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The Gears of War: The State of the Aerospace Gear Industry and the Implications for Accelerating Acquisition

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The Gears of War: The State of the Aerospace Gear Industry and the Implications for Accelerating Acquisition

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Abstract

Innovation is transformed into combat power through industrial capacity and production. Though much attention in Acquisition Reform centers on lowering barriers to entry for new entities and encouraging innovation and accountability for defense primes, these same primes are often paced by their sub-tier suppliers. This paper will explore how a subset of this supply base, namely aerospace gear and gear component manufacturers, illustrates the broader challenges of the defense acquisition enterprise. Chronic underinvestment from defense primes and national policymakers, coupled with recent inflationary trends, has created a supply base in this segment with flat or declining output and upward cost pressure. This paper will demonstrate, through exploration of United States Government Databases, that a buildup in the combat power required to defeat U.S. adversaries will be rate limited unless policy changes are made. Though the U.S. Government has tools to shore up supply chain capability, such as utilizing the Defense Production Act, these tools are often underutilized and/or too narrowly applied. Though the idiosyncrasies of the aerospace gear industry do not precisely generalize to the acquisition system as a whole, taking a finer, limited view of one aspect of the supply chain illustrates broader challenges and highlights the need to focused just as much on producibility as a catalyst for accelerating acquisitions.

Keywords: defense industrial base, defense economics, supply chain management, aviation manufacturing, defense production act

Introduction

A hovering helicopter externally lifting a tactical vehicle, a tiltrotor transitioning to forward flight, a C-130 executing a short field landing. All these impressive and innovative feats of engineering and manufacturing contribute to the United States' primacy in the military domain. The precision raid in Caracas conducted by U.S. Special Operations Forces (Gordon, 2025), using rotorcraft from the 160th Special Operations Aviation Regiment, portray an image of inevitability and near invincibility; the equipment and operators of the U.S. Armed Forces will simply be there, and be ready, to accomplish any mission asked of them.

The reality of course is much more complicated, and messy. Setting aside for a moment the amount of training and rehearsals needed to conduct such an operation, think for a moment about what it takes to get an MH-47 off the ground. At the flick of a switch, digital computers provide signals to start fuel flow, power hydraulics, and activate avionics. Drilling in further, fuel ignites in the engine's combustion chamber, which powers a turbine. This turbine, spinning tens of thousands of revolutions per minute, connects to out output shaft which transfers the mechanical energy into a gearbox, where the real work begins.

The purpose of a gearbox sounds simple, but successfully achieving this purpose is anything but. At a rudimentary level, a gearbox reduces the output from the engine and changes the direction of this energy. By changing the ratio between speed and torque, propulsive power is created via gearbox output shafts which turn the rotor system, enabling flight. Within the gearbox itself, smaller gears, expertly machined, perform a tightly coupled dance to reduce engine speed by a factor of ten or more (Air Service Training [Engineering] Limited, 2007), under conditions where minor imperfections in the quality or craftsmanship performed on the metals could result in catastrophic failure, resulting in a loss of aircraft and aircrew. In many instances, an aircraft can safely land should one or more engines failure; however, a significant failure or seizure within a gearbox is more often than not unrecoverable.

This is not a paper about mechanical or aerospace engineering, but rather about defense acquisitions and the aerospace supply base. For years, commentators, academics, and policymakers have warned the country about fragility in the defense industrial base, to include landmark government reports such as the 2018 report “Assessing and Strengthening the Manufacturing and Defense Industrial Base and Supply Chain Resiliency of the United States” (Interagency Task Force in Fulfillment of Executive Order 13806, 2018). Indeed, as long as policymakers have recognized and publicized the China’s rise as a strategic competitor, there’s been a recognition that something is amiss in U.S. Defense Industrial Performance.

Two of the treatments recently put forward for what ails industrial performance are innovation and accountability. The war in Ukraine illustrates the vital role that innovation, both in tactics and in system development, has on battlefield success (Slusher, 2025). The argument for innovation as the path forward out of our industrial morass plays upon well-known U.S. industrial and technological strengths and is indeed the main argument in Seth Jones’ influential book *The American Edge* (Jones, 2026). As for accountability, recent Executive Orders and pronouncements by senior leaders place blame for poor industrial performance on misaligned incentives (Trump, 2026), in that defense primes plow profits back into share buybacks rather than investing in increased capacity or modernization.

While both treatments are necessary, their implicit focus on defense primes (for accountability) and new entrants (for innovation), leaves untouched the driving, propulsive force behind industrial output, namely the sub-tier suppliers. Without an understanding of and focus on the numerous often privately owned companies, that cast, forge, and machine the components comprising complex end products, policy makers risk sub-optimal or counterproductive outcomes. Much like the MH-47 uses the gearboxes in its transmission system to transform energy into propulsive flight, it is these sub-tier suppliers that transform the intellectual and fiscal resources of our country into combat power.

This paper will examine the economic background of a small subset of the supply chain, namely the sectors that comprise gearbox manufacturing. While their performance does not precisely generalize to the defense industrial base as a whole, important trends, and more importantly, recommendations, can be gleaned from relevant economic data. The picture this analysis reveals is one of fragility, where continuing business as usual is creating an unacceptable risk to success in future conflicts, where chronic underinvestment in in Tier 2-4 suppliers has left key segments of the defense supply chain unable to rapidly productionize defense items in sufficient quantities needed to compete.

Method

Using suppliers for CH-53K Gearboxes as a base, the six-digit North American Industry Classification System (NAICS) codes for these suppliers were cross-checked with the SAM.gov Entity database to ensure the NAICS codes were relevant to conduct broader analysis. See Table 1.

Table 1. NAICS Codes Used in CH-53K Gearboxes

NAICS	Description
331512	Ferrous metal foundries noninvestment
331529	Other nonferrous metal foundries
332111	Iron forging
332112	Nonferrous forging
332510	Hardware manufacturing
332710	Machine shops
332721	Precision turned product manufacturing
332999	All other miscellaneous fabricated metal product manufacturing
336411	Aircraft manufacturing
336412	Aircraft engine and engine parts manufacturing
336413	Other aircraft parts and auxiliary equipment manufacturing

Data Sources

Using the above NAICS codes as a foundation for analysis, this study drew on five publicly available datasets across four U.S. government agencies to create a view of industry performance from 2012 until the present day. Though research focused on Tier 2-3 suppliers, represented by ferrous and nonferrous foundries (NAICS 331512, 331529), forgings (NAICS 332111, 332112), hardware manufacturers (NAICS 332510), machine shops (NAICS 332710), precision turned products manufacturers (NAICS 332721), and miscellaneous fabricated metal products manufacturers (NAICS 332999), Tier 1 aircraft manufacturing data (NAICS 336411–336413) were also analyzed. I chose 2012 as the base year, and the year to which all data was normalized, as the Defense Strategic Guidance (Sustaining U.S. Global Leadership, 2012) published early that year is one of the earliest strategic documents which speaks to an orientation away from counter-terrorism and towards the Pacific Competition.

Datasets used in this study included the Federal Reserve Bank of St. Louis' Federal Reserve Economic Data (FRED) Industrial Production and Capacity Utilization Indices via the FRED API. Six series were retrieved covering the period January 2012 through January 2026: aerospace and miscellaneous transportation equipment industrial production (IPG3364S), aerospace capacity utilization (CAPUTLG3364T9S), and industrial production indices for primary metals (IPG331S), fabricated metal products (IPG332S), machinery (IPG333S), and the producer price index for primary metals (PCU331331). Series were normalized to a January 2012 baseline (index = 100).

Bureau of Labor Statistics Quarterly Census of Employment and Wages (BLS QCEW). Establishment, employment, and wage data were retrieved for 2014–2023 using the BLS QCEW Open Data API. Annual data were extracted at the national level (area FIPS = US000) for private-sector employers (ownership code 5) across 11 six-digit NAICS industries. Variables included annual average establishment count, annual average employment level, average weekly wage, and total annual wages Bureau of Labor Statistics Industry Productivity Program (via FRED). Labor productivity (output per hour), unit labor costs, and capital input indices were retrieved from FRED, which hosts BLS Industry Productivity and Costs data (IPUEN series). Series were obtained for NAICS 331, 332, 333, 336, and 3364 for the period 2012–2024. All series are indexed to 2017 = 100 by BLS and were reindexed to 2012 = 100 for cross-industry comparability.

U.S. Census Bureau Annual Survey of Manufactures (ASM) capital expenditure and shipment data were obtained from two Census Bureau API endpoints. The timeseries/asm/industry endpoint provided data for 2012–2016, including total capital expenditures (CEXTOT), machinery capital expenditures (CEXMCH), building capital expenditures (CEXBLD), total receipts (RCPTOT), value added (VALADD), and employment (EMP). The timeseries/asm/benchmark2022 endpoint provided receipts, value added, and employment for 2018–2021. No ASM data were available for 2017 due to the Census Bureau's survey cycle, resulting in a gap in the capital expenditure series. Nominal values were deflated to 2012 constant dollars using the GDP Implicit Price Deflator (GDPDEF) retrieved from FRED.

Bureau of Economic Analysis GDP by Industry (BEA) nominal and real value added and gross output by industry were obtained from the BEA GDPbyIndustry dataset via the BEA API for the period 2012–2024. Four table IDs were used: nominal value added (TableID 1), real value added in chained 2017 dollars (TableID 10), nominal gross output (TableID 15), and chain-type quantity indexes for gross output (TableID 16). BEA industry resolution does not permit separate identification of NAICS 3364; aerospace data are reported as a combined "3364OT" (Aerospace and Other Transportation Equipment) category. A value-added share ratio (value added / gross output) was derived as an indicator of supply chain depth.

Granularity on the gearbox value stream varied from database to database. While it was possible to map specific gearbox suppliers to six-digit NAICS codes, in many cases data were only available at the 3-digit NAICS code level, which covered a much broader and potentially superfluous number of additional entities. However, and as stated previously, capturing a broader sense of the relevant industrial landscape met the needs of the study, in that it was assumed specific entities in the value stream were subject to the same trends and conditions as the broader, more expansive sector definitions. Further, more granular investigation may be warranted in future studies.

Results

First, an examination of the FRED Industrial Production (Figure 1) and Industrial Capacity (Figure 2) data reveals a slight downward trajectory in most, but not all industrial categories. For the purposes of this study, the gearbox value chain to FRED Industrial category can be mapped as follows: Primary Metal Manufacturing encapsulated NAICS Codes starting with 331, meaning the mills and foundries (both ferrous and non-ferrous), Fabricated Metals consists of NAICS codes 332, comprising forging and machine shops, while Machinery Manufacturing consist of finished machinery as a product class NAICS codes 333. Finally, Aerospace consists of NAICS codes 3364 and can be mapped to Tier 2 and higher entities. While the most noticeable element of these datasets is the severe drop in both production and capacity due to COVID-19 shocks, an additional conclusion is that despite a decade or more of the re-industrialization drive, relevant segments of the gearbox value stream are producing less than they were when the re-balance to the Pacific began. However, all aspects of the value stream appear to be operated at 80% capacity or lower, indicating that capacity is not necessarily the constraint towards increasing throughput.

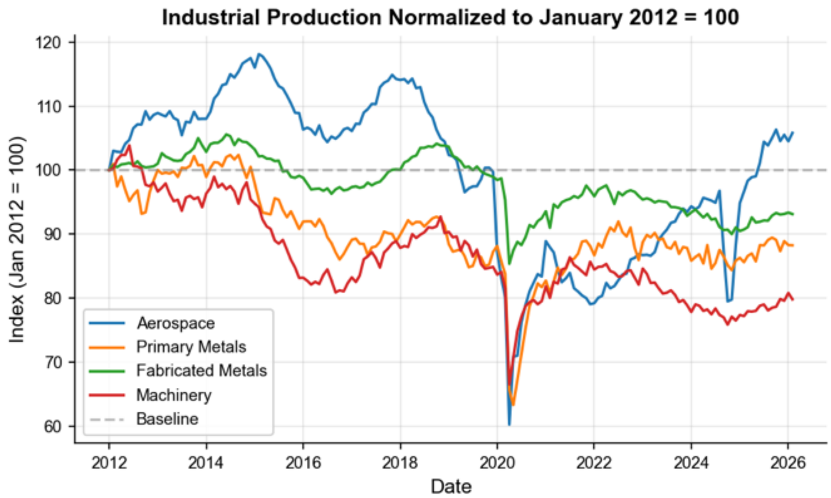

Figure 1. ***Industrial Production Indices for Gearbox Value Chain Sectors, January 2012–January 2026 (Normalized to 2012 = 100). Data from Federal Reserve Bank of St. Louis FRED Database.***

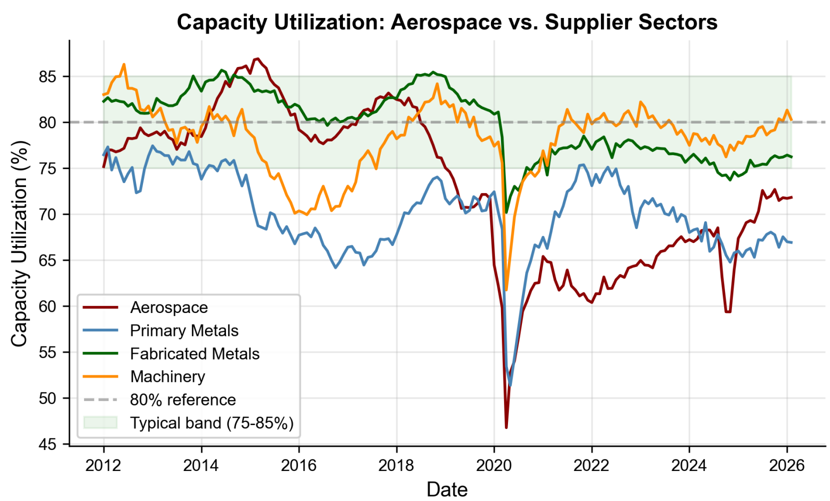

Figure 2. ***Industrial Capacity Utilization for Gearbox Value Chain Sectors, January 2012–January 2026. Data from Federal Reserve Bank of St. Louis FRED Database.***

Next, and perhaps more dire, we see the divergency in labor productivity and unit labor costs. As shown in Figure 3, in all instances there is a marked divergence in unit labor cost and productivity. As review, while Figure 1 indicates the total industrial output of the relevant sectors, productivity is a measure of output relative to inputs. Here, across the board, we see that it's becoming more expensive overtime to produce a comparable unit of output. Additionally, unit labor costs are increasing rapidly, which tracks the overall decline in productivity. While this topic will be discussed further later in this paper, the data shown here is likely no surprise to those working in defense acquisition, dealing with both schedule slips and cost overruns. Figure 4 combines both elements into one chart, clearly indicated the inflationary pressure across all sectors of the value stream.

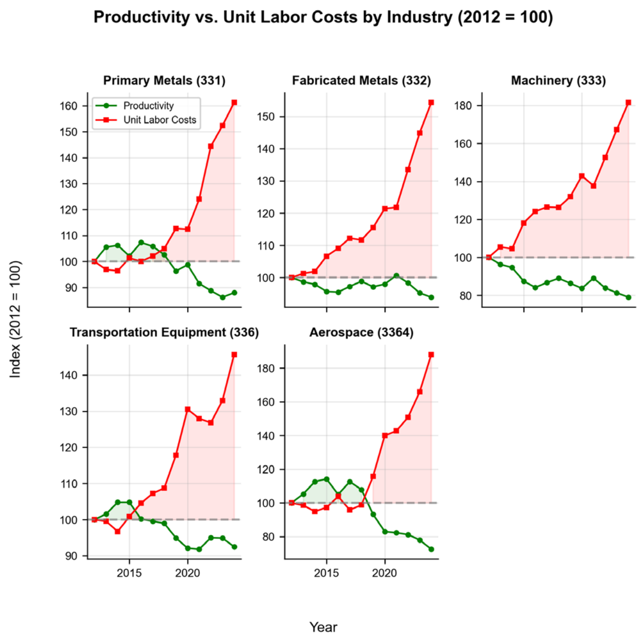

Figure 3. ***Labor Productivity and Unit Labor Cost Indices for Gearbox Value Chain Sectors, 2012–2024 (Normalized to 2012 = 100). Data from Bureau of Labor Statistics Industry Productivity Program via FRED.***

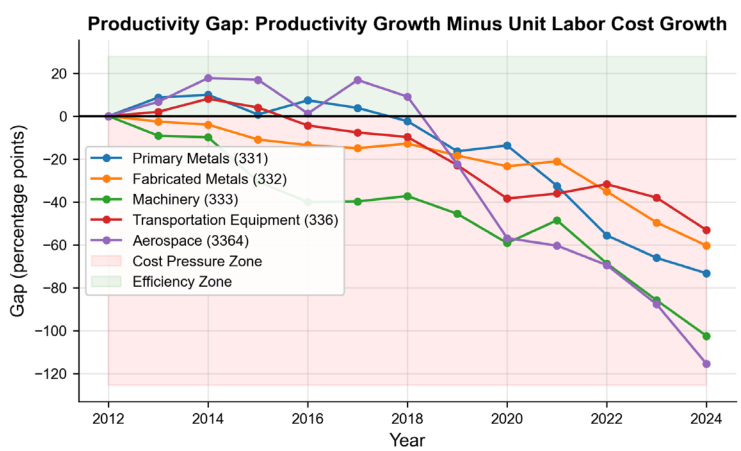

Figure 4. ***Combined Inflationary Pressure Indicators Across All Gearbox Value Chain Sectors, 2012–2024. Data from Bureau of Labor Statistics Industry Productivity Program via FRED.***

Next, an examination of the demographics of the value stream is in order. For this, an analysis of Bureau of Labor Statistics Data, specifically the number of establishments and the total amount of workers in each respective industry. Here an interesting split is seen, in that there has actually been an increase in the number of industrial establishments participating in the value stream, in some instances, increases of 27.1% (aircraft engines and parts), 32.7% (misc. fabricated metal products), and even 62.2% (aircraft manufacturing). This would seem to indicate significant reindustrialization. However, employment trends are more mixed. While certain industries do show an increase in employment, on the whole, total employment is down across the majority of industries. This additionally drives down the average number of employees per industry nearly across all sectors, further tempering optimism regarding reindustrialization. While this analysis focused on percentage changes for ease of comparison, a discussion of absolute values is warranted. In the case of non-ferrous foundries, those entities which often produce the critical gearbox housings, we see that the workforce has increased by over 7% from 2012 until 2023, the last observation in this data set. That is an increase of only 853 workers, and while that’s still a step in the right direction, it does not portend a massive shift is U.S. labor force trends.

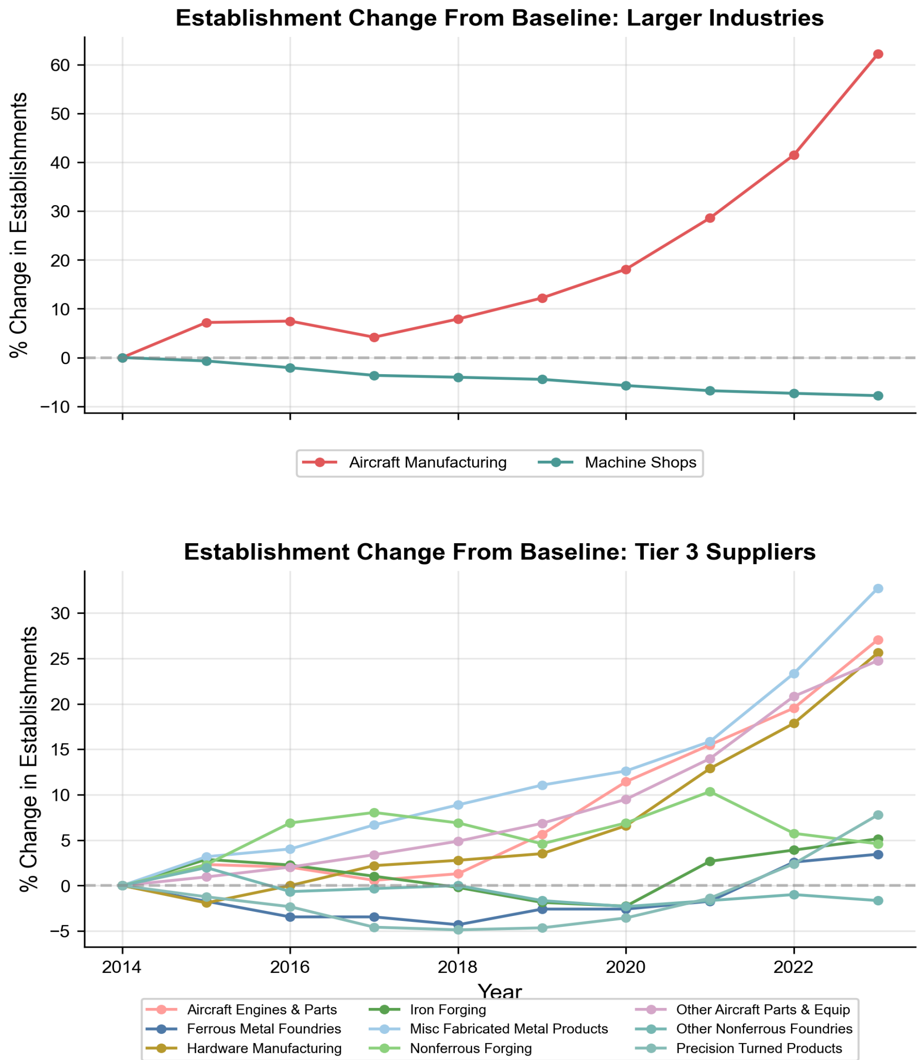

Figure 5. ***Percentage Change in Establishment Count by Industry Sector, 2012–2023. Data from Bureau of Labor Statistics Quarterly Census of Employment and Wages.***

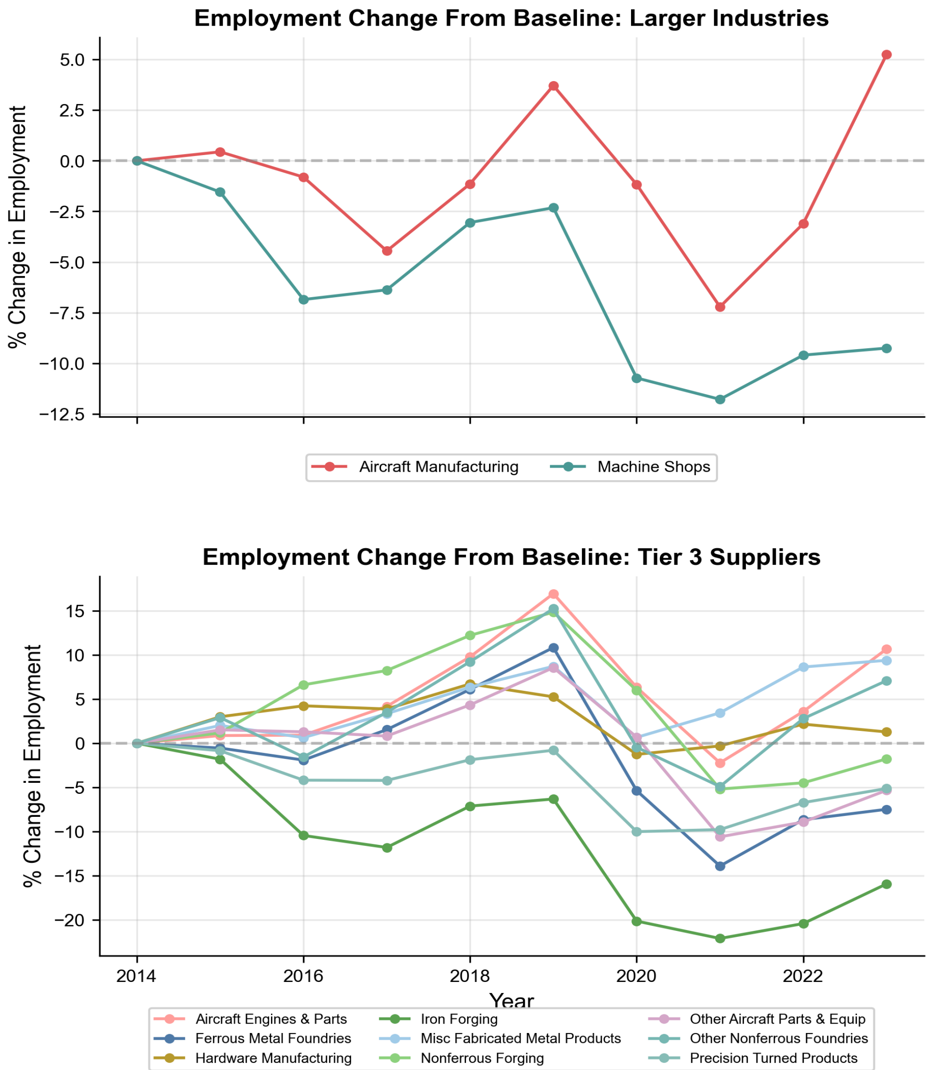

Figure 6. ***Percentage Change in Total Employment by Industry sector, 2012–2023. Data from Bureau of Labor Statistics Quarterly Census of Employment and Wages.***

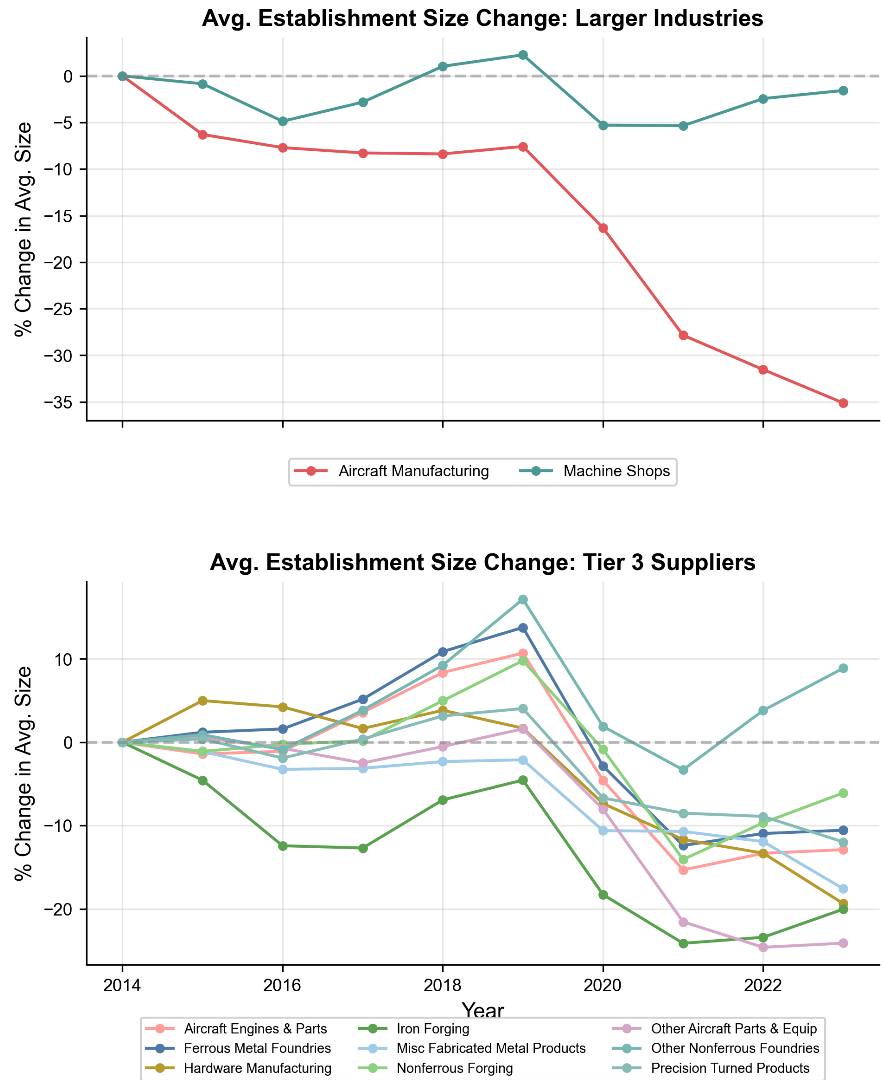

Figure 7. ***Average Number of Employees per Establishment by Industry Sector, 2012–2023. Data from Bureau of Labor Statistics Quarterly Census of Employment and Wages.***

Census data for Capital Expenditure Intensity, though extremely limited (2012 to 2016 only), is included here for completeness. Figures 8 and 9 show a flat and consistent Capex Intensity for the observation period, indicating a potential lag from strategic shift to Pacific competition towards the industrial actions needed to do so. We also see that the machinery share of CAPEX remained constant, with a notable dip in ferrous metal forging throughout the limited observation period.

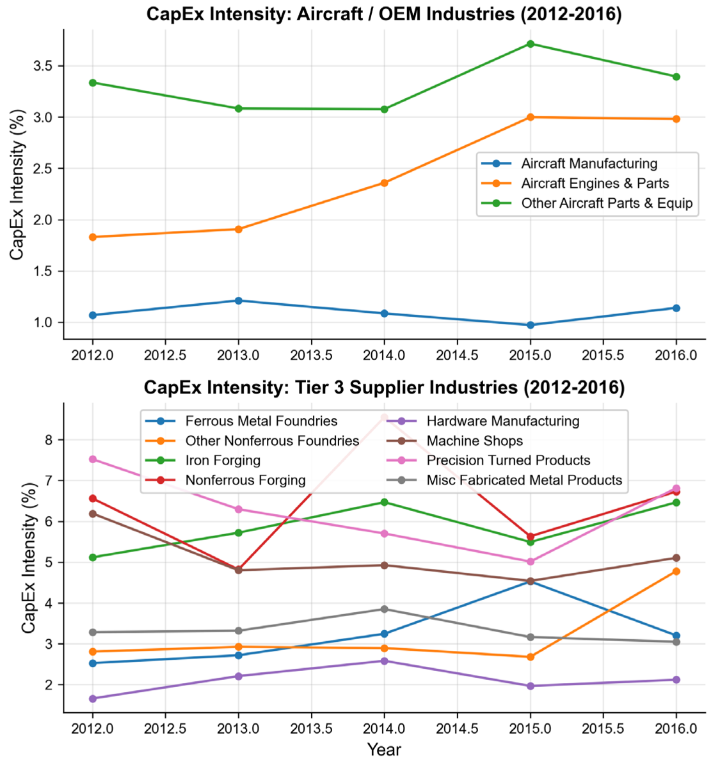

Figure 8. Capital Expenditure Intensity by Industry Sector, 2012–2016. Data from U.S. Census Bureau Annual Survey of Manufactures.

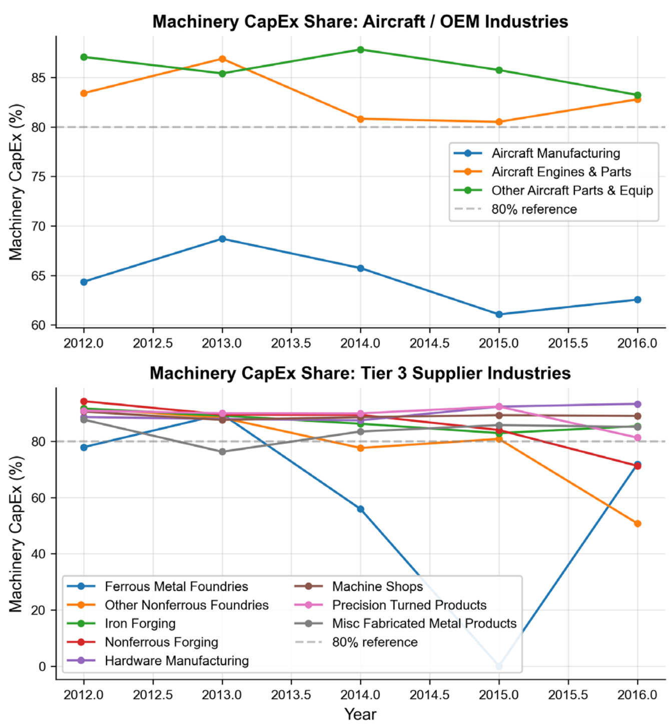

Figure 9. Machinery Share of Capital Expenditures by Industry Sector, 2012–2016. Data from U.S. Census Bureau Annual Survey of Manufactures.

Last, we examine Bureau of Economic Analysis Data for Value Added and Real Output by Industry. Here, results are mixed. Though primary metals has seen its share of value added increase sharply from 2012, the output quantity has not seen a corresponding increase. Also notable is the decrease in both value added and output in fabricated metal and machinery.

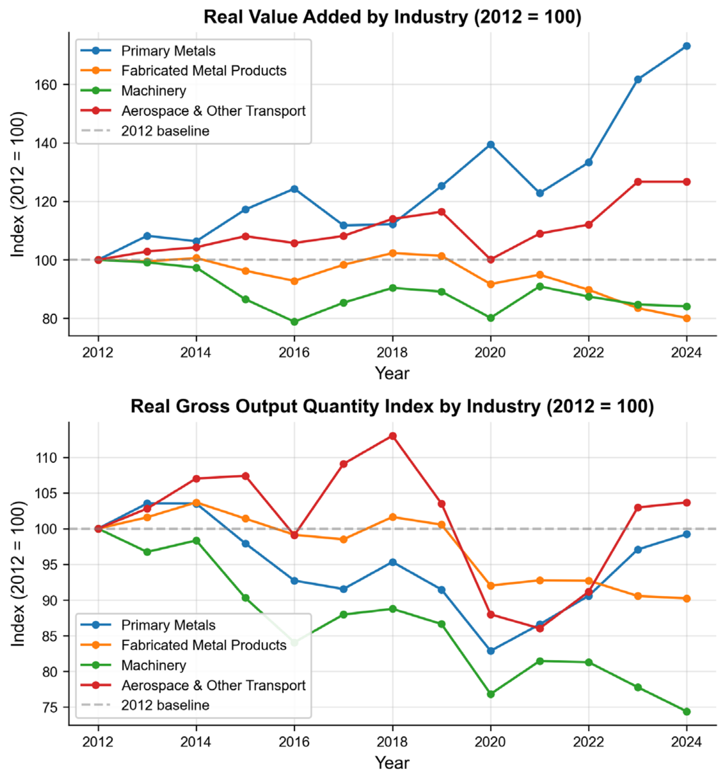

Figure 10. Value Added and Real Gross Output by Industry Sector, 2012–2024. Data from Bureau of Economic Analysis GDP by Industry dataset.

Discussion

What do each of these disparate data sets tells us about the state of the aviation gearbox industry, and perhaps for U.S. Defense production as a whole? In sum, the rhetoric about Great Power competition and reindustrialization has not been backed up with concrete changes. Instead, production appears flat or declining, investment is static, and costs are skyrocketing. The increase in labor costs was the most notable finding of this paper, and is also the most worrisome, as the labor force is on the whole decreasing across most of the sectors surveyed. It is important to recognize and distinguish that unit labor cost and labor salaries are not one and the same and instead refers to the compensation per hour worked divided by the output per hour, meaning unit labor cost could also be driven by falling productivity due to untrained workers, aging equipment, and rework. The result becomes a downward spiral for the Department of War, where rising costs decrease buying power, which tamps down demand, which further increases cost and results in exorbitant per-unit cost for aircraft. No wonder the shift towards lower-cost massed systems is so attractive now.

As a struggling sector with firm demand (U.S. Government contracts), skyrocketing cost, and poor output, the Tier 2-4 supply chain appears ripe for Private Equity's involvement, with their traditional focus on cutting cost and improving topline performance. Indeed, this has been the case over the last several years, with many smaller suppliers being purchased by Private Equity Firms, a trend exacerbated by the sector distress experienced during the COVID-19

Pandemic (Rowan et al., 2021). Though potentially a welcome development in the short-turn, provided PE firms can execute on their strengths of driving efficiency and discipline into an otherwise struggling firm, one should question whether efficiency is the proper outcome in a reindustrialization push. Efficiency and cost control are often driven by reducing headcount and shedding unused, unneeded capacity, and we have already seen that many of the sectors surveyed are operating below capacity. However, an industrial base that is always and everywhere lean, efficient, and optimized for current demand is not one that can pivot to a mass build up, or really even produce systems in quantities necessary for credible deterrence.

Asking any company, let alone a publicly held company, to invest in unused capacity needed for a potential future contingency would, of course, be fiduciary malpractice. Shareholders expect that a company take actions that would maximize their return, and any CEO would not keep their job for long if they prioritized patriotic, yet uncertain investments at the expense of shareholder returns. So, while recent exhortations against companies prioritizing share buy-backs at the expense of contract performance is welcome (Trump, 2026), we must still realize that current incentive structures favor short term financial performance over long-term strategic national security considerations.

Further, while industry certainly has a huge role to play in national security, setting both the pace and direction of change is the responsibility of the U.S. Government. Tools such as the Defense Production Act, designed to "shape national defense preparedness programs and to take appropriate steps to maintain and enhance the domestic industrial base" (Levin, 2025) are available and indeed have seem to see somewhat of a renaissance following the Act's extensive use in the COVID-19 Pandemic. However, while DPA Title III Authorities certainly could drive productivity gains through the purchase of industrial equipment, as well as more recently emphasizing the domestic production of critical minerals, labor force training and improvement programs are outside the purview of this act and instead fall under Department of Labor as well as a variety of state and local programs. This appears to be a legislative gap that could either be rectified due to an amendment to the DPA or else having an increased focus on interagency coordination between the Department of War, Department of Labor, and other relevant stakeholders.

This paper purposely began with a small, tailored scope, but as we have seen the implications and findings are anything but small and tailored. Practitioners in the Warfighting Acquisition system, particularly those operating at the program level, may lament the trends we see while also feeling a sense of helplessness. However, the recent advent of Portfolio Acquisition Executives (Office of the Undersecretary of War for Acquisition and Sustainment, 2025) provides an opportunity to affect change at a meaningful level. An individual program may focus on the gearboxes of their specific system, using a carrot or stick approach to an individual prime who is operating in an environment of misaligned incentives and negative demographic trends, and still suffer delayed schedules and cost overruns due to poor sub-tier performance. This is not a program-level problem, it is a structural problem. In PAE, with its broader scope and authority, there is a potential to make meaningful impacts across platforms and programs, to include consolidated and expanded DPA decision authority or advocacy that could shape and fix structural issues in their area of concern. As evidenced by increase senior leader attention, and increased defense funding, more and more energy is going towards correcting these structural issues. Without an appropriate transmission system, without the right gearing, tailored on discrete, measurable problems and outcomes, this energy will be misspent. Building an effective gearbox involves precision, and accelerating defense production requires a precise understanding of the challnges faced.

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