the 100-point level for 2020, remaining unchanged from 2018 and 2019. This trend is based on the way in which schedule-based cost changes dropped from an average of $43.5 billion between 2016 and 2018 to an average of $42.3 billion between 2017 and 2019—a decrease of $1.2 billion.

2 Shah, Gourang; Mandhana, Varoon; and Vikrant Verma, "J.P. Morgan Working Capital Index: Helping companies benchmark for success," J.P. Morgan, July 2019, https://www.jpmorgan.com/content/dam/jpm/cib/complex/content/treasury-services/benchmarking-working-capital/pdf-1.pdf

3 Shah, Gourang; Mandhana, Varoon; and Vikrant Verma, "J.P. Morgan Working Capital Index 2020: Helping companies benchmark for success," J.P. Morgan, June 2020, https://www.jpmorgan.com/content/dam/jpm/cib/complex/content/treasury-services/benchmarking-working-capital/pdf-0.pdf

4 Mayer, Abby, "Supply Chain Metrics That Matter: A Focus on Aerospace & Defense," Supply Chain Insights LLC, March 18, 2014. https://supplychaininsights.com/wp-content/uploads/2020/08/Supply_Chain_Metrics_That_Matter-A_Focus_on_Aerospace__Defense-18_MAR_2014.pdf

5 EY, "A&D Edge: Supply chain management in aerospace and defense," February 2018, https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/manufacturing/ey-AD-Edge-Supply-chain-management-in-aerospace-and-defense.pdf?download

6 NDIA, "*Vital Signs* 21 Survey." Question 36, August 2020.

Just as production times affect supply chain health, changes to production schedules induce changes in the cost of acquisition programs by either increasing or decreasing the need for resources. For MDAPs—the largest and often most complex acquisition programs—the cost impact of schedule changes can translate into billions of dollars. The Department of Defense's quarterly Selected Acquisition Reports (SARs), which provide information on expected cost changes to MDAPs, offer important data for analyzing trends in schedule-based supply chain cost management. Using data taken from SARs ranging from FY81 to FY19, NDIA scored annual estimated schedule-based cost changes against 3.6%, an average annual percentage of schedule-based cost changes from FY81 to FY85. This baseline reflects a key historical standard as it corresponds to the last era of a major increase in defense hardware production.

The drop in cost changes is helped in large part by a drop in Air Force schedule-based cost changes, which fell from over $2 billion in 2018 to just $48 million in 2019. This Air Force drop coincided with a 50% reduction in Army cost changes from $10 billion down to $5 billion. However, these improvements have mostly been negated by an almost 50% increase in Navy cost changes, which increased from $6.5 billion in 2018 to $12 billion in 2019.

COST MANAGEMENT

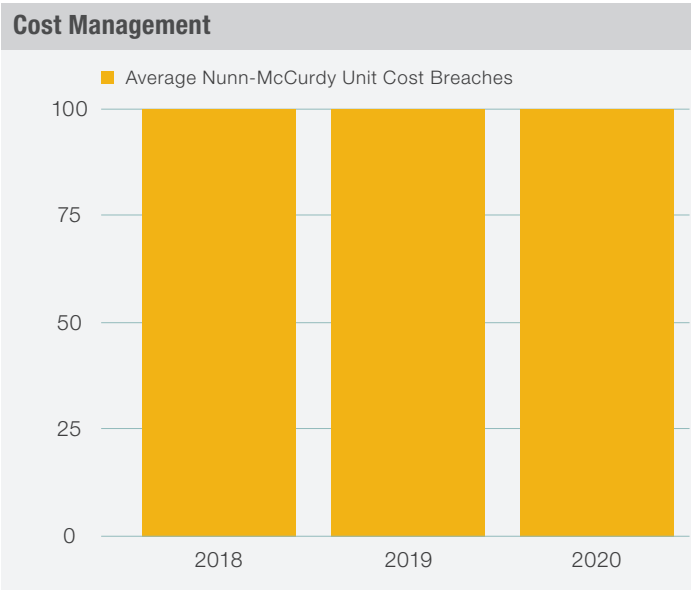


Figure 4.7, Source: NDIA

The number of significant or critical Nunn-McCurdy breaches earned a score of 100 for 2020, representing no change from its 2018 and 2019 scores. Increasing slightly from 1.6 between FY16 and FY18, MDAPs averaged two Nunn-McCurdy breaches from FY17 to FY19.

Like supply chain schedule management, supply chain cost management affects both the health and readiness of the defense industrial base. Supply chain costs include multiple factors such as those related to changes in quantity, engineering, maintenance, milestone achievement schedules, and macroeconomics. For decades, Congress has focused on cost control and management for MDAPs. In 1983, Congress passed the Nunn-McCurdy Act, which established procedures for notifying Congress when an MDAP breaches a pre-determined cost growth threshold. Such congressional notification of Nunn-McCurdy breaches serves as a useful mechanism for cost management. Additionally, trends in Nunn-McCurdy breaches indicate evolving patterns in the overall defense supply chain's efforts directed at controlling costs.

Nunn-McCurdy breaches reached a peak in both 2009 and 2010 with a total of eight breaches. Analysis by the Congressional Research Service (CRS) found that, since FY07, most cost breaches have occurred during the production phases of the MDAP acquisition process rather than during the engineering and manufacturing development phases.[7]

CONCLUSION

Industry faces deteriorating overall conditions with respect to supply chain management when compared to two years ago. However, 2020's results represent an improvement over 2019's results. Earning a score of 77 for 2020, supply chain conditions have fallen by six points since 2018. Contract failure increased to a score of 27, indicating an uptick in the management and oversight of contract awards leading to a lower rate of termination. Supply chain financial performance declined by 21 points between 2018 and 2020, for cash conversion cycles lengthened as the result of two specific factors: a growing body of contract awards to deliver and growing inventories. Accordingly, industry's average inventory turnover ratio fell by 17 points—significantly less than in previous years—as growing defense demand drove inventory expansion. However, supply chain conditions for major defense acquisition programs remain favorable as scores for schedule-based cost changes and breaches of overall program cost limits continued to return at the 100-point level. The lasting effects of COVID-19 remain to be seen on supply chains, but results from our *Vital Signs* Survey indicate that most companies expect the supply chain situation to stabilize. Only about 30% of respondents expect their supply chains to be less reliable next year.[8]

7 Schwartz, Moshe and Charles V. O'Connor, "The Nunn-McCurdy Act: Background, Analysis, and Issues for Congress," Congressional Research Service, May 12, 2016. https://fas.org/sgp/crs/natsec/R41293.pdf

8 NDIA, "*Vital Signs* 21 Survey." Question 33, August 2020.

COMPETITION

Change, 2018 – 2020

+2

COMPETITION SCORES

Overall Factor	2020	Change, 2018 – 2020
Contract Competition	92	+5
Market Concentration	100	0
Foreign Ownership	100	0
Profitability	77	+12
Liquidity	93	-1
Leverage	91	+3
Capital Investment	82	-8
Overall Competition Score	***91***	***+2***

Figure 5.1, Source: NDIA

Factor Score Key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

OVERVIEW

The state of competition between firms exerts a powerful influence on the productive performance of firms within industry. Many firms of varying sizes, product and service specializations, and even national origin compete for the same contracts within the defense industrial base. While such competition occurs, trends in financial performance indicate the financial health of the involved firms. The competition between firms for contracts results in patterns of market concentration that illustrate the extent to which relatively few firms dominate defense contracting dollars. The entry of firms into defense contracting provides insight into the openness of the defense contracting market to new sources of competition. This section of the report informs our understanding of the health of competitive dynamics within the defense industrial base. We relied on publicly available Securities and Exchange Commission filings from the top 100 publicly traded recipients of defense contracts to complete our analysis.

While the competition between firms for these contracts creates patterns of market concentration that illustrate the extent to which firms dominate defense contracting dollars, the entry of new firms into defense contracting helps to demonstrate the openness of the defense contracting market to increased sources of competition.

Notably, the competitive environment for the defense industrial base remained stable over the last few years and had a small increase in score when compared to the previous two years. The positive trend in this section was augmented by only two factors having negative progress since 2018; only one of those two declines was greater than five points. Though capital investment had a large drop between 2018 and 2020, there were three different factors that improved their scores over the same period.

> **"As noted in the 13806 report, certain defense market segments may be highly and increasingly concentrated—like fuzes—or extremely fragmented—like transportation services. This factor is also demonstrated by our *Vital Signs* survey in which almost 30% of respondents said that they were the sole eligible provider of a product for DoD.**

KEY TAKEAWAYS

- Competition conditions scored well with a 91 for 2020
- Before the COVID-19 pandemic, the level of competition proved stable throughout the previous three-year period
- For full and open competition, the number of offers per awards increased by 67% from FY15 to FY19
- The defense industrial base continues to provide opportunities for small businesses and new entrants

COMPETITION SCORES

Factor	Indicator	2020	Change, 2018 – 2020
Contract Competition	Average Number of Competitive Offers Received Per Contract Actions	92	+5
Overall Contract Competition		***92***	***+5***
Market Concentration	Level of Market Concentration (Herfindahl-Hirschman Index)	100	0
Overall Market Concentration		***100***	***0***
Foreign Ownership	Contracting Market Share of Foreign-Owned Firms	100	0
Overall Foreign Ownership		***100***	***0***
Profitability	Weighted Average Core Operating Margin (Return on Sales)	93	+1
	Weighted Average Earnings Per Share	96	+18
	Weighted Average Return on Assets	66	-5
	Weighted Average Return on Equity	51	+31
Overall Profitability		***77***	***+12***
Liquidity	Weighted Average Free Cash Flow	86	+2
	Quick Ratio (Acid Test)	94	-4
	Working Capital Ratio (Current Ratio)	98	-1
Overall Liquidity		***93***	***-1***
Leverage	Debt to Equity Ratio	83	+1
	Solvency Ratio	98	+4
Overall Leverage		***91***	***+3***
Capital Investment	Capital Expenditure Ratio	82	-8
Overall Capital Investment		***82***	***-8***
Overall Competition Score		***91***	***+2***

Figure 5.2, Source NDIA

Factor Score Key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

INTRODUCTION

The defense industrial base consists of thousands of companies competing for and performing on contracts with the Department of Defense. The conditions that characterize and shape competition help determine the composition of the industry and its performance outcomes. A competitive defense sector can be both beneficial and indicative—beneficial in that competition can drive innovation and efficiencies to deliver better capabilities at reduced cost to the warfighter, and indicative in that the market incentives and perceived opportunities keep producers in the sector while also potentially pulling in new firms. The market concentration, contract competitiveness, profitability, cash availability, capital investment, and foreign ownership of the defense industrial base are used as assessments in this section of *Vital Signs*. By understanding the trends across these measures, we can determine the current state of competitiveness and whether the dynamics of the defense contracting marketplace are evolving in a healthy direction.

The overall competitive environment for the defense industrial base remained stable in the three-year period preceding the novel coronavirus pandemic. Small declines in the industry's liquidity and leverage were offset by increased capital investment. A somewhat low industry concentration and a low level of foreign ownership in the defense industrial base also contribute to the competitive environment.

METHODOLOGY

Indicator scores are determined by the ratio of an indicator's average value to a baseline value. Baseline values reflect historical peak values or ideal standard values, which means that they are unique for each indicator. Ultimately, the availability of data in the public domain constrained the selection of baseline values. The overall section score averages variable scores that consist of averages of indicator scores, which are capped at 100 to allow for a 0-to-100 scoring scale.

NDIA calculated indicator scores for profitability, cash availability, capital expenditures, market concentration, and foreign ownership using financial data for the top 100 publicly traded Department of Defense contractors. We also relied on annual financial data obtained through FTSE Russell's Mergent Online database. NDIA calculated the scores for competitive bidding with federal procurement data from Govini.

Several changes have been made in this section since *Vital Signs 2020*. Most of these changes add new variables so that the indicators are no longer reliant on a single variable. Additionally, some baselines have also been adjusted to account for some variables and to reflect new peaks in our dataset. Additionally, as Govini's dataset has improved since last year, so has our dataset.

CONTRACT COMPETITION

Contract Competition

Figure 5.3, Source: Govini (2020)

Contract competition earned a score of 92 for 2020, which is a slight decrease from its 2019 score of 93. Contract competition refers to the number of firms seeking a contract offered by the Department of Defense. Contracts can be awarded through either a competitive or non-competitive bidding process.

Between FY15 and FY19, the average number of offers received for each contract award offered by the Department of Defense and each of the DoD Services decreased significantly or stayed at even levels. Then, over the three-year period from FY17 to FY19, the number of contract actions for the Department of Defense increased by one million. The most significant increase in actions was from Department Agencies and Field Activities (DAFAs) with 0.3 million new contract actions.

Between FY15 and FY19, the total obligation and average award amount for competitive awards increased by approximately $60 billion. During the same period, the amount of non-competitive awards also increased by nearly $50 billion. Since 2016, contract obligations by the Department of Defense and the DoD Services increased by a substantial amount—nearly 30%.

Average Offers Received Per Award, By DoD Component, FY15 – FY19

Figure 5.4, Source: Govini (2020)

DoD Contract Actions, Including Modifications, FY15 – FY19

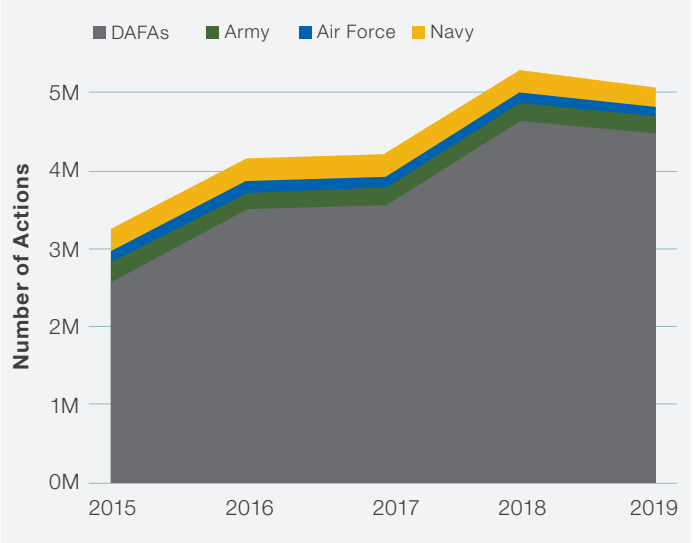


Figure 5.5, Source: Govini (2020)

DoD Contract Awards, FY15 – FY19

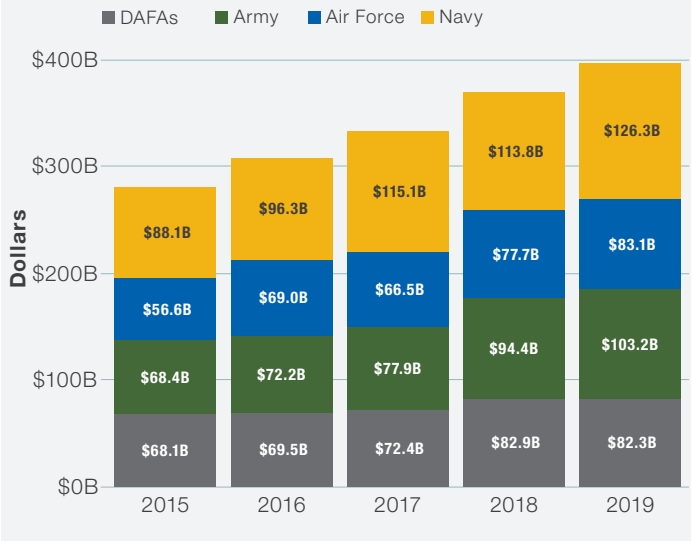


Figure 5.6, Source: Govini (2020)

From FY15 to FY19, offers per award for full and open competition increased by an average of 3.10 offers received and 1.19 offers received per award for full and open competition after the exclusion of sources. Most notably, transportation and logistics services received the highest average number of offers per award (14.34) among specific category groups. Moreover, R&D had the next highest average number of offers received per award at 7.04 offers. The number of offers per award is significantly less for manufactured goods, especially as capabilities become more specialized (fighter, armor, fuzes, etc.).

DoD Competitive Awards: Average Offers Received Per Award, FY15 – FY19

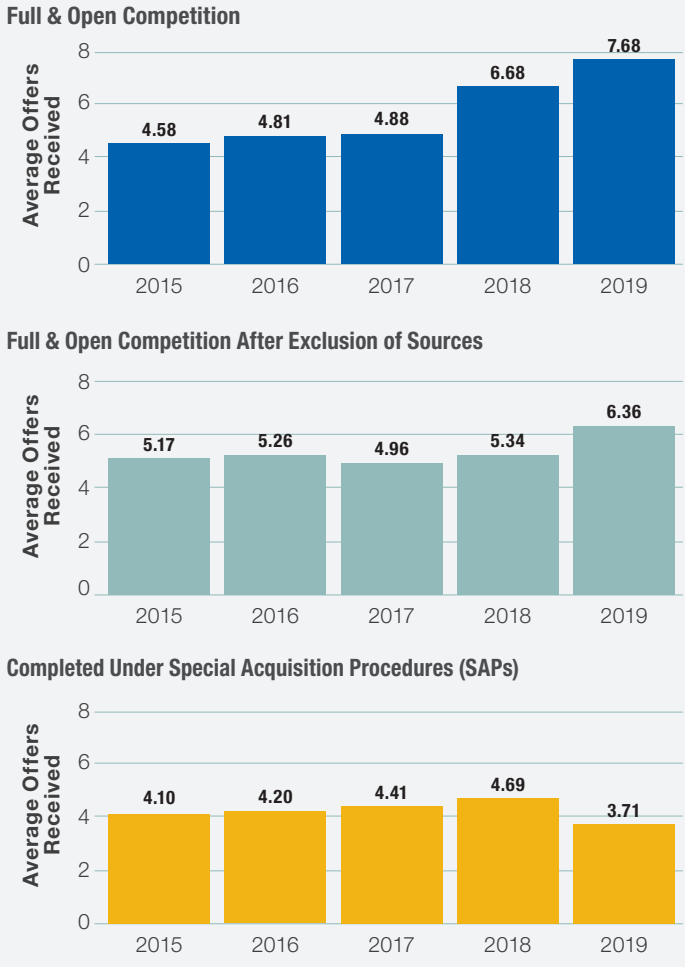


Figure 5.7, Source: Govini (2020)

DoD Competitive Awards: Average Offers Received Per Award, By Category Management Group, FY15 – FY19

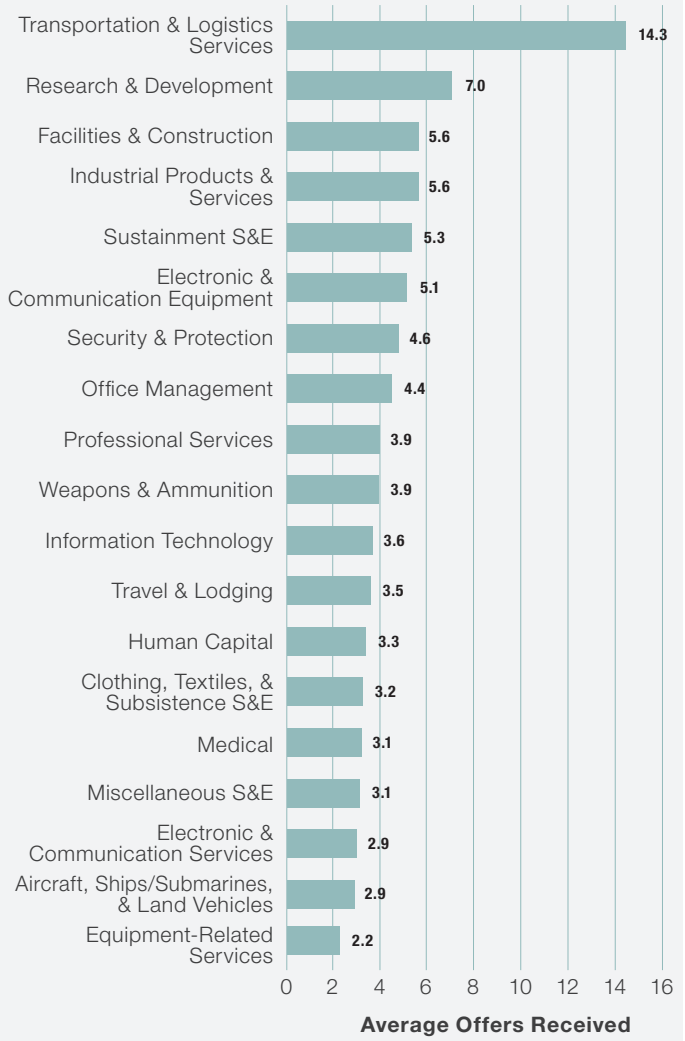


Figure 5.8, Source: Govini

MARKET CONCENTRATION

Market Concentration

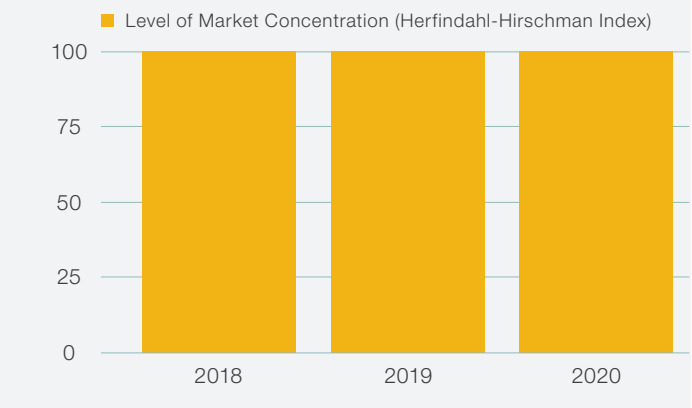


Figure 5.9, Source: NDIA (2020)

The overall score for market concentration remains unchanged from last year—a perfect 100—despite expanding our dataset to include the 300 largest recipients of Department of Defense contracts for *Vital Signs 2021*. The score is derived from a calculation of the Herfindahl-Hirschman Index (HHI), with a baseline index score of 1,500. The Herfindahl-Hirschman Index is used to measure market concentration within an industry. A high HHI score is indicative of an industry that is dominated by a few firms. For the health of the defense industrial base, low market concentration is generally preferable to high market concentration. Low-concentration markets feature more competition, leading to lower prices and more innovation. Since HHI is the standard statistical measure of market concentration, it is widely used among federal policymakers.[1]

In 2020, the defense industrial base's HHI was 429, well below the Department of Justice's threshold of 1,500 for a moderately concentrated industry. Comparatively, the DIB's HHI score that was calculated for *Vital Signs 2021* is nearly double the score of 276 that was calculated for *Vital Signs 2020*, breaking a three-year tendency of decreasing market concentration. Importantly, that tendency occurred before the industry felt the effects of the COVID-19 public health crisis. While the industry's HHI score is still far below the standard moderate-concentration threshold, this trend should be closely watched going forward. The defense industrial base's low HHI indicates that total contract obligation dollars remain widely allocated among contractors and suggests a high degree of competition within the defense industrial base. Although the overall defense industrial base market concentration indicates a competitive market, the industry is marginally more concentrated than in previous years.

Due to definitional and unclassified data availability challenges, we did not attempt to calculate the HHI for different defense market segments. As noted in the 13806 Report, certain defense market segments may be highly and increasingly concentrated—like fuzes—or extremely fragmented—like transportation services. This factor is also demonstrated by our *Vital Signs* Survey in which almost 30% of respondents said that they were the sole eligible provider of a product for DoD.[2]

1 Rhoades, Stephen A., "The Herfindahl-Hirschman Index," 79 Fed. Res. Bull. 188, (1993). Available at: https://fraser.stlouisfed.org/files/ docs/publications/FRB/pages/1990-1994/33101_1990-1994.pdf

2 NDIA, "*Vital Signs* 21 Survey." Question 27, August 2020.

The defense industrial base's increased level of market concentration is, in part, due to a change in the number of Department of Defense vendors. An analysis by Govini revealed that DoD agencies and the Services—such as the Department of the Army, the Department of the Navy, and the Department of the Air Force—obtained contracts from fewer vendors in 2019 than in 2018. Notably, the Department of the Navy had the most significant decrease in the number of unique vendors over the same time period.

DoD Vendors By Funding Agency, Three-Year Moving Average, FY17 – FY19

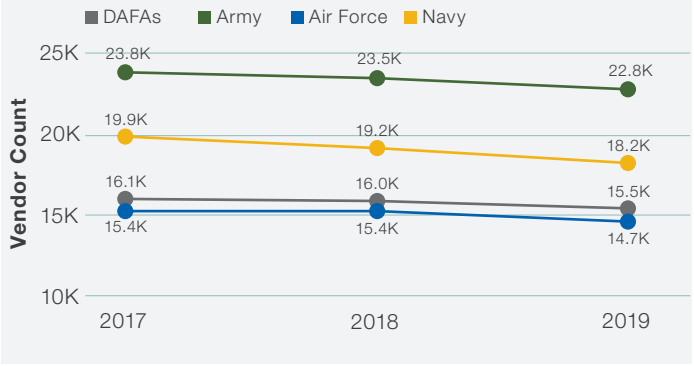


Figure 5.10, Source: Govini (2020)

Although the Department of Defense experienced a decline in the number of unique vendors in FY19, it welcomed a significant number of new vendors, suggesting that there remains considerable perceived opportunity in the defense industrial base for new entrants. In FY19, most new vendors were awarded contracts of less than $1 million. Of the three DoD Service Departments, the Department of the Army awarded the most contracts of less than $1 million to new vendors. Conversely, the Department of the Air Force granted the most contract awards that exceeded $1 million.

Despite the relative lack of overall industry concentration by Department of Justice standards, some parts of the industrial base are at risk of having only one supplier. For example, the industrial base for fuzes has shrunk from 30 businesses in 1995 to only three today. Despite this rapid consolidation, DoD's acquisition plans are on track to leave the United States with potentially only one domestic supplier for aerial bomb fuzing by 2023. The presence of only one aerial bomb fuze supplier may introduce unacceptable risks to the supply chain. Foreign fuze makers will likely fill the void, which may not meet U.S. or NATO standards.

New Vendors By Place of Performance, FY19

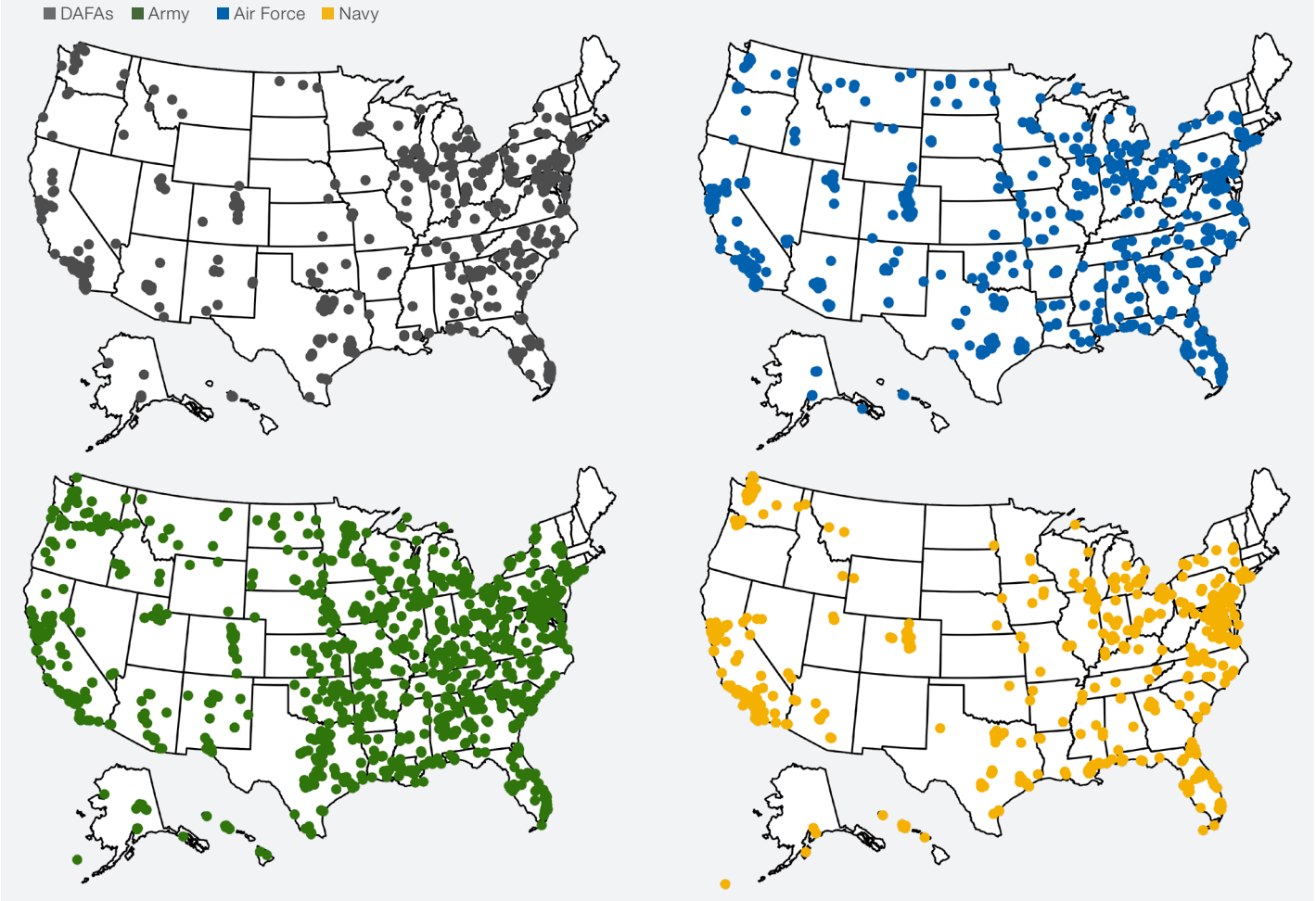


Figure 5.11, Source: Govini

FOREIGN OWNERSHIP

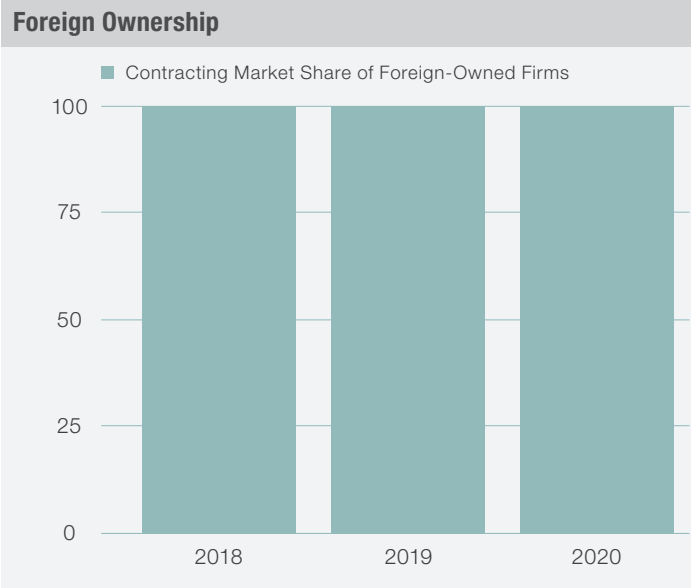


Figure 5.12, Source: NDIA (2020)

Foreign ownership in the defense industrial base was 8.4% for 2020, demonstrating an increase over last year's share of 8.0%. Additionally, foreign ownership scored a 100 for 2020 like in 2018 and 2019. Foreign ownership is the percentage of the 100 largest public companies in the DIB that are not based in the United States. It is baselined against the Carter-Reagan buildup of the late 1970s through the mid-1980s. In 1981, the Government Accountability Office reported foreign ownership at 9.4%, which represents the highest level of foreign ownership within the data available to NDIA.

PROFITABILITY

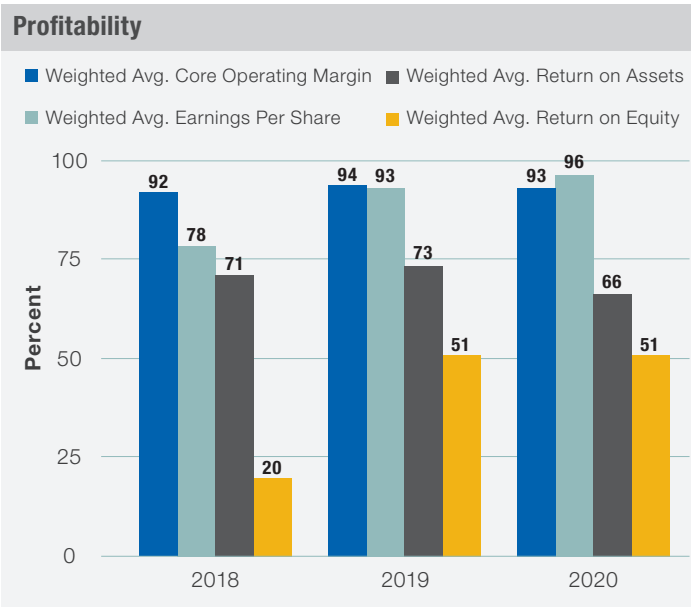


Figure 5.13, Source: NDIA (2020), 2019 10-K Filings of Top DoD Contractors (FY19)

The defense industrial base remained profitable while its performance remains consistent with overall U.S. corporate profits for 2019.[3] Profitability dropped slightly from last year; it saw a total reduction of one point from 78 in 2019 to 77 in 2020. The drop was driven by the Return on Assets (ROA), which decreased by seven points.

Return on Equity (ROE) and Earnings Per Share (EPS) are new variables in this year's profitability section. Meanwhile, Core Operating Margin and ROA are still factored into this year's report. Together, these four variables show a more detailed picture of profitability in this year's version of *Vital Signs* compared to that of last year.

These four variables are weighted averages. The individual company values have been weighted by the defense-related market share of their respective companies. Weighting in this manner ensures that large companies with large non-defense businesses do not skew the scores. ROA is baselined to the Defense Financial and Investment Review study from 1985.[4] Core Operating Margin and ROE are baselined to 2019 while EPS is baselined to 2020. Both of these years represented high watermarks within our dataset.

LIQUIDITY

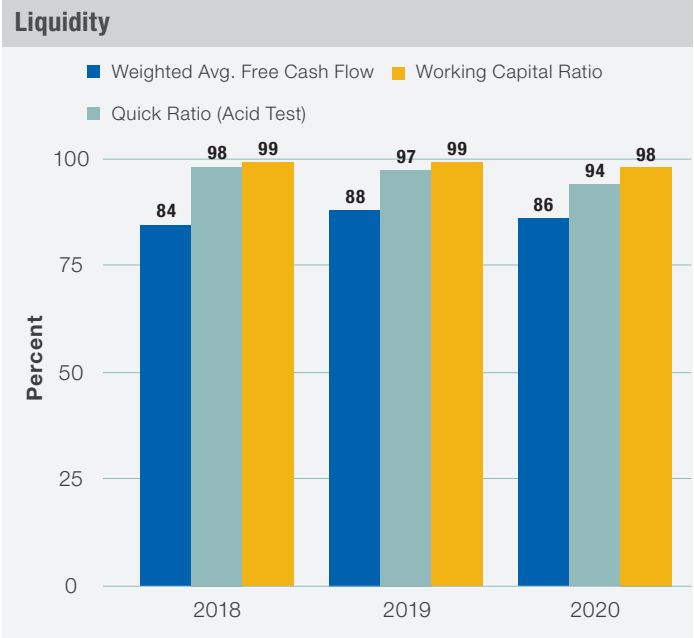


Figure 5.14, Source: NDIA (2020), 2019 10-K Filings of Top DoD Contractors (FY19)

Liquidity's overall score is 93 for 2020, having been baselined against 2018, the historical peak for our dataset. This year's report includes the Quick Ratio, Current Ratio, and Free Cash Flow. The Current Ratio is a measure of a company's current assets to current debt while the Quick Ratio is a measure of liquidity to current debt. Free Cash Flow represents cash available to creditors or investors. Taken together, these indicators show that—before the COVID-19 pandemic—the defense industrial base was well positioned to meet its outstanding obligations.

3 Corporate Profits, Bureau of Economic Analysis. November 25, 2020. https://www.bea.gov/data/income-saving/corporate-profits

4 Touche Ross & Company, Defense Financial and Investment Review Appendix 1, Volume 1, Washington DC, April 1985. Available at: https://ia800109.us.archive.org/34/items/DTIC_ADA158241/DTIC_ADA158241.pdf

LEVERAGE

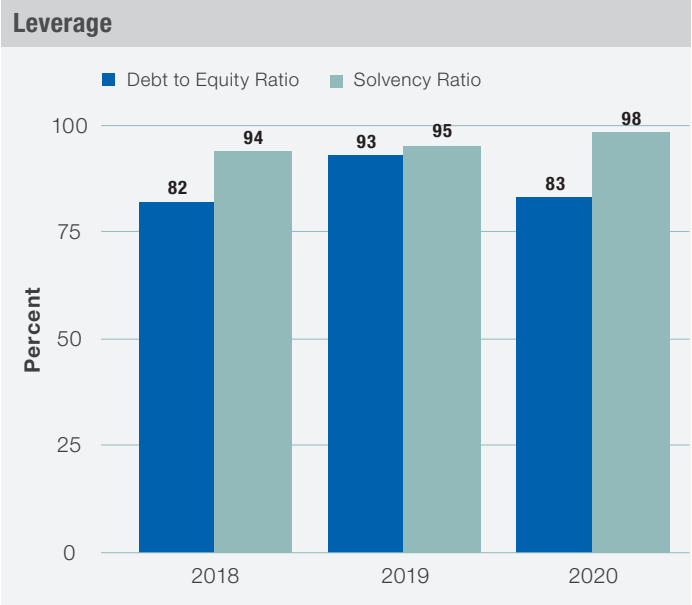


Figure 5.15, Source: NDIA (2020), 2019 10-K Filings of Top DoD Contractors (FY19)

Leverage received a score of 91 for 2020, marking a three-point increase from 2019. Baseline years of 2019 and 2018 were used for the Solvency Ratio and Debt to Equity, respectively. These two years represent the best performing years within our limited data-set. Before the COVID-19 pandemic, the increase in the score for leverage was driven by the Debt to Equity ratio increasing from 1.07 to 1.09 and by the Solvency Ratio rising from 0.125 to 0.13.

Leverage is an entirely new indicator for *Vital Signs 2021* and is comprised of the Solvency Ratio and the Debt to Equity Ratio. The Solvency Ratio measures income to liabilities, while the Debt to Equity Ratio measures liabilities to equity. Together, the two variables measure companies' ability to cover both long- and short-term debts, and are suitable measures of how leveraged companies in the defense industrial base are.

CAPITAL INVESTMENT

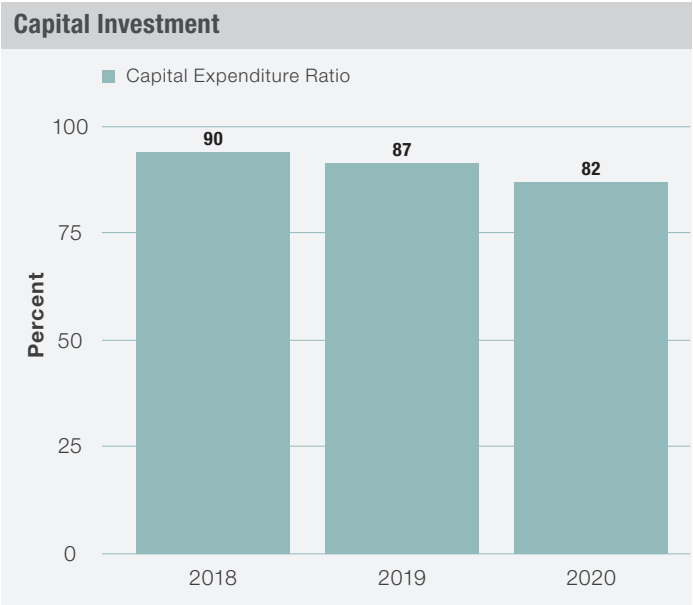


Figure 5.16, Source: NDIA (2020), 2019 10-K Filings of Top DoD Contractors (FY19)

Capital investment scored an 82 this year, which is an eight-point drop from 2018. Our baseline year for this factor is 2016, which had a 3.94% ratio. In last year's edition of *Vital Signs*, we only looked at capital expenditures. This year, we used a new ratio of capital expenditure to total revenue, which better controls for differences in size between companies in the list of the top 100 Department of Defense contractors and is a more accurate representation of the defense industrial base's capital investment. This year's score of 82 is representative of a landscape in which there is a year-to-year decrease in capital investment relative to revenues.

CONCLUSION

An overall score of 91 for competition might appear as a drop from *Vital Signs 2020*. However, the change in the overall competition score is mostly due to new variables and other methodological changes that enable a much clearer picture of competition in the defense industrial base. When these changes are applied to last year's data, the score becomes 92. Thus, under the new methodology, the year-to-year change is only a drop of one point from last year and an increase of three points from 2018. These relatively small changes are representative of the overall stability in the competition that existed within the defense industrial base before the COVID-19 pandemic. Market concentration and contract competition continue to constitute bright spots for the defense industrial base.

INDUSTRIAL SECURITY

Change, 2018 – 2020

-1

INDUSTRIAL SECURITY SCORES		
Overall Factor	**2020**	**Change, 2018 – 2020**
Threats to Intellectual Property Rights	89	+7
Threats to Information Security	22	-9
Overall Industrial Security Score	***56***	***-1***

Figure 6.1, Source: NDIA

Factor Score Key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

OVERVIEW

The security of industrial operations against threats to information systems and intellectual property rights contributes to a comprehensive portrait of the health of the defense industrial base. American industry faces persistent, increasing threats of intellectual property theft, economic espionage, cyber crime, and other forms of attacks. This section of the report examines new FBI intellectual property rights violation investigations, the average annual newly reported common IT cyber vulnerabilities, and the severity of newly reported common IT vulnerabilities.

Industrial security conditions continue to decline, losing ground on what was an already poor score. This decline reflects larger trends in the erosion of industrial cybersecurity despite increasing attention and resources being dedicated to combating the threat.

The drop in score between 2019 and 2020 came exclusively from worsening information security. In fact, the drop is due entirely to the number of newly reported IT cyber vulnerabilities, which is the only industrial security indicator to decrease in score since 2018. However, the magnitude is so large that it erases all the other gains, resulting in a decreased overall score for industrial security in 2020.

In spite of these circumstances, the threat to intellectual property rights continues to lessen and, thereby, improve. The increase in its score is due to a steadily declining number of new FBI IP rights investigations that came after years of enhanced law enforcement.

Industrial security is also an area of active rulemaking. In 2020, the release of an Interim Rule for the Cybersecurity Maturity Model Certification (CMMC; 85 FR 61505) and an Interim Rule for Section 889(a)(1)(B) of the FY19 NDAA (Section 889 Part B; 85 FR 42665) highlighted DoD's heightened focus on industrial security issues that impact the defense industrial base. How CMMC, Section 889 Part B, and other measures taken to address the various threats to industrial security impact this score will be tracked in future editions of *Vital Signs*.

> **"[The] decline reflects larger trends in the erosion of industrial cybersecurity despite increasing attention and resources dedicated to combating the threat.**

KEY TAKEAWAYS

- Industrial security earned an overall middling score of 56
- The number of newly reported common IT cyber vulnerabilities continues to increase
- The average severity of each known vulnerability has slightly decreased since 2016

INDUSTRIAL SECURITY SCORES

Factor	Indicator	2020	Change, 2018 – 2020
Threats to Intellectual Property Rights	New FBI Intellectual Property Rights Violation Investigations	89	+7
Overall Threats to Intellectual Property Rights		***89***	***+7***
Threats to Information Security	Average Annual Newly Reported Common IT Cyber Vulnerabilities	26	-19
	Severity of Newly Reported Common IT Vulnerabilities	18	+1
Overall Threats to Information Security		***22***	***-9***
Overall Industrial Security Score		***56***	***-1***

Figure 6.2, Source NDIA

Factor Score Key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

INTRODUCTION

Since the release of the 2018 National Defense Strategy and its focus on renewed great-power competition, concern with industrial security in the defense sector has steadily increased. Data breaches, intellectual property theft, and state-sponsored traditional industrial and scientific espionage in both private companies and university labs are on an unrelenting rise. Some estimates place the resulting annual cost to the U.S. economy at $600 billion. These constant and evolving threats not only hit the commercial sector but often target the defense industry.

Industrial security issues continue to be a priority for the defense industrial base and the Department of Defense. 2020 saw the release of an Interim Rule for the Cybersecurity Maturity Model Certification (CMMC; 85 FR 61505) and an Interim Rule for Section 889(a)(1)(B) of the FY19 NDAA (Section 889 Part B; 85 FR 42665).

In 2020, the Interim Rule implementing Section 889 Part B was published, prohibiting executive agencies from entering into contracts with any entity that incorporates any equipment or service that uses telecommunication equipment made by Huawei, ZTE, and several other Chinese-made telecommunications equipment manufacturers. Section 889 is intended to help prevent the exfiltration of sensitive data from the U.S. defense industrial base.

CMMC is a DoD effort to improve the handling of sensitive information by and within the defense industrial base. The certification is intended to provide a "unifying standard for the implementation of cybersecurity across the Defense Industrial Base."[1]

When asked, as part of our *Vital Signs* Survey, "how secure against attacks are the information assets your company uses to perform defense contracts?," 55.7% of respondents said that their assets were "very secure" while 41.2% said that their systems were "somewhat secure." In the same survey, 10% of respondents said that the restrictions on Chinese-made telecommunications equipment stipulated by Section 889 Part B, which is intended to protect the IP of our industrial base, will have a "somewhat unfavorable" (8.2%) or a "very unfavorable" (1.8%) impact on their business. These responses highlight the industrial base's increasingly global supply and the concomitant risk of reliance on foreign-made goods that support the operations of America's defense industrial base.

METHODOLOGY

Indicator scores are determined by the ratio of an indicator's average value to a baseline value. Baseline values reflect historical peak values or ideal standard values, which means that they are unique for each indicator. Ultimately, the availability of data in the public domain constrained the selection of baseline values. The overall section score averages variable scores that consist of averages of indicator scores, which are capped at 100 to allow for a 0-to-100 scoring scale.

NDIA's industrial security conditions measure threats to our nation's intellectual rights and cybersecurity vulnerabilities. NDIA's industrial security indicators are derived from FBI IP rights investigation statistics, cybersecurity data provided by the National Institute of Standards and Technology, and the MITRE Corporation's Common Vulnerabilities and Exploits tracking project.

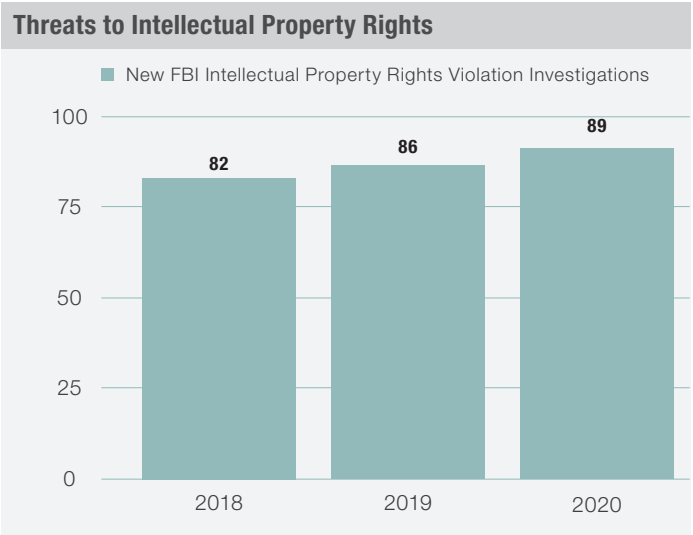


Figure 6.3, Source: NDIA

IP rights are essential to profitability for the DIB. The perception of risks to IP rights shapes industry's willingness to invest in R&D and commercialization activities. The protection of IP rights also compels investments in costly information security measures. New IP rights investigations by the FBI scored an 89 for 2020, which is

1 Department of Defense, "CMMC FAQs." https://www.acq.osd.mil/cmmc/faq.html

up seven points from 2018. This score is based on an annual average of 50 new FBI IP rights investigations between 2017 and 2019. The frequency of new investigations has continuously decreased since 2011 and was scored against the 2017 single-year value of 44 investigations—the smallest in our dataset.

Since 2008, the FBI has published statistics on its intellectual property-based investigative activities. The new IP rights investigations statistic includes trade secret theft, counterfeiting, copyright infringement, and trademark infringement cases with an impact on national security or a link to organized crime. This indicator was baselined against the 235 new IP rights cases launched in 2011, the peak number of new investigations since reporting began. Multiple factors drive this trend. The FBI shares IP rights enforcement responsibilities with more than 20 other federal agencies; it collaborates on investigative activities through the National Intellectual Property Rights Coordination Center, which is hosted by the Department of Homeland Security and deconflicts thousands of investigations each year. This coordination may have led to fewer FBI intellectual property rights cases that are not reflected in the FBI's reporting.

THREATS TO INFORMATION SECURITY

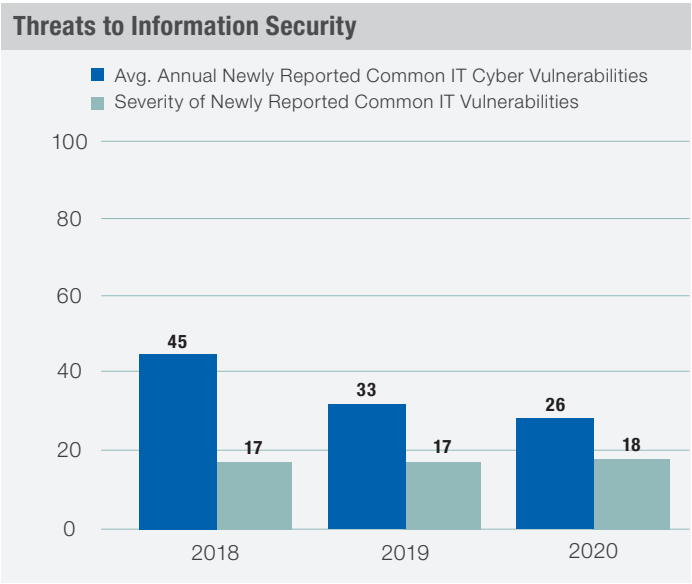


Figure 6.4, Source: NDIA

Threats to information security scored a 22 for *Vital Signs 2021.* The number of newly reported common IT cyber vulnerabilities rose to 17,305 in 2020 from just 14,645 in 2017. The number of average annual documented IT cyber vulnerabilities was scored against a "peak low" value of 4,150 from 2011. Despite the increase over the 2011 baseline, the average severity of newly reported vulnerabilities decreased slightly from 5.8 in 2017 to 5.5 in 2019.

Defense manufacturing and services rely on secure information to produce the defense products and services that our servicemembers need. Vulnerabilities in information systems that facilitate the flow of industrial information threaten production capabilities, service deliveries, and the integrity of IP rights. Information security threats are also an enduring source of overhead costs as firms implement measures to protect and recover from cyber threats.

The MITRE Corporation maintains the Common Vulnerabilities and Exposures (CVE) List, a "dictionary of publicly disclosed cybersecurity vulnerabilities" that serves as the most authoritative list of known security holes in IT hardware and software products.[2] The National Institute of Standards and Technology (NIST) publishes an annual version of the CVE list that includes severity scores for each vulnerability.

Known cybersecurity vulnerabilities continue to rise at a very aggressive rate. New cybersecurity vulnerabilities increased to 17,305 in 2019 from 6,447 in 2016—a 168% increase. In both years, vulnerabilities affecting business applications as well as internet and mobile software accounted for at least 45% of new CVE entries. A 2020 analysis by Skybox Security indicated that the popular commercial software products Google Android and Microsoft Windows produced the most new vulnerabilities of any product.[3] Researchers at NIST and Loyola University of Maryland found that two-thirds of the vulnerabilities posted to the CVE related to simple and persistently unfixed software implementation errors.[4]

The surge in data breaches underscores the risk industry faces from cyber vulnerabilities that continue to proliferate, providing a compelling indication of the focus that adversaries, competitors, and bad actors have placed on attacking U.S. systems to garner sensitive information. The ID Theft Center reported that the total number of breaches reported in 2019 (1,473) increased 17% from the total number of breaches reported in 2018 (1,257) and that the business sector exposed the highest number of non-sensitive records with a total of 705,106,352 exposed.[5]

The *Vital Signs 2021* scores for industrial security indicate an environment that presents a continuously increasing risk to the DIB.

CONCLUSION

Overall industrial security conditions received a score of 56 for 2020, down one point from an already dismal score in 2018. This decline reflects larger trends in the erosion of industrial cybersecurity despite increasing attention and resources being dedicated to combating the threat. Threats to IP rights scored an 89 for 2020, increasing seven points since 2018 because of a steadily declining number of new FBI IP rights investigations that came after years of enhanced law enforcement. How CMMC, Section 889 Part B, and other measures taken to address the threats to industrial security impact this score will be an aspect to track in coming years.

2 MITRE, "Common Vulnerabilities and Exposures," Web site, https://cve.mitre.org/cve/index.html

3 "The 2020 Threat Landscape," Skybox Security, https://www.skyboxsecurity.com/resource/2020-threat-landscape/

4 Kuhn, D.R., Raunak, M.S., and R. Kacker, "An Analysis of Vulnerability Trends, 2008-2016," NIST https://tsapps.nist.gov/publication/ get_pdf.cfm?pub_id=923379

5 Based on NDIA calculations. See the most recent report from the ID Theft Resource Center: https://notified.idtheftcenter.org/s/

POLITICAL & REGULATORY

Change, 2018 – 2020

-10

POLITICAL & REGULATORY SCORES

Overall Factor	2020	Change, 2018 – 2020
Public Opinion	49	-21
Congressional Budgeting Process	84	-2
Regulatory Burden	82	-7
Overall Political & Regulatory Score	***72***	***-10***

Figure 7.1, Source: NDIA

Factor Score Key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

OVERVIEW

More than most industries, legislative and regulatory processes have a direct impact on defense industry productivity. The public's attitudes toward defense spending shape congressional interest in defense acquisition, ultimately affecting congressional budgets. The time that Congress takes to authorize a budget for national defense programs affects capital availability and the product delivery schedule of defense supply chains. Similarly, changes to defense acquisition regulations affect defense contractors' eligibility and administrative costs. In this way, policymakers can have a significant impact on the defense industry in terms of the demand for goods and services, availability of inputs, conditions in related and supporting industries, and structure of industry competition. This section of the report assesses political and regulatory trends that shape defense industrial productivity.

To examine those conditions, this section of the report analyzes public opinion, congressional action, and regulatory action. All three indicators saw a score decrease from 2018 to 2020, with public opinion and regulatory conditions scoring particularly poorly. Two examples from the current environment are the implementation of Section 889 of the FY19 NDAA and the Cybersecurity Maturity Model Certification framework, which have created additional regulatory burdens for all defense contractors. Public opinion saw the largest decrease and has fallen in recent years, possibly due to rising defense budgets. Regulatory conditions also saw a noticeable drop from last year. Small improvements in the average time for both forward pricing audits and incurred cost audits did not make up for the performance of the calculated red tape ratio.

The highest-performing factor of this condition is the congressional budgeting process. Congress was measured on the time to pass defense appropriations and the NDAA. Additionally, Govini measured congressional interest in MDAPS and supply chain issues. Recent years have seen a decrease in such congressional interest but increasing scores for the passage of defense appropriations and the NDAA. The data for this report does have some lagging data. As a result, *Vital Signs 2021* does not include data for the most recent round of NDAA and appropriations bills, which saw a historic veto override and last-minute omnibus, respectively.

> **"In 2020, the implementation of Section 889 of the FY19 NDAA and the Cybersecurity Maturity Model Certification framework created additional regulatory burdens for all defense contractors.**

KEY TAKEAWAYS

- Political and regulatory conditions scored a 72 for 2020, which is down 10 points from 2018
- Public opinion saw a major decline in its score since 2018
- Congressional budgeting and regulatory burden scores decreased modestly

POLITICAL & REGULATORY SCORES

Factor	Indicator	2020	Change, 2018 – 2020
Public Opinion	Public Opinion on Defense Spending	49	● -21
Overall Public Opinion		***49***	● ***-21***
Congressional Budgeting Process	Average Number of Days Elapsed after October 1 for NDAA Passage	89	● +4
	Average Number of Days Elapsed after October 1 for Defense Appropriations Passage	77	● +20
	Congressional Interest in MDAPs	81	● -19
	Congressional Interest in Supply Chains	88	● -12
Overall Congressional Budgeting Process		***84***	● ***-2***
Regulatory Burden	Red Tape Ratio	74	● -26
	Average Elapsed Days for Incurred Cost Audits	74	● +3
	Average Elapsed Days for Forward Pricing Audits	98	● +1
Overall Regulatory Burden		***82***	● ***-7***
Overall Political & Regulatory Score		***72***	● ***-10***

Figure 7.2, Source: NDIA

Factor Score Key	● -6 and worse	● -1 – -5	● 0	● +1 – +5	● +6 and better

INTRODUCTION

The political and regulatory environment has profound effects on the defense industry. U.S. public opinion plays an integral role in guiding policymakers' decisions about these processes. Where national security lands on the nation's agenda, the nature of threats and how they're perceived by the public, and the national discourse over whether there is too much or not enough regulation of corporations all play into what kind of environment surrounds the defense industrial base. That political atmosphere drives Congress and the Executive Branch in shaping the DIB through legislation and regulations that control the barriers to entry for the defense market, the cost of doing business and potential profit margins, acquisition budgeting, product and service specifications, and contract management. These trends shed light on the direction of future resourcing and illuminate the constraints on the defense industrial base.

This section presents scores for indicators of political and regulatory factors shaping defense production. These indicators describe 1) public opinion, 2) congressional budgeting and interest, and 3) rulemaking trends. First, the public opinion indicators are based on long-standing and publicly available survey data from the Gallup Organization.[1] Second, congressional budgeting indicators come from data published by the Congressional Research Service.[2] Third, the congressional interest indicator is provided by Govini through its proprietary text analytics methods. Finally, the rulemaking indicator is founded on the basis of NDIA's analysis of Federal Register records.[3]

METHODOLOGY

Indicator scores are determined by the ratio of an indicator's average value to a baseline value. Baseline values reflect historical peak values or ideal standard values, which means that they are unique for each indicator. Ultimately, the availability of data in the public domain constrained the selection of baseline values. The overall section score averages variable scores that consist of averages of indicator scores, which are capped at 100 to allow for a 0-to-100 scoring scale.

1 Gallup Poll Social Series: World Affairs. February 3-16, 2020.

2 https://crsreports.congress.gov/AppropriationsStatusTable?id=2020

3 https://www.acq.osd.mil/dpap/dars/archive/2020/change_notices.html

PUBLIC OPINION

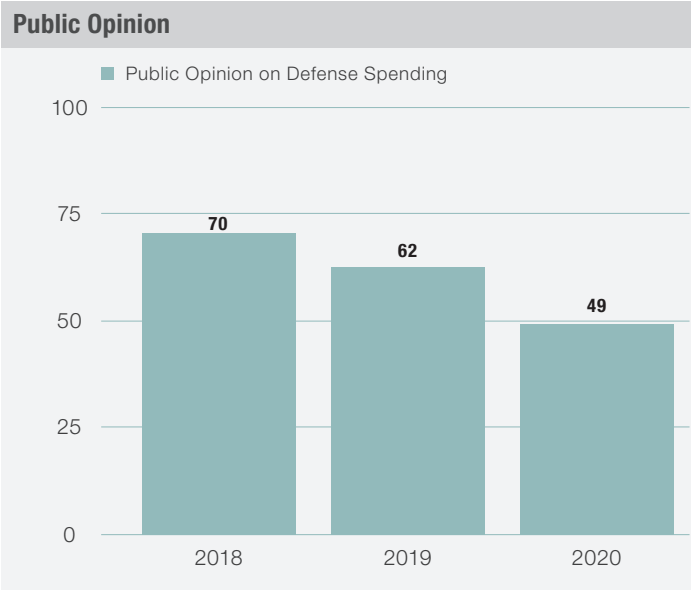


Figure 7.3, Source: NDIA

Since 1969, the Gallup Organization has conducted a poll of U.S. adults in which it asked, "There is much discussion as to the amount of money the government in Washington should spend for national defense and military purposes. How do you feel about this? Do you think we are spending too little, about the right amount, or too much?"[4]

In 2020, public opinion scored a 49, which is 13 points lower than the 62 scored for 2019 and 21 points lower than the 70 scored for 2018, continuing a downward trend for this indicator. This score is based on the percentage of respondents who answered "too little" to the Gallup Organization's poll question. In February 2020, 17% of respondents said that the United States is spending too little on national defense and military purposes, compared to 25% in 2019 and 33% in 2018. This decline is the largest two-year decline since the 1981-to-1983 time period—the height of the Carter-Reagan buildup.[5]

Recent defense spending increases may have reduced some of the public's anxiety about the need for more military investment. In 2020, 50% of participants believed that defense spending is "about right," which marks a 7% increase from 43% in 2019.[6] This 2020 result of 50% is the highest percentage of "about right" responses for this question since Gallup began asking it more than 51 years ago.

In general, public opinion about defense policy reflects broad attitudes about both the state of national security and the perceived trade-offs between preferred defense policies and other national priorities. As previously noted, this result came prior to the onset of the COVID-19 pandemic.

The decline in Americans' belief that the government spends "too little" on defense partly results from the high-and-rising confidence that Americans have in the U.S. military. According to Gallup, the percentage of Americans that believed the U.S. military was "not strong enough" declined to 25% in February 2020 from 31% in February 2019.[7] The strongest indicator of this trend is the fact that 62% of respondents believe the strength of U.S. national defense is "about right."[8]

The same Gallup poll indicated that the majority of Americans feel it is important for the United States to be the leading military in the world.[9] While most Americans support continuing America's role in global security, they demonstrate a growing concern about the trade-offs involved. This potential trend towards isolationism is one to watch going forward.

CONGRESSIONAL BUDGETING PROCESS

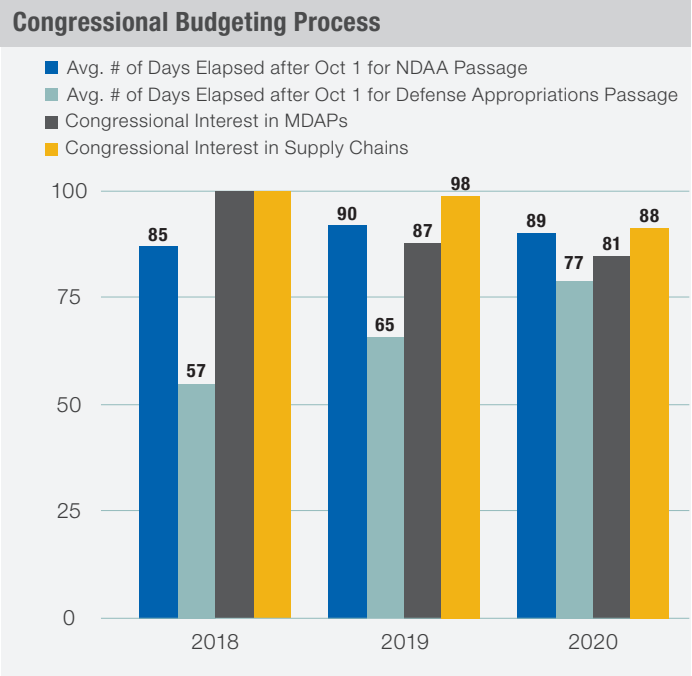


Figure 7.4, Source: NDIA

The congressional budgeting process for national defense programs scored an 84 for 2020. This score reflects a combination of two indicators with contrasting trend lines: the average number of days past October 1 taken to pass the NDAA and defense appropriations, the number of hearings with five or more mentions of MDAPs,

4 Gallup Poll Social Series: World Affairs. February 3-16, 2020. Page 3.

5 *Id.* Between 1981 and 1983, the percentage of respondents that said the U.S. spends "too little" on defense and national security issues, declined to 21% in 1983 from 51% in 1981.

6 *Id.*, at page 6.

7 *Id.*, at page 6.

8 *Id.*, at page 6.

9 *Id.*, at page 2.

and congressional interest in supply chains. The congressional interest indicator score is calculated by our data partner, Govini.

Since FY18, the running average number of days past October 1 taken to pass the NDAA and defense appropriations has decreased by 12 days. From FY16 to FY18, it was 53 days. Between FY18 and FY20, the NDAA was, on average, passed 41 days after October 1. The time taken to pass defense appropriations has seen a similar drop in recent years. The three-year average ending in FY18 was 155 days but is now down to a three-year average of 84 days.

The duration of the congressional budgeting process ultimately reveals the level of priority that Congress awards to defense acquisition issues. Congress faces a statutory expectation to complete the defense budgeting process between the first week of February and October 1 for the next fiscal year. When Congress breaches that schedule, the Executive Branch cannot advance, start, or sustain defense acquisition plans. Therefore, the amount of time that Congress takes to deliberate on passing the NDAA indicates the performance of the legislative budgeting process.

In recent years, the irregularity of congressional budgeting processes and the long durations required for NDAA passage have subjected the Department of Defense to disruptive budget uncertainty. Frequently forced to operate under continuing resolutions, DoD has had to delay urgent contract awards and future acquisition planning.

The score for the three-year average of congressional interest in MDAPs dropped from 100 in 2018 to 81 in 2020. This score is based on the number of hearings with at least five mentions of any MDAPs, which decreased from 160 in FY17 to just 110 in FY20. Mentions of supply chains have also decreased over that same period from 82 hearings with five or more mentions down to 57. Both the scores and the number of hearings reported in *Vital Signs 2021* are higher than those reported in *Vital Signs 2020* because Govini has been able to better capture the number of times an item is mentioned in a hearing. This improvement brought the totals up for each year for which we have data. As a result, we are no longer scoring against data from 2014. Rather, annual congressional interest totals were scored against a baseline value of 160 for MDAPs and 82 for supply chains, both of which are from 2017—the earliest year for which data was producible.

While Congress plays a central role in deciding, enabling, and supervising defense acquisition policy, congressional attention devoted to acquisition-related topics fuels policymaking activity. Therefore, the level of congressional interest in defense acquisitions is a good indicator of the amount of related activity within the legislative environment. Rising levels of interest in defense programs and systems suggest a correlation with increasing policy activity. That activity may take the form of critical oversight of high-visibility MDAPs or forward-looking hearings on the status of future requirements. For this report, Govini measured congressional interest as the number of mentions of MDAPs in congressional hearings, applying a significance threshold of five mentions.

Over the past several years, Congress has embraced a new campaign of acquisition reform that has involved the passage of hundreds of legislative provisions in the annual NDAA to improve the cost, schedule, and performance of the overall defense acquisition system. Meanwhile, congressional leadership has expressed caution about further reform-based legislative activity until DoD has had more of an opportunity to absorb past statutory acquisition reforms.[10] The drafting of the FY20 NDAA reflected the new reticence toward legislating acquisition reforms.[11] As a result, the declining congressional interest in MDAPs during the last two years appears intentional rather than a matter of disregard.

REGULATORY BURDEN

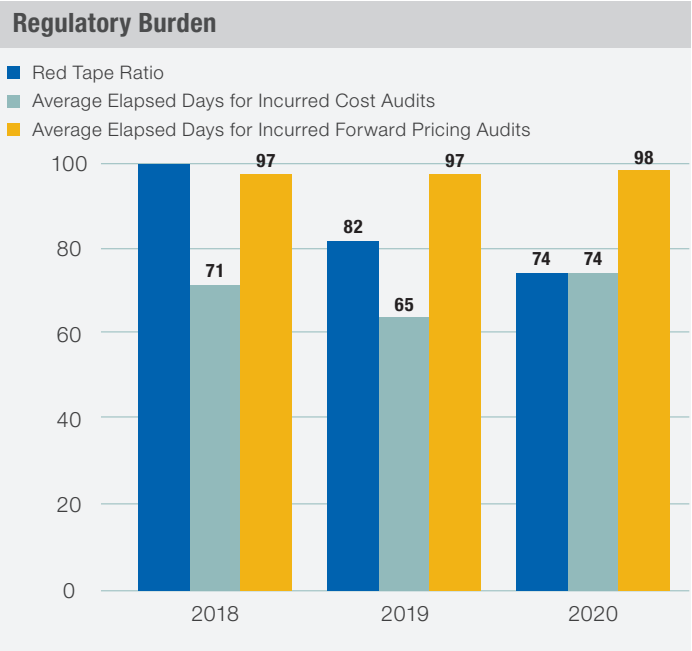


Figure 7.5, Source: NDIA

Regulatory conditions continue to trend downward with the index score for regulatory trends dropping by seven points from 2018. In addition to the industry's red tape ratio, the *Vital Signs 2021* score for regulatory burden accounts for the average time taken for incurred cost audits and the average elapsed time during the forward price auditing process. Accounting for these new indicators, the regulatory burden scored an 82 for 2020.

For this report, the red tape ratio was calculated by taking the ratio of new final rules in FY20 that decrease restrictions to rules that increase restrictions. For this report, the level of regulatory burden was scored against a red tape ratio calculated for 2016,

10 Gould, Joe and Leo Shane III, "3 takeaways from Thornberry's 2020 DoD reform agenda," Defense News, May 17, 2019. https://www. defensenews.com/congress/2019/05/17/3-takeaways-from-thornberrys-2020-dod-reform-agenda/; "Representative Adam Smith on the FY 2020 National Defense Authorization Act," Event Transcript, Center for Strategic and International Studies, June 12, 2019. https://www. csis.org/analysis/representative-adam-smith-fy2020-national-defense-authorization-act

11 Williams, Lauren C., "Acquisition reforms take a back burner as Congress reconciles NDAA," Washington Technology, September 24, 2019. https://washingtontechnology.com/articles/2019/09/24/ ndaa-conference-acquisition-williams.aspx

the earliest year available in this dataset. The average time elapsed was calculated by taking the three-year running average of the time elapsed for an audit and dividing it by the single-year peak value in our dataset, which, in this case, was 2019 for both.

The level of regulatory burden that industry faces in contracting with the Department of Defense ultimately affects industry's productivity and produces barriers to entry for new companies interested in joining the defense industry. DoD regularly issues new rules that modify the Defense Federal Acquisition Regulation Supplement (DFARS), defining the rights and obligations of the parties involved in defense contracting in accordance with the preferences of Congress, the President, and the Secretary of Defense. Often, such new rules add or subtract restrictions or requirements for parties involved in the contracting process. These rules ultimately add up to an overall regulatory burden that imposes costs on companies seeking to do business with the government.

Under the direction of Executive Orders 13771 and 13777, DoD has prioritized the exploration of ways to reduce the regulatory burden and, thereby, improve the performance of the defense acquisition system. This effort has involved various benefit-cost assessments of existing and proposed regulations in addition to the elimination of unnecessary ones, including some that affect defense acquisitions. The White House Office of Information and Regulatory Affairs (OIRA) reports that DoD implemented four deregulatory actions in FY19, achieving a cost savings of $101.2 million. As of December 2020, OIRA has not published new results for FY20.[12] Therefore, the Section 809 Panel, which was commissioned to streamline existing DoD acquisition regulations, proposed many actions to reduce the overall regulatory burden, including the repeal of outdated rules.

Both audit indicators showed improvement, which is highlighted by 2019—the peak year in both cases. While the time taken to complete incurred cost audits was down to 88 days, the time taken to complete forward pricing audits was down to 82 days. The three-year average for incurred costs is only down to 119 days, which is why the score is still only 74 in *Vital Signs 2021*. Meanwhile, forward pricing audits had a three-year average of 83 days, which produced a score of 98.

According to the Defense Contract Audit Agency (DCAA), the agency only had 48 pending audits at the end of FY19, demonstrating a drastic reduction from the 1,844 pending reviews it had at the end of FY18.[13] Remarkably, the agency was able to reduce the time taken to complete incurred cost audits to 88 days from 125 days.[14] In FY19, DCAA was able to complete 710 forward pricing audits and reduce the average time to complete the audits from 85 days to 82 days.[15] DCAA's impressive backlog reduction is the product of an improved auditing process and of contracting private auditors; the result is critical in facilitating contracts to quickly meet military and defense needs.

CONCLUSION

In 2020, the implementation of Section 889 of the FY19 NDAA and the Cybersecurity Maturity Model Certification framework created additional regulatory burdens for all defense contractors. Political and regulatory conditions received an overall score of 72 for 2020, reflecting a decline from 82 in 2018. Public opinion towards defense spending fell from 70 points in 2018 to a score of 49—a decrease driven by rising defense budgets. The overall rating of the congressional budgeting process fell by two points from 2018 to an overall score of 84 as the result of a broad loss of congressional interest in major defense acquisition programs. The regulatory burden decreased as well but scored an 82. With these scores in mind, the trend for political and regulatory conditions is downward and marks a considerable fall over the last several years.

12 White House OIRA, "Regulatory Reform under Executive Order 13771: Final Accounting for Fiscal Year 2019," https://www.reginfo. gov/public/pdf/eo13771/EO_13771_Final_Accounting_for_Fiscal_ Year_2019.pdf

13 Defense Contract Audit Agency, "Report to Congress on FY 2019 Activities Defense Contract Audit Agency" (Fort Belvoir, 2020).

14 Defense Contract Audit Agency, 8. See Table 5 for the full number of audits completed.

15 *Id*. at 11, 13.

PRODUCTIVE CAPACITY & SURGE READINESS

Change, 2018 – 2020

+12

PRODUCTIVE CAPACITY & SURGE READINESS SCORES

Overall Factor	2020	Change, 2018 – 2020
Output Efficiency	48	+26
Intensity of Capital Usage	83	-2
Overall Productive Capacity & Surge Readiness Score	***66***	***+12***

Figure 8.1, Source: NDIA

Factor Score Key				
-6 and worse	-1 – -5	0	+1 – +5	+6 and better

OVERVIEW

The need for an increase in defense production often appears suddenly, leaving little time for defense suppliers to ramp up production to fulfill a surge in demand for their goods, services, or materials. Meeting surge demand requires leveraging the latent excess productive industrial capacity in the national economy. In manufacturing industries, firms must activate unused industrial capital assets to reach necessary levels of productivity. However, the complex structure of industrial supply chains means that the flows of goods and services between industries will limit the extent to which an increase in demand for industrial end-products translates into an increase in industrial output. This section analyzes the output efficiency and the capacity utilization of the economy.

The U.S. defense industrial base must be ready to respond to a surge in demand for its goods, services, or materials. The sudden arrival of the COVID-19 pandemic showed just how quickly surge capacity can be needed. However, productive capacity and surge readiness presently form a weak spot of the defense industrial base. Though this condition's 2020 score marks a 12-point improvement over its 2018 score, it marks a large drop from 2019 and is still a failing grade. This variation is accounted for by fluctuations in the industrial output gap best seen by the output gap moving from negative to positive in 2019. Capacity utilization remains high but is trending in the wrong direction. This trend has been slowly unfolding for a few years, finally appearing in scores through the trailing averages.

As many *Vital Signs* Survey questions focused on the impact of COVID-19 on the supply chain, the survey responses explored in this section give some insight into the resulting state of the defense industrial base.

KEY TAKEAWAYS

- Productive capacity and surge readiness scored a 66, marking a rise of 12 points since 2018 but a drop of 15 points since 2019—mostly as the result of the 26-point drop in the output efficiency factor's score between 2019 and 2020
- Capacity utilization in durable goods manufacturing remained stable between 2018 and 2020

> **"Overall, there appears to have been some contraction in productive capacity before the COVID-19 pandemic, which anecdotal evidence from during the pandemic confirms.**

PRODUCTIVE CAPACITY & SURGE READINESS SCORES			
Factor	**Indicator**	**2020**	**Change, 2018 – 2020**
Output Efficiency	U.S. Output Gap	48	● +26
Overall Output Efficiency		***48***	● ***+26***
Intensity of Capital Usage	Capacity Utilization in Durable Goods Manufacturing	83	● -2
Overall Intensity of Capital Usage		***83***	● ***-2***
Overall Productive Capacity & Surge Readiness Score		***66***	● ***+12***

Figure 8.2, Source: NDIA

Factor Score Key	● -6 and worse	● -1 – -5	● 0	● +1 – +5	● +6 and better

INTRODUCTION

Productive capacity and surge readiness comprise important components of the health and readiness of the defense industrial base. Since productive capacity generally indicates the extent to which the national economy can expand to accommodate new demand for goods and services, its significance lies in its indication of the defense industrial base's ability to adapt to changes in defense supply chain requirements. Likewise, an assessment of the surge readiness of industries that provide critical defense supplies and equipment offers insight into the defense industrial base's ability to perform successfully under scenarios of heightened Department of Defense procurement. Since the data we used forms trailing indicators, this section gives us the ability to understand how well the defense industrial base was postured before we entered the COVID-19 pandemic—rather than how the pandemic impacted the defense industrial base. Such impacts remain to be analyzed.

METHODOLOGY

Indicator scores are determined by the ratio of an indicator's average value to a baseline value. Baseline values reflect historical peak values or ideal standard values, which means that they are unique for each indicator. Ultimately, the availability of data in the public domain constrained the selection of baseline values. The overall section score averages variable scores that consist of averages of indicator scores, which are capped at 100 to allow for a 0-to-100 scoring scale.

This section analyzes capacity and readiness by looking at the intensity of capital usage and output efficiency. The intensity of capital usage is calculated by looking at the capacity utilization for durable goods manufacturing; output efficiency is calculated from the national industrial output gap. The first is retrieved from the Federal Reserve's monthly G.17 release; the second comes from the Congressional Budget Office's July 2020 report, "An Update to the Economic Outlook: 2020 to 2030." This method marks a slight change since last year, when the output gap for each quarter was averaged to create an annual output gap. This year, we used the annual figure provided by the Congressional Budget Office.

OUTPUT EFFICIENCY

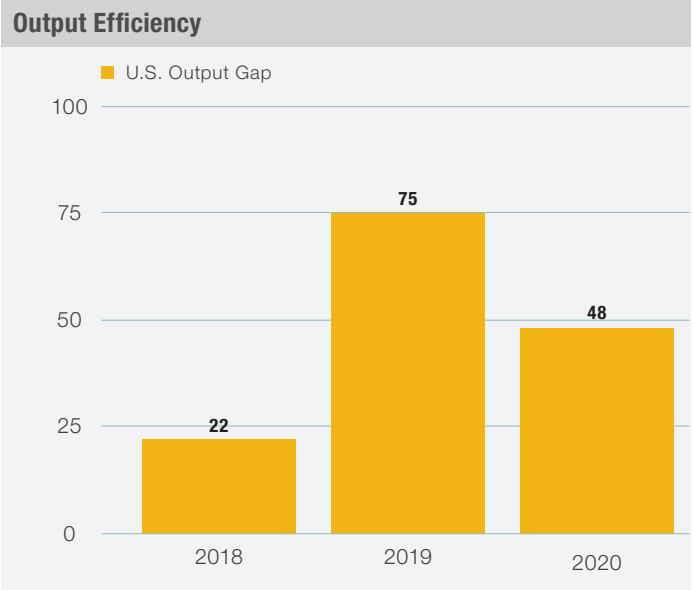


Figure 8.3, Source: NDIA

The U.S. output gap, which measures productive efficiency, increased by 26 points since 2018 to earn a score of 48 for 2020. This year's score is based on an output gap of 0.46% between 2017 and 2019, bringing our trailing average into the positive range for the first time.[1] This year's numbers will also look slightly different from those from last year due to a slight change in the data used. In addition to the annual figure being provided by the Congressional Budget Office for this year's report, this year's data was scored against the 2007 output gap value of 0.2. This value presents the closest that the output gap has been to zero in our dataset.

The productive efficiency of the U.S. economy shapes the productive capacity of the defense industrial base. We use the national output gap as a proxy indicator of the economy's productive efficiency by estimating the difference between the economy's actual output and its potential output. When this difference holds a positive value, the output gap indicates an economy that is over-performing its long-run potential. When this situation occurs, high aggregate demand for goods and services throughout the economy forces production facilities to operate in an unsustainable manner and at

1 Congressional Budget Office, "An Update to the Economic Outlook: 2020 to 2030," July 2020. https://www.cbo.gov/publication/56442

peak efficiency levels to provide enough supply, leading to tight labor markets and possible price inflation. Under an output gap with a negative value, the economy's production capabilities experience inferior efficiency, indicating that some productive capacity is underutilized. Under ideal conditions, no output gap would exist with actual economic output matching potential output.

In broad terms, the output gap illustrates the way in which the economy would react to a surge in defense-related demand. For example, a surge of new demand when there is a positive output gap would likely result in production shortages, price inflation, and a lack of investment in new productive capacity. On the other hand, a surge of new demand when there is a negative output gap would likely activate dormant capacity; however, production could suffer from low productivity and other inefficiencies. The positive output gap for 2019—from before the COVID-19 pandemic—was driven by the continued economic strength of the defense industrial base. The labor market was still tight and could be seen in the low levels of unemployment at the end of 2019.[2] That reality, in turn, pushed up both efficiency and the output gap, giving the U.S. output gap a positive value in *Vital Signs 2021*.

INTENSITY OF CAPITAL USAGE

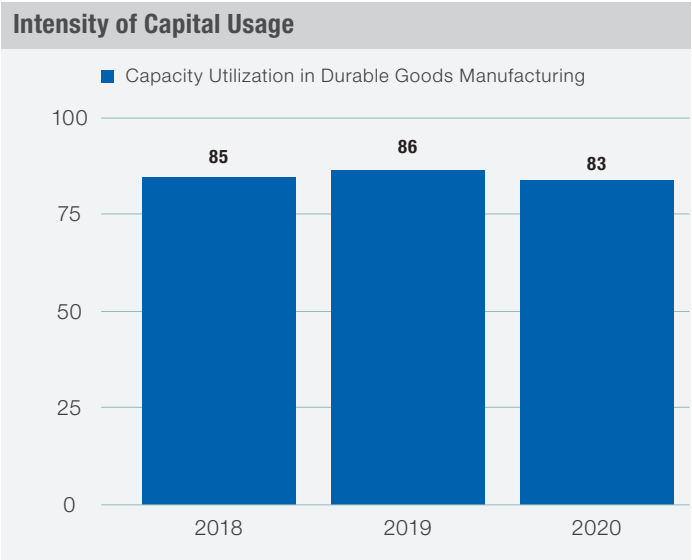


Figure 8.4, Source: NDIA

Capacity utilization in durable goods manufacturing industries, which measures the usage of U.S. manufacturing capital assets, earned a score of 83 for 2020—two points lower than its 2018 score. This score is based on a capacity utilization rate of 73.9% for the period between 2017 and 2019, which marks a decrease of 1.4% from 2015 to 2017. Capacity utilization continues to be scored against a 1973 baseline value of 88.6%.

The health of industry's productive capacity is linked to the extent to which manufacturing industries use their productive capabilities. Physical capital assets include the facilities, machinery, and equipment used in the production of goods and services. For manufacturing industries, physical capital assets are a key limiting factor of productive capacity. Industrial capacity utilization rates serve as a useful indicator of the intensity of physical capital assets usage throughout such industries. Capacity utilization rates measure the share of industrial productive capacity in use, on average, during a given period.[3] This year continues the overall downward trend in capacity utilization that has been present for many years.[4] Upward-trending capacity utilization rates indicate an increasing dedication of productive capital assets to the production of supply to meet new market demand. Downward-trending capacity utilization rates suggest a decreased usage of productive capital assets by firms.

SURVEY RESULTS

In August 2020 during the COVID-19 pandemic, NDIA conducted a member survey that had over 1,100 respondents. The survey focused on our members' surge readiness and the impacts of COVID-19 on their businesses. As 2020 is the first year in which we conducted this survey, we do not have the data history necessary to incorporate any of the results into our scoring for *Vital Signs 2021.* Nevertheless, the results are still insightful.

The first two questions of our survey are identical to questions in the U.S. Census Bureau's Small Business Pulse Survey (Pulse Survey), which creates an interesting point of comparison. Those two questions are 1) "Overall, how has this business been affected by the COVID-19 pandemic?" and 2) "In your opinion, how much time do you think will pass before this business returns to its normal level of operations relative to one year ago?" In response to the first question, our members were more optimistic than the Pulse Survey respondents. About 71% of our respondents experienced negative business effects from COVID-19 compared to about 79% of Pulse Survey respondents.

2 Edwards, Roxana, and Sean M. Smith, "Job market remains tight in 2019, as the unemployment rate falls to its lowest level since 1969," Monthly Labor Review, April 2020. https://www.bls.gov/opub/mlr/2019/article/tight-labor-market-continues-in-2018-as-the-unemployment-ratefalls-to-a-49-year-low.htm

3 Corporate Finance Institute, "Capacity Utilization," Technical Knowledge Resources Web Site, 2020. https://corporatefinanceinstitute.com/resources/knowledge/economics/capacity-utilization/

4 Gunnion, Lester, "Manufacturing capacity utilization has been falling; has anyone noticed," Deloitte Insights, May 2018. https://www2.deloitte.com/us/en/insights/economy/spotlight/economics-insights-analysis-05-2018.html

In your opinion, how much time do you think will pass before this business returns to its normal level of operations relative to one year ago?

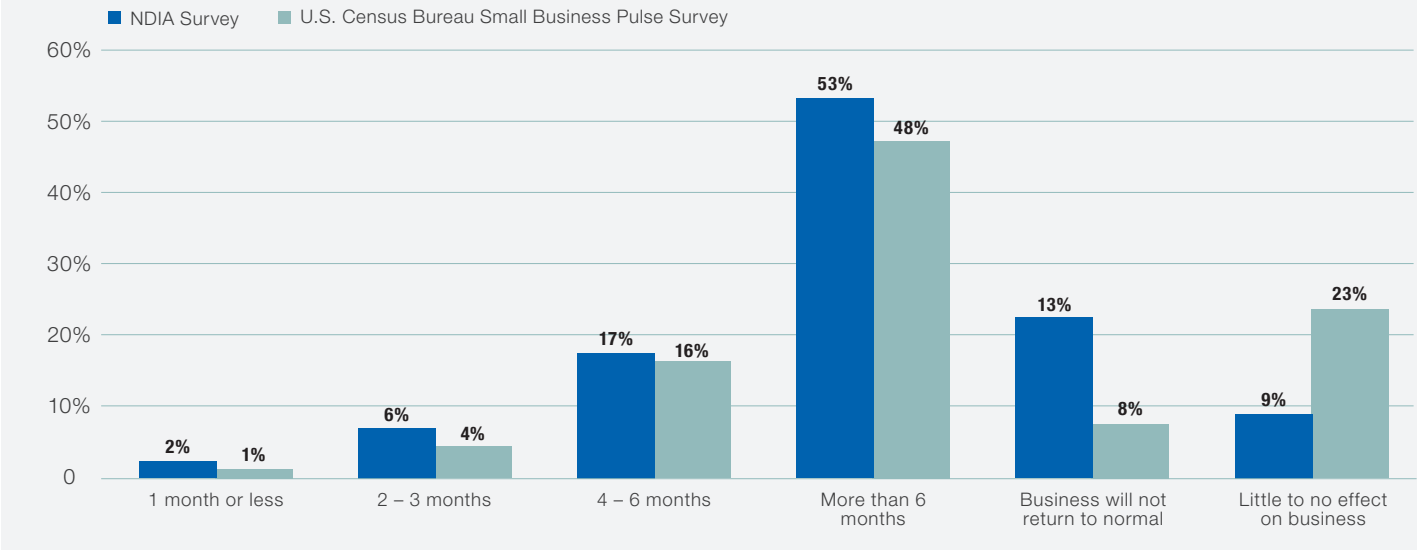


Figure 8.5, Source: NDIA

Overall, how has this business been affected by the COVID-19 pandemic?

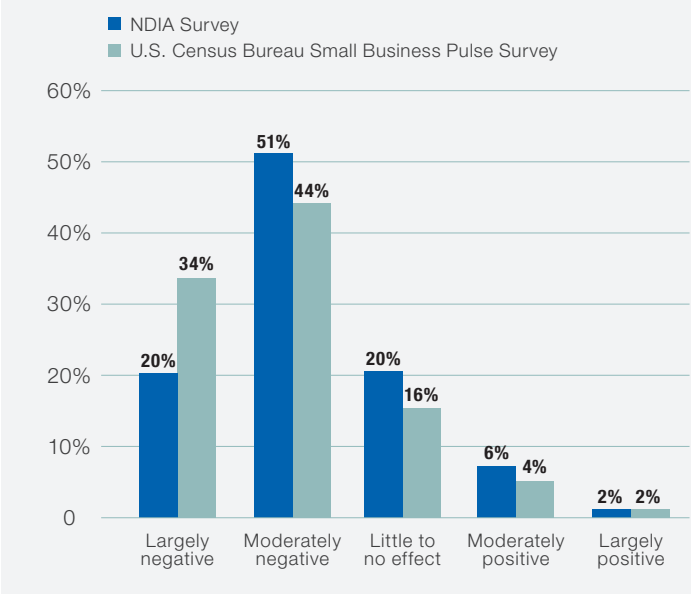


Figure 8.6, Source: NDIA

Responses to the second question showed more mixed results. More of our respondents saw little or no impact resulting from the COVID-19 pandemic. More specifically, 9% of our respondents answered as such versus 8.5% of the Pulse Survey respondents. However, the defense industrial base also had a higher percentage of companies that thought that it would take more than six months for business to return to normal levels with 53% of our respondents answering as such versus 47.5% of Pulse Survey respondents.

The comparison between the two surveys is not perfect since the two populations are not the same; not all NDIA members are small businesses, but 78% of our respondents' companies have fewer than 500 employees.

For surge capacity, our survey respondents thought that, within 30 days of receiving an increased demand signal, a 44% increase in products and services would be possible; a 100% increase would be possible within 180 days; and a production increase over 200% would be possible within 365 days. The longest time frame was getting to over a 100% increase, which would take 180 days. These results show that, in the first 30 days, our industrial base could ramp up quickly, but the rate of progress would slow soon thereafter.

CONCLUSION

Productive capacity and surge readiness form a current weak spot for the defense industrial base. A score of 66 might be a 12-point improvement over 2018, but it represents a significant drop from 2019. This fluctuation is accounted for by major fluctuations in the Industrial output gap, caused by the gap going into the positive range. Capacity utilization remains high but continues to slowly trend in a worrying direction. Some bright spots can be found in our *Vital Signs* Survey, through which fewer DIB companies reported having experienced negative effects of COVID-19 than nationally; moreover, the survey results show that companies believe they could increase production by almost 50% in 30 days. Overall, there appears to have been some contraction in productive capacity before the COVID-19 pandemic, which anecdotal evidence from during the pandemic confirms.

VITAL SIGNS SURVEY RESULTS

In August 2020, at the height of the COVID-19 pandemic, NDIA conducted a member survey that garnered responses from over 1,100 respondents. *Vital Signs 2021* is a data-driven look at the state of the American defense industrial base that uses accessible datasets and enables both snapshot views and the ability to see trends over time. Building on *Vital Signs 2020,* we made it a priority to include industry members' qualitative sense of how they saw the state of the industry and the environment in which they operate.

We believe that we can stay true to the *Vital Signs* mission of providing conclusions based on real data and including the richness of industry member inputs by instituting a survey that accomplishes two goals. First, we developed a series of questions that we will ask every year, which includes queries that get after the demographics of the industry such as size or sector as well as self-assessments of business confidence, surge capacity, and other factors. A second set of questions will change year to year depending on the topical issues of the day. This year and without surprise, the second set of questions in the *Vital Signs* Survey focused on the impacts of the COVID-19 crisis on the defense industry.

With the first set of questions asked every year, we will build a compelling dataset over time, which will factor into our scores to spot significant trends. The second set of questions will allow for a rapid "taking of the pulse" of the defense industry on topical issues immediately affecting the base.

METHODOLOGY

Since this is the first year that we have conducted this survey, we do not have the historical data required to incorporate any of the results into our scoring. Furthermore, we are not giving this section a grade. The survey instrument used in August 2020 was 42 questions long. Some of the pertinent results follow herein.

KEY TAKEAWAYS

- Due to the COVID-19 pandemic, 70% of respondents experienced a moderate or large impact on their business while 12% of respondents thought that their business would not return to 2019 levels of business
- Reforming the acquisition process and the need for budget stability continue to be top priorities for NDIA's members
- The uncertain prospect of a continuation of their volume of business was a moderate deterrent of our members' willingness to devote larger amounts of productive capacity to military production

If you have experienced disruptions in your cash flow as a result of the COVID-19 crisis, why?

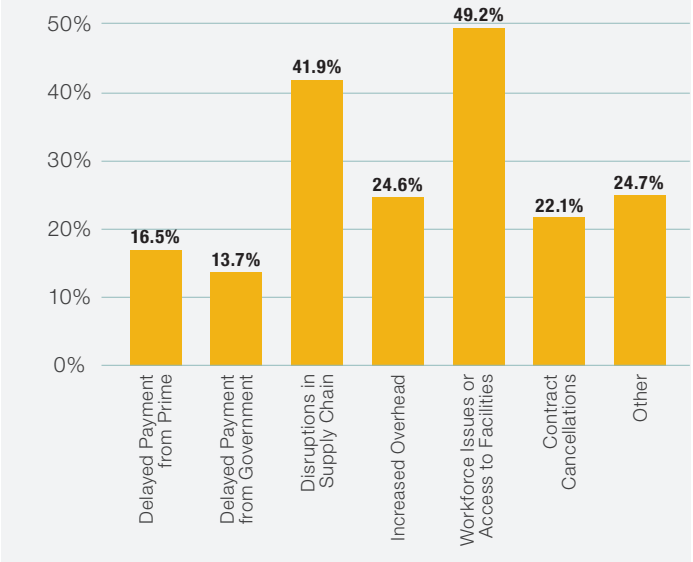


Figure 9.1, Source: NDIA

For how many years has your company performed prime contracts or subcontracts for the Department of Defense?

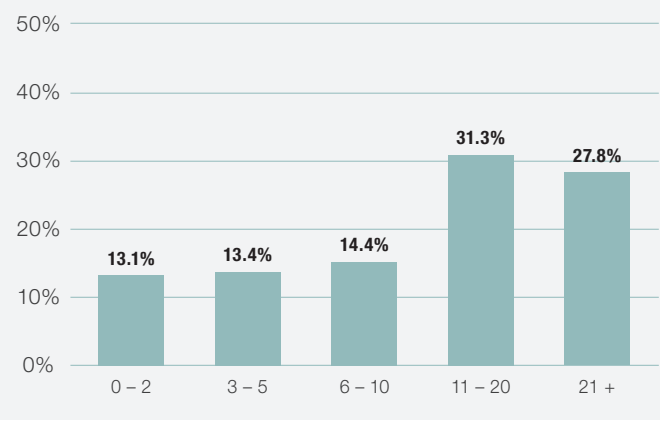


Figure 9.2, Source: NDIA

Suppose a crisis occurs and leads to a surge in demand for defense-related output. Please estimate the maximum percent increase of your company's total defense-related products and services of your primary NAICS Code that could be achieved within the following response times:

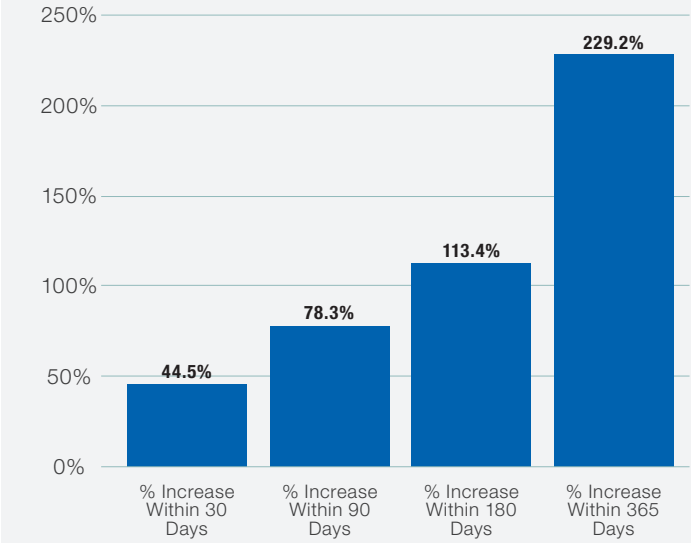


Figure 9.3, Source: NDIA

Approximately what percent increase in the price of your defense-related primary NAICS Code products would be necessary to cover the cost of the output completed within the time period indicated?

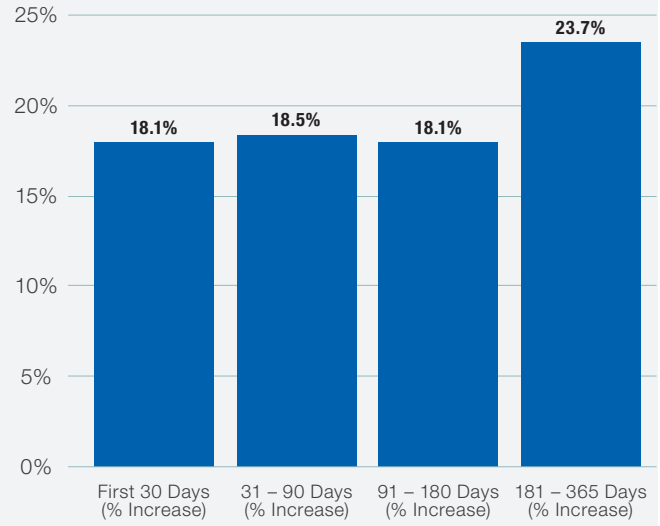


Figure 9.4, Source: NDIA

Please indicate which actions would be necessary in order to achieve the maximum potential production increases for each given time interval.

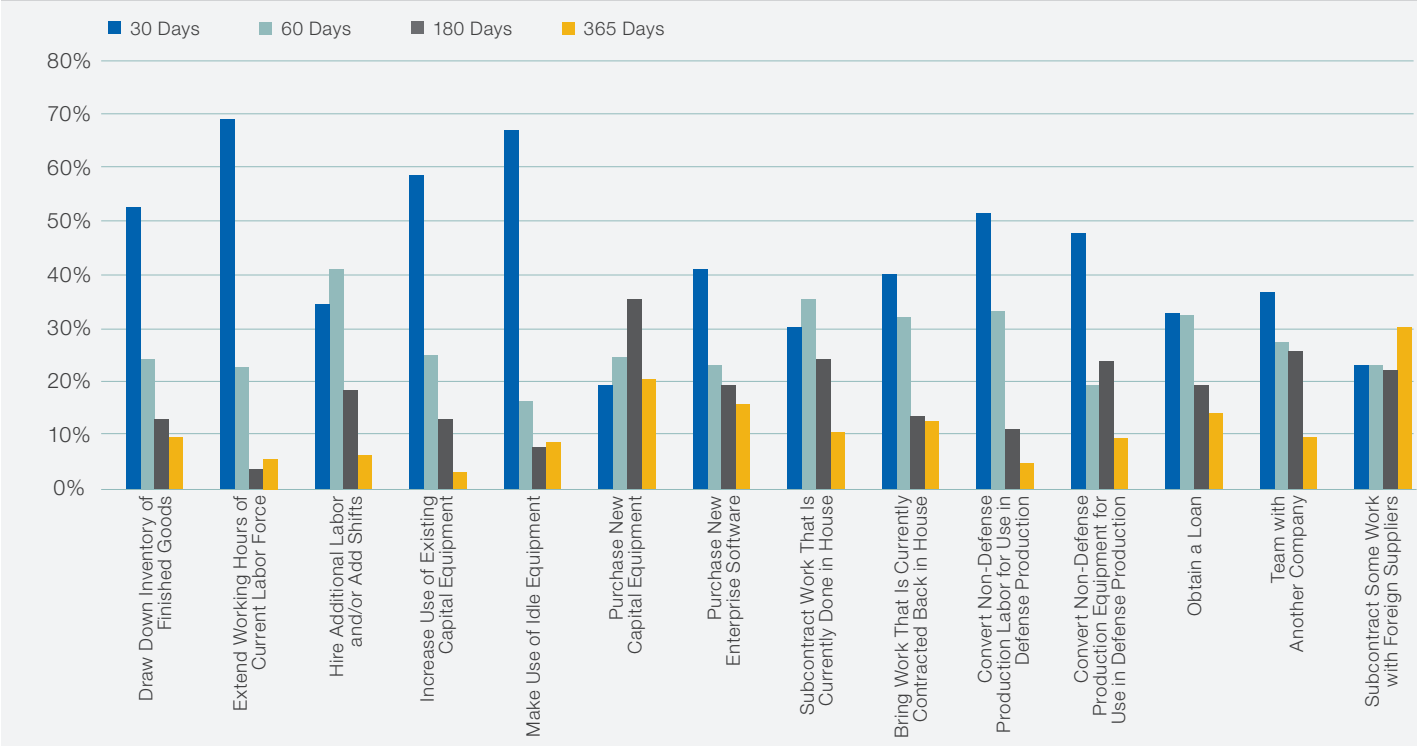


Figure 9.5, Source: NDIA

How would each of the following factors affect your firm's ability to increase defense production in response to surge demand?

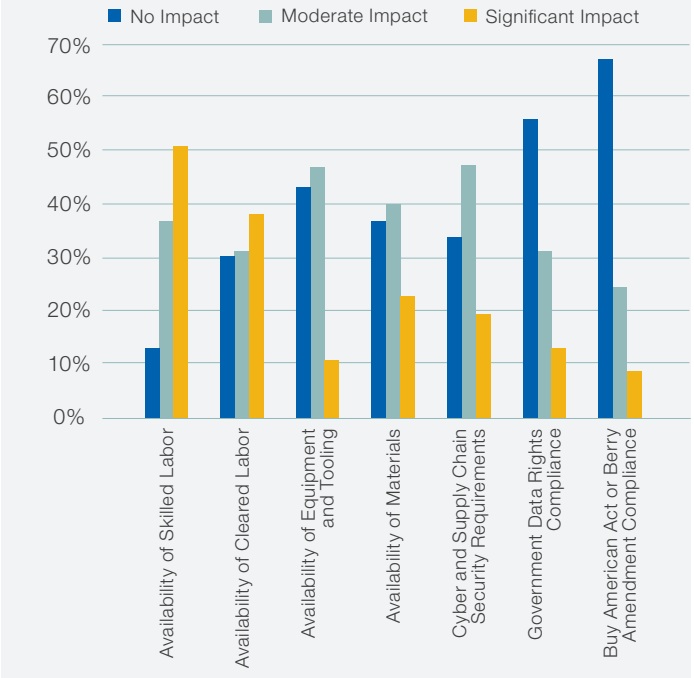


Figure 9.6, Source: NDIA

Would any of the conditions listed below limit your firm's willingness or ability to devote larger amounts of productive capacity to military production?

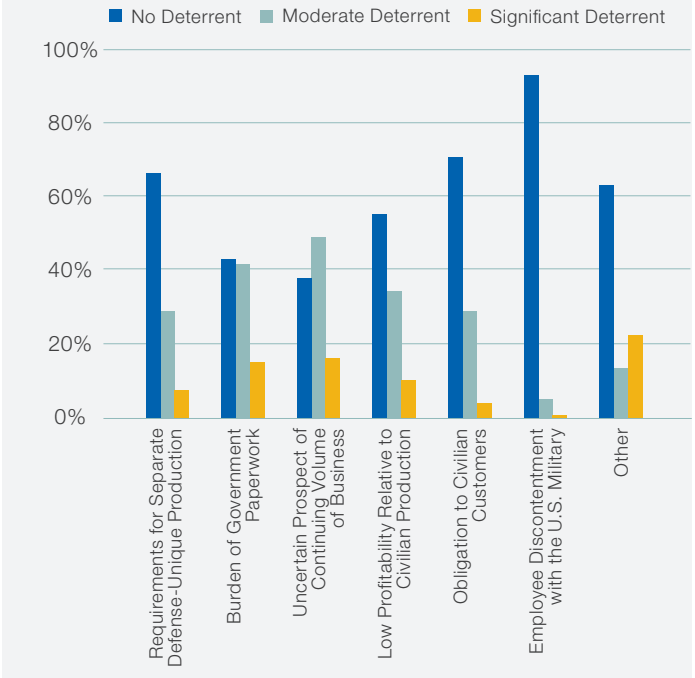


Figure 9.8, Source: NDIA

Does your company produce any defense-related products, regardless of industrial line of business, for which it is the sole eligible provider in the United States?

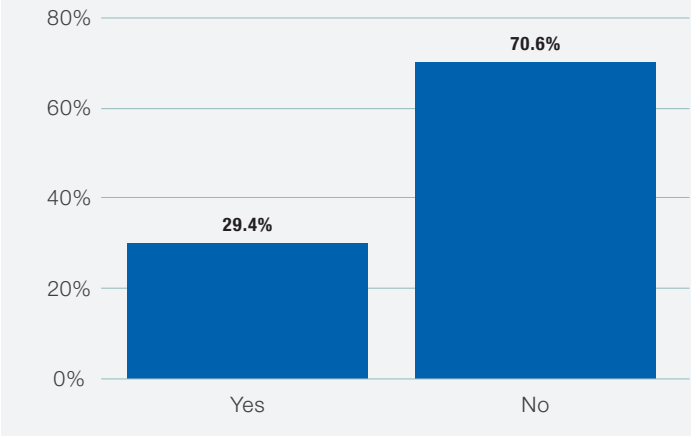


Figure 9.7, Source: NDIA

In a situation short of a declared national emergency, would any of the conditions listed below limit your firm's willingness or ability to devote significant amounts of productive capacity to military production?

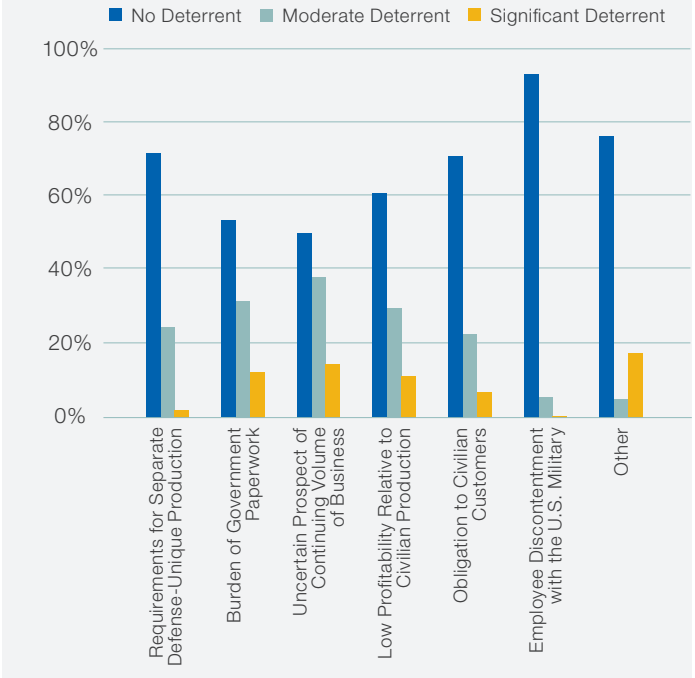


Figure 9.9, Source: NDIA

One year from now, do you think general business conditions will be worse, about the same, or better compared to this year?

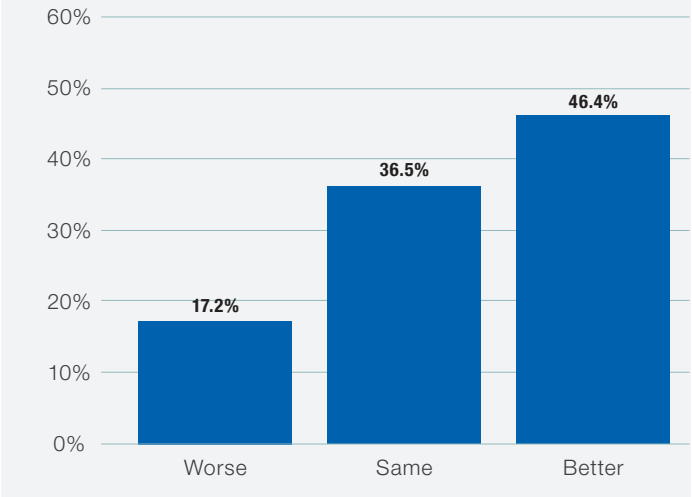


Figure 9.10, Source: NDIA

Given current conditions, do you think your company will bid on fewer, about the same number of, or more defense contracts next fiscal year compared to this year?

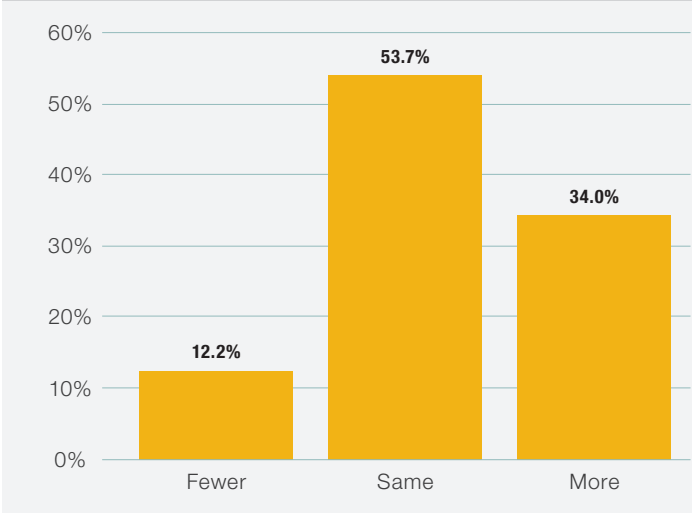


Figure 9.12, Source: NDIA

Given current conditions, do you think your company's defense contracting business will be less profitable, about the same, or more profitable next fiscal year compared to this year?

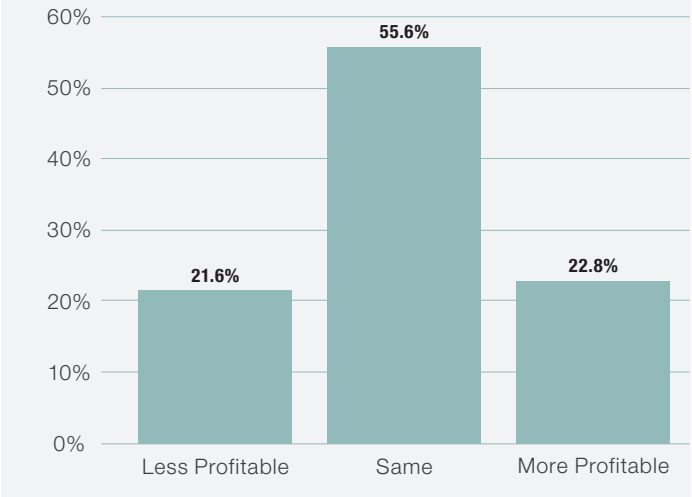


Figure 9.11, Source: NDIA

Given current conditions, do you think your company's supplier network will be less reliable, at about the same level of reliability, or more reliable at delivering goods, materials, and services necessary for DoD contracts on time and at an acceptable cost next fiscal year compared to this year?

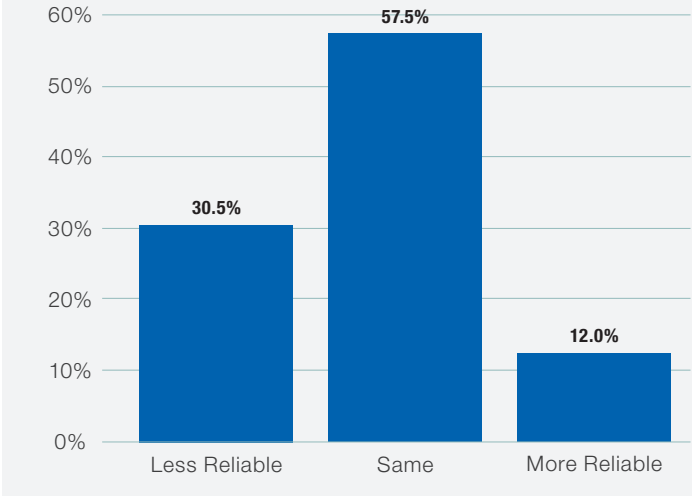


Figure 9.13, Source: NDIA

Please rate the difficulty of finding workers for the following areas:

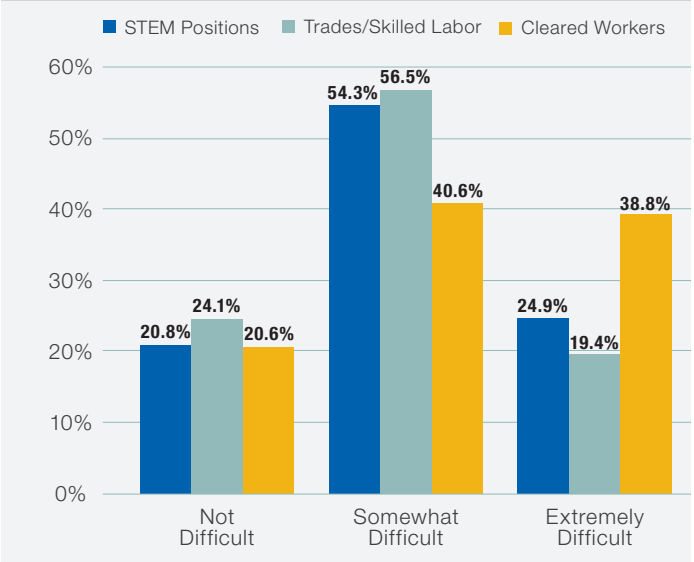


Figure 9.14, Source: NDIA

How confident are you in your supply chain?

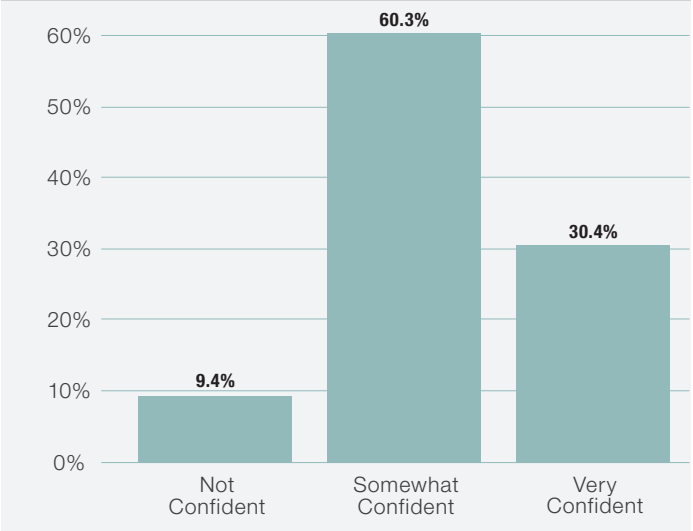


Figure 9.15, Source: NDIA

Given current conditions, how secure against attacks are the information assets your company uses to perform on defense contracts?

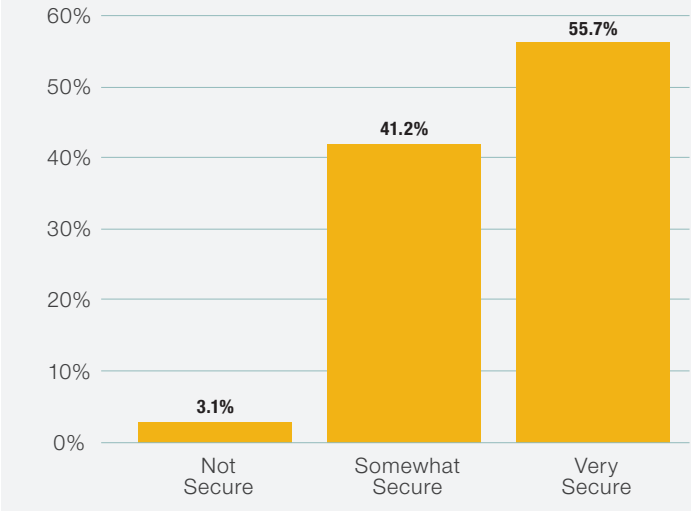


Figure 9.16, Source: NDIA

The most important thing that the government can do to help the defense industrial base is...

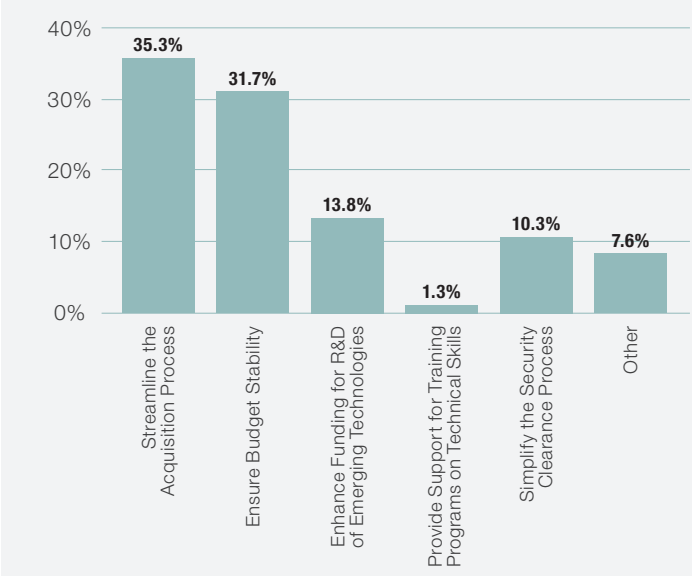


Figure 9.17, Source: NDIA

In your opinion, which part of your supply chain is most vulnerable?

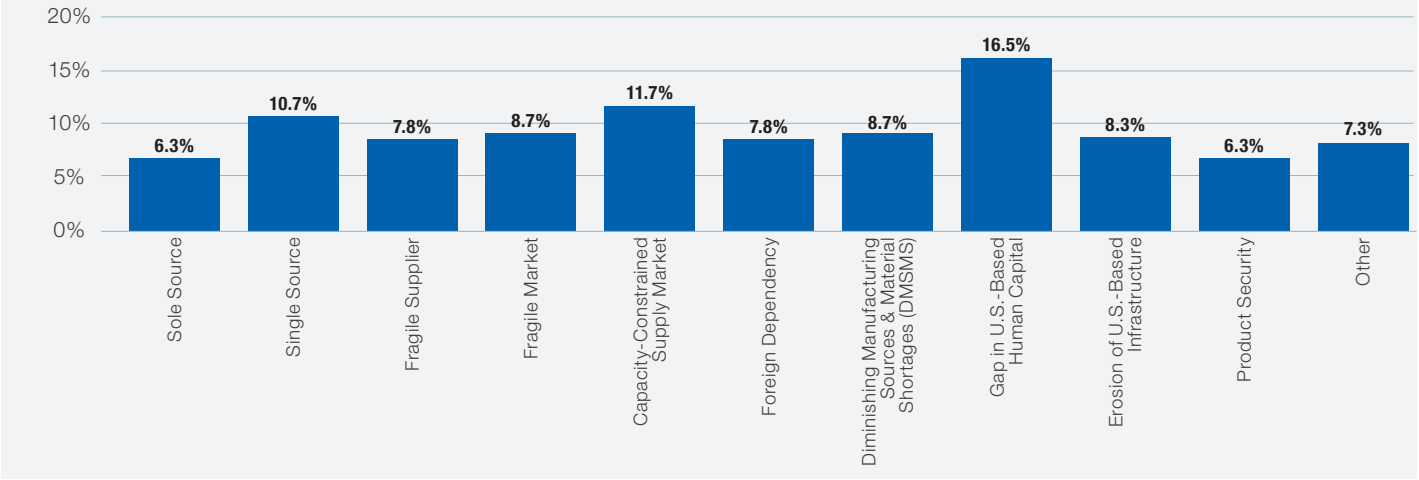


Figure 9.18, Source: NDIA

CONCLUSION

The health and readiness of the defense industrial base present numerous challenges to national security and the defense policy community. *Vital Signs 2021* highlights the hurdles that exist as demands on the defense industrial base rise in the age of renewed great-power competition.

Continuing a trend from last year, industrial security and cyber risks are some of the top challenges for the industrial base. Modern defense supply chains rely on sharing sensitive information across networks to meet the needs of DoD and our servicemembers in uniform. Ultimately, industry will incur significant costs to protect itself from the related risk. The importance of these issues to policymakers can be seen though the implementation of CMMC and Section 889 Part B, which were created in response to these increased risks.

The escalating costs and constraints on the availability of defense production inputs also threaten the defense industrial base. One significant risk is the acquisition of rare earth metals: The United States is almost entirely reliant on foreign rare earth metal production, with the vast majority coming from our long-term strategic competitor, China. When a sector depends on a single producer or on supplies from global competitors or politically unstable regions, risks increase for that same supply chain.

The U.S. defense industrial base's overall health and readiness score of 74 out of 100, a middling "C," suggests a satisfactory environment and a satisfactory ability to meet current requirements. However, this score is a one-point drop from last year when adjusted for the methodology-based changes of *Vital Signs 2021*. Changes to this year's edition of *Vital Signs* included new factors and indicators as well as improved datasets from Govini.

Such a middling score may not be good enough in the future. The era of great-power competition will require an industry that can quickly respond to emerging needs, protect its sensitive information, and attract and retain America's best talent to deter, compete, and win across all domains.

As suggested by our survey results, we expect the COVID-19 pandemic to have had a measurable impact across the depth and breadth of the defense sector. How the defense industrial base weathers the pandemic will serve as an indication of its resilience and may point to structural adjustments to come. We will soon examine that data as we begin to work on *Vital Signs 2022*.

Finally, we continue to look at ways to improve the usefulness of this report year after year. Please send us your comments and suggestions on how we can make *Vital Signs* better.

APPENDIX 1

FULL INDICATOR SCORES LIST

#	Factor	Indicator	2018	2019	2020	Change, 2018 – 2020
Demand						
1	Demand	Department of Defense Contract Obligations	77	85	93	+16
Overall Demand			***77***	***85***	***93***	***+16***
Production Inputs						
2	Costs of Goods, Services, and Strategic Materials	Producer Price Index of Services for Intermediate Demand	90	88	85	-5
3		Producer Price Index of Processed Goods for Intermediate Demand	98	96	93	-5
4	Access to Strategic Materials	Average Rare Earths Minerals (REMX) ETF Prices	100	100	100	0
5		U.S. Share of World Rare Earths Mine Production	5	10	23	+18
6		Net Import Reliance as a Percentage of Domestic Consumption	8	6	6	-2
7	Productivity	Total Factor Productivity	99	99	99	0
8	Workforce Size	Estimated Total Defense-Related Direct Employment	32	33	34	+2
9	Workforce Compensation	Estimated Average Annual Per-Worker Pay for Defense-Related Employment	75	77	78	+3
10	Workforce Diversity	Gender Diversity in Employment in Defense Supplier Industries	85	85	85	0
11		Racial Diversity in Employment in Defense Supplier Industries	71	75	79	+8
12		Latino Ethnicity Diversity in Employment in Defense Supplier Industries	39	40	41	+2
13		Age Diversity in Employment in Defense Supplier Industries	100	100	100	0
14	STEM Talent Pool	STEM Percentage of Total U.S. Occupational Employment	95	97	98	+3
15	Security On-Boarding	Annual Inventory of Security Clearance Investigation Cases	30	24	28	-2
16		Duration of Initial Top Secret Reviews (days)	32	24	23	-9
17		Duration of Top Secret Periodic Reinvestigations (days)	44	36	33	-11
Overall Production Inputs			***68***	***68***	***68***	***0***
Innovation						
18	Innovation Inputs	Average Annual Value of Worldwide R&D Paid for by United States-Based Companies (Durable Industrial Goods Manufacturing Industries)	100	100	100	0
19		Average Annual Value of Worldwide R&D Paid for by United States-Based Companies (Information and Communications Technologies)	100	100	100	0
20		Average Annual Value of Worldwide R&D Paid for by United States-Based Companies (Scientific R&D Services)	35	36	31	-4
21	Innovation Outputs	Average Annual Patent Applications (Durable Industrial Goods Manufacturing Industries)	75	58	46	-29
22		Average Annual Patent Applications (Information and Communications Technologies)	80	79	94	+14
23		Average Annual Patent Applications (Scientific R&D Services)	45	37	38	-7
24	Innovation Competitiveness	U.S. Share of Global R&D Investment	75	74	76	+1
Overall Innovation			***73***	***70***	***71***	***-2***

Factor Score Key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

Supply Chain						
25	Contract Failure	Average Annual DoD Contracts Terminated for Cause	22	25	27	+5
26	Financial Performance	Weighted Average Cash Conversion Cycle for Top Defense Contractors	95	54	74	-21
27	Inventory Management	Weighted Average Inventory Turnover Ratio for Top Defense Contractors	100	62	83	-17
28	Schedule Management	Average Schedule Performance Index for MDAPs	100	100	100	0
29	Cost Management	Average Nunn-McCurdy Unit Cost Breaches	100	100	100	0
Overall Supply Chain			***83***	***68***	***77***	***-6***
Competition						
30	Contract Competition	Average Number of Competitive Offers Received Per Contract Actions	87	93	92	+5
31	Market Concentration	Level of Market Concentration (Herfindahl-Hirschman Index)	100	100	100	0
32	Foreign Ownership	Contracting Market Share of Foreign-Owned Firms	100	100	100	0
33	Profitability	Weighted Average Core Operating Margin (Return on Sales)	92	94	93	+1
34		Weighted Average Earnings Per Share	78	93	96	+18
35		Weighted Average Return on Assets	71	73	66	-5
36		Weighted Average Return on Equity	20	51	51	+31
37	Liquidity	Weighted Average Free Cash Flow	84	88	86	+2
38		Quick Ratio (Acid Test)	98	97	94	-4
39		Working Capital Ratio (Current Ratio)	99	99	98	-1
40	Leverage	Debt to Equity Ratio	82	93	83	+1
41		Solvency Ratio	94	95	98	+4
42	Capital Investment	Capital Expenditure Ratio	90	87	82	-8
Overall Competition			***89***	***92***	***91***	***+2***
Industrial Security						
43	Threats to Intellectual Property Rights	New FBI Intellectual Property Rights Violation Investigations	82	86	89	+7
44	Threats to Information Security	Average Annual Newly Reported Common IT Cyber Vulnerabilities	45	33	26	-19
45		Severity of Newly Reported Common IT Vulnerabilities	17	17	18	+1
Overall Industrial Security			***57***	***56***	***56***	***-1***
Political & Regulatory						
46	Public Opinion	Public Opinion on Defense Spending	70	62	49	-21
47	Congressional Budgeting Process	Average Number of Days Elapsed after October 1 for NDAA Passage	85	90	89	+4
48		Average Number of Days Elapsed after October 1 for Defense Appropriations Passage	57	65	77	+20
49		Congressional Interest in MDAPs	100	87	81	-19
50		Congressional Interest in Supply Chains	100	98	88	-12
51	Regulatory Burden	Red Tape Ratio	100	82	74	-26
52		Average Elapsed Days for Incurred Cost Audits	71	65	74	+3
53		Average Elapsed Days for Forward Pricing Audits	97	97	98	+1
Overall Political & Regulatory			***82***	***76***	***72***	***-10***
Productive Capacity & Surge Readiness						
54	Output Efficiency	U.S. Output Gap	22	75	48	+26
55	Intensity of Capital Usage	Capacity Utilization in Durable Goods Manufacturing	85	86	83	-2
Overall Productive Capacity & Surge Readiness			***54***	***81***	***66***	***+12***

Figure 10.1

Factor Score Key	-6 and worse	-1 – -5	0	+1 – +5	+6 and better

APPENDIX 2

TOP 100 PUBLICLY TRADED DEFENSE CONTRACTORS

Rank	Parent Vendor	FY16 – FY20 Total
1	Lockheed Martin Corp	$229,724,722,530.80
2	The Boeing Co	$117,408,183,319.69
3	Raytheon Technologies Corp	$106,017,088,517.49
4	General Dynamics Corp	$81,632,721,936.63
5	Northrop Grumman Corp	$60,809,494,817.66
6	Huntington Ingalls Industries Inc	$31,506,080,184.45
7	L3Harris Technologies Inc	$28,302,958,856.73
8	BAE Systems PLC	$28,018,672,195.15
9	Humana Inc	$25,316,089,190.08
10	Leidos Holdings Inc	$15,230,293,182.67
11	Booz Allen Hamilton Holding Corp	$14,639,406,140.76
12	Science Applications International Corp	$14,492,806,234.48
13	Centene Corp	$14,340,957,363.74
14	General Electric Co	$13,877,958,302.02
15	McKesson Corp	$12,909,546,165.93
16	Honeywell International Inc	$12,051,497,099.15
17	AmerisourceBergen Corp	$10,414,816,473.68
18	CACI International Inc	$10,352,499,384.54
19	Oshkosh Corp	$9,490,262,825.38
20	Textron Inc	$9,018,235,893.19
21	Fluor Corp	$8,971,271,881.46
22	UnitedHealth Group Inc	$7,358,670,404.44
23	KBR Inc	$7,340,523,410.68
24	Perspecta Inc	$6,918,341,259.60
25	Leonardo SpA	$6,584,275,222.86
26	Idemitsu Kosan Co Ltd	$6,337,166,116.14
27	Vectrus Inc	$5,519,914,009.14
28	Jacobs Engineering Group Inc	$5,293,701,908.38
29	Rolls-Royce Holdings PLC	$4,601,330,170.17
30	Austal Ltd	$4,554,342,024.56
31	Parsons Corp	$3,976,567,485.00
32	BP PLC	$3,972,831,544.79
33	FedEx Corp	$3,666,892,159.13
34	Cigna Corp	$3,391,810,502.57
35	Royal Dutch Shell PLC	$3,188,684,199.98
36	PAE Inc	$3,126,137,778.98
37	ManTech International Corp/VA	$2,867,512,790.48
38	Insight Enterprises Inc	$2,643,224,773.44
39	Serco Group PLC	$2,584,269,855.65
40	Cardinal Health Inc	$2,411,359,598.55
41	Cubic Corp	$2,346,007,291.50
42	Verizon Communications Inc	$2,200,341,118.58
43	Great Lakes Dredge & Dock Corp	$2,163,296,829.51
44	AECOM	$2,161,904,777.05
45	ViaSat Inc	$2,050,249,465.36
46	Accenture PLC	$2,017,174,541.93
47	Microsoft Corp	$2,005,275,650.91
48	CDW Corp/DE	$1,993,766,684.37
49	Dell Inc	$1,930,846,323.55
50	AP Moller - Maersk A/S	$1,880,359,785.87
51	International Business Machines Corp	$1,795,867,101.61
52	Marathon Petroleum Corp	$1,675,628,403.01
53	Valero Energy Corp	$1,659,438,488.06
54	AT&T Inc	$1,537,786,697.47
55	AAR Corp	$1,495,354,933.50
56	CAE Inc	$1,493,485,981.76
57	Phillips 66	$1,363,298,431.28
58	Airbus SE	$1,359,729,803.48
59	Par Pacific Holdings Inc	$1,338,855,849.06
60	TransDigm Group Inc	$1,331,065,375.44
61	VSE Corp	$1,326,042,642.46
62	WSP Global Inc	$1,268,688,332.31
63	Sodexo SA	$1,253,020,170.49
64	Cisco Systems Inc	$1,251,760,761.93
65	Kratos Defense & Security Solutions Inc	$1,236,847,063.43
66	Elbit Systems Ltd	$1,186,162,964.87
67	CenturyLink Inc	$1,168,099,837.17
68	Johnson Controls International plc	$1,165,228,560.53
69	Owens & Minor Inc	$1,163,079,857.13
70	Parker-Hannifin Corp	$1,148,170,415.73
71	Clairvest Group Inc	$1,127,811,481.31
72	Caterpillar Inc	$1,034,790,209.29
73	ASGN Inc	$1,034,017,447.31
74	The Interpublic Group of Cos Inc	$1,023,226,369.24
75	Aerojet Rocketdyne Holdings Inc	$990,315,863.64
76	Magellan Health Inc	$956,829,924.06
77	HP Inc	$953,531,259.43
78	Siemens AG	$932,984,801.72
79	Exxon Mobil Corp	$922,078,748.15
80	Thales SA	$909,637,293.62
81	Motor Oil Hellas Corinth Refineries SA	$900,864,285.06
82	Teledyne Technologies Inc	$886,340,954.19
83	Tutor Perini Corp	$873,468,288.51
84	CMA CGM SA	$866,079,717.46
85	Moog Inc	$864,214,506.63
86	Tetra Tech Inc	$839,117,926.40
87	ENEOS Holdings Inc	$834,890,806.10
88	FLIR Systems Inc	$829,099,495.16
89	Sysco Corp	$822,356,647.53
90	Rheinmetall AG	$821,283,462.41
91	Chemring Group PLC	$776,944,989.76
92	Ball Corp	$751,926,526.68
93	Meggitt PLC	$741,586,328.08
94	WPP PLC	$732,372,607.96
95	Safran SA	$716,213,384.30
96	Navistar Defense LLC (Navistar International)	$695,738,764.88
97	Cummins Inc	$694,247,023.56
98	3M Co	$692,875,553.11
99	Southern Co/The	$688,933,673.41
100	Kongsberg Gruppen ASA	$682,258,128.98

Figure 10.2

The National Defense Industrial Association is the trusted leader in defense and national security associations. As a 501(c)(3) corporate and individual membership association, NDIA engages thoughtful and innovative leaders to exchange ideas, information, and capabilities that lead to the development of the best policies, practices, products, and technologies to ensure the safety and security of our nation. NDIA's membership embodies the full spectrum of corporate, government, academic, and individual stakeholders who form a vigorous, responsive, and collaborative community in support of defense and national security. For more than 100 years, NDIA and its predecessor organizations have been at the heart of the mission by dedicating their time, expertise, and energy to ensuring our warfighters have the best training, equipment, and support. For more information, visit **NDIA.org**

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