# Measuring Space Manufacturing Plant Utilization and Own-Account Production

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**Abstract** Manufacturing is the largest sector in the U.S. space economy, comprising 25.2 percent of its gross domestic product (GDP) in 2022. Space manufacturing is also a significant contributor to overall U.S. manufacturing, responsible for 6.4 percent of computer and electronics products manufacturing GDP in 2022 and 7.5 percent of other transportation equipment manufacturing GDP. Given the significance of space-related manufacturing to both the space economy and domestic manufacturing, having accurate measures of economic activity for this area of the economy is crucial. In this paper, we examine two topics we believe are a priority for better understanding the current state of domestic space manufacturing. First, we introduce a space economy manufacturing plant utilization index, a novel approach to estimating utilization of manufacturing plants that contribute to the space economy. Second, we discuss initial efforts to account for manufacturing of satellites and space vehicles by companies providing these capital goods for themselves, known as own-account production. As manufacturing continues to lead the U.S. space economy, ongoing improvements to measures of production are becoming increasingly important to inform policy and business decisions.

**Keywords** Satellite manufacturing, space vehicle manufacturing, plant utilization, own-account production

**JEL Code** E01, O30

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# 1. Introduction

Manufacturing is the largest industry sector in the U.S. space economy, comprising 25.2 percent of its gross domestic product (GDP) in 2022 (BEA 2024a).[1] The computer and electronics products (CEP) and other transportation equipment (OTE) industries together accounted for over 94 percent of space-related manufacturing GDP (57.8 percent and 36.3 percent, respectively). Space manufacturing in the CEP industry consists mostly of communications equipment, including satellites, ground stations, and GPS/PNT equipment. The OTE industry consists mainly of space and launch vehicles and space weapons systems, such as intercontinental ballistic missiles that go into space.[2] Space manufacturing is also a significant contributor to overall domestic manufacturing, responsible for 6.4 percent of CEP manufacturing GDP in 2022 and 7.5 percent of OTE manufacturing (BEA 2024b). Given the significance of space-related manufacturing to both the space economy and domestic manufacturing, having accurate measures of economic activity for this area of the economy is crucial.

In this paper, we discuss two topics we believe are a priority for better understanding the current and future state of domestic manufacturing in the space economy. The first topic covered in this paper is the space economy manufacturing plant utilization index (SEMPI), a novel approach to estimating utilization of manufacturing plants that contribute to the space economy. SEMPI is constructed from public statistics: a combination of survey data—published by the U.S. Census Bureau (Census), Federal Reserve Board (FRB), and Defense Logistics Agency (DLA)—and U.S. Bureau of Economic Analysis (BEA) space economy estimates. When combined with price and output data, capacity utilization data can provide insights into supply chain issues. For example, a higher-than-average peak utilization rate followed by a persistently lower average utilization rate and greater real output is consistent with high demand leading to new investments in plant capacity. We describe the construction of SEMPI, present some preliminary findings from the index in its current state, and discuss potential improvements and insights that could be drawn from future versions.

Second, we discuss initial efforts to explicitly account for manufacturing of satellites and space vehicles by companies for their own use, known as “own-account” production. Typically, economic production is reflected in government statistics based on data collected about companies’ sales or revenues. When companies manufacture and use their own capital, such as a company that builds

1. The U.S. government collects data on economic activity for detailed industries organized under the North American Industry Classification System.

2. In U.S. Bureau of Economic Analysis statistics, the space economy consists of space-related goods and services that are used in space, or directly support those used in space; require direct input from space to function, or directly support those that do; and are associated with studying space (Highfill, Georgi, and Surfield 2024).

their own space vehicles and uses them to launch their own payloads, the value of that capital does not show up in the normal economic data because there is no market transaction. In this example, without an explicit adjustment for own-account production of space vehicles, the value of capital (investment) and therefore GDP is being underestimated. We discuss a few possible options for accounting for this area of production that will likely continue to grow as satellite internet constellations continue to deploy.

# 2. A Space Manufacturing Plant Utilization Index

## 2.1 Background

“Manufacturing plant utilization” is the percentage of the total production capability of a manufacturing facility that was used. "Space economy manufacturing plant" covers manufacturing facilities producing goods and services that are used in space, or directly support those used in space, as defined by BEA. The space economy manufacturing plant utilization index, SEMPI, is a new measure of U.S. space economy manufacturing plant utilization constructed from publicly available data. The plant capacity utilization data used in SEMPI comes from the Census Quarterly Survey of Plant Capacity Utilization (QPC), and the space economy definitions and index weights come from the BEA space economy satellite account (SESA) statistics. The QPC is the only source for statistics on U.S. industrial plant capacity. The FRB uses the QPC data to estimate monthly industrial production, assess the change in industrial production and capacity, and identify potential industry-level bottlenecks and sources of inflationary pressure. The DLA uses the QPC data to assess the ability of U.S. industries to meet demand for goods under national emergency scenarios.

## 2.2 Capacity Utilization Data and Methods

### 2.2.1 Data

The capacity utilization data in QPC are generally reported at the four-digit North American Industry Classification System (NAICS) level, though sometimes they are at the six-digit NAICS level. As previously discussed, the two primary components of space economy manufacturing, as determined by BEA, are the OTE and CEP industries. This analysis uses the 2023 BEA SESA public release,[3] which covers 2012–2021, and QPC releases over the same period.

3. The 2023 release was used for this analysis because the June 2024 SESA release only covers years 2017–2022.

### 2.2.2 Methods

To construct the SEMPI, BEA SESA documentation is used to select NAICS codes from the QPC relating to manufacturing in the space economy. These codes are classified into two categories: OTE (NAICS 3364-9) and CEP (NAICS 334). The level of NAICS code aggregation in public BEA SESA statistics does not always match the level of NAICS code aggregation in QPC statistics. Consequently, both BEA SESA and QPC statistics are aggregated to a common level. The QPC provides statistics on manufacturing plant utilization for several segments within these categories reported under the manufacturing header of the BEA SESA documentation. The specific NAICS codes reported in QPC and used in constructing SEMPI, based on BEA SESA documentation, are shown in table 1. While finer distinctions would be useful—e.g., it is not possible to distinguish avionics and transponder equipment manufacturing at the three-digit NAICS level, or guided missiles and Crew Dragon production at even the six-digit NAICS level—this analysis is limited by the granularity of NAICS codes. Since the QPC data are quarterly, SEMPI also varies at the quarterly level. While the plant capacity utilization estimates underlying SEMPI vary quarterly, the weights that convert them to space economy-relevant utilization rates only vary annually.

**Table 1. NAICS Codes Included in Space Economy Manufacturing Plant Utilization Index**

| NAICS industry in SESA | NAICS code reported in QPC | Industries included under reported code but not separately reported in publicly released data |
|---|---|---|
| Computer and electronic products | 3341 | Electronic computer manufacturing; computer storage device manufacturing; computer terminal and other peripheral equipment manufacturing |
| | 3342 | Telephone apparatus manufacturing; radio and television broadcasting and wireless communications equipment manufacturing; and other communications equipment manufacturing |
| | 334412,6–9 | Bare printed circuit board manufacturing; capacitor, resistor, coil, transformer, and other inductor manufacturing; electronic connector manufacturing; printed circuit assembly (electronic assembly) manufacturing; other electronic component manufacturing |
| | 334413 | Semiconductor and related device manufacturing |
| Other transportation equipment | 3364 | Aircraft manufacturing, aircraft engine and engine parts manufacturing, other aircraft parts and auxiliary equipment manufacturing, guided missile and space vehicle manufacturing, guided missile and space vehicle propulsion unit and propulsion unit parts manufacturing, and other guided missile and space vehicle parts and auxiliary equipment manufacturing |
| | 3365–9 | Railroad rolling stock manufacturing; ship and boat building; other transportation equipment manufacturing |

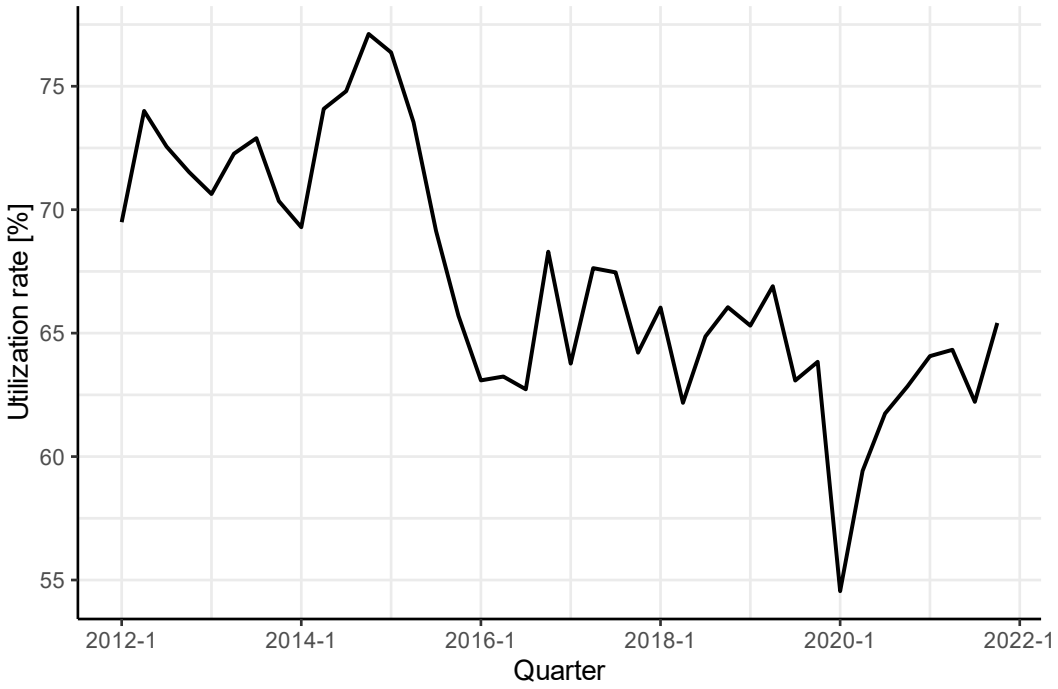
**NAICS** North American Industry Classification System
**SESA** Space economy satellite account
**QPC** Quarterly Survey of Plant Capacity Utilization

Utilization across segments is averaged with equal weights to produce quarterly OTE and CEP utilization rates. The BEA SESA annual estimates of OTE and CEP value added to total space economy GDP are then used to construct annual weights on the relative significance of OTE and CEP utilization to the overall U.S. space economy. Finally, SEMPI is constructed as a weighted average of OTE and CEP utilization rates to account for changes in the composition of the U.S. space economy's manufacturing base over time. The weighting also adjusts utilization to reflect trends in the space economy-specific influences. For example, if the SESA states that the contribution of OTE to overall U.S. GDP in a particular quarter ("value added") is $30 while the contribution of CEP is $20, OTE manufacturing utilization receives a weight of 60 percent in the SEMPI for that quarter while CEP manufacturing utilization receives a weight of 40 percent. If space economy value added by OTE remains steady while CEP value added increases to $30 in the following quarter, the weight on OTE manufacturing utilization will fall to 50 percent while the weight on CEP manufacturing utilization will increase to 50 percent, reflecting the shift in composition of the U.S. space economy in dollar terms. Since the weights sum to 100 percent, SEMPI can be interpreted directly as a measure of overall space economy manufacturing plant capacity utilization.

### 2.3 Space Economy Manufacturing Plant Utilization Index Results

Space economy manufacturing plant utilization averaged 67.2 percent over 2012-2021. For context, average quarterly capacity utilization across all U.S. manufacturing facilities over the same period varied between 64.6 percent and 77.7 percent. The average quarterly variation in space economy manufacturing plant utilization was +/- 2.4 percentage points, though the peak quarterly increase and decline was +5.6 percent in 2016Q4 and -9.3 percent in 2020Q1. There were two significant declines: a persistent decline that occurred over the course of 2015 and a temporary decline concentrated in 2020Q1. Figure 1 shows the SEMPI from 2012 to 2021.

**Figure 1: Space Economy Manufacturing Plant Utilization Index Over 2012Q1–2021Q4**




Aggregate space economy manufacturing plant capacity utilization calculated from BEA space economy satellite account and Census Quarterly Survey of Plant Capacity Utilization.

The persistent decline saw utilization fall roughly 10 percentage points, from a high of 76.4 percent in 2015Q1 to a low of 65.7 percent in 2015Q4. In a separate analysis, Highfill and Weinzierl (2024) used non-public BEA data over this period and found that the value of U.S. space economy manufacturing output increased in real (i.e., price- and quality-adjusted) terms. This pattern—a higher-than-average peak followed by a persistently lower average, with greater real output—is consistent with high demand leading to new investments in plant capacity. This persistent utilization decline also coincides with an increase in the number of U.S. launch vehicles produced or planned. Overall, utilization averaged 72.1 percent over 2012–2015 and 63.9 percent over 2016–2021.

The temporary decline saw utilization fall from 63.8 percent in 2019Q4 to 54.5 percent in 2020Q1, likely due to COVID–19 impacts. The associated year-over-year decline from 2019Q1 to 2020Q1 was roughly 10.8 percentage points, i.e., 65.3 percent to 54.5 percent. Overall space economy manufacturing plant utilization appears to have recovered from this decline by the end of 2020, with utilization in 2021Q1 reaching 64.1 percent. This pattern—a short and sharp decline in utilization followed by recovery to similar levels as before—is consistent with a temporary reduction in supply but not overall capacity. More detailed analysis shows that the recovery was driven by computer and electronic components. The OTE and CEP components show divergent trends: space economy OTE manufacturing plant utilization fell by 22.8 percent, while space economy CEP manufacturing plant

utilization grew by 5.0 percent. Figure 2 shows the disaggregated utilization trends. The shares of value added by each component to the space economy mirrored this pattern, with the value added by CEP rising.

**Figure 2: Capacity Utilization in Space Economy Manufacturing Plant Utilization Index Components**


Manufacturing plant capacity utilization by three-digit North American Industry Classification System sector from Census Quarterly Survey of Plant Capacity Utilization.

The COVID–19 shock appears to have impacted OTE more significantly than CEP. From 2019Q1 to 2020Q1, OTE manufacturing plant utilization declined by 31 percent while CEP manufacturing plant utilization declined by 10 percent. CEP manufacturing plant utilization also appears to have recovered more rapidly, exceeding its average level over 2016–2019 in every quarter beginning in 2020Q2 (except 2021Q3). In contrast, after 2020Q1 OTE manufacturing plant utilization has not yet returned to its 2016Q1–2019Q1 average. The relative robustness of CEP utilization compared to OTE utilization may be due to greater variety of demand sources for the outputs of CEP manufacturing facilities (e.g., more sectors of the economy demand circuit boards than airframes). Greater granularity in the component construction can support more detailed analysis of inflationary pressure and supply chain issues in the U.S. space industrial base. Additionally, accounting for labor and capital utilization can affect estimates of total factor productivity (TFP) (Fernald 2014). Our measure of space economy manufacturing plant capacity utilization may therefore explain some of the measured trends in TFP in the space sector or the U.S. economy more broadly.

# 3. Own-Account Production of Satellites and Space Vehicles

## 3.1 Background

Own-account investment involves additions to the capital stock that are created directly by the business that owns the new asset rather than being purchased from another business. When companies manufacture and use their own capital, such as a company that builds their own reusable space vehicles and uses them to launch their own payloads, the value of that capital does not show up in regular economic data because there is no market transaction captured. As a result, own-account production must be measured using alternative methods.

Three notable categories of own-account investment included in GDP are construction, research and development (R&D), and software (BEA 2024c). Own-account investment in software occurs when companies develop or improve their own software rather than purchasing custom-made and prepackaged software from companies primarily engaged in software development. The estimates for own-account software are measured as the sum of production costs, including the value of capital services. The estimates are based on U.S. Bureau of Labor Statistics (BLS) data on occupational employment and wages, on Economic Census data, and on BEA-derived measures of capital services (Moylan 2018). An example of own-account investment in construction is the building of a railroad storage building by the railroad's maintenance crew when they are not busy repairing or inspecting tracks. Own-account construction consists of the value of construction materials supplied by the project owner and the value of the labor supplied by the owner's own construction employees assigned to the project. The estimates are based on data from the Census Value of Construction Put in Place Survey. Own-account R&D is also included in GDP using a sum of production costs methodology.

In recent years, companies in the space economy have begun engaging in own-account production of satellites and space vehicles. For example, SpaceX builds their own space vehicles and uses them to launch payloads for the government, for some private companies, and for their own Starlink satellites. Since the launch vehicles are not sold, the value of the space vehicle would not show up in the Census shipments data. Note that space vehicles have generally been entirely single-use consumption items rather than capital. While partially reusable vehicles that carry payloads to orbit are not new—the Space Shuttle flew to orbit atop single-use rockets and returned for more flights—reusable rockets have become more popular since the success of SpaceX's Falcon 9 vehicle in 2017. Since then, other companies have pursued reusability, and the share of launches on reusable space vehicles is likely to grow. Similarly, without an explicit adjustment for own-account production of satellites, the value of private fixed investment and therefore GDP is being underestimated. Although the value of this production is currently likely relatively small, this type of production is expected to increase as satellite internet constellations proliferate from companies engaging in own-account production.

The lifecycle of the production process is important to consider when thinking about measuring own-account production. Expenditures that are incurred when initially researching a product, whether for-sale or own-account satellites, are considered own-account R&D activity by that company. This includes the initial development of a prototype, testing the prototype, and other R&D performed while the product is in test phase. The cost of materials in the prototype stage is also considered R&D; only when the vehicle is no longer in the test phase are expenditures no longer considered R&D.

### 3.2 Potential Data Sources

A measure of own account production of space vehicles and satellites should reflect the costs of producing those products, including labor costs, an estimate of the value of capital services, and intermediate inputs. For labor costs, one possible option is the BLS Occupational Employment and Wage Statistics (OEWS) data that are used in BEA's own-account software estimates. Table 2 shows the two NAICS industries where own-account production is occurring, communications equipment manufacturing (NAICS 3342) for satellites and aerospace product and parts manufacturing (NAICS 3364) for space vehicles. The table also shows four occupations that seem likely to be involved in the building of this type of equipment, specifically, aerospace engineers, aerospace engineering and operations technologists and technicians, electrical engineers, and assemblers and fabricators.

**Table 2. Selected Occupations in Major Space Manufacturing Industries, 2023**

| Occupation title | Employment | Share of total employment (percent) | Median hourly wage (dollars) | Mean hourly wage (dollars) | Annual mean wage (dollars) |
|---|---|---|---|---|---|
| **Communications equipment manufacturing (NAICS 3342)** | | | | | |
| Aerospace engineers | 500 | 0.59 | 53.52 | 59.42 | 123,600 |
| Aerospace engineering and operations technologists and technicians | 120 | 0.15 | 40.50 | 38.00 | 79,030 |
| Electrical engineers | 2,370 | 2.83 | 60.95 | 60.99 | 126,850 |
| Assemblers and fabricators | 11,740 | 14.04 | 18.98 | 21.00 | 43,680 |
| **Aerospace product and parts manufacturing (NAICS 3364)** | | | | | |
| Aerospace engineers | 26,400 | 5.18 | 62.85 | 64.74 | 134,650 |
| Aerospace engineering and operations technologists and technicians | 4,700 | 0.92 | 38.02 | 39.33 | 81,800 |
| Electrical engineers | 9,380 | 1.84 | 62.92 | 64.87 | 134,930 |
| Assemblers and fabricators | 54,400 | 10.68 | 26.57 | 28.31 | 58,880 |

Source: BLS (2024).
**NAICS** North American Industry Classification System

A number of adjustments would need to be made to isolate own-account production within these occupations (as is done with the own-account software estimates). First, we would need to estimate the share of each industry that is space related. Then we would need to differentiate between employees that work on building paid satellite and space vehicle manufacturing versus employees working on own account. Nonetheless, the number of employees might at least be useful to serve as a starting point for our estimates.

To measure the total costs of production, we would also need to estimate the value of materials purchased to build the satellite or space vehicle. Analysys Mason (2023) recently began estimating "virtual revenue" in their Satellite Manufacturing and Launch Market report for own-account satellites based partially on the mass of the satellite. If purchasing the data is not an option, it may be possible to come up with an estimate of cost of capital used in production based on publicly available information on the number and mass of satellites launched each year. There is also the potential to use existing measures of own-account production as an indicator or guide for space vehicle manufacturing, barring any other options. In the case of own-account software, the value of inputs is measured indirectly based on Census data that show the relationship between inputs and compensation for similar industries; own-account production of satellites and space vehicles may also consider using representative industries to estimate the value of inputs.

# 4. Conclusion

As space manufacturing continues to innovate and lead the space economy, it becomes increasingly important to have accurate and reliable data about this area of the economy. In this paper, we discuss two areas we consider a priority for improving measurement of space economy manufacturing: plant capacity utilization and own-account production. We introduce an index of space economy manufacturing plant utilization, SEMPI. Disaggregating value added and manufacturing plant capacity utilization data to finer NAICS levels will enable detailed assessments of production bottlenecks, inflation, and sectoral composition. Second, we introduce the concept of estimating and adding the value of own-account production of satellites and space vehicles to U.S. GDP. Although data are sparse, we believe it may be possible to use existing data and methods from related areas to come up with this missing piece of investment.

The topics covered in this paper are intended to start a conversation on areas of the space economy that would benefit from new or improved economic measures. Better measures of plant utilization and own-account manufacturing in the space economy will give businesspeople and policymakers a more accurate picture of the scope, strength, and prospects of this important area of the economy.

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