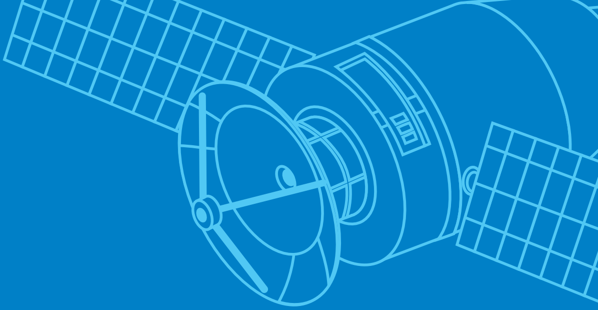

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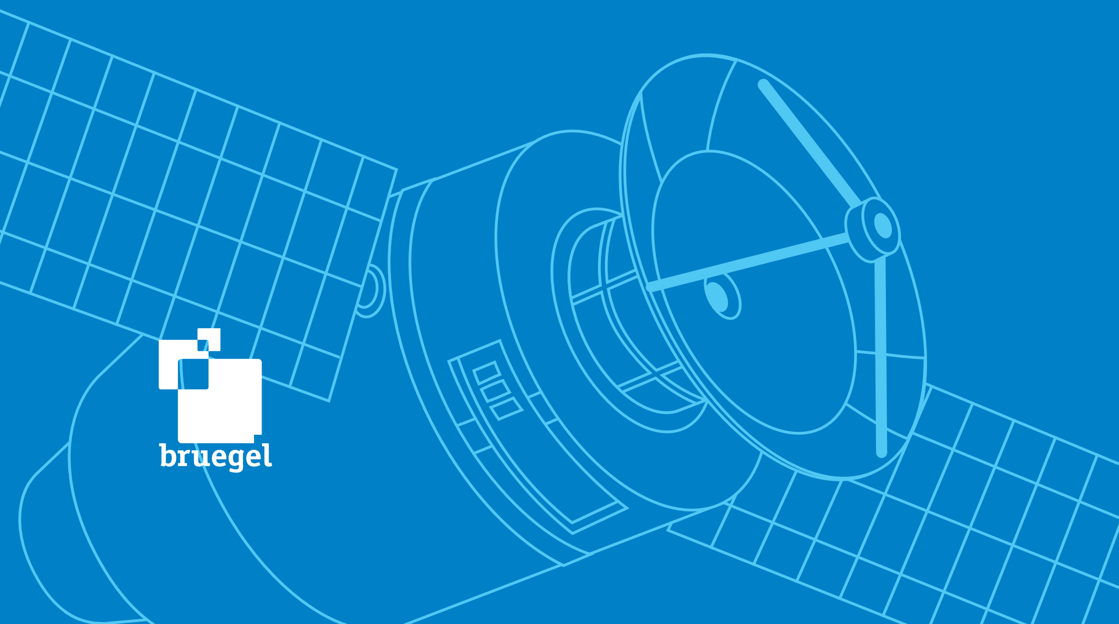

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Contents

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1 The European Union in the new space economy

The space industry once focused mostly on scientific exploration. During the Cold War, the United States and the Soviet Union spearheaded expensive, mission-oriented space exploration programmes to showcase technological superiority and bolster national pride, with the Soviet Union in 1961 being the first to put a man in space, and the US in 1969 the first to put a man on the moon. Following these early successes, however, a difficult period ensued, marked by the NASA budget reductions imposed by US administrations[1] and the exorbitant costs of the Space Shuttle programme, culminating in its retirement in 2011, and the subsequent rise of the private company, SpaceX, as the biggest launch provider in the world.

Today, space is back. Space is no longer only a frontier for scientific exploration and posturing. It has become a multifaceted domain with huge commercial, military and strategic opportunities; an arena for breakthrough innovations and new technologies. The space sector now thrives on launching satellites for Earth-based communication, significantly expanding the scope for new space-related applications. In 2024, a record 258 launches reached orbit and 2854 satellites were deployed (McDowell, 2025), which is more than the combined number of satellites orbiting Earth just five years ago. Satellite navigation systems such as GPS (global positioning system) and Galileo support industries ranging from broadcasting and transportation to food delivery. Earth observation from space helps facilitate climate change

1 NASA's budget peaked in the mid-1960s. See The Planetary Society, 'Your Guide to NASA's Budget', undated, https://www.planetary.org/space-policy/nasa-budget.

monitoring[2], the energy transition[3], natural disaster management[4] and smart agriculture.

Meanwhile, Russia's full-scale invasion of Ukraine in 2022 highlighted the role of space in providing connectivity for drones, secure communications, real-time intelligence and battlefield awareness. Russia may be developing a nuclear anti-satellite weapon to counter defence technologies in space[5]. Meanwhile, China is emerging as the United States's main technological rival, intensifying geopolitical competition in space as much as on Earth.

Civil space exploration has regained momentum too. With the International Space Station scheduled for decommissioning by 2030, NASA's flagship Artemis programme – backed by partners including the European Space Agency (ESA) – is in a race to return astronauts to the moon and establish an outpost there ahead of the International Lunar Research Station, a lunar base being developed by a coalition of countries led by China and Russia[6]. Ambitions for astronauts reach even beyond the moon to other planets, most notably Mars.

The sector is also seeing the emergence of new space companies seeking to leverage critical technological innovations. The most notable of these is industry frontrunner, the US's SpaceX, which has pioneered

2 Airbus, 'Climate monitoring,' undated, https://www.airbus.com/en/sustainability/respecting-the-planet/climate-monitoring.

3 ESA news of 21 February 2023, 'How scientists use space data to help advance the energy transition,' European Space Agency, https://earth.esa.int/eogateway/news/how-scientists-use-space-data-to-help-advance-the-energy-transition.

4 Airbus news of 6 September 2023, 'Disasters: How Earth observation satellites help guide emergency workers,' https://www.airbus.com/en/newsroom/stories/2023-09-disasters-how-earth-observation-satellites-help-guide-emergency-workers.

5 Minho Kim, 'Intelligence Chairman Defends His Hints About a Russian Space Weapon,' *The New York Times*, 18 February 2024, https://www.nytimes.com/2024/02/18/us/politics/mike-turner-russia-nuclear-space.html.

6 *Xinhua*, 'China's planned lunar research station ushers in new era of global space collaboration,' 7 September 2024, https://english.www.gov.cn/news/202409/07/content_WS66dbeb9dc6d0868f4e8eab63.html.

partial reusability with its Falcon rockets and now controls nearly two-thirds of the operational satellites in space (McDowell, 2025). The company continues to push technological boundaries with Starship, the largest and most powerful rocket ever to be developed[7]. In October 2024, SpaceX achieved the successful return of Starship's first-stage booster to its launch pad, and in September 2024, it conducted the first-ever commercial spacewalk.

But there are many more companies, such as Rocket Lab, which has launched more than 30 carbon-composite rockets with mostly 3D-printed engines, and Blue Origin, owned by Amazon founder Jeff Bezos, with its New Glenn heavy rocket, first launched in January 2025. China has a large range of relatively opaque but dynamic startups, most of which enjoy deep public funding and aim to compete with their American counterparts (Liu *et al*, 2019; ESPI, 2024). China's Galactic Energy, one of the industry's standout companies, has completed 18 successful launches of its Ceres-1 rocket and is working on a launchpad powered by magnetic levitation technology[8].

These major changes have made the space sector strategically relevant for policymakers, not only in terms of traditional space exploration, defence and geopolitical power, but also from an industrial-policy perspective that seeks to ensure value creation and capture from space-derived products, services and knowledge. These areas are inherently interconnected, as many space technologies can serve multiple purposes: scientific, military and commercial.

While the US and China continue to invest heavily in space technology and infrastructure and are pushing the space technology frontier at a

7 Josh Dinner, 'SpaceX's Starship Rocket Reached Record Heights before It Was Lost,' *Scientific American*, 14 March 2024, https://www.scientificamerican.com/article/spacexs-starship-rocket-reached-record-heights-before-it-was-lost/.

8 Zhang Tong, 'China Aims to Deploy Maglev Rocket Launch Pad by 2028, Challenging SpaceX,' *South China Morning Post*, 25 March 2025, https://www.scmp.com/news/china/science/article/3303761/china-bid-challenge-giant-spacex-deploying-maglev-rocket-launch-pad-2028.

breathtaking pace, the concern in Europe is whether there is still enough room for a globally competitive EU space economy. Part of this discussion are Europe's concerns about strategic autonomy and ensuring access to space and its derived value. One particular strategic issue for Europe is guaranteeing access to cost-effective launch capacity and the operations of mega-constellations of satellites.

In this Blueprint, we analyse the scope for the European Union to become a leader on innovation, sustainability, resilience and security in the space sector. We assess the state and trajectory of the European space sector, the challenges it faces and policy avenues for moving forward. In chapter 2, we introduce the new space economy and outline the most significant global trends shaping it. Chapters 3 and 4 then provide an in-depth analysis of the two most important forces driving the space economy: governments and companies. Together, these chapters identify the following major trends:

- Technological shifts: the introduction of reusability, miniaturisation and new materials has drastically reduced the cost of launching into and operating in space, opening up unprecedented opportunities for dual-use innovative commercial and defence applications.
- Growing role of the private sector: driving the new technological opportunities for space, private companies are entering and/or diversifying into the space economy. The sector is also seeing rapidly growing demand for the commercial use of space infrastructure.
- Growing strategic importance of space: space has become more critical for national security, defence and geopolitical competition. Governments increasingly view space as essential for military applications. This has led to growing public investments in space-related activities.
- Public and private sector interplay: while private companies are playing increasing roles, governments remain pivotal in shaping the space economy. Public spending on space, particularly in research and development (R&D), and procurement practices, continue to be

major drivers of private-sector innovation in space technologies.
- US firms are at the forefront of the new space economy: there are several reasons for this, including the vibrant, innovative US private sector, the unique entrepreneurial spirit of US companies, the role of the US government as an anchor customer and a shift in US public-procurement practices, which has empowered competition and created incentives for private companies to innovate and reduce costs.

Chapter 5 examines Europe's position in the fast-changing new space economy, analysing Europe's strengths and weaknesses compared to its major global counterparts, most notably the US. It finds that:

- Europe hosts excellent firms in some space-industry segments, such as satellite manufacturing and operations. Companies including Airbus, Thales and Eutelsat/OneWeb are major global players;
- The European Space Agency (ESA) has been a significant public player in scientific missions and space exploration;
- EU public programmes such as Galileo and Copernicus showcase Europe's technological prowess;
- However, Europe struggles to keep pace with the US and a rising China in the new space economy;
- EU government space budgets have stagnated;
- Europe's total public sector space budget is approximately six times smaller than that of the US, and the gap is even bigger in defence, which limits Europe's ability to leverage the dual use of space for commercial and military purposes;
- Europe has a fragmented institutional landscape, with overlapping roles for ESA (a non-EU body), the EU and national space agencies in EU countries and non-EU European countries such as the United Kingdom;
- Europe lacks the US-style competitive, innovation-driven private

ecosystem. The EU suffers from a lack of venture capital and scale-up financing for space start-ups, as for other start-ups, which constrains the growth of new players in the industry that might be able to provide new technology solutions;
- The European private sector has not produced new success stories comparable to those in the US. Europe's heavy reliance on its large incumbent conglomerates limits competition and innovation;
- Public procurement in Europe is less innovative than in the US and is characterised by a continued focus on traditional technological models and incumbent space-active firms, such as the Ariane launch programme, which, while once a leader, now lags behind US competitors such as SpaceX in terms of cost and launch innovation;
- There is also a notable absence in Europe of public support through grants for high-risk, high-reward ventures, in the way done in the US through the Defense Advanced Research Projects Agency (DARPA);
- The dominant role of US companies and in particular SpaceX in launching and operating satellites creates for Europe the potential for critical dependency and lack of access to critical space infrastructure.

To succeed in its pursuit of an industrial policy for the space economy, and given that it seriously lags behind the US, Europe should first and foremost focus on next-generation space technologies, infrastructure and services. In these areas, Europe can leverage its research and innovation capacity and challenge and/or cooperate with the current frontier firms. The gap relative to the US is primarily down to the commercialisation of new space projects, especially highly risky disruptive projects, which are most likely to originate from new players, rather than from incumbents.

For Europe to compete against the US and China, it will be essential to mobilise large amounts of public spending, overcome fragmentation and establish a clear governance structure in which the various public actors complement each other. The EU has the potential to reposition itself as a global leader in the new space economy, but only if it implements a forward-looking space-economy policy. Only then can it build on its strengths, creating and capturing value from new technologies, fostering innovation and ensuring strategic autonomy in critical space capabilities. Chapter 6 sets out policy recommendations for the EU on how to do this, including:

- Clearly identify and distinguish institutional roles: Europe as a whole should rationalise and reorganise its institutional footprint, assigning to ESA a strong scientific mandate, and giving the EU (the European Commission's Defence Industry and Space directorate-general and its operational agency, the EU Agency for the Space Programme) economic and industrial policy functions associated with the space economy and its defence component.
- Increased public investment and coordination: the EU must scale-up public investment in space, particularly in R&D and defence-related space activities. Streamlining space-related public procurement by coordinating the fragmented national space agencies, the EU and ESA, is essential.
- Leverage defence spending for dual use: Europe lacks a dedicated defence space agency, leading to fragmented military space budgets. Increasing and coordinating defence spending, as is done in the US and China, is crucial to leverage synergies between defence and non-defence space activities.
- Commercialisation as a core principle: the EU should adopt a more competitive and market-driven approach to its space industry, similar to the US. This would increase the benefits for the EU from a higher economic-growth dividend and would also make the build-up of the space component for public purposes more cost efficient. In particular, downstream space activities, most notably space-data applications, are ripe for more EU private activities, as are upstream and midstream activities, though these present more challenges in terms of reaching the required scale and scope for competitiveness.
- Next generation technology innovations and dynamic competition as a core principle: the focus should be on fostering entrants,

engaging incumbents in taking risky, innovative technological decisions and encouraging commercialisation across the space ecosystem. This requires public-procurement practices to be revisited to prioritise competition, innovation and commercialisation. It also requires willingness to share the risks of new breakthrough approaches.
- Create EU-ARPA for high-risk, high-reward projects: establishing a European Advanced Research Projects Agency for Space (SP-ARPA) will be crucial to fund disruptive, high-risk space technologies. This would mirror the US DARPA model, fostering next-generation space capabilities and supporting Europe's strategic autonomy.
- Support for innovation and start-ups: Europe needs to cultivate a vibrant space start-up ecosystem by providing better access to private capital and creating an environment in which new space players can challenge and compete and cooperate with incumbents.
- Strategic autonomy: Europe should seek strategic autonomy in critical areas including satellite navigation and launch capabilities, building on next-generation, world-leading innovative solutions developed and supported in EU public and private space markets.
- International openness and collaboration with strong partners including the US remain essential to ensure access to markets and cutting-edge technology.

Given the strategic importance of the space economy and the EU's lagging position, the EU cannot afford to continue with an incremental and piecemeal policy approach. It is essential to continue to push for big innovation leaps, which will provide Europe with strategic control of next-generation, globally competitive space capabilities. The path forward for the European space industry, with the EU public sector as a market-shaper, necessitates a multifaceted, systemic and radical approach to space policymaking.

Acting only on some of the policy recommendations in chapter 6 will not be enough. It will not be enough to increase and coordinate public budgets, including defence budgets. It will also be critical to have commercialisation-oriented dual-use public procurement grounded in open competition and innovation. To leverage private innovative capacity, it will also be necessary to alleviate the bottlenecks holding back private investment in space, particularly for new innovators to scale-up commercialisation of their products and services. Not addressing these bottlenecks – such as access to risk finance – in a holistic way will hold back the power of public investment to deliver on the EU's objectives in the space economy. None of these recommendations should be relegated to the medium or long terms.

2 The changing global space economy

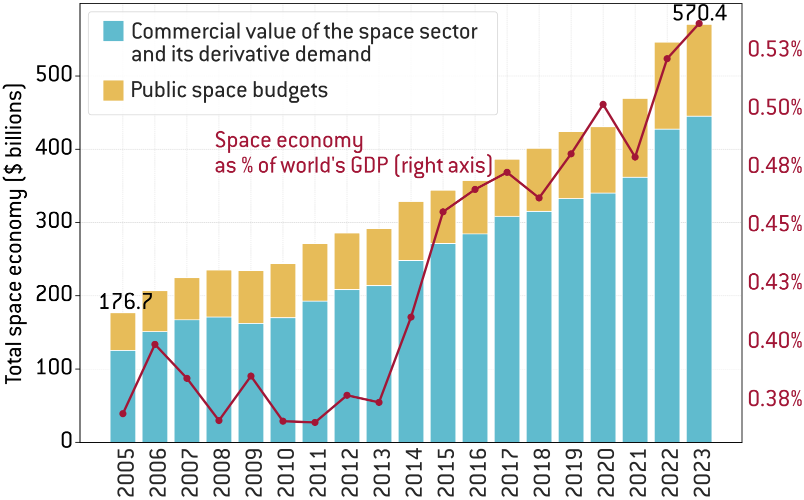
The space economy is growing rapidly. Figure 1 shows the global size and rate of growth of the core space sector, the satellite broadcasting sector and the position, navigation and timing (PNT) industry, which we dub collectively the space economy[9]. In value terms, the global space economy has more than tripled, from approximately $176.6 billion in 2005, to $571 billion in 2023. Its growth rate outpaces the overall global GDP growth rate, meaning the space economy represents an increasing share of the world economy. Projections for the global space economy are for solid future growth, though forecasts of the rate of growth vary. Acket-Goemaere *et al* (2024) estimated its value will reach $1.8 trillion in 2035[10], whereas space consultancy firm Novaspace[11] puts it at $944 billion by 2033 (Novaspace, 2025). Even if different accounting approaches are used, the past and prospective growth rates of the space sector are substantial (Terzi and Nicoli, 2024).

9 This follows the established practice of most data providers in how data about the space industry is reported.

10 Jason Rainbow, 'The trillion-dollar question,' *SpaceNews*, 18 April 2024, https://spacenews.com/the-trillion-dollar-question/.

11 Previously known as Euroconsult.

Figure 1: Estimated global value of the space economy



Source: Bruegel based on Space Foundation. Note: the space economy includes the space sector and enabled sectors (such as satellite broadcasting and PNT). Total value of the space economy is the sum of public space budgets globally and the commercial value of the economy. Data should be read as liberal estimates, with possible double counting between categories (see Crane *et al*, 2020; Terzi and Nicoli, 2024).

As it grows, the space economy is changing fundamentally. Figure 1 shows that increased public space budgets devoted to exploration, science and defence had only a limited impact on the growth of the global turnover of the space industry. Rather, growth has resulted from the increased value and volume of commercial space activities. Most growth in commercial space activities has been made possible by the increasing value of the data transmitted, with space infrastructure stemming from the digitalisation of the economy and advancements in the space sector's core activity of launch technology (section 2.2) and satellite technology (section 2.3), which are reducing the cost of accessing and operating in space. Before discussing the changing global space economy landscape in sections 2.2 and 2.3, it is useful to first define its segments more granularly.

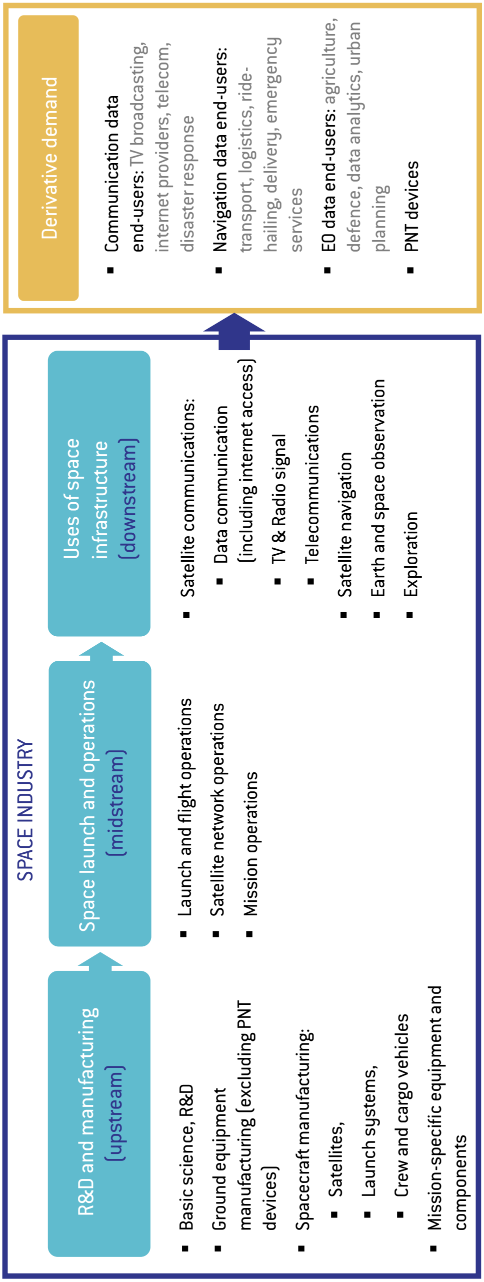
2.1 Introducing the space economy

The space economy underpins many services in the modern economy, which can make what counts as a 'space' activity difficult to identify. We define the space economy, in line with the OECD (2022), as the full range of activities that create value through utilising space. 'Space' thus includes all public and private entities involved in developing, providing and using space-related products and services. The space economy therefore extends beyond the space sector itself, encompassing the increasingly pervasive and continually evolving economic impact of space-derived services and data.

Figure 2 details what constitutes the space economy, valued at $596 billion in 2024 according to Novaspace. The space industry itself – the business of manufacturing, launching and operating infrastructure in space, and of facilitating exploration missions – accounted for roughly $288 billion in 2024 according to Novaspace. Of almost equal size ($308 million) is the derived demand for the space industry, which includes end users of data generated from satellite navigation, satellite communications and Earth observation (EO), as well as manufacturing of PNT devices.

In line with the literature, we categorise the industry into upstream, midstream and downstream (OECD, 2022). Upstream covers research, development and manufacturing of space infrastructure, including launchers and satellites. Midstream bridges production and use, involving the deployment of infrastructure and the operation of space missions and satellite constellations. Downstream delivers space-based services including satellite communication, broadcasting and Earth observation, forming the core of the traditional space sector.

Figure 2: Space economy segments



Source: Bruegel.

Traditionally, public space agencies have developed space missions and have largely outsourced manufacturing to private companies. The private sector has thus always played an important role in the upstream sector, whereas operation of scientific missions (midstream) has remained largely an undertaking of public agencies. However, the private sector has become more autonomous in the upstream sector, with many companies now providing launch services for commercial use.

Global spacecraft manufacturing and launch markets (spanning our classification of upstream and midstream) were valued at €63 billion in 2024 (not including the manufacturing of ground equipment) (Novaspace, 2025). The biggest customer in the upstream segment is still the public sector. According to Novaspace (2025), 69 percent of the upstream space market is for the public sector, with 46 percent of the total devoted to defence (and thus 23 percent to civil government). Commercial customers are responsible for 31 percent of the upstream market.

The situation is different for the satellite communications sector, where private companies have pioneered commercial applications since the beginning of the space exploration era. With decreasing satellite-launch costs, most of the opportunities for new value added can be found currently in the downstream segment. The downstream sector was worth €137 billion in 2024 (Novaspace, 2025). Downstream value is generated by companies that provide space-derived data and services in Earth observation and satellite communication (these segments are discussed in greater detail in section 2.3). In these segments, commercial clients are responsible for the majority of the market (87 percent, according to Novaspace (2025), with 8 percent being accounted for by the public civil institutions, and the remaining 5 percent by the military). Additionally, publicly-owned navigation constellations provide great value to the economy. According to Novaspace (2025), in 2024, the value of products and services enabled by space-based infrastructure reached $308 billion.

The segments depicted in Figure 2 have significantly different business models, have evolved at different paces and vary in terms of the scale and risks associated with R&D and capital investments. Many companies operate across these market segments. The significance of vertical conglomerates and the advantages they offer is further explored in section 2.2.

2.2 Shifts in the launch segment

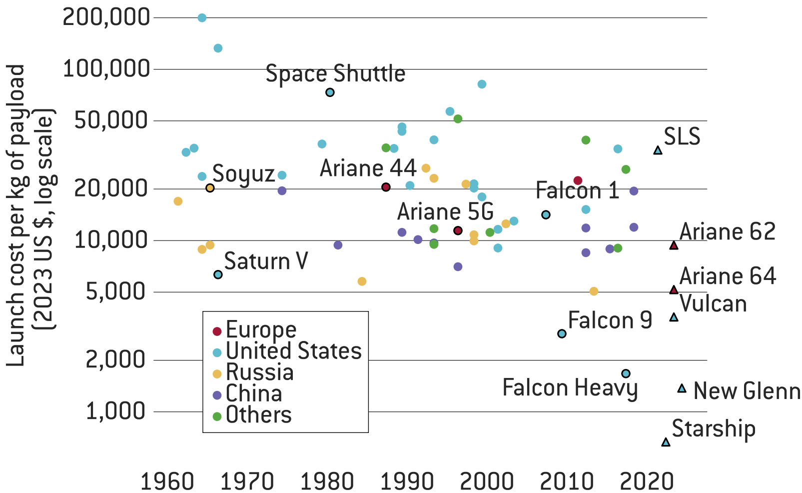
Historically, launching payloads into space has always been costly. Rockets were mostly designed by space agencies in collaboration with the private sector. Early on, the newness of the technology meant that engineers were still learning, and agencies such as NASA needed to adopt conservative 'safety-first' approaches, as failures could have severe political repercussions for space programmes. Furthermore, rockets were built for one-time use, which further increased costs. However, the cost of launching payloads into orbit has steadily declined since the 1960s (Figure 3), particularly in the US – a change driven by the commercial sector.

The most radical cost reductions have been achieved by Space Exploration Technologies Corporation (SpaceX), with its Falcon 9 and Falcon Heavy rockets (Figure 3). By utilising new mass-produced components in the development of their launch equipment, taking massive risks with a learn-fast-by-successive-trials business model, SpaceX achieved reusability by successfully recovering the first stage of a Falcon 9 rocket in December 2015 and launching it again in March 2017. Reusability of the first-stage was considered far-fetched by many in the industry at the time[12]. With limited demand, the cost of developing and refurbishing reusable vehicles might not be recovered. Additionally, such vehicles require extra systems which, in situations when rocket mass is critical, can reduce performance. However, the

12 Jeff Foust, 'Debating Reusability', *The Space Review*, 8 October 2018, https://www.thespacereview.com/article/3583/1.

benefits include lower costs, a smaller environmental footprint, and greater reliability. SpaceX's achievement cut costs significantly and made commercial space access more viable. The Falcon 9 rocket, introduced in 2010, is considered to be one of the most reliable and cost-effective vehicles in the industry[13].

Figure 3: Cost of transporting payload to outer space



Source: Nicoli *et al* (2023). Note: Year indicates the year of the first successful launch or the predicted year of the first mission. Data is adjusted for inflation and reported in 2023 dollars. Observations depicted as triangles are early estimates.

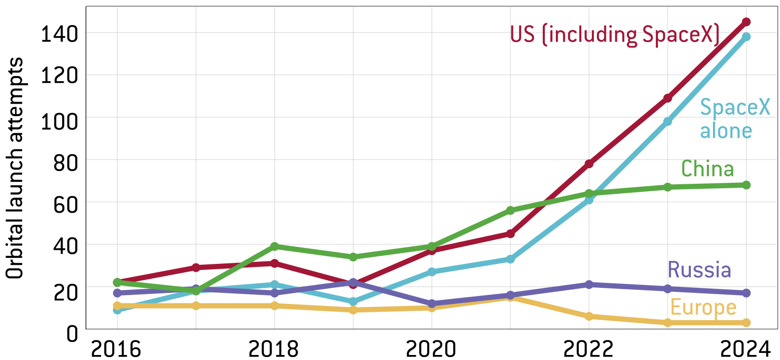
This pattern of cost reductions is predicted to continue, particularly for rockets developed by the private sector (such as SpaceX's Starship or Blue Origin's New Glenn). Europe's Ariane 6 and the US SLS (Space

13 Eric Berger, 'The Falcon 9 may now be the safest rocket ever launched,' *Ars Technica*, 3 February 2022, https://arstechnica.com/science/2022/02/spacexs-falcon-9-rocket-has-set-a-record-for-most-consecutive-successes/.

Launch System) are public-private partnerships[14]. They have reduced costs but still have a substantial cost-premium over Falcon 9 and Starship, putting into question the traditional involvement of the public sector in launch activities.

Figure 4 shows the increase in orbital launches, especially since 2021. Most of the US orbital attempts since 2016 have been operated by SpaceX. Following the success of the lower-cost Falcon rocket, SpaceX has been able to capture a big share of the growing launch market in the US, a market previously dominated by the public sector. The technological success of Falcon 9 means that the US has also become very active in launching payloads for other countries. In 2024, the US accounted for 145 of the total of 263 launches, followed by China with 68 and Russia with 17. By contrast, there were in 2024 only three launches of rockets developed in Europe. The great majority of US launches were operated by SpaceX (138), which has a near monopoly over orbital launches in the West.

Figure 4: Orbital launch attempts (2016-2024)



Source: Bruegel.

14 Europe's Ariane 6 is a public-private partnership between ESA and Ariane Group (a joint venture between Airbus and Safran). American SLS is a public-private partnership between NASA and Boeing and Northrup.

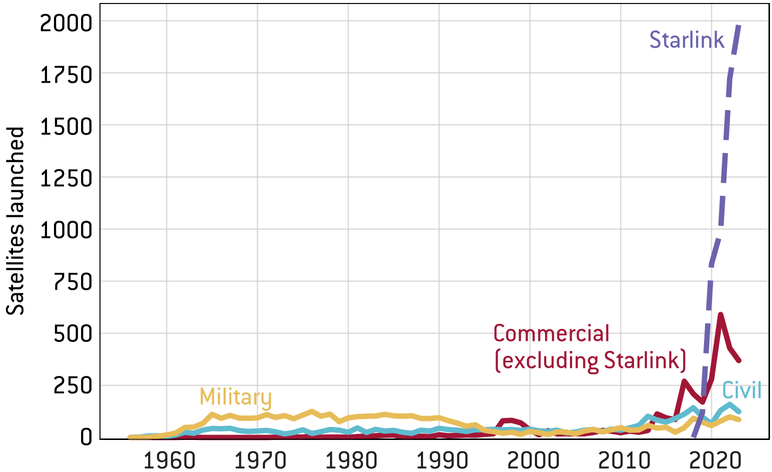
2.3 Trends in the satellite sector

Lower launch costs have reduced market-entry costs for companies across all segments of the space industry, spurring entry of new firms, increasing competition and incentivising further innovations and cost reductions. This has been most notable in the satellite industry segment. Satellites currently constitute the main use of space, both for commercial and civil applications (including navigation, internet access in remote areas and Earth observation), and for military applications (including intelligence sharing, early warnings, communication and drone control). In 2024, satellite services represented 70 percent of the global space industry by value (Novaspace, 2025).

Satellites date to the start of the space exploration era. In 1962, AT&T launched the first broadcasting satellite, Telstar 1, in collaboration with NASA[15]. This was followed by a continuous development of technology. In the late 1990s, the number of launches of commercial satellites overtook the number of civil and military launches (Figure 5). Companies including Iridium and Globalstar attempted to provide cellular signals using satellite constellations, but because of the lack of a sufficient customer base, technological problems and high launch costs, a wave of bankruptcies followed (Garber and Vedda, 2019). But technological improvement continued and the late 2010s brought about a considerable increase in the number of commercial satellites, most notably the unprecedented rise of the Starlink constellation owned by SpaceX.

15 Bob Granath, 'Telstar Opened Era of Global Satellite Television', NASA, 10 July 2012, https://www.nasa.gov/history/telstar-opened-era-of-global-satellite-television/.

Figure 5: Annual satellite launches by category



Source: Bruegel. Note: civil satellites include satellites launched by civil public institutions, academic and other research institutions. Starlink is a commercial satellite constellation owned by SpaceX.

Most derived demand for the space industry is related to the usage of data generated by publicly-owned GPS constellations. This system has proved extremely useful for many sectors. The US National Institute of Standards and Technology (NIST, 2019) estimated that since its inception in 1983, GPS has generated a total value of $1.4 trillion spread across several American industries, including agriculture, transportation, energy and consumer goods. Most of the value (90 percent) has been realised due the rapid digitalisation since then of the economy. The authors estimate that a 30-day outage affecting the GPS infrastructure, would result in the loss of roughly $1 billion per day for US residents[16]. If the outage were to happen during the planting season, losses in agriculture would amount to additional $0.5 billion per day. In

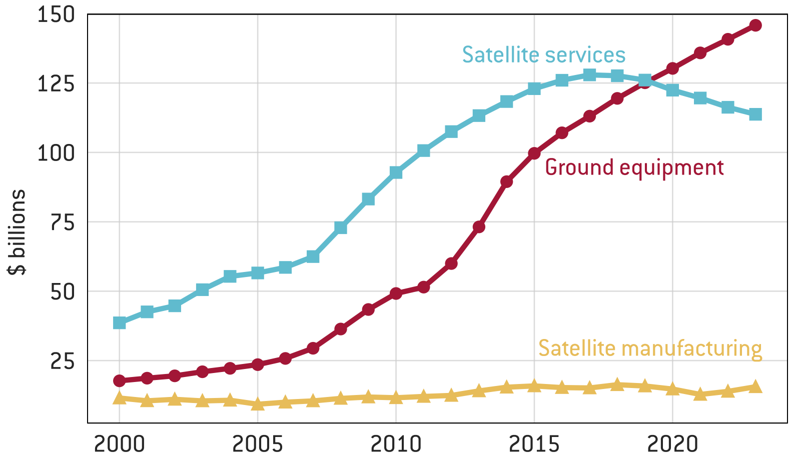
16 The total range of 30-day losses varies between $16 billion and $45 billion, depending on assumptions used and the season, and excludes some non-monetary benefits of GPS such as emergency services and accidents avoided.

the global context, PNT data provided $219 billion in value in 2024 (or 37 percent of the global space economy; Novaspace, 2025).

Lastly, the need to connect personal devices to GPS constellations has given rise to the PNT devices manufacturing industry, estimated to be worth $89 billion (15 percent of the global space economy). This industry mostly produces consumer-grade chips that enable smartphones and other devices to receive signals from GPS satellites (so-called Global Navigation Satellite System (GNSS) receivers) but also produces specialised systems for the military or the financial sector, where reliable information on position or timing is critical.

Beyond the publicly-operated GPS constellation, the private satellite industry consists mostly of satellite communication (88 percent of the sector according to Novaspace, 2025). This sector is dominated by a waning satellite television business, visible in the declining satellite services revenues of private operators since 2017. As a result of the public character of the signal sent by GPS satellites, the publicly-operated satellite navigation sector has much smaller revenues than the communications sector; with just seven percent of the downstream market. That said, satellite navigation fuels the growth of the private ground-equipment industry, as demand rises for GNSS chips that connect private devices to public infrastructure. Another satellite sector that is technologically important but has struggled to convert that into monetary value is Earth observation, with just four percent of the market.

Figure 6: Trends in satellite revenues



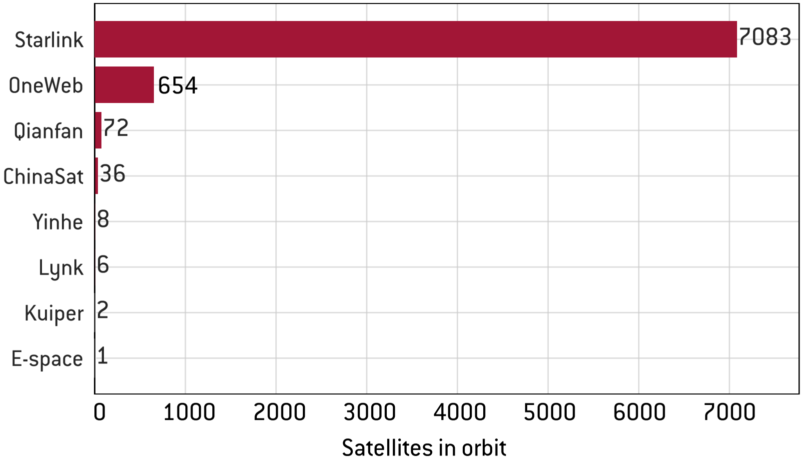
Source: Bruegel based on Christensen *et al* (2023). Note: the ground equipment category includes PNT devices.

Whereas satellite operators have been traditionally centred around broadcasting and telecommunications, new satellite mega-constellations are focused on providing internet access with greater accessibility and at a lower cost. The prefix 'mega' indicates the large number of satellites required to form the system. While the GPS constellation has only around 30 satellites, many planned constellations are expected to include more than a thousand. Although the capacity of mega-constellations is still low compared to the most efficient terrestrial networks (Pachler *et al*, 2021), satellite systems have a particular role to play in providing cellular and internet access in remote areas, and by providing a backbone network for mobile users (OECD, 2021). Those systems are also particularly important for the military and the government, as they provide secure communication channels. Providing internet access may soon reverse the trend of falling satellite services revenues and provide additional impetus for the sector.

The mega-constellation trend is largely led by SpaceX and its distant runner-up, UK-headquartered One Web (currently Eutelsat OneWeb).

New players, including Amazon with its Project Kuiper, are entering the arena (Figure 7). China is also actively developing three mega-constellations: Qianfan, ChinaSat and Yinhe. The Qianfan constellation alone, developed by Shanghai Spacecom Satellite Technology, is planned to have more than 14,000 satellites in orbit[17].

Figure 7: Progress towards planned mega-constellations by provider



Source: Bruegel based on McDowell (2025). Note: data as of 23 February 2025. All companies plan to have more than 1,000 satellites in orbit.

SpaceX-owned satellite constellation Starlink accounts for the bulk of the commercial payloads (Table 1). In 2020-2021, SpaceX operated more than 73.5 percent of all commercial satellites by mass, a spectacular increase from the 5.5 percent it operated from 2015-2019 (Table 1). As of February 2025, it operates more than 7000 Starlink satellites in orbit (Figure 7). With SpaceX's dominance as launch operator, this underscores the advantages vertical conglomerates have, but raises antitrust concerns about

17 Andrew Jones, 'China launches first satellites for Thousand Sails megaconstellation,' *SpaceNews*, 6 August 2024, https://spacenews.com/china-launches-first-satellites-for-thousand-sails-megaconstellation/.

potential abusive monopoly behaviour foreclosing or raising costs for downstream rivals.

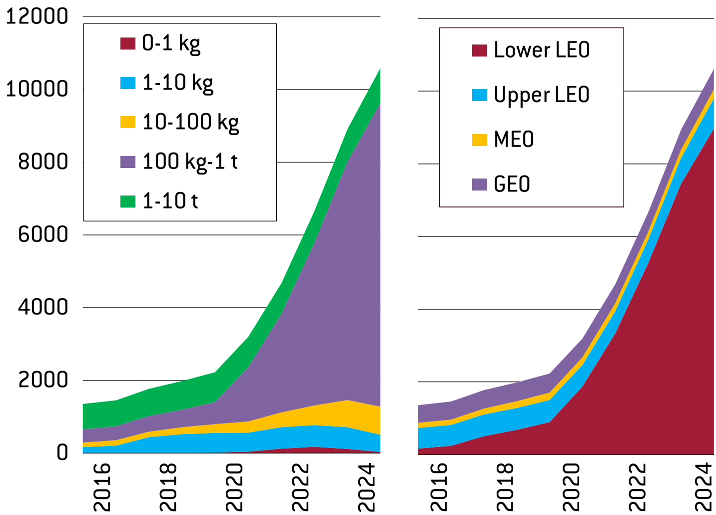
Table 1: Shares of mass launched, top-10 commercial satellite operators

Position	Top 10 (2015-2019)	Share of the total mass of commercial satellites	Top 10 (2020-2021)	Share of the total mass of commercial satellites
1	Iridium	11.7%	SpaceX	73.5%
2	Intelsat	10.2%	OneWeb	8.7%
3	SES	5.8%	ChinaSat	2.5%
4	Eutelsat	5.5%	SiriusXM	2.1%
5	SpaceX	5.5%	RSCC	1.3%
6	Inmarsat	4.9%	Turksat	1.2%
7	SKY Perfect JSAT	4.4%	Eutelsat	1.1%
8	Telesat	3.4%	SES	1%
9	Arabsat	3.3%	Embratel	0.9%
10	DirecTV	2.7%	SKY Perfect JSAT	0.9%
	Total	**57.4%**	**Total**	**93.2%**

Source: European Space Policy Institute.

In addition to the massive increase in the number of satellites in orbit, there has been a substantial change in where in space these new satellites are located (Figure 8). Legacy satellite services such as GPS use satellites in what is known as geostationary Earth orbit (GEO): more than 35,000 kilometres from the Earth's surface. By contrast, most satellites launched in recent years occupy what is referred to as low Earth orbit (LEO): less than 2000 kilometres from earth. Accessing LEO is much cheaper than accessing GEO, especially when factoring in reusability. A modern GPS satellite, for instance, costs $250 million[18] (launch costs excluded) and is designed to remain in orbit for decades. Currently, GPS satellites have an average orbital lifespan of 13 years, with some satellites remaining up to 27 years in GEO[19]. This means that the GEO innovation cycle is slow and updates are rare.

Figure 8: Active satellites by mass and orbit type



Source: Bruegel based on McDowell (2025). Note: GEO = geostationary Earth orbit, MEO = medium Earth orbit; LEO = low Earth orbit.

18 Sandra Erwin, 'Space Force pauses GPS satellite orders due to excess inventory,' SpaceNews, 13 March 2023, https://spacenews.com/space-force-pauses-gps-satellite-orders-due-to-excess-inventory/.

19 Argyris Kriezis and Jack Kuhr 'Rise and Stall of GPS: The Average Age of GPS Satellites Hits 13 Years,' *Payload*, 28 August 2024, https://payloadspace.com/rise-and-stall-of-gps-the-average-age-of-gps-satellites-hits-13-years/.

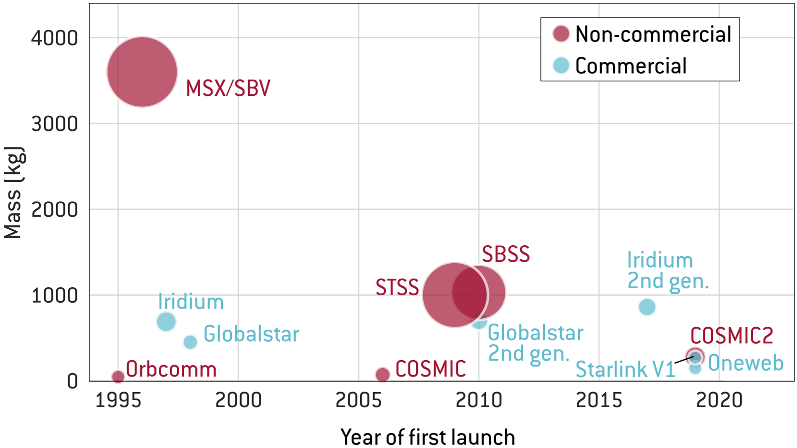
Advances in miniaturised computing have enabled the construction of smaller[20], cheaper satellites (Figure 9) that are also cheaper to deploy. There is a large variety of these satellites, often simply called SmallSats, usually defined as having a mass below 600 kilogrammes, which serve different purposes. For instance, CubeSats, built from standardised modules, weigh usually below 15 kilogrammes, while microsatellites range from 10 to 100 kilogrammes (Branz *et al*, 2023). Starlink satellites are at the other end of the spectrum. The first generation weighted 260 kilogrammes (those satellites constitute 55 percent of the current Starlink constellation by number[21]), but V2 mini satellites weigh around 800 kilogrammes[22] (45 percent of the current Starlink constellation), putting them outside the SmallSats category. SmallSats are commonly used for applications such as remote sensing, weather measurements and communications. Typically operating in low Earth orbit, SmallSats are designed for frequent replacement, with operational lifespans of one to seven years and costs ranging from as low as a few thousand dollars (for CubeSats) to $18 million. Their affordability has been instrumental in broadening the range of downstream space services that rely on space-derived data.

20 Historically, many early satellites were lightweight. For example, the famous Sputnik 1, which weighed only 83.6 kilos and was launched in 1957, belonged to this category. However, these satellites were technologically much less capable than current-generation satellites. See Branz *et al* (2023).

21 Bruegel calculation based on McDowell (2025) database.

22 Jon Brodkin, 'SpaceX unveils "V2 Mini" Starlink satellites with quadruple the capacity,' *Ars Technica*, 27 February 2023, https://arstechnica.com/information-technology/2023/02/spacexs-2nd-generation-starlink-satellites-start-launching-as-soon-as-today/.

Figure 9: Mass and estimated cost per satellite of selected constellations in LEO



Source: Bronson and Gladstone (2023). Note: bubble sizes correspond to cost per satellite in $ millions. The cheapest satellite (OneWeb) cost $5.3 million, whereas the most expensive, Midcourse Space Experiment/Space Based Visible (MSX/SBV) cost $1.3 billion.

3 The public sector as shaper of the space economy

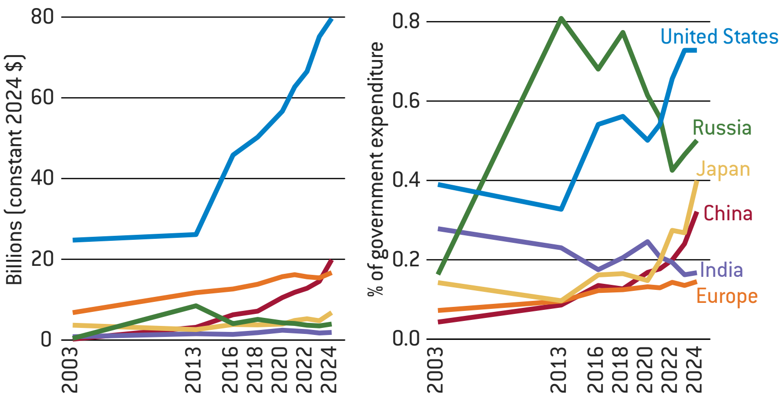
While technological change has opened up the space sector to commercial demand, the sector has a history of strong interplay between public and private actors. The public sector is a major shaper of the space industry as investor, developer, owner, operator, regulator and customer (OECD, 2021). It invests in technology, develops infrastructure and finances space missions through civil and military space agencies. It purchases satellite services for scientific research and national security, and through policies and incentives, it supports the growth of the commercial space industry. In this chapter, we focus on the role of the public sector as market shaper.

3.1 Trends in public space budgets

Driven by the increasing importance of the space sector, governments' space budgets have been growing since at least 1990 (Figure 10). The US public space budget dwarfs all other space budgets, coming to more than 60 percent of the total combined space budget of all other major players (Europe, China, Russia, Japan and India). Figure 10 shows that budgets have increased in most countries, with the exception of Russia, but the increase is most notable for the US. In 2024, China overtook Europe as the second biggest space spender (Figure 10, Panel 1). Chinese space advancements have been propelled by increased state investment, with the government maintaining tight control over strategic projects. This state-driven approach has enabled China to rapidly scale up its ambitions and to complete technologically advanced missions.

Figure 10, Panel 2 shows the size of government space budgets as a share of total government expenditure, reflecting the relative importance of space in public spending. The US and Russia spend relatively the most out of their public budgets on the space sector, but while for the US this share has increased since 2010s, it is decreasing for Russia. The most striking growth, however, comes from Japan and China, whose momentum has outpaced Europe.

Figure 10: Trends in space-related public budgets



Source: Bruegel based on Novaspace, Müller *et al* (2025). Note: data on space budgets in the first panel is adjusted for inflation.

3.2 The growing importance of space for national security

National security imperatives have guided national space programmes through both declared objectives and underlying strategic considerations. When John F. Kennedy proposed landing a man on the Moon in 1961, it was against the backdrop of the Cold War rivalry with the Soviet Union, which had just launched Sputnik-1, the first satellite. The interplay between national security and space activities has persisted since and, with technological maturity, has become even more important. Satellite services, including navigation, Earth observation and communication are vital now space services for security and defence.

Significant changes are reshaping the national security impacts on the space economy.

First, new powers have emerged, most notably China, which plans to land a man on the moon by 2030, something only the United States has accomplished so far. China's space capabilities challenge the technological edge historically maintained by the West. At the same time, the growing geopolitical tensions between the West, China and Russia have increased the demand for space services for defence and increased competition for space leadership.

Second, the cost of satellites and launches has declined sharply (see chapter 1), making them more accessible to the public sector for security and defence purposes. The rise of the American-owned Starlink network and its role in the war in Ukraine have made other nations increasingly aware of their limited control over critical space-based infrastructure. In 2024, the European Union allocated €6 billion to create the Infrastructure for Resilience, Interconnectivity and Security by Satellite (IRIS²), a multi-orbital satellite constellation to compete with SpaceX's Starlink. China is also deploying its own mega-constellations (see Figure 7).

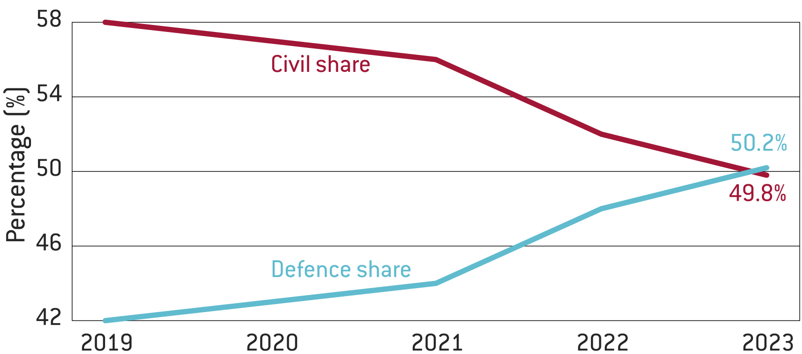
Third, the growth of the commercial space industry, spearheaded by SpaceX, has shifted the traditional balance between countries and companies when it comes to control of strategic space infrastructure, especially launch systems and mega-constellation services, raising concerns of excessive market concentration, if not monopolisation of private suppliers. SpaceX's decision to suspend Ukrainian access to SpaceX over Crimea during a critical attack had direct military consequences[23]. Considerations of Starlink's geopolitical weight go beyond conflict zones. It can provide direct internet access to mobile ground stations and even mobile phones, bypassing

23 Dearbail Jordan, 'Elon Musk says he withheld Starlink over Crimea to avoid escalation', *BBC News,* 8 September 2023, https://www.bbc.com/news/world-europe-66752264.

national censorship. It centralises enormous power over private communications outside the jurisdiction of the countries where these communications take place.

As a result of these trends, the global increase in public space spending has been largely driven by an increase in defence spending on space (Figure 11). Most of the increase in US public spending on space since 2013 has been within the Department of Defense (DoD), culminating in the creation of the US Space Force in 2019, a dedicated military branch for national space security, which in 2023 had a budget of $26.3 billion (US DoD, 2023), surpassing NASA. DoD's Space Development Agency (SDA), also formed in 2019 and later integrated into the Space Force, was tasked with rapidly developing and deploying new space technologies, with a particular focus on low Earth orbit (LEO) satellite constellations. The SDA has awarded contracts worth nearly $11 billion to major defence contractors as well as to new entrants in the sector to construct, launch and operate satellites (ESA, 2025).

Figure 11: Civil and defence allocations in space budgets



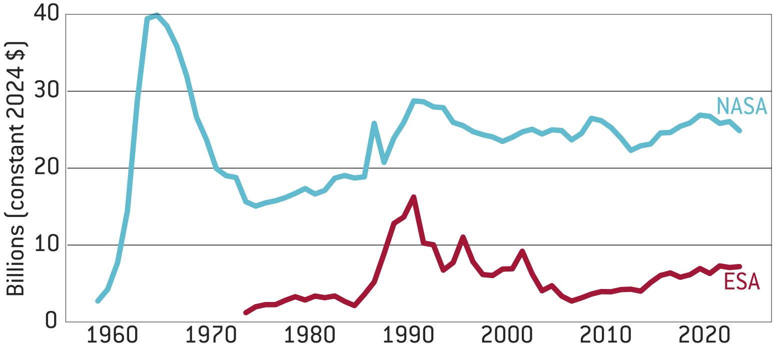
Source: ESA (2025).

3.3 Government spending on civil space and R&D

In contrast to the increasing US defence budget, the allocation for its civil space programme since the 1990s has remained relatively flat after adjusting for inflation, and has oscillated around $25 billion in constant 2024 dollars (Figure 12). In fact, as a share of total government expenditure, NASA's budget has declined continuously since at least the 1990s, and is obviously much smaller than during the Apollo era (1961-1972).

However, so far NASA's funding has remained significantly larger than that of any other space agency, including its close collaborator and the second largest globally, the European Space Agency (ESA). In 2024, the ESA budget was about $7.2 billion, around a third of the $24.9 billion NASA budget in that year. However, the difference has not always been this large. ESA's 1991 budget was over half the size (about 56 percent) of NASA's. During this high-ambition period, ESA advanced key projects such as Ariane 5, its most successful rocket, and the Columbus laboratory module for the International Space Station.

Figure 12: NASA and ESA budgets

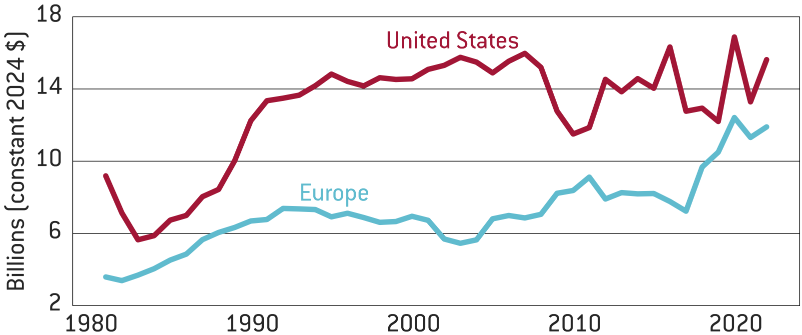


Source: Bruegel based on ESA's annual reports and CSIS (2022). Note: data adjusted for inflation.

Beyond procurement for security, defence and space exploration, the public sector subsidises private and public space R&D projects directly.

Figure 13 shows the government budget allocations for supporting R&D projects (GBARD) focused on the exploration and exploitation of space (excluding military expenses). Also, on public spending on civil space R&D, the US outperforms European countries, but the difference is smaller for public space R&D than for overall public space spending. This reflects Europe's focus on civil exploration space projects.

Figure 13: GBARD for exploration and exploitation of space



Source: Bruegel based on OECD GBARD data. Note: GBARD measures the level of government support to R&D activity and is broken down with regard to its socio-economic objectives (from which we are able to filter non-defence spending for space). 'Europe' includes the EU and countries that are ESA members or have cooperation agreements with ESA.

3.4 Changing procurement practices

Although government spending broadly defines the scope of national space initiatives, how public funds are spent plays a crucial role in determining their efficiency. Though easily overlooked as mere bureaucracy, procurement reforms were pivotal in sparking the recent surge of commercial space activity in the United States (see chapter 4). These changes began at NASA in early 2000s and have revolutionised the relationship between the public and private sectors in the American space industry, increasing the incentives for innovative commercial solutions and making space activity more affordable.

In 2006, NASA commenced the Commercial Orbital Transportation Services (COTS) programme, aimed at increasing coordination between the agency and the private sector for the development of cheaper launching vehicles. As outlined by Weinzierl (2019), "*the key innovation in the COTS program was to make NASA a customer and a partner, not a supervisor of its private contractors*".

The changes in US procurement for space contracts followed a surge in pro-competition attitudes that grew in NASA after the failure of the publicly funded Space Shuttle programme, which proved extremely costly with every mission (Figure 3) and suffered two disasters in 1986 and 2003, the last of which led to the slow retirement of the programme, finalised in 2011. NASA's new pro-market attitude resulted in collaboration with private industry to develop a system capable of delivering payloads to the International Space Station.

SpaceX developed the Falcon 9 rocket and its Dragon cargo vehicle under the programme, whilst Orbital Sciences (later acquired by Northrop Grumman) developed its Antares rocket and the Cygnus spacecraft.

Box 2: Key elements of the COTS contracts

- Competition between private companies built into the programme;
- Programme participation open to new companies and not dependent on participation in earlier versions of the programme;
- Projects co-financed by the public and private sectors;
- Companies reimbursed for results and not their costs;
- Companies have the freedom to develop technological solutions that meet milestones set by the public procurer;
- Companies retain intellectual property and ownership of developed solutions and are free to use them commercially or as a service to the public;
- The public space agency provides guidance (including know-how) and funds for development to maturity.

The move to fixed-cost contracts was significant. Prior to the programme, NASA's suppliers were given 'cost-plus contracts', with companies reimbursed for the full cost of the work completed, including possible overspends, alongside the profit they made (NASA, 2014). With fixed-cost contracts any extra work needed to reach milestones agreed *ex ante* became the financial responsibility of the company, not the space agency. Intellectual property generated under COTS and subsequent programmes is largely owned by companies, and not by NASA (NASA, 2014), which empowers innovation. This has also been the dominant stated practice at ESA, where the contactor remains the owner of the intellectual property developed under an ESA contract (Baumann and Smith, 2011).

Following the success of COTS, NASA extended collaboration with the private sector in three other programmes:

1. Commercial Resupply Services (CRS): NASA procured SpaceX and Orbital Sciences services for cargo resupply missions to the International Space Station;
2. Development of the Commercial Crew Program (CCDev): two companies (SpaceX and Boeing) were selected. SpaceX developed crewed versions of its Dragon vehicle and Boeing developed Starliner;
3. Commercial Crew integrated Capability (CCiCap) combined the goals COTS (development of rockets), CRS (spacecraft), CCDeV (crewed spacecraft) and CCiCap (integrated end-to-end service of transporting payload to ISS), and required companies to complete end-to-end 'concepts of operation', covering the launch, spacecraft, mission operation and recovery.

COTS revolutionised US space procurement by encouraging new entrants with innovative solutions to the sector, enhancing competition and changing the incentive structure of space supply chains. This resulted in drastically reduced costs of space access. NASA's estimated cost per launch for the Falcon 9 rocket and Crew Dragon carrier from SpaceX was around $1.7 million per kilo, a reduction of 90 percent from the estimated $16.1 million/kilo cost of NASA's Space Shuttle (Jones, 2018).

The success of NASA's change in procurement practices in expanding competition and lowering costs spurred shifts elsewhere in the US and beyond. For instance, the US Space Force – the newer agency within the DoD – also introduced pro-competition procurement practices. Its SDA adopted a highly innovative 'spiral development' procurement model. In this model, the SDA partners with both more established and emerging satellite manufacturers to design, build and launch satellites in tranches, with new capabilities introduced every two years. The model facilitated innovation that led to cost reductions and significantly accelerated deployment timelines (ESA, 2025).

It started to be copied outside of the US as well. In 2023, the China Manned Space Agency announced a call for low-cost cargo transportation proposals, similar to CRS[24]. In the same year, ESA announced the Commercial Cargo Transportation Initiative (CCTI), hoping to replicate the success of COTS[25]. The ability of those contracts to intensify competition and generate new, more cost-efficient offerings has been limited by the fact that the EU does not have a dynamic private space sector. New firms have failed to successfully scale up sufficiently to replace, compete with or collaborate with large space incumbents, a topic we explore in chapter 6.

The use of innovative public procurement, ie procurement with an explicit mission to directly support innovation and/or R&D grants, can also drive private industry's technological progress. However, this requires the public finance provider to assess and encourage innovation and have the willingness and capacity to take risks. The US Defense

24 Andrew Jones, 'China calls for space station commercial cargo proposals,' *SpaceNews,* 16 May 2023, https://spacenews.com/china-calls-for-space-station-commercial-cargo-proposals/.

25 Bob Chesson, 'Hands-On vs. Hands-Off Project Management at ESA,' APPEL Knowledge Services, 11 January 2012, https://appel.nasa.gov/2012/01/11/hands-on-vs-hands-off-project-management-at-esa/.

Advanced Research Projects Agency (see Box 3) is a prime example. DARPA funded SpaceX, which exemplifies a high-risk venture (see section 4.2 for more on SpaceX). While SpaceX has brought this logic to the extreme, there was a more general shift in the US private space sector that saw new players adopting aggressive, risk-taking strategies. This was spurred by public procurement that was supportive of high-risk innovation (see section 4.3).

Box 3: DARPA

The Defense Advanced Research Projects Agency (DARPA) is an advanced-technology branch of the US Department of Defense. Originally called ARPA, it was created after the Soviet Union launched the Sputnik satellite into space in 1957, sparking worries that the US was falling behind technologically. Its founding goal was to position the US at the forefront of strategic technological initiatives, with a priority to assert the US military presence in space. ARPA funded transformative technologies, including a nuclear test programme to detect when a nuclear missile is launched (the VELA satellite), and a satellite launching fighter jet (Airborne Launch Assist Space Access, ALASA), which aimed to reduce launch costs and to have satellite launches available on demand, rather than having to rely on rockets.

ARPA became DARPA in 1972. Some examples of DARPA projects for space include a space plane (XS-1), a folding space telescope design (Membrane Optical Imager for Real-Time Exploitation or MOIRE), a satellite recycling project (Phoenix) and projects on repairing and refuelling satellites in orbit. DARPA and NASA also collaborate on nuclear thermal rockets (DRACO).

But the internet and the global positioning system (GPS), DARPA's biggest success stories, illustrate the commercial opportunities embedded in its projects[26]. DARPA is keenly aware of these commercial opportunities. It jointly engages with commercial stakeholders to ensure a servicing capability for its missions and selects and funds civilian space projects, eg the 10-Year Lunar Architecture Capability Study (LunA-10) or the 'lunar railroads' developed by Northrop Grumman[27].

Beyond the US, procurement has been used to stimulate innovation in the space sector in Europe. Castelnovo *et al* (2023) studied the Archimedes public procurement programme from the Italian space agency (Agencia Spaciale Italiana, ASI) which aimed explicitly at supporting innovation. Comparing Archimedes procuring firms with similar non-Archimedes procuring firms they found that innovation-oriented space procurement contracts have a strong effect on patent production by firms. The effect was not only an increase in private space sector patenting, but also a shift in direction with a greater acceptance of risk and failure among companies in the short term, supporting the creation of more radical innovations. Nonetheless, even if successful, the small scale of the Italian Archimedes project limited its impact.

3.5 The limits of public planning and the legacy of SLS

Even though the American public sector has worked towards developing a healthier relationship with the private sector in the past two decades, public money is not necessarily always spent effectively. One of the most controversial examples is the Space Launch System (SLS) mega-rocket, part of the Artemis project to establish a permanent base on the moon. The SLS mega-rocket is developed jointly by 'old space' companies:

26 Regina E. Dugan and Kaigham J. Gabriel, '"Special Forces" Innovation: How DARPA Attacks Problems', *Harvard Business Review*, 1 October 2013, https://hbr.org/2013/10/special-forces-innovation-how-darpa-attacks-problems.

27 Mike Wall, 'DARPA picks Northrop Grumman to develop 'lunar railroad' concept', *Space*, 19 March 2024, https://www.space.com/darpa-northrop-grumman-moon-railroad.

Boeing, Northrop Grumman, Aerojet Rocketdyne and Lockheed Martin. It incorporates some older technology. For example, its boosters are an updated version of those used on the Space Shuttle (1981-2011), and its design is heavily inspired by the Ares V rocket, developed under the Constellation programme.

This is not a coincidence. When the Obama administration cancelled the costly Constellation programme, a public backlash ensued[28], as the programme employed numerous federal workers across several states. In response, Obama signed the NASA Authorization Act of 2010, which directed NASA to develop a heavy launch system reusing technology, contracts and the workforce responsible for the Ares V rocket. As a result, the SLS is essentially a refurbished version of a rocket that was already plagued by cost overruns and delays. Most notably, the SLS missed the most significant revolution in the launch industry – reusability. Unlike modern commercial rockets, it has no reusable components, making it significantly more expensive to operate.

The SLS is the most expensive rocket of the past 30 years and is significantly more costly than any privately developed alternatives (Figure 5). The cost per kilogramme of payload for the SLS is around 23 times higher than that of SpaceX's Falcon Heavy[29], and the difference is likely to be even greater compared to SpaceX's Starship, still in development.

The SLS has faced long-standing criticism, even from within NASA's senior management[30]. However, SLS remains in service as NASA claims that it is *"the only rocket that can send NASA's Orion spacecraft, four*

28 Amy Klamper, 'Obama's Move To End Constellation Prompts Industrial Base Questions,' *SpaceNews*, 12 February 2010, https://spacenews.com/obamas-move-end-constellation-prompts-industrial-base-questions/.

29 Authors' calculations.

30 Jackie Wattles, 'NASA's mega moon rocket is "unaffordable," according to accountability report,' *CNN*, 8 September 2023, https://www.cnn.com/2023/09/07/world/nasa-gao-report-sls-moon-rocket-scn/index.html.

astronauts, and large cargo directly to the Moon on a single mission" [31]. However, each flight is extremely costly (around $4.2 billion, compared to $100 million for Starship), and operationally difficult, so that only a few SLS rockets can be launched per year.

Modifying the Artemis Programme to rely more on Starship is an obvious alternative, and SpaceX, the producer of Starship and Falcon Heavy rockets, is already involved in the Artemis Programme. It is developing the Starship Human Landing System (Starship HLS), a variant of the Starship spacecraft, which will be used to transport astronauts to the lunar surface[32]. Under current plans, Starship HLS is expected to be delivered to Earth orbit by the SLS rocket, and astronauts will also be transported there via SLS. But there is speculation that major changes to the Artemis Programme could be on the horizon, including a shift from SLS to SpaceX's Starship rocket as the primary launch system[33].

31 See NASA, 'Space Launch System,' https://www.nasa.gov/reference/space-launch-system/.

32 See NASA, 'Human Landing System,' https://www.nasa.gov/humans-in-space/human-landing-system/.

33 William Harwood, 'Outgoing NASA leader Bill Nelson weighs in on Elon Musk and SpaceX, defends plans for moon rocket,' *CBS News*, 18 December 2024, https://www.cbsnews.com/news/bill-nelson-nasa-interview-elon-musk-spacex/.

4 Private investment: the emergence of new space companies

New technological opportunities coupled with new government practices, including procurement practices, have revolutionised the private space sector, with new companies emerging to compete with incumbent aerospace companies in a virtuous Schumpeterian creative-destruction process. The resulting lower launch costs and lower-cost satellites have attracted new private-sector customers to the space economy and have shaped investor confidence in the commercial viability of space investments, attracting venture capital to fund even more new space companies.

These dramatic changes have taken place most obviously in the United States. This chapter starts in section 4.1 by characterising the leading incumbent space companies. Section 4.2 introduces the game-changing private player, SpaceX – the most outstanding example of new-firm entry into the space economy. Section 4.3 discusses the broader landscape of new firms in the space sector and the venture capital behind them. Section 4.4 closes this chapter with a dive into the private firms that are the leading innovators in the space economy.

4.1 The leading incumbents in space infrastructure and services

Figure 14 shows the largest publicly listed companies in the space sector. SpaceX is a non-listed company and therefore not included in Figure 14[34] (see section 4.2 for more detail on SpaceX). All companies shown

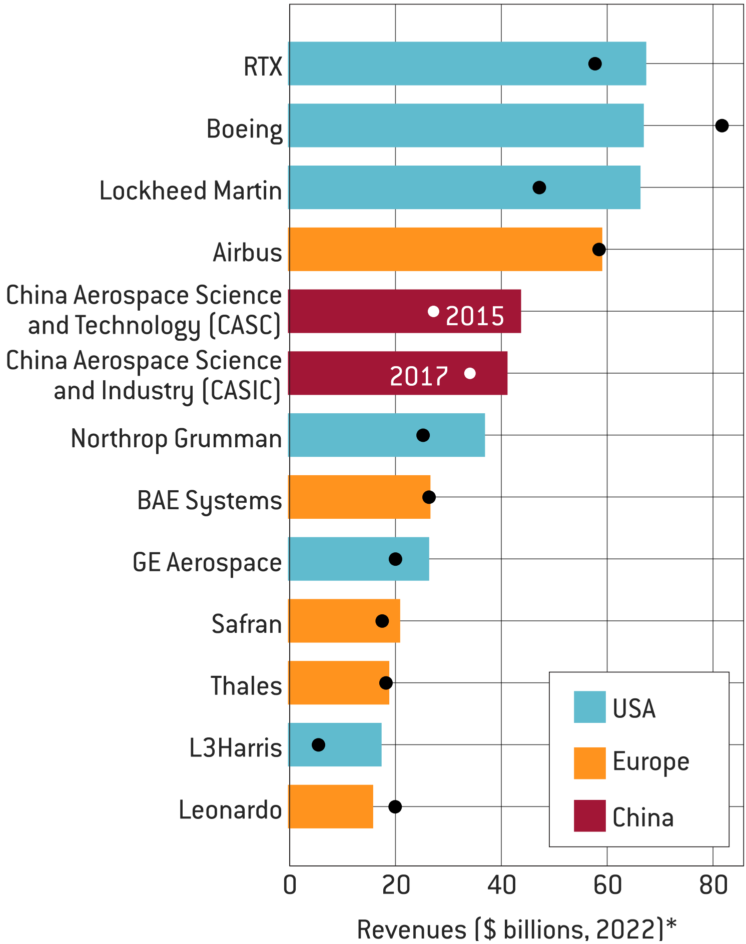
34 The two Chinese state-owned enterprises are also not publicly listed.

are large conglomerates with operations extending beyond the space industry, notably into commercial aviation and defence, and hence their reported consolidated revenues extend beyond their revenues from their space activities. The largest space companies are mainly active in the upstream segment of the space economy.

Most of the largest companies in the space industry are based in the United States, with RTX Corporation (formerly Raytheon), Boeing and Lockheed Martin ranking as the top three. Since 2012, most of these companies have expanded, with the exception of Boeing, which has lost its market leading position. But overall, Figure 14 shows persistent positions of the large incumbent players between 2012 and 2022. These large incumbents act as top-level contractors for their clients, and they deploy complex networks of suppliers. They frequently collaborate on contracts[35].

35 Sandra Erwin, 'Northrop Grumman selects Airbus to supply satellite buses for U.S. military constellation,' *SpaceNews*, 5 July 2022, https://spacenews.com/northrop-grumman-selects-airbus-to-supply-satellite-buses-for-u-s-military-constellation/.

Figure 14: Leading publicly listed companies in the space industry, 2012 and 2022



Source: Bruegel based on PwC, 2023, and Fortune 500. Note: only publicly listed companies and state-owned companies are included (SpaceX is non-listed). Revenues are at conglomerate level and therefore not only space revenues. See Table 3 for a detailed breakdown. *Dots signify revenues in 2012.

Given the deep technological overlap and scope for synergies between the aerospace, defence and space sectors, most leading space economy incumbents are conglomerates operating across these industries. For example, there is a close connection between space launchers and intercontinental ballistic missiles (ICBMs)[36]. Many launchers are either repurposed ICBMs or are based on technology which has evolved from them[37].

All leading incumbents in our list involved in the manufacturing of launch systems are also defence contractors. This is true for China Aerospace Science & Industry Corporation and China Aerospace Science and Technology Corporation (CASIC and CASC), companies with a near duopoly in the Chinese space industry since the 1990s (Liu *et al*, 2019) and known Chinese missile producers[38]. Similarly, Boeing produces propulsion systems for NASA's Artemis programme and develops the only land-based ICBM in service in the US, the Minuteman 3 (Boeing, 2023). Also, leading incumbent companies in the space and defence sector have been contracted to supply the next generation of ICBMs (Northrop Grumman in collaboration with Lockheed Martin and others[39]). There are many other examples of technology synergies between space, aeronautics and defence. For instance, the highly thermally resistant carbon material developed for ballistic missiles has found applications in both space launchers and in the brakes of

36 Gary Milhollin, 'The Link Between Space Launch and Missile Technology', Wisconsin Project on Nuclear Arms Control, 16 March 2000, https://www.wisconsinproject.org/the-link-between-space-launch-and-missile-technology/.

37 John Riordan, Daniel Dant and Timothy Cox, 'Time to Move ICBM and missile defense units to the Space Force', *SpaceNews*, 26 June 2020, https://spacenews.com/op-ed-time-to-move-icbm-and-missile-defense-units-to-the-space-force/.

38 Amy Hawkins, 'Three defence industry leaders removed from China advisory body', *The Guardian*, 28 December 2023, https://www.theguardian.com/world/2023/dec/28/three-defence-industry-leaders-removed-from-china-advisory-body.

39 Northrop Grumman, 'About Sentinel', undated, https://www.northropgrumman.com/what-we-do/advanced-weapons/sentinel.

commercial airplanes[40].

These technological synergies provide a basis for the typically conglomerate character of space industry incumbents. Leading incumbents in the space industry can be classified into two broad categories based on the scope of their conglomerate operations. First, there are companies predominantly active in the defence sector. RTX, Lockheed Martin and Northrop Grumman are the three biggest US defence companies, with L3Harris Technologies a little further down the rankings. For those companies, defence provided between 77 percent and 96 percent of total revenues in 2022[41], and the US government was their biggest client, responsible for an average of 74 percent of their sales[42]. Consequently, their sales are concentrated in the US with Europe a distant second market (9.5 percent of net sales on average).

In Europe, Leonardo and Thales are among the European Union's biggest defence contractors, with defence providing 83 percent and 52 percent of their revenues respectively[43]. Similarly, CASIC is China's largest missile maker[44], while CASC is China's only maker of intercontinental nuclear missiles[45].

Other leading incumbents are primarily engaged in civil aerospace. The chief example is Europe's Airbus, for which commercial aircraft

40 Airbus response to the European Commission consultation on 'Civil, defence and space industries (action plan on synergies)', 23 October 2020, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12611-Action-Plan-on-synergies-and-cross-fertilisation-between-the-civil-defence-and-space-industries/F739255_en.

41 *Defense News*, 'Top 100 Defense Companies 2024', undated, https://people.defensenews.com/top-100/.

42 Bruegel calculation based on companies' annual reports.

43 Bruegel calculation based on companies' annual reports.

44 Amy Hawkins, 'Three defence industry leaders removed from China advisory body', *The Guardian*, 28 December 2023, https://www.theguardian.com/world/2023/dec/28/three-defence-industry-leaders-removed-from-china-advisory-body.

45 China Aerospace Science and Technology Corporation, 'Strategic Nuclear Missiles', undated, https://english.spacechina.com/n17215/n17272/c2388530/content.html.

sales represented 69 percent of its revenues in 2022 (Airbus, 2023). This is also the case for Boeing, for which such aircraft provided 53 percent of revenues in 2022 (Boeing, 2023). Compared to its rival Airbus, Boeing is more diversified and more engaged in the defence sector. These companies all sell globally but with strong preferences for their regions of origin. For example, 59 percent of Boeing's total sales are in the US and 12 percent in Europe, whereas Airbus sells 41 percent in Europe and 23 percent in the US (Boeing, 2023; Airbus, 2023).

Since leading space industry incumbents are conglomerates, estimating the shares of their revenues that stem from the space industry is important but difficult (Table 3). Only a few of those companies report revenues from space activities as a separate category in their annual reports. In 2022, Lockheed Martin earned $11.5 billion from space activities, or 17 percent of total revenues. Another American incumbent, Northrop Grumman earned 34 percent of total revenues from its space segment. Those values are far greater than the space activities of European companies. For example, Thales Alenia Space and Telespazzio (a Thales/Leonardo joint venture) posted consolidated revenues of approximately $3 billion in 2022, or nine percent of the total revenues of their parent companies[46]. Similarly, Ariane Group (a Safran and Airbus joint venture) provided $2.5 billion in 2022. Other companies in Table 3 do not provide separate revenues for their space activities and therefore only estimates are given for their space revenues.

46 Leonardo also owns 29.6 percent of Avio, one of the leading launch providers in Europe, with revenues of $371 million in 2022.

Table 3: Space-related revenues of the leading space sector conglomerates

Company	Space-related revenues in 2022 ($ billions)	% of total revenue
RTX	< 34.9 (Collins Aerospace and Raytheon Intelligence and Space)	< 52%
Boeing	< 23.2 (Boeing Defence, Space & Security, including ULA* with Lockheed Martin)	< 34%
Lockheed Martin	11.5 (including ULA* with Boeing)	17%
Airbus	< 11.8 (Airbus Defence and Space, including Ariane Group, JV with Safran)	< 20%
Northrop Grumman	12.3 (including 'Strategic Missiles')	34%
GE Aerospace	< 7.3 (including military and avionics systems)	<28%
Safran	2.5 (Ariane Group, JV with Airbus)	12%
Thales	2.9 (Thales Alenia Space and Telespazzio, JVs with Leonardo)	16%
L3Harris	< 6 (including airborne systems)	<35%
Leonardo	3.3 (Thales Alenia Space and Telespazzio, JVs with Thales and Avio (~ 30% shares))	21%

Source: Bruegel based on companies' annual reports and other public information. Note: precise estimates are in bold. *ULA (United Launch Alliance) is a Boeing/Lockheed Martin joint venture; see https://www.boeing.com/space/united-launch-alliance.

Most of the leading incumbents operate in multiple segments of the space industry (Table 4). Within manufacturing, aerospace giants such as Airbus and Northrup Grumman have long produced satellites for civil and military government agencies. Companies that manufacture spacecraft and their components are frequently also involved in the launch segment. For example, one of the biggest launch companies in the US, ULA, is a 50/50 joint venture between Boeing and Lockheed Martin (see Table 3). Similarly, Airbus and Safran, two major space manufacturing companies, control 74 percent of the shares of Arianespace, the biggest launch operator in Europe. Airbus also manufactures satellites for OneWeb[47]. But even new space companies operate across segments, with most notably SpaceX being involved in launch, manufacturing and provision of internet services. Other companies are also involved in those markets, including Blue Origin, which may soon become the closest private competitor to SpaceX in the launch sector. Blue Origin also works on Project Kuiper, an internet constellation for Amazon[48].

47 Airbus press release of 17 December 2024, 'Airbus awarded Eutelsat contract to build OneWeb low orbit constellation extension', https://www.airbus.com/en/newsroom/press-releases/2024-12-airbus-awarded-eutelsat-contract-to-build-oneweb-low-orbit.

48 Amazon, 'Project Kuiper', undated, https://www.aboutamazon.com/what-we-do/devices-services/project-kuiper.

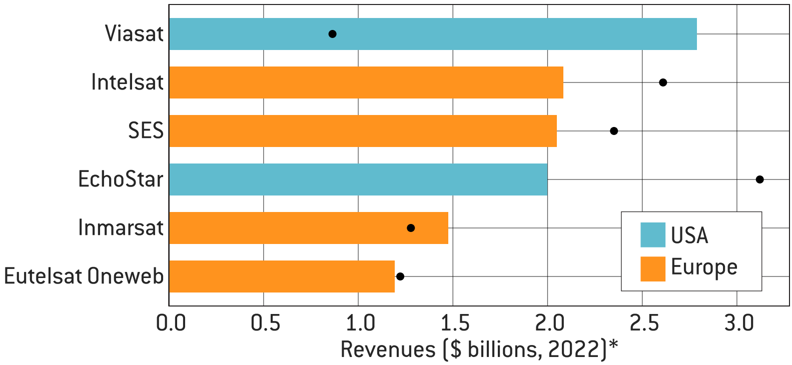
Table 4: Main activities of the space-sector incumbents

	Launch	Spacecraft and infrastructure	Satellite manufacture	Satellite services	Space security	Space electronics	Ground systems and equipment
RTX		●	●	●	●		●
Boeing	●	●	●			●	●
Lockheed Martin	●	●	●	●	●		●
Airbus	●	●	●		●		●
CASC	●	●	●	●	●		●
Northrop Grumman	●	●	●	●	●		
BAE Systems					●	●	●
GE Aerospace	●						
Safran	●		●			●	●
Thales	●		●		●		

Source: Bruegel based on companies' annual reports and other public information. Note: colours denote origin (blue for the US, orange for Europe and red for China). Launch includes launch systems manufacturing and launch services. 'Spacecraft & infrastructure' includes orbital infrastructure and space exploration vehicles. 'Satellite services' include Earth observation services. 'Ground systems' include all satellite communication devices. 'Space security' includes early-warning technology, space surveillance and cybersecurity.

Leading space companies have most of their space activities in the upstream segments. They are rarely involved in operating satellite constellations. This role is predominantly fulfilled by specialised companies, who provide internet and TV broadcasting services (Figure 15). In this segment, revenues are much smaller, but competition is high. The exception is SpaceX, the vertical scope of which also covers satellite operations. SpaceX, being non-public, is not reported in Figure 15, but SpaceX's Starlink revenues were estimated at around $1.4 billion in 2022[49], which would place the company among the leading satellite communication companies.

Figure 15: Leading satellite operators, revenues, 2012 and 2022

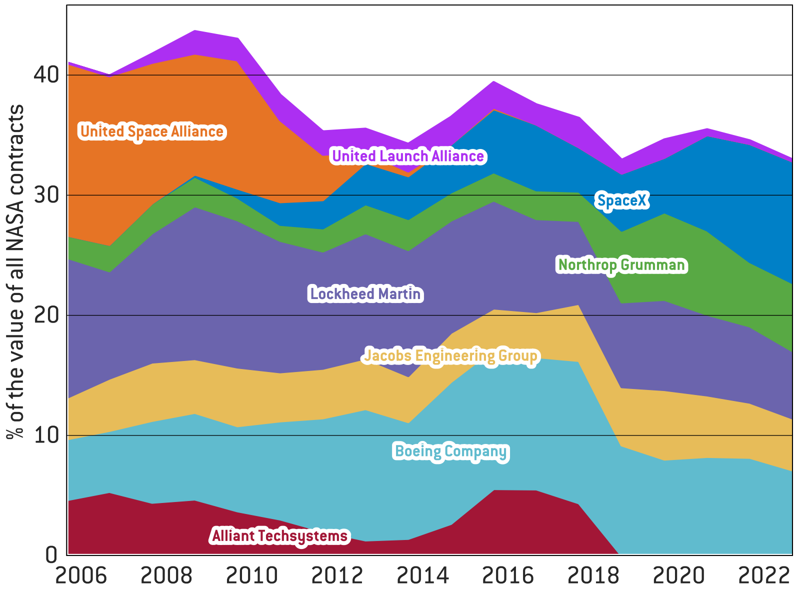


Source: Bruegel based on PwC, 2023 and Fortune 500. Note: only publicly listed companies and state-owned companies are included. *Dots signify revenues in 2012.

The top-three incumbent US public space companies (Lockheed Martin, Boeing and Northrop Grumman) are also major NASA contractors, as shown in Figure 16.

49 Jon Brodkin, 'SpaceX Projected 20 Million Starlink Users by 2022—It Ended up with 1 Million,' *Ars Technica*, 13 September 2023, https://arstechnica.com/tech-policy/2023/09/spacex-projected-20-million-starlink-users-by-2022-it-ended-up-with-1-million/.

Figure 16: Main private-sector NASA contractors



Source: [SAM.gov.](SAM.gov)

In 2006, Lockheed Martin, Boeing and Northrop Grumman accounted for 32 percent of all money spent by NASA on contractors. This figure includes United Space Alliance, a Boeing-Lockheed Martin joint venture that operated the Space Shuttle programme. More recently, since reform of the US Commercial Orbital Transportation Services programme (see chapter 3), the share of the top-three incumbents has been reduced considerably, but still represented 21 percent of the total value of NASA contracts in 2022. Meanwhile, Figure 16 shows the steep rise of SpaceX as a major NASA contractor, illustrating the role NASA has played with its modified procurement policy in changing the landscape of space companies in recent years.

4.2 SpaceX

SpaceX was founded in 2002 to *"revolutionise space technology, with the ultimate goal of enabling people to live on other planets"*. In contrast to the publicly listed incumbents in Table 3, SpaceX is fully focused on the space sector and is active in all segments of the space sector.

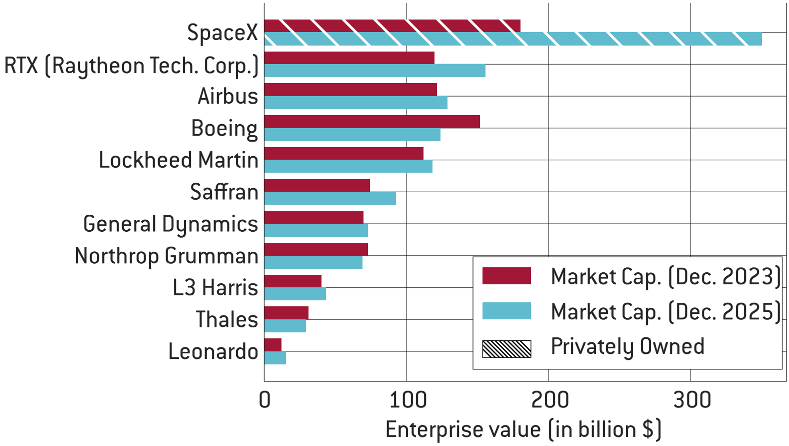
4.2.1 A new market leader in the space economy

Over two decades, SpaceX has become a leader in the space industry, challenging conglomerate incumbents. An estimate of its revenues for 2024 – 100 percent space related – arrived at $13 billion[50], still substantially smaller than the revenues of RTX and Boeing, but comparable to the space revenues of incumbents Lockheed Martin, Northrop Grumman and Airbus (Table 3)[51]. When looking at estimates of its market valuation, as provided by Bloomberg (Figure 17), it even surpasses all other space companies, showing its remarkable success in the short time since its founding.

50 Rich Smith, 'How Much Money Did SpaceX Make in 2024?' Motley Fool, 8 February 2025, https://www.fool.com/investing/2025/02/08/how-much-money-did-spacex-make-in-2024/.

51 SpaceX, being a private company, does not disclose information such as revenues, or their financing history. Provided estimates should be treated with caution.

Figure 17: Valuations of space companies



Source: Bruegel based on YCharts, Bloomberg. Note: values for SpaceX are estimated based on a tender offer as reported by Bloomberg. Valuations are reported as of 13 December 2023 and 11 December 2024 when tender reports were published.

Heavyweight and reusable rockets have been key to SpaceX's success. These are at the frontier in the launch segment in terms of cost efficiency and effectiveness. SpaceX has taken up leading positions not only in the launch segment, but across various segments of the space economy. It manufactures, launches and operates its own satellite mega-constellations. SpaceX is not alone as a company that both manufactures and operates satellites. For instance, Spire Global, a US startup founded in 2012, designs, manufactures and operates a fleet of over 100 nanosatellites, making use of cheaper and more efficient mass-produced components. OneWeb, a UK firm founded in 2012 (now part of France's Eutelsat Group), manufactures and operates its own satellite mega-constellations.

But SpaceX is unique among space entrants in that it is vertically integrated within the satellite industry. SpaceX manufactures all of its Starlink satellites in-house and launches them using proprietary launch vehicles at private launch sites.

SpaceX, with its vertical integration, is not only unique among space startups, it is even quite unique among the large space incumbents, which are typically more restricted than SpaceX in terms of vertical integration across space segments (Table 4). Its vertically integrated range of activities including launch gives it a strong competitive advantage in downstream markets compared to other satellite operators who must rely on the launch facilities of others. SpaceX shows the viability of integrating innovation, manufacturing, launch infrastructure and operations segments under the umbrella of a single new firm.

Box 4 lists SpaceX's main milestones.

Box 4: SpaceX milestones

- 2002: Elon Musk creates SpaceX.
- 2008: first successful launch of SpaceX's Falcon 1, the first privately-developed rocket to go into orbit. Falcon 1 is retired soon after, as the company focuses on the development of Falcon 9, a reusable rocket, as part of the COTS programme (chapter 3).
- 2012: Falcon 9 flies on its first commercial resupply mission, making SpaceX the first private company to send a spacecraft to the International Space Station before returning to Earth; SpaceX starts to provide commercial resupply services to NASA. The final cost of developing Falcon 9 proves up to ten times less than projected by NASA's internal model. Falcon 9 proves to be one of most cost-effective launchers in history (Figure 5).
- 2015: Starlink announced; SpaceX opens satellite development facility.
- 2019: first batch of 60 Starlink satellites launched.
- 2020: first operational crewed flight of the Dragon spacecraft to the International Space Station.
- 2022: shortly before Russia invaded Ukraine in February 2022, Russian hackers launched a cyberattack against the network of satellites

operated by Viasat, which was used by the Ukrainian military[52]. To enable communication and control over drones, Starlink has been deployed over Ukraine. Starlink is also used by hospitals, aid organisations and businesses.
- 2022: Starshield, a military version of Starlink, is announced.
- 2023 US Department of Defence contracts Starlink for operations in Ukraine.
- 2023: first test flight of the Starship rocket.
- 2024: SpaceX achieved the first successful landing of a Starship booster, caught by the launch tower's mechanised arms.

4.2.2 Drivers of SpaceX's growth

High gain/high risk innovative entrepreneurship

The story of SpaceX illustrates the importance of entrepreneurship, innovation, risk taking, access to finance, perseverance, technological know-how and a passion for space exploration. The early days of SpaceX were fraught with difficulties, including the unsuccessful first launch of the Falcon rocket. Nonetheless, founder Elon Musk was committed to SpaceX's unique industrial innovation model of early testing of alternative designs and iterative product development stages, based on fast learning from trials. Other US startups, including Teledesic and GlobalStar, had similar projects, though on a much smaller scale. All of them went bust.

A mixture of own, public and private funding

Beyond Musk's own risk taking and financial resources, public space agencies were important in SpaceX's development and growth. NASA and the US Department of Defense (including DARPA) created opportunities via their reformed procurement policies for companies such as SpaceX

52 NCSC, 'Russia behind cyber attack with Europe-wide impact an hour before Ukraine invasion', 10 May 2022, UK National Cyber Security Centre, https://www.ncsc.gov.uk/news/russia-behind-cyber-attack-with-europe-wide-impact-hour-before-ukraine-invasion.

to try out risky new projects. A deep and well-functioning private US risk-finance ecosystem was also instrumental in SpaceX's success. Box 5 sets out the funding history of SpaceX, showing the mixture of own, public and private funding.

Box 5: The SpaceX funding timeline

- 2002: Musk creates SpaceX, providing $100 million in funding (Berger, 2021).
- 2002-2005: SpaceX gathers $72 million in Series A-B venture-capital funding (early-stage VC).
- 2006: SpaceX is awarded $278 million by NASA to develop a launch vehicle and cargo delivery vehicle, to be paid incrementally up to 2012 on completion of milestones.
- 2008: NASA contracted SpaceX, paying $1.6 billion for 12 International Space Station (ISS) resupply missions as a part of commercial resupply services (CRS) programme.
- 2009: the first two Falcon 1 flights were covered by the US Department of Defense (about $7 million per launch).
- 2010-2012: SpaceX received an additional $118 million to spend as part of the increase in COTS funding initiated by Congress.
- 2010-2012: SpaceX wins $75 million to develop a crewed version of the Dragon vehicle as part of the CCDev-2 programme (Box 2 in chapter 3). CCDev-2 is extended, becoming CCiCap, the goal of which is for NASA to obtain a full end-to-end concept of operation (from the ground to the space station and with recovery). SpaceX receives an additional $460 million.
- 2010-2012: the US government provides $396 million to SpaceX for development of Falcon 9, while the company is able to mobilise $454 million, according to NASA.
- 2010-2012: SpaceX raises $258.4 million from a series of major private investment later-stage venture capital financing rounds.
- 2014: SpaceX receives $15.3 million from the state of Texas as an incentive

to build a factory in Boca Chica. SpaceX collects another $5 million from a local non-profit.

- 2014: SpaceX is contracted for crewed missions to the ISS, with the contract worth $2.6 billion as part of the Commercial Crew Program.
- 2015: Google and Fidelity Investment invest $1 billion in SpaceX in exchange for an 8.33 percent ownership stake
- 2016: SpaceX is contracted by NASA for at least six missions up to 2024.
- 2018: between 2015 and 2018, SpaceX gets $1.2 billion from three later-stage investment rounds. During the same period, it also raises an additional $250 million in debt financing.
- 2020: Starlink is subsidised with $885.5 million to support rural broadband US customers. But a year later, this subsidy was cancelled as SpaceX was assumed to be unable to deliver the promised broadband speed.
- 2021: Starlink opens up to the public for pre-orders, generating $222 million in revenue in 2021.
- 2018-2021: SpaceX raises an additional $5 billion in venture funding and secondary financing.
- 2022: Starlink generates $1.4 billion in revenues worldwide (according to internal documents).
- 2022: SpaceX raises $2 billion in venture funding and private equity.
- 2023: the Department of Defense starts paying for Starlink operations in Ukraine (the contract value is undisclosed).
- 2023: SpaceX wins its first contract with US Space Force: $70 million for Starshield satellites, the military version of Starlink.
- 2024: SpaceX revenue estimated to be between $11.8-13.1 billion[53] [54], with Starlink revenue surpassing launch revenue.

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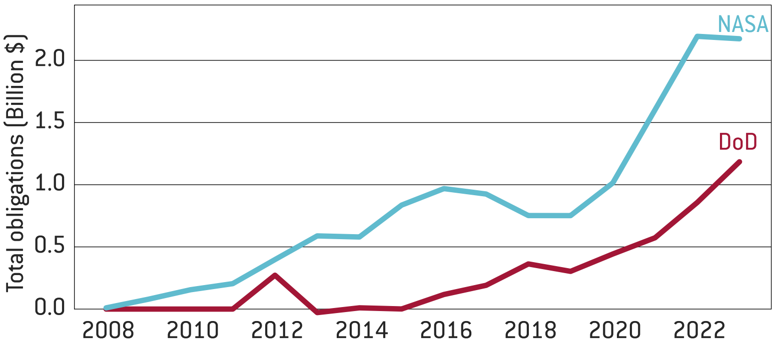
53 Novaspace press release of 6 May 2025, 'Starlink Outpaces Launches: SpaceX Enters New Era of Profitability', https://nova.space/press-release/starlink-outpaces-launches-spacex-enters-new-era-of-profitability/.

54 Jack Kuhr, 'Estimating SpaceX's 2024 Revenue', *Payload*, 29 January 2025, https://payloadspace.com/estimating-spacexs-2024-revenue/.

Even in its early stages, SpaceX attracted private capital, primarily from major American private-equity firms, including some of the world's largest asset management companies and Peter Thiel's Founders Fund, and smaller entities specialising in space, such as SpaceVC. As the company expanded, a broader range of investors, including Google, began to contribute. According to Crunchbase, the company has raised at least $9 billion on the private market since 2002.

The public sector has also played a significant role in financing SpaceX. This started early. SpaceX was granted at least $931 million by NASA to develop the Falcon 1 launch system between 2006 and 2012, as part of several programmes introduced to create operational commercial launch systems. It also received DARPA funding. This initial public funding was followed by a series of public contracts, including for the Falcon 9 rocket and Dragon vehicle, in cargo and human-transportation versions. Figure 18 shows the increasing public grants and contracts provided by NASA and the US Department of Defense (incl DARPA) to SpaceX.

Figure 18: Total US government obligations to SpaceX by contracting agency



Source: Bruegel based on Federal Procurement Data Systems.

With the election of Donald Trump, whose 2024 presidential campaign received significant financial backing from Elon Musk, SpaceX seems set for a lucrative collaboration with the federal government. This process has already started. Some countries were reported to have provided SpaceX with favourable treatment directed at Starlink as part of a strategy to negotiate tariff deals with the Trump administration, which the administration had suggested[55]. SpaceX is also the frontrunner to build the Golden Dome missile defence system proposed by the Trump Administration[56], which could potentially cost upwards of $500 billion. The system would detect and neutralise incoming intercontinental missiles, using a satellite network modelled on Starlink's low-Earth-orbit architecture. In his inauguration speech, Trump also expressed enthusiasm for SpaceX's long-term vision of

55 Jeff Stein and Hannah Natanson, 'U.S. pushes nations facing tariffs to approve Musk's Starlink, cables ahow,' *The Washington Post*, 7 May 2025, https://www.washingtonpost.com/business/2025/05/07/elon-musk-starlink-trump-tariffs/.

56 Mike Stone and Marisa Taylor, 'Exclusive: Musk's SpaceX Is Frontrunner to Build Trump's Golden Dome Missile Shield,' *Reuters*, 17 April 2025, https://www.reuters.com/business/aerospace-defense/musks-spacex-is-frontrunner-build-trumps-golden-dome-missile-shield-2025-04-17/.

establishing a human colony on Mars. Signals in the early part of his administration suggested support for expanded collaboration between NASA and SpaceX on both lunar and interplanetary missions.

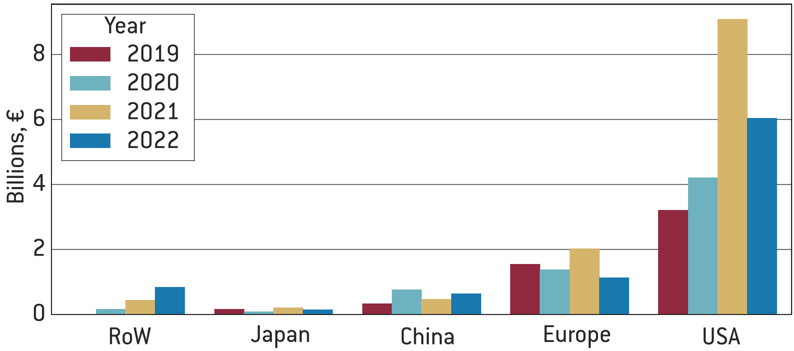
4.3 Investment in space startups

The rapidly growing space sector has seen unprecedented levels of investment in the industry and entry of new firms. In addition to SpaceX, a new wave of startup space companies has grown rapidly[57]. SpaceX with its breakthrough innovations and the resulting massive reduction in the costs of operating in the space economy, has contributed to this growth in new firms. For instance, while US Iridium, a satellite constellation operator founded in 2001, relied on government launch services in the US, Russia and China for its first-generation satellite constellation to reach orbit, it used SpaceX exclusively for its second-generation constellation, launched in 2017-2019.

Advances in technology and lower launch costs have also fuelled investor confidence in the commercial viability of new space startups, easing the access to venture financing for these startups. Growth in VC and other investment in space startups has been largely US-based. In 2022, 47 percent of 422 private investors in space companies were based in the US, followed by China (8 percent), Japan (6 percent), the UK (6 percent) and France (5 percent) (Christensen *et al*, 2023). The geographic destination of investments in space startups has been concentrated in the US (Figure 19), similarly to the concentration in the US of public space budgets.

57 For example, Sierra Space ('new space' launch company with most funding collected after SpaceX) is valued at $5.3 billion. Rocket Lab is valued at $11.6 billion, with revenues less than $0.5 billion. UK's OneWeb, founded in 2013, bankrupt in 2020, merged with French Eutelsat in 2023. OneWeb Eutelsat market cap dropped from $3.5 billion around the time of the merger to $1.9 billion in May 2025.

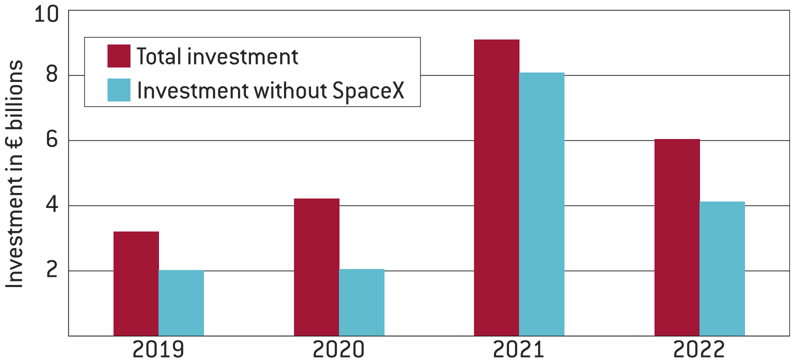
Figure 19: Total investment in startups in the space sector (2019-2022)



Source: Bruegel based on European Space Policy Institute database.

A significant part of overall investment in US space startups went to SpaceX: about 28 percent of total investment in American space startups between 2019 and 2022 was accounted for by SpaceX alone (Figure 20). But that still leaves a large share of investments for other US space startups. Box 6 describes the cluster of 'New Space' firms in California (in and around Los Angeles). They are heirs to a century-old aerospace tradition, rebooted in 2002 by SpaceX. SpaceX moved its headquarters to Texas, but the wave of new space firms continued, most of them spin-off from SpaceX. This illustrates a vibrant innovation ecosystem, characterised by highly ambitious high-gain, high-risk entrepreneurship, a fluid market for talent and a sufficiently large public and private funding appetite at very early stages of new ideas.

Figure 20: Total investment in US startups with and without SpaceX



Source: Bruegel based on European Space Policy Institute.

Box 6: California's New Space Cluster

Angeleno New Space cluster is a cluster of firms located in the Los Angeles metropolitan area, building on a tradition of aerospace in the region. SpaceX located there in 2002. Early SpaceX management came from neighbouring Boeing and TRW (acquired by Northrop Grumman in 2002). Many startups were founded by former SpaceX employees. Though SpaceX moved its headquarters to Texas in 2024, the Angeleno New Space cluster continues to host and attract grand risky ideas with high breakthrough potential. Beyond work on the next generation of launch equipment and satellites, there are plans for missions to explore Mars, mine asteroids, manufacture in space and put private space stations into orbit.

Some examples[58]:

Rocket Lab is a space manufacturer and launch service provider. Its Electron orbital rockets launch small satellites. It also supplies satellite

58 See also *The Economist*, 'Dreams of asteroid mining, orbital manufacturing and much more', 3 December 2024, https://www.economist.com/science-and-technology/2024/12/03/dreams-of-asteroid-mining-orbital-manufacturing-and-much-more.

components. It was founded in 2006 in New Zealand, but moved its headquarters in 2013 to Long Beach, California. Its expendable Electron rocket was first launched in 2017. In 2020, the company launched its first Photon satellite. The company builds and operates satellites for the US Space Force. It is one of the few new space firms, alongside SpaceX, that is making money from launches. It has about 2000 employees globally, of whom 1300 are in the US.

Varda Space Industries, founded in 2021 by Will Bruey, an ex-SpaceX engineer, aims to run fully automated pharmaceutical production in orbit, where the unique properties of the microgravity environment could enable production of more effective drugs, or even new drugs it would not be possible to produce on Earth. In 2024, Varda successfully recovered an automated capsule that had crystallised the anti-HIV drug ritonavir in orbit and re-entered Earth's atmosphere. Since then, it has completed two more missions in collaboration with the US Air Force, during which the capsules collected data to support improvements in hypersonic navigation.

Outpost Space works on transportation systems for in-orbit manufacturing. It is developing Carryall spacecraft, which would serve as a satellite bus. Delivered to orbit by launch vehicles, Carryall would deploy autonomous manufacturing systems in space and later retrieve them, returning them to a precise location on Earth. The return system combines a heat shield with a robotic paraglider for controlled descent and landing. The device is also of interest to the military, to store gear in orbit and deliver it when needed to hard-to-reach parts of the world. The US air force is paying for the first four launches of a smaller test version, Ferryall.

Vast Space, founded in 2021 by Jed McCaleb, an entrepreneur who made a multi-billion-dollar fortune in cryptocurrencies, is hiring former SpaceX employees and plans to operate private space stations with artificial gravity. Launch of Vast's first station, Haven-1, is planned for 2026. Vast is counting on contracts from NASA. In 2026 NASA will select finalists for its Commercial Low Earth Orbit Destinations programme, which aims to develop stations to replace the International Space Station after its deorbit, expected sometime after 2030. Vast plans to participate, but faces more experienced competitors, such as Axiom Space, a Texas-based company already backed by NASA, and Bezos's Blue Origin.

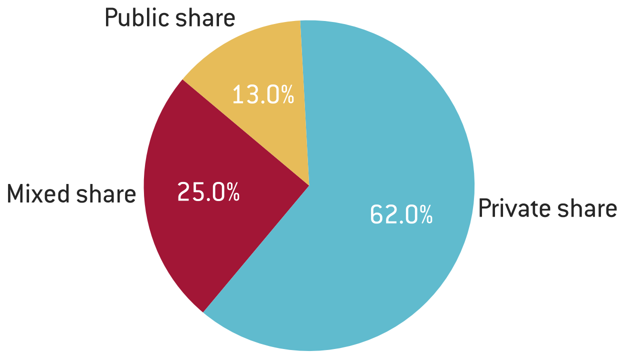
Venturi Astrolab is one of the three companies selected by NASA to develop a Lunar Terrain Vehicle for the return-to-the-moon Artemis programme. It's biggest vehicle, FLEX is designed as a modular vehicle capable of accommodating up to 1,500 kilos of cargo and being operated remotely or by two on-board astronauts.

Impulse Space, founded in 2021 by Tom Mueller, also a former SpaceX hire, makes small rockets that move satellites around in space. Like SpaceX, it has ambitions for Mars missions. For this, it has teamed up with **Relativity Space,** another new space venture, to provide the launcher and cruise stages, and the entry capsule and lander for a Mars trip.

While the US space startup financing landscape involves private investors only[59], in Europe, the public sector plays a much larger role in financing new space ventures: public funding (13 percent) and mixed consortia (25 percent) contribute significantly (Figure 21). The share of private investment in space startups is even smaller in China (43 percent between 2014-2023), where central, provincial and municipal governments actively operate as investors (ESPI, 2023b; Liu *et al*, 2019).

59 Between 2019 and 2022, the share of private investment in total American startup investment oscillated around 99 percent.

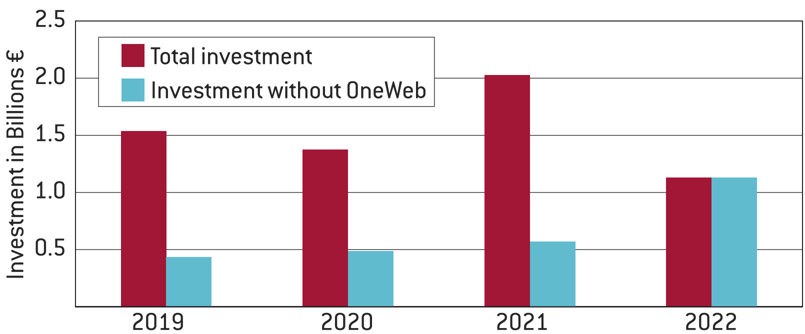
Figure 21: Startup investment in Europe by type (2019-2022)



Source: Bruegel based on European Space Policy Institute database.

Figure 22 shows that, between 2019 and 2021, a significant portion of European investment in the space sector was directed towards a single entity: the UK-based satellite manufacturer, OneWeb. Nevertheless, excluding OneWeb from the analysis reveals an upward trajectory of space investment in Europe since 2019 and in 2022, private investment in European space companies, excluding OneWeb, surpassed €1 billion for the first time.

Figure 22: Private investment in European space startups



Source: Bruegel based on European Space Policy Institute database.

The European space sector consists mainly of investees based in the UK. Between 2014 and 2022, private investment in space the UK accounted for significantly more than any other country in Europe, at just over €6 billion, with France a distant second with €487 million (ESPI, 2023b). Once again, this is heavily impacted by investment in OneWeb, which represented €5 billion of investment in the UK during this period. But even without OneWeb, the UK still led the rest of Europe, receiving more than double the investment in second-place France. On the investor side, the UK is also the leading European nation. After the US and China, the UK is home to the most private investors in the sector, representing 7 percent of the global total (BryceTech, 2023). France is second with 5 percent. Though still miniscule compared to the US, this is a reminder of the significance of the UK, a non-EU European Space Agency member, when evaluating investment in the European space sector.

When it comes to private investment in startups, venture capital plays a pivotal role, accounting for most funding. Worldwide, VC has been responsible for 84 percent of global space startup investment (Christensen *et al*, 2023). In Europe, VC contributed 76 percent of total private funding since 2019, as reported by ESPI (2023a). European VC funding experienced a peak between 2021 and 2022. In 2023, there were 30 percent fewer deals than in 2022, and a 7 percent decrease in total investment. This peak likely included generalist VC funds which lacked space-specific knowledge moving into the industry, and correlated with an increased failure rate at the early stages of fund-raising and product development (ESPI, 2023a).

4.4 Positions in R&D and patents

4.4.1. R&D in aerospace and defence

The EU Industrial R&D Investment Scoreboard[60] traces the R&D investments of the 2500 largest R&D-spending firms in the world, at the consolidated firm level and only for publicly listed companies. For the space sector this means that SpaceX is not included and that the R&D levels are not for space solely, but for the broader aerospace and defence field, as most of the firms are not only operating in the space sector. In 2023, there were 41 Scoreboard companies in the aerospace and defence sector. Of these, 15 were from the US, 12 from the EU, two from the UK and three from China. With an average R&D to sales ratio of 4.5 percent, the sector is a medium-tech sector.

Corporate R&D spending in aerospace and defence is heavily concentrated among few big players, all incumbents (as SpaceX is not included). The top-four aerospace and defence R&D spenders worldwide represent 48 percent of all sector R&D tracked by the Scoreboard. The largest spender in 2022 was the EU's Airbus, with an R&D-to-sales ratio of 5.5 percent, representing 16 percent of global R&D in the sector and 39% of EU R&D in the sector, as tracked by the Scoreboard. The next three biggest spenders worldwide are US companies: Raytheon, Lockheed and Boeing with, respectively, 14 percent, 10 percent and 7 percent of global sector R&D tracked by the Scoreboard, equivalent to 27 percent, 26 percent and 17 percent respectively of US R&D as recorded in the Scoreboard. Overall, the EU accounts for 29 percent of Scoreboard firms in the sector and 41 percent of sector R&D, while for the US it is 37 percent of firms and 44 percent of sector R&D recorded in the Scoreboard.

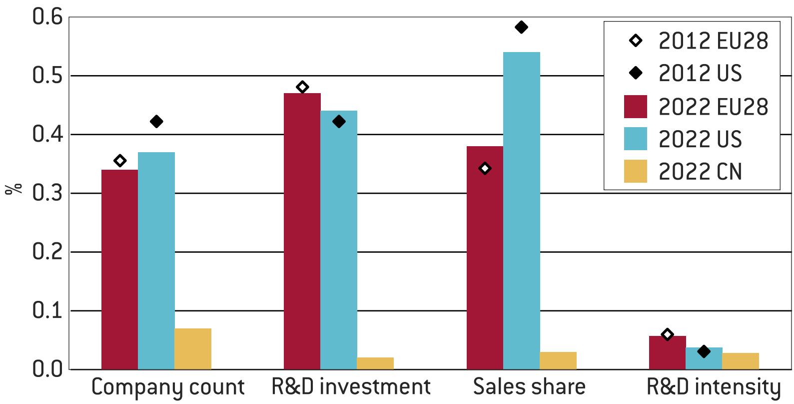
While EU firms are more or less on an equal footing with their US counterparts in terms of total R&D spending, US firms listed in the Scoreboard dominate their EU counterparts in terms of sales (see also

60 See https://iri.jrc.ec.europa.eu/data.

Figure 14). As a consequence, EU firms have higher R&D-to-sales ratios (R&D intensity) than their US counterparts (6.3 percent versus 3.7 percent). However, while R&D intensity has decreased over time for EU Scoreboard firms (in 2012 it was 7.1 percent), the R&D intensity of US Scoreboard firms has increased (in 2012 it was 3.1 percent). Disruptive innovator SpaceX is not included for the US, but might have prompted US incumbent firms to become more innovative.

Chinese aerospace and defence firms, of which there were three in the Scoreboard in 2022 (none in 2012), are less R&D-intensive and accounted for only 1.7 percent of sectoral R&D.

Figure 23: Aerospace and defence Scoreboard data



Source: Bruegel based on the EU Industrial R&D Investment Scoreboard.

4.4.2. Patenting of space technology

Patenting is another indicator used frequently to trace innovation activities. The space sector is somewhat different from other innovative sectors because patents are not a commonly used mechanism for protecting space-related innovation. This is in part because inventions can often be used both for the space and the defence sectors. The prevalence of government procurement for defence, with secrecy embedded in the contracting, tends to make patenting rarer than in other sectors in which companies need to protect their intellectual property. Nevertheless, as the space market has changed over the past two decades, with a strong increase in commercial space activities, and with the changes in procurement procedures with firms allowed to retain the intellectual property developed in the context of government contracts, protection of intellectual property is becoming increasingly prevalent.

A big outlier is SpaceX, which remains not highly active in patenting. Although the company filed for 202 patents between 2002 and 2022, its patent portfolio remains exclusively related to Starlink satellites rather than its core rocketry technology[61]. This is a small number compared to companies such as Boeing, which filed 1,416 patents between 2000 and 2023, or public research organizations such as the Chinese Academy of Sciences, which filed 2,186 patents during the same period[62].

Bearing in mind the specific characteristics of space industry patenting activity, it is nevertheless interesting to see who is applying for and obtaining patents and how these trends have changed. We use data from PATSTAT, the European Patent Office's worldwide patent database, and select all patents with International Patent Classification (IPC) code 'B64G', which refers to 'Cosmonautics; vehicles or equipment therefor', filtered further by keeping only patents with abstracts containing the word 'space'. For our sample, we keep only the most valuable patents – the 20 percent of patents with the most citations in their first five years.

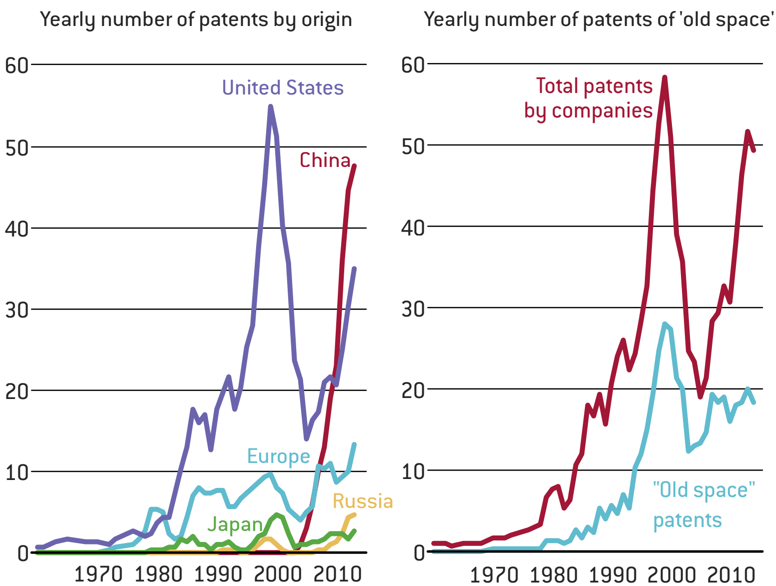
Figure 24 shows two clear spikes in the amount of patenting in the space sector: one around 2000 and one starting in about 2010. While the 2000 peak was almost entirely driven by the US, the more recent peak has also been driven by a huge increase in Chinese patenting. Europe's

61 Insights by GreyB, 'SpaceX Patents – Insights & Stats (Updated 2024)', 10 March 2025, https://insights.greyb.com/spacex-patent/.

62 WIPO, 'Top patent owners: patent activity', *WIPO Technology Trends Technical Annex: Future of Transportation in Space*, undated, https://www.wipo.int/web-publications/wipo-technology-trends-technical-annex-future-of-transportation-in-space/en/top-patent-owners.html.

share of patents in this field has remained stable and relatively small. Panel B of Figure 24 shows that the recent increase in space patents is mostly driven by entities other than legacy companies identified in Figure 14.

Figure 24: Number of space patents by origin



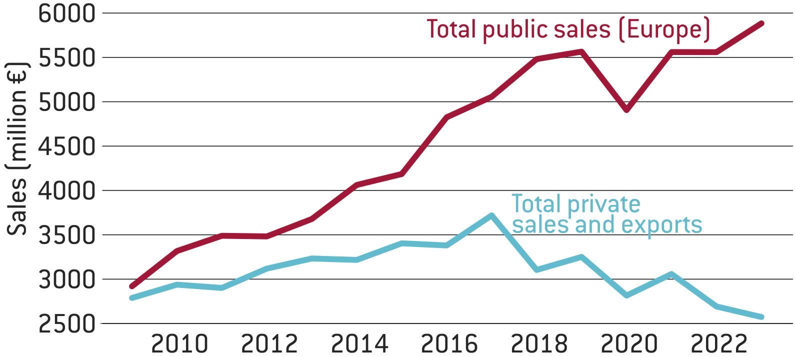
Source: Bruegel based on PATSTAT database.

5 Challenges facing Europe's space industry

In a global space economy dominated by the United States, Europe has nevertheless been able to build and maintain specific industrial capabilities and know-how. However, the major shifts in the space economy documented in chapter 2 are challenging Europe's competitive position. The European space sector has been losing out in terms of commercial sales and exports of space products (see Figure 25), exacerbated by the COVID-19 pandemic and the war in Ukraine, which caused severe supply chain disruption (Draghi, 2024). In 2024, Europe represented only about 10 percent of the global upstream space market value. In downstream markets and in terms of derived demand of the space industry (Figure 26, right panel), Europe has a somewhat more substantial market share at 23 percent[63].

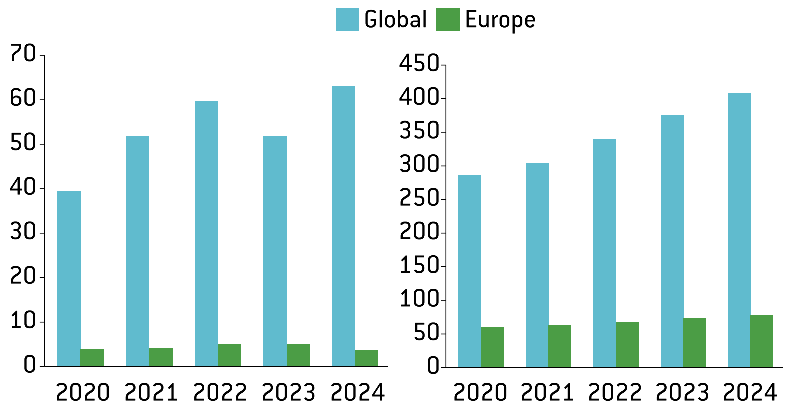
63 Euroconsult data as cited by ESA (2025).

Figure 25: Sales of the European upstream space industry (€ millions)



Source: Bruegel based on ASD-Eurospace. Note: data includes only sale of space products; midstream and downstream segments are excluded. Europe includes ESA members, associate members and cooperating countries.

Figure 26: Europe's positions in global upstream/midstream space markets (left panel) and downstream market (right panel)



Source: ESA (2025). Note: the left panel covers manufacturing and launch value, which we categorise as upstream and midstream, respectively (Table 1). The right panel is downstream value as defined by Euroconsult. Importantly, downstream includes derived demand, as defined in chapter 2.

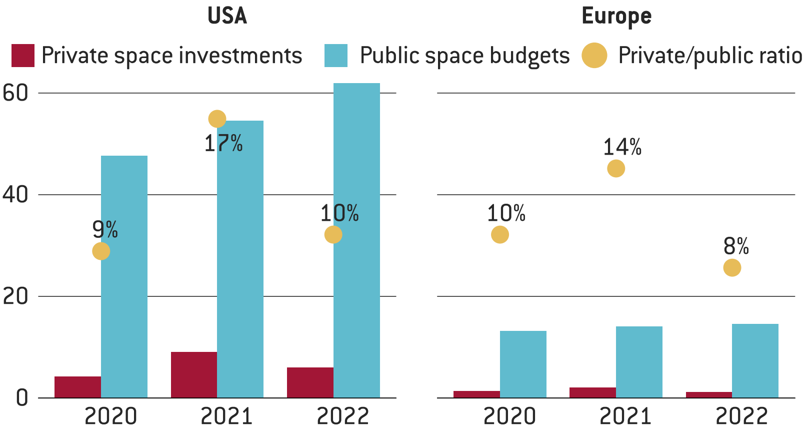
While remaining technically competitive in the space segments of Earth observation, navigation and exploration, the European Union lags behind the US in rocket propulsion, mega-constellations for telecoms, and satellite receivers and applications. The EU has lost its leading market position in commercial launchers (Ariane 4-5) and as a result, has had, for example, to rely on US SpaceX rockets to launch satellites for its strategic Galileo programme[64].

Figure 26 makes clear how far behind the US the EU is lagging in terms of both public and private investment in space. With public investment acting as a critical anchor for private investment in the space industry, Europe's stagnating public funding, compared to the much larger and growing US budget, is a major setback. European public investment in space is about 21 percent of that in the US – a considerable gap. Meanwhile, in 2024, China overtook Europe in terms of public funding for space (see Figure 10 in chapter 3). Private space investment in Europe is only about 27 percent of that in the US[65]. This chapter explores the reasons for these gaps. Sections 5.1 to 5.4 analyse the public factors holding back the EU, while section 5.5 focuses on the shortfall in private investment.

64 See European Commission news of 18 September 2024, 'Successful launch of two new Galileo satellites', https://defence-industry-space.ec.europa.eu/successful-launch-two-new-galileo-satellites-2024-09-18_en.

65 Annual investment in space start-ups averaged €1.5 billion in Europe between 2019 and 2022, compared to €5.6 billion in the US; see Figure 17 in chapter 4.

Figure 27: Space budgets in the US and Europe (€ billions)



Source: Bruegel based on Euroconsult and ESPI.

5.1 A complex European public institutional set-up

The public-sector institutional arrangements for space are much more complex in Europe than in the US. Europe's involvement in the space industry is supported by public funding in European countries and from the EU. Most (though not all) countries have their own space agencies. Additionally, most (but not all) EU countries are part of the European Space Agency (ESA), an intergovernmental organisation founded in 1975, with 23 members, includes 20 EU countries, the United Kingdom, Norway and Switzerland[66]. The ESA, with its focus on civil space exploration and science, operates on the basis of unanimity voting. Although considerably smaller than NASA, ESA has acquired over time extensive

66 ESA's 23 members are: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, The Netherlands, Norway, Poland, Portugal, Romania, Spain, Sweden, Switzerland, Slovenia and the United Kingdom. Slovakia, Latvia and Lithuania are Associate Members, whereas Bulgaria, Canada, Croatia, Cyprus and Malta have cooperation agreements with ESA.

space know-how and a reputation from its past successes in scientific exploration missions.

Alongside ESA, the EU has its own space programme[67]. The European Commission's Directorate General for Defence Industry and Space (DG DEFIS) develops and enforces the regulatory frameworks that govern the EU's space activities. It implements, together with its operational agency, the European Union Space Programme Agency (EUSPA), the Union Space Programme 2021-2027, the EU's industrial policy approach to the space economy.

The Union Space Programme 2021-2027 has the stated goal of enhancing European technological autonomy by providing secure space-related data, while maximising economic benefits through fostering the development of a stronger European space economy[68]. The programme has several components:

- Navigation: providing positioning services through Galileo, a global navigation satellite system;
- Observation: providing Earth observation data through the Copernicus programme (Box 6) and monitoring space debris;
- Connectivity: providing satellite communications services to governments and boosting satellite-based connectivity through the IRIS² constellation (Box 6);
- Innovation: fostering the development of a strong EU space economy;
- Access: supporting autonomous and cost-efficient access to space by investing in European launch capabilities – Ariane (Box 7).

ESA and the EU are separate public institutions with different sets of member states, governed by different rules and procedures and with

67 The legal basis for the EU space programme is Regulation (EU) 2021/696, available at https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32021R0696.

68 Article 4, Regulation (EU) 2021/696.

different competences. They nevertheless work increasingly closely together. For instance, ESA has designed and developed elements of the EU's space programme, including the Galileo, Copernicus and Ariane programmes and, more recently, IRIS² (Boxes 6 and 7).

Box 6: Main components of the Union Space Programme

Navigation (EGNOS and Galileo)

The EU provides free navigation data available to everyone, with a high-precision signal reserved for public authorities and the military, and a plan to provide additional commercial services. Historically, however, Europe relied on the US-owned GPS constellation. The European Geostationary Navigation Overlay Service (EGNOS), was built to augment and improve on the quality of the signal from American satellites[69]. However, the need to break free from reliance on US infrastructure became apparent to European policymakers. In 1999, the definition phase of the European GNSS (Global Navigation Satellite System), known as Galileo, began, becoming operational in 2016 (Reillon, 2017). Design and deployment of Galileo were entrusted to ESA. When it was established in 2021, EUSPA became the operator and overseer of ESA's activities. As of 2017, the estimated total cost of the project and its operation was €11.7 billion from the EU and €1.5 billion from ESA. Galileo is now considered to be the world's most accurate and secure positioning system.

Observation (Copernicus)

The concept of a European environmental monitoring system emerged in the late 1990s. This initiative became known as Copernicus, the European system for monitoring the Earth. It became operational in 2014. The system

69 ESA, 'What is EGNOS?' undated, https://www.esa.int/Applications/Satellite_navigation/EGNOS/What_is_EGNOS.

consists of Earth observation satellites and in-situ sensors[70] on Earth, such as ground-based weather stations and data-collecting ocean buoys. Copernicus is used for numerous applications, including in agriculture, pollution monitoring and natural disaster response. Importantly, data generated by Copernicus is free of charge. Non-European tech giants including Amazon and Google have been reported as using free data generated by Copernicus to increase the value of their services, as have Earth observation new space companies, such as Planet Labs[71]. Similarly, around 40 percent of emergency response activations have been for non-EU countries, including the US and Indonesia. As of 2017, €7.1 billion had been allocated to Copernicus by the European Commission (€5.7 billion) and the European Space Agency (€1.4 billion) (Reillon, 2017).

Connectivity (GOVSATCOM and IRIS2)

In the late 2010s the European Commission proposed to add a connectivity component to its space programme. This plan evolved into IRIS2 (Infrastructure for Resilience, Interconnection and Security by Satellites), a multi-purpose, multi-orbital satellite constellation, inspired by SpaceX's Starlink.

While $IRIS^2$ will prioritise the delivery of government communication services, it will also facilitate the provision of commercial broadband services by the European private sector. Those services can provide internet access to remote areas and thus contribute to EU connectivity goals (ESPI, 2022a). In December 2024, the concession contract was signed and the full constellation of 290 satellites is expected to be operational by 2030. The 12-year budget is €10.6 billion, of which the EU provides €6 billion, ESA €0.55 billion and the private sector the rest. Cooperation with the private sector is

70 In-situ sensors observe phenomena in close proximity to their original place of occurrence. This is different to remote sensors, which are not in direct contact with observed phenomena.

71 Joshua Posaner and Zoya Sheftalovich, 'EU Soft Power Fills Space for US Tech Giants', *Politico*, 25 March 2019, https://www.politico.eu/article/copernicus-space-natural-disaster/.

implemented through a public private partnership, the SpaceRISE consortium[72], composed of SES, Eutelsat, and Hispasat, with partners including Airbus Defence and Space and Thales Alenia Space.

Innovation

EU programmes supporting private entrepreneurship in the space sector include:

- **CASSINI** (Competitive Space Start-ups for Innovation Initiative) groups support measures for start-ups and small and medium-sized enterprises related to the space sector under a single €1 billion initiative that runs until 2027. It offers prizes and competitions, provides capital to VC funds and gives business advice.
- **InvestEU** mobilises both private and public funds to drive investment in infrastructure, innovation and digitisation among European SMEs and small mid-caps. It has a budgetary guarantee of €26.2 billion, to be deployed through the European Investment Bank and national banks, of which a small fraction is allocated to the space sector[73].
- **Horizon Europe** is the overarching EU research funding programme. Its Pillar II centres on 'Global Challenges and European Industrial Competitiveness'. This includes Cluster 4 – 'Digital, Industry and Space' – intended to foster an innovative and self-sufficient European space ecosystem. Cluster 4 is projected to receive a total of €13.5 billion over the 2021-2027 period of Horizon Europe, plus an additional €1.35 billion from the NextGenerationEU post-pandemic economic recovery initiative.

Access (Ariane)

To secure access to space, independently of other states or private companies, the EU, together with ESA, supports its own Ariane rocket (Box 7). The EU

72 See https://www.spacerise.eu/.

73 As of February 2024, only €151.55 million in signed operations had been allocated to the space sector.

also procures launch services, and can coordinate launch services for EU countries at their request.

Box 7: Ariane 6 and beyond

As part of the Union Space Programme, the EU together with ESA supports the Ariane launch vehicle system – currently Ariane 6. Ariane 6 is a public private partnership, selected by ESA. The public sector provides by far most of the funding (about 90 percent), from ESA, the European Investment Bank, Horizon Europe and InvestEU. Ariane 6 is constructed and operated by ArianeSpace, a French joint venture of Airbus and Safran.

From its start in December 2014, Ariane 6 encountered delays and cost overruns. Its first successful launch, initially planned for 2020, took place on 9 July 2024. Ariane 6 is running significantly behind the industry frontier set by SpaceX, in terms of cost and reusability (Figure 5). Proposals for a successor to Ariane 6, ArianeNext, with a goal of at least partial reusability and the halving of Ariane 6's launch costs, have been made, although it is still uncertain whether such rocket will be developed through the traditional collaboration between ESA and Arianespace, or will involve new industry players. ESA has so far been exploring both options.

With Arianespace, ESA is working on the Themis reusable rocket. So far, Arianespace has received €473 million from ESA's budget[74]. While primarily funded by ESA, Themis has also received €39 million in European Union support through the SALTO initiative ('reuSable straTegic space Launcher Technology & Operations'), and will benefit from another horizon project, ENLIGHTEN (called the 'European iNitiative for Low cost, Innovative and Green

74 Andrew Parsonson, 'ESA Awards Another €230M to ArianeGroup for Themis Demonstrator', *European Spaceflight*, 21 November 2024, https://europeanspaceflight.com/esa-award-another-e230m-to-arianegroup-for-themis-demonstrator/.

High Thrust Engine'), worth €20 million. ENLIGHTEN's goal is to progress work on the Prometheus engine intended for Themis, contributing to the broader improvement of European propulsion technologies, making them more affordable and environmentally friendly.

At the same time ESA is looking to the market. Jointly with the European Commission, which wants to include "*a fully-fledged access-to-space component*" in the next Union Space Programme[75], ESA has introduced the European Flight Ticket Initiative. Its objective is to stimulate the development of new competitive European launch systems by providing framework contracts to selected start-ups, which then will bid for contracts for specific launch tasks, depending on the EU's and ESA's needs[76]. ESA and the EU frame this initiative as a change towards an "*anchor*" customer model for European launch development, similar to what NASA does. This change has been promoted by delays with the heavily subsidised Ariane 6 and the resulting need to rely on SpaceX for launching ESA payloads[77].

While the Galileo and Copernicus constellations are already working, IRIS² is still at the kick-off stage. IRIS² has been a controversial project because of its exceptionally high costs[78], uncertain public gains and restricted interest from private funding. As noted by ESPI (2022a), IRIS² marks the first EU space project being established in the context of a now mature commercial market, raising questions about the capacity

75 Martin Greenacre, 'The EU wants to play its part in solving Europe's launcher crisis,' *Science|Business*, 25 January 2024, https://sciencebusiness.net/news/aerospace/eu-wants-play-its-part-solving-europes-launcher-crisis.

76 Jeff Foust, 'ESA and EU collaborate on launch initiative,' *SpaceNews*, 24 January 2024, https://spacenews.com/esa-and-eu-collaborate-on-launch-initiative/.

77 Joshua Posaner, 'EU agrees US deal to launch satellites with Elon Musk's SpaceX,' *Politico*, 19 March 2024, https://www.politico.eu/article/eu-signs-security-deal-us-launch-satellite-spacex-elon-musk/.

78 Joshua Posaner, 'EU's Starlink rival triggers big Brussels-Berlin bust-up,' *Politico*, 6 May 2024, https://www.politico.eu/article/brussels-blasts-back-berlin-over-gambit-stop-eu-starlink-rival/.

of the EU to develop a long-term sustainable comparative advantage in mega-constellations. Similarly, the new European approaches to launch capacity being followed with ArianeNext, and particularly with the European Flight Ticket Initiative, raise concerns about whether these initiatives will be enough for the EU to catch-up with frontier launch technologies, and to be able to provide competitive offerings.

A crucial consideration is whether the EU effectively facilitates private-sector adoption of services and use of data generated by publicly funded projects. A dedicated fund to support uptake was part of Horizon 2020 – the predecessor to Horizon Europe – and remains part of Horizon Europe through calls under Cluster 4 of pillar II (Box 6). However, the European Court of Auditors in 2021 audited 30 Horizon 2020 actions and concluded that, although services and data generated by EU space infrastructure are valuable, they have had limited impact on the industry and the promotion of uptake has been underwhelming (ECA, 2021).

Data used by Galileo was quickly taken up by the consumer market. By 2020, 95 percent of Global Navigation Satellite System (GNSS) chipsets produced were compatible with Galileo infrastructure (ECA, 2021). These chipsets are capable of receiving signals from the Galileo constellation, allowing users to access navigation and positioning services at no cost. However, the main commercial service provided by Galileo – a commercial authentication service that provides encrypted Galileo signals to private clients and is safer against cyber-attacks – was non-operational as of 2024 (EUSPA, 2024). The European Court of Auditors has criticised EU agencies for awarding long-duration projects in a rapidly changing GNSS market and with limited impact on the uptake of Galileo services. In the Earth observation market, the situation is similar. The Commission only receives small numbers of responses to calls promoting downstream applications.

As well as engaging in activities associated with the space programme, the EU also regulates the space economy. The Commission's aim is to harmonise relevant national laws, with EU-level action based on three pillars[79]:

- Safety, which deals primarily with management of the ever-growing number of satellites in orbit and reducing the associated risk of collisions, including with space debris;
- Resilience, focusing on the security of space infrastructure (both ground- and space-based) by reducing digital, physical and supply-chain vulnerabilities;
- Sustainability, introducing approaches to limit the carbon footprint of space technology.

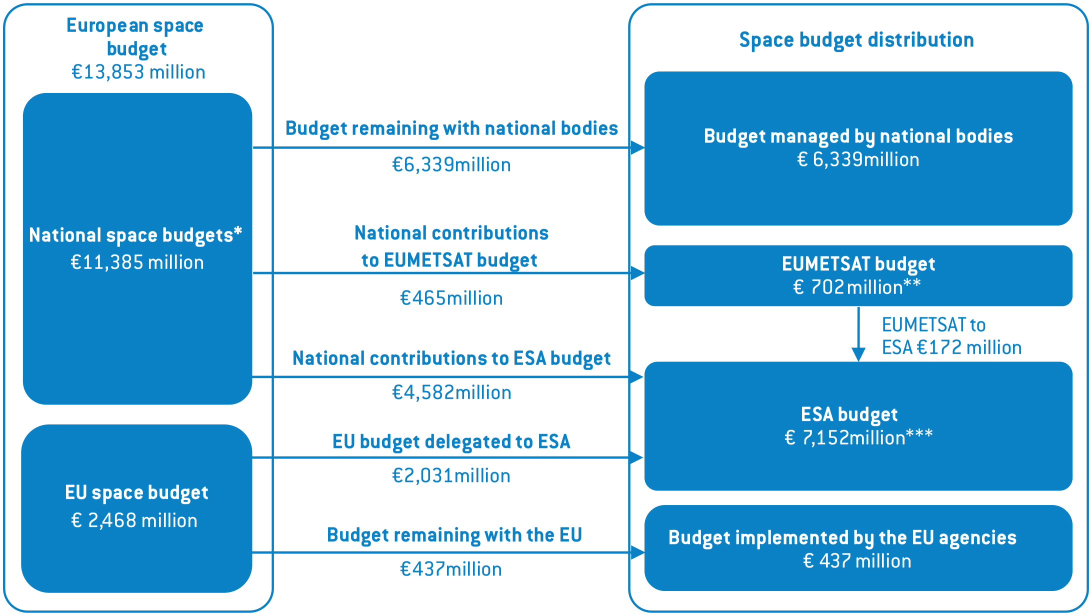
5.2 Public space budgets in Europe: too small and too fragmented

As the biggest customer of the European space industry, the public sector plays its market-shaping role. In 2023, 70 percent of the revenues of the European space industry came from sales to European public institutions. Sales to non-European public institutions provided another 4 percent (Eurospace, 2024).

Though the public sector collectively is the biggest customer of the European space industry, this part of the business is anything but uniform. The various public institutions involved each have their own space industry goals. Consequently, European public space budgets, are not only dwarfed by the US (Figure 26), they are also highly fragmented (Figure 27). This lack of cohesion contrasts sharply with the more centralised activities coordinated by the governments of the US, China and Russia.

79 ESPI, 'ESPI's Provision of Feedback for the Public Consultation of EU Space Law', European Space Policy Institute, 5 December 2023, https://www.espi.or.at/news/espis-provision-of-feedback-for-public-consultation-of-eu-space-law/.

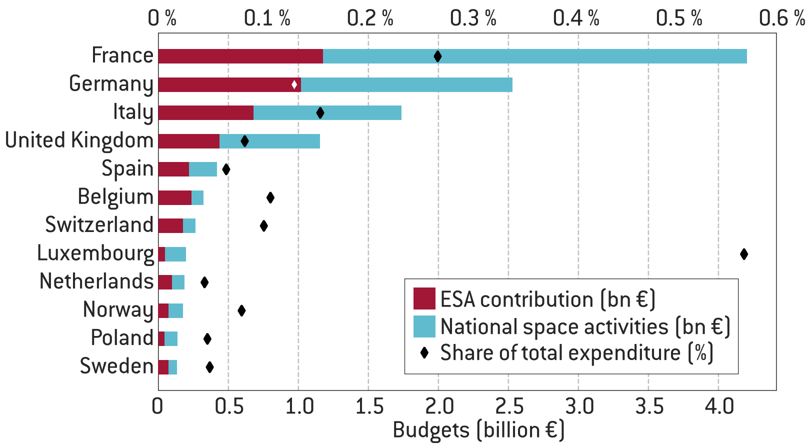
Figure 28: Consolidated European public space budget by source and implementing authority, 2022



Source: (ESPI, 2024). Note: *National space budgets include the budgets of EU and ESA member states. ** EUMETSAT budget includes €237million from other sources including the contribution from Turkey. *** ESA budget includes €367 million from other sources including the contribution from Canada.

The first source of fragmentation is the dispersed nature of national space activities between European countries. Over a half of European national spending on space remains with national space agencies or other national institutions. These national agencies collectively control 44 percent of the total European space budget, but this spending is virtually uncoordinated. Four countries are crucial to the European space sector: France, Germany, Italy and the United Kingdom (Figure 29). France is the top spender with a budget for national space activities in 2022 equal to €3 billion, slightly below the combined budgets of Germany (€1.5 billion), Italy (€1.1 billion) and the UK (€0.7 billion).

Figure 29: Space budgets of European countries, 2022 (€ billions)



Source: Bruegel based on ESPI (2023c), GMD. Note: countries that spend over €100 million on space annually were selected. Total space budget of a given country is the sum of ESA contributions and national space activities. Diamonds denote total space budgets as % of total government expenditure.

A second source of fragmentation across public institutions arises at European level. Together, the European level represents 56 percent of the total public space budget in Europe. The European level has two main institutions: ESA and the EU, with European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) playing a much smaller role.

EU's role is to provide additional finance to top up national contributions to ESA — 17 percent of the European public space budgets is financed by the EU (see Figure 27), most of which is transferred to ESA, which acts as the implementing body of the EU's civil space programme. The EU also funds space activities directly through funds from the EU budget and via Horizon Europe, InvestEU and the European Defence Fund (Box 6; ESPI, 2023c). However, only 3 percent of the collective European space budget is under direct EU-level control (Figure 27).

ESA is pivotal, controlling 88 percent of the public space budget held at European level, or 49 percent of the consolidated European public space budget (including national spending). About three quarters of ESA's budget is from its members. While France and the UK allocate significantly more funds to their domestic space endeavours than to ESA, Germany and Italy distribute their spending more evenly between national projects and ESA (see Figure 28). Smaller countries, particularly Belgium and Switzerland, tend to focus their financial resources for space on ESA activities.

ESA operates a policy of geo-return, which guarantees that about 85 percent of contributions ESA receives from its member states is returned to them in the form of contracts with their national companies[80]. This preferential treatment holds back the consolidation and distribution of industrial capacities across Europe, making it challenging to achieve collaboration and scale at a European level. Geo-return in a capital-intensive sector with high fixed costs and fixed-cost contracting may often imply 'geofencing', with only a few

80 See ESA, 'Industrial policy and geographical distribution', undated, https://www.esa.int/About_Us/Business_with_ESA/How_to_do/Industrial_policy_and_geographical_distribution.

or only one firm established in each country a thus winning all the contracts allocated to that country. Furthermore, geo-return implies that companies must create large cross-national consortia to ensure that the money is spend in adequate proportions for each country, which in turn means that companies set up large-scale collaborations, rather than outbidding each other by making the most competitive offers.

5.3. Limited defence-related space activities in Europe

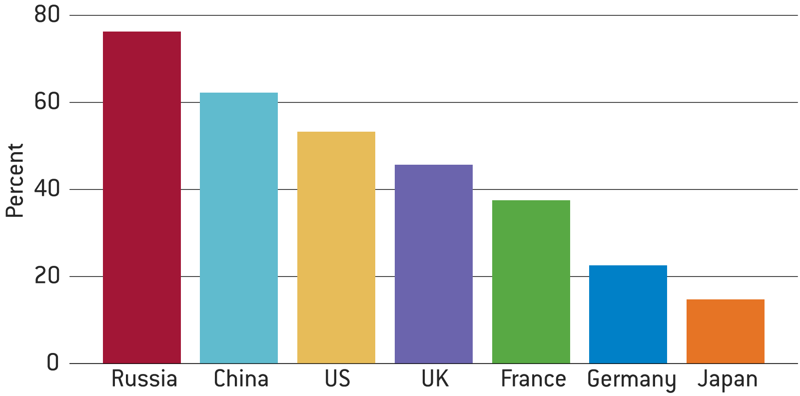
The different missions of the various European-level public institutions are a further challenge for public involvement in the European space economy. ESA is a 22-member inter-governmental organisation independent of the EU that was established like NASA for peaceful space exploration and science missions – excluding defence. ESA's focus is reflected in its governance structure, which involves scientists and science ministers from its members[81]. In contrast, the EU, as a supranational body with 27 member countries, has a broader approach to space than ESA. The EU focus is promoting commerce and strategic autonomy and security, including, more recently, military space capabilities, at least to the extent that such activities fit with the EU remit and align with the security and defence goals of its member states.

Unlike the US, Russia and China, European investment in military space activities is modest (Figure 30). At European level, there is no dedicated military branch for national space security – Europe lacks the equivalent of the US Space Force. Military use of space remains mainly for EU national governments. Not only do European countries spend relatively less than the US and other counterparts on space for defence (Figure 30), their national budgets for defence use of space are highly fragmented with significant duplication, leading to

81 ESA is controlled by the Ministerial Council, which is made up primarily of science ministers. Each member state has one vote. ESA's programme is implemented by a director general with around 10 assistant directors. So far, every ESA director general has been a space scientist.

huge inefficiencies and jeopardising the catalysing effect of military demand for the space economy[82].

Figure 30: The military component as a share of public space budgets, 2024



Source: Bruegel based on Euroconsult. Note: assessing the military part of public space budgets is notoriously difficult. Euroconsult does not share sources and methodology for its data collection. Data should be treated with caution.

However, there have been EU-level developments intended to improve the efficiency and effectiveness of defence space spending. In a Space Strategy for Security and Defence, the European Commission has acknowledged synergies between civil and military space uses, and pledged to *"take into account long-term military requirements (time horizon 2035) for space-based defence services"*, with the support of the European Defence Agency (European Commission and HRVP, 2023).

However, the EU's move towards greater engagement in military space applications is complicated because it cannot be accompanied by ESA, which has a purely civil mandate. For example, Galileo, the only civil-run navigation system in the world, is going through an upgrade, initiated by the EU, with the goal of enhancing its capabilities

82 EPRS (2023) estimated that if they joined forces on defence, EU countries could save between €24.5 billion and €75.5 billion annually.

for military applications. ESA is not part of this initiative. In the wake of Brexit, the UK has also chosen not to participate in the military aspects of Galileo.

5.4 A private space sector dominated by incumbents

As in the US, big conglomerates dominate the EU corporate space economy, major players being France's Airbus, Thales and Safran, and Italy's Leonardo (Figure 14). Those conglomerates employ 46 percent of the space workforce in Europe[83] and operate within an oligopoly in some subsectors of the European space industry. In the heavy-launcher sector, Arianespace, operated largely by a joint venture between Airbus and Safran, has a monopoly. In the medium-launcher sector, Vega has a monopoly (Avio, partially owned by Leonardo).

The connections between the big conglomerates and ESA are long-standing and sustained by ESA's geo-return policy. A good example of this is Arianespace, with a history that goes back to ESA's foundation and development of the Ariane 1 rocket. To support the management and operation of Ariane 1, the French space agency established Arianespace, a state-supported enterprise[84], which became the world's first launch services provider. Eventually, the development of Ariane rockets was transferred to ESA as the public overseer and Arianespace as the private contractor, with the relationship between the two heavily intertwined. ESA remains a non-voting member of the Arianespace board. Arianespace receives subsidies from ESA[85] and its member

83 See 'Eurospace facts & figures', 12 July 2023, https://eurospace.org/wp-content/uploads/2023/07/press-release-ff-2023-final-release-v2.pdf.

84 In 2015, the last remaining French public shares in Arianespace were sold to a joint venture between Airbus and Safran, known as ArianeGroup, which controls 74 percent of Arianespace, the rest being held by other European companies.

85 Peter B. De Selding, 'Arianespace Reports 30% Boost in 2021 Revenue, to $1.4 Billion, on 50% More Launches', *Space Intel Report*, 6 January 2022, https://www.spaceintelreport.com/arianespace-reports-30-boost-in-2021-revenue-to-1-4-billion-on-50-more-launches/.

states[86] to maintain financial stability. These historic relationships influence the way Arianespace does business. Pierre Godart, chief executive of ArianeGroup Germany said *"I cannot choose my supplier. It is decided* [by ESA]*"* and *"even if I have suppliers who are not performing, I cannot change them"*[87].

5.5 A difficult landscape for new space firms

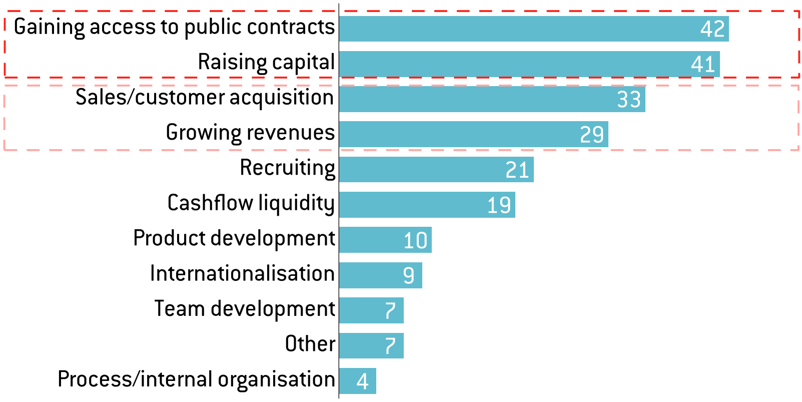
Europe's innovation ecosystem is less vibrant than that of the US, where new players ride on new technologies in order to grow and become new industry leaders, or challenge the big incumbents to become more innovative. A critical missing link compared to the US is access to risk capital funds for ventures that are looking to commercialise their innovative space projects. In 2021, the European Space Policy Institute surveyed 74 European space start-ups on several aspects of their businesses (ESPI, 2022b). They identified gaining access to public contracts and raising capital as their biggest challenges (Figure 31).

The problem start-up companies have in scaling-up is also evident in low next-stage scale-up funding in Europe. According to the ESPI (2023a), only 30 percent of the space start-up companies that raised some capital during their initial seed round between 2019 and 2021 managed to progress into larger first-stage venture financing – moving beyond prototyping into further product and market development (Series A financing). The scarcity of scale-up funding in Europe is a critical shortfall. It has often led to a flight of talent and companies to the US, where private VC financing and public funding market for space endeavours is more available.

86 Andrew Parsonson, 'ArianeGroup to Receive €340M Per Year to Operate Ariane 6', *European Spaceflight*, 7 November 2023, https://europeanspaceflight.com/arianegroup-to-receive-e340m-per-year-to-operate-ariane-6/.

87 Jeff Foust, 'European governments and companies seek changes to georeturn', *SpaceNews*, 14 November 2023, https://spacenews.com/european-governments-and-companies-seek-changes-to-georeturn/.

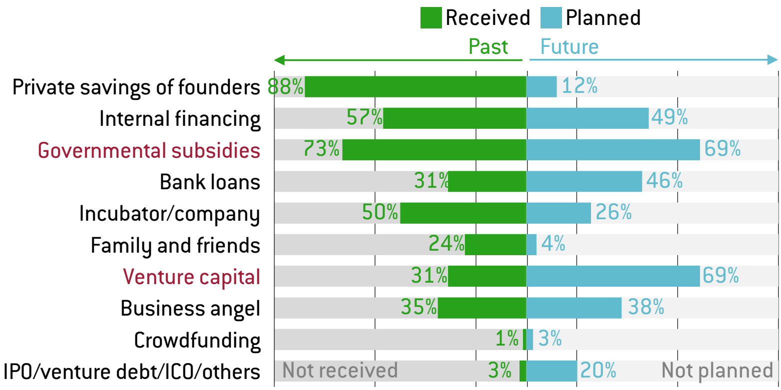
Figure 31: Top challenges for European space start-ups (2021) (%)



Source: ESPI (2022b). Note: the figure shows % of respondents identifying the issue as a challenge; multiple responses possible.

Another characteristic of the European start-up system compared to the US is its reliance on government subsidies as a source of financing at seed and scaling-up stages. This is almost as important as venture capital financing (Figure 32). This finding reinforces the picture of the heavy reliance of the European space sector on public investment. This applies not only to incumbents but also to new firms, and contrasts with space start-up financing in the US, which is almost exclusively private.

Figure 32: European space start-ups, received and planned financing (2021)



Source: ESPI (2022b).

6 A European Union industrial policy for the space economy

The previous chapters have shown the difficulties that Europe's space industry faces in attracting both the public and private investment needed to compete on a global scale. Because of this, it needs a system-wide policy plan. Preparing such a comprehensive plan in detail is a daunting mission beyond the scope of this Blueprint. However, we outline in section 6.3 the main issues that a policy plan at EU level should address as a priority. Before that, we briefly summarise the state of affairs (section 6.1) and the challenges and trade-offs that need to be addressed when developing an industrial policy for the EU space industry (sections 6.2 to 6.4).

6.1 Europe's position in the space economy

Because the space sector is becoming increasingly important from a strategic point of view – for growth, technological and economic competitiveness and national security reasons –Europe's lagging position is worrying. The US dominates the new space economy, while China and other nations, including Japan and India, are working vigorously to catch up.

Europe's relative shortcomings are structural, caused by interlinked public and private-sector constraints. Europe's public space budget is six times smaller than that in the US, and is highly fragmented and missing a defence part. Not only is there the fragmentation between national and European levels, but even at European level, the public institutional landscape for space is highly complex, with overlapping and conflicting roles of national space agencies, the European Space Agency, the European Commission and the EU Agency for the Space

Programme. The institutional complexity is particularly difficult to navigate for smaller and newer corporate players.

Meanwhile, the long-standing relationships between national space agencies, ESA and the large incumbents, exacerbated by ESA's geo-return policy, are unhealthy for a competitive, dynamic space economy. This is perhaps best illustrated by Europe's launch segment with its one-horse bet on Ariane 6, directed by ESA and operated by the Arianespace joint venture. On the private side, Europe lacks the US's vibrant space innovation ecosystems, in which new players can ride on new technology opportunities and grow into new leading firms by successfully competing for public and private customers, challenging the incumbents. European space start-ups face limitations that make it hard to get onto a successful trajectory to critical scale. An important limitation remains the lack of early-stage risk capital, which in the US is provided via a public procurement system that is more competitive and open to non-incumbents and highly innovative new offerings. Europe also lacks equivalents to deep US private venture capital markets. This is a general problem for Europe, but even more pronounced in the space economy, taking into account the lesser public demand, which reduces the attractiveness of investing in European space start-ups compared to their US counterparts.

6.2 Challenges for Europe

The European space sector faces four main challenges.

First, Europe must find long-term, sustainable positions in the highly competitive global space economy. An industry policy plan for space must build on European strengths, while recognising weaknesses compared to the highly dynamic and persistently more successful US space industry, and the fast-growing Chinese space industry. It is unrealistic to expect to overtake the US lead across all space industry sub-sectors. To promote the competitiveness of the European space industry, policy has to encourage industry where it is able to uniquely create and capture value within globally competitive supply chains. It is thus crucial to understand the entire vertical chain thoroughly in order to assess the viability of Europe's positions, assessing which activities can be successfully developed within Europe, and for which external partners will need to be identified.

The second challenge is to find the right balance between competition and scale. Space markets are characterised by fast-evolving technologies that involve high degrees of risk-taking, deep tech investment, high fixed operating costs and economies of scale and scope. Markets may tilt to large-scale positions that may become difficult to contest. When combined with incumbent advantages – for example, experience with procurement practices – space markets can quickly tend towards high levels of concentration, even monopoly outcomes. In less contestable markets, less cost-efficient, higher priced and less varied and less innovative offerings may result. Increasing concerns about SpaceX dominating the space sector illustrate this challenge.

The third challenge is to address the fragmentation of European space markets (see Figure 19), enabling the exploitation of much-needed critical scale for European companies, which are now often tied politically to specific European countries. As size and scope matter in the space sector, a single market is critical for Europe's competitiveness. Only bigger deal flows will allow firms to operate at competitive scale. A significant political challenge is to reconcile the national sovereignty of the European countries with the interests of Europe as a whole, particularly in relation to defence and security objectives for space.

The fourth challenge is to reconcile competitiveness with Europe's so-called strategic autonomy. Strategic considerations imply the need to secure the supply of certain space products, services and know-how. A particular issue is defence-sector access to launch facilities and Earth-observation satellite constellations. Implementing security of supply through local production requires the trade-off with cost-efficiency to be understood. A competitive, cost-efficient European launch market requires sufficient activity in the market, typically beyond the extent of domestic demand in individual countries or even Europe as a whole. This is particularly challenging with the new space markets concentrating on large US companies, whose scale European firms may find difficult to match. This challenge is further exacerbated by increasingly protectionist US policies involving more-stringent local content requirements, trade restrictions and foreign direct investment screening, all of which make it harder for European firm to grow by accessing the large US market.

6.3 Principles for an EU industrial policy plan for the space economy

A space industrial strategy for Europe should focus on commercialisation as a core principle, similarly to the U.S. This would increase the benefits from a greater competitiveness and economic growth dividend, and would also make the build-up of the space component for public purposes more cost efficient. To this end, policy should:

- Enable companies build long-term sustainable competitive positions in global space markets, building on their innovative strengths;
- Ensure large, open, integrated space markets in which scale and scope advantages are combined with innovation-based competition;
- Ensure access to first-best space infrastructure.

For Europe to succeed in its pursuit of an industrial policy for the space economy, given the serious gap with the US, it should focus as a priority on next-generation space technologies, infrastructure and services, where it can leverage its research and innovation capacity and challenge and/or partner with the current frontier firms. Europe's relative position in research is not the main reason for the gap relative to the US (see chapter 3). The gap with the US arises at the stage of commercialisation of new space projects, especially highly risky disruptive projects, which are most likely to be developed by new players, rather than incumbents. Europe's industrial policy for the space economy should support highly innovative projects with a high potential for commercialisation.

For the European public sector to be a space market shaper, like the US, European public investments for space must be scaled-up and its structures reorganised to address the fragmentation of Europe's public space programmes. Fragmentation limits the size of public funding for space projects and also introduces complexity because of the varying objectives of different public funding streams for space. In particular, Europe's space defence budget is smaller than others and therefore cannot be used to fully leverage complementary non-defence space activities. Mobilizing large amounts of public spending, overcoming fragmentation and establishing a clear governance structure in which the various public actors complement each other is imperative.

Europe's various public and private-sector constraints need to be addressed comprehensively as part of a long-term industrial policy plan for space. The approach should not be incremental and piecemeal. It must be bold and take a comprehensive systemic perspective on the space industry, focusing not only on moonshot projects (eg a European on the moon) and specific subsectors (eg the launch industry). It should enable whole space ecosystems, spanning upstream, midstream and downstream activities, covering civil, commercial and military space, embracing state-of-the-art and next-generation technologies, and ensuring the needed size to exploit scale and scope economies.

Andrius Kubilius, the EU Commissioner responsible for defence and space, has been tasked with fostering *"a strong and innovative space industry"* and given a clear target *"to foster cost-efficiency, innovation, merits-based* [sic] *competition and an effective internal market for space* *products and services"*[88]. The ambition and focus are very much inspired by Europe's competitiveness push, as embodied in the September 2024 report by former Italian prime minister Mario Draghi, who clearly identified the need for ambition and warned that Europe would fall further behind unless public and private investment is increased, including in European space assets and capabilities (Draghi, 2024). Nevertheless, European Commission plans so far fall short of the drastic overhaul of policymaking needed. Plans are too vague or incremental, focusing on the development, deployment of existing EU space assets[89], most notably Copernicus, Galileo and IRIS². Further development of these programmes may be desirable, but they do not address the EU's structural challenges, most notably, the lack of an innovative private sector because of insufficient mobilisation of public and private investment. Additionally, effective leveraging of defence spending has not been adequately pursued. The call for enhanced cooperation with ESA also fails to address underlying governance issues, particularly the geo-return principle.

In what follows, we set out what Europe – mainly the EU – should do to realise its ambitions for the space economy.

6.4 Recommendations for an EU industrial policy plan for the space economy

6.4.1 Upscaling Europe's public budget and reorganising governance framework

For Europe to claim a leading position in the space economy and for the European public space sector to be a market shaper, the starting

88 Ursula von der Leyen, mission letter to Andrius Kubilius, Commissioner for Defence and Space, 1 December 2024, https://commission.europa.eu/document/download/630c289c-7ff1-4fdd-944f-0f596e7e7914_en.

89 Jeff Foust, 'New EU Space Commissioner Outlines Priorities', *SpaceNews*, 1 December 2024, http://spacenews.com/new-eu-space-commissioner-outlines-priorities/.

point should be a massive upscaling of its public investments in space. Effectiveness of this spending will depend on structural reorganisation to address the fragmentation of Europe's public space programmes.

Europe as a whole should rationalise and reorganise its institutional footprint. In particular, the roles of the EU and ESA should be clarified, with the EU in charge of the security and economic functions associated with space, and ESA having a scientific exploration mandate. These activities should be coordinated with a high level of cooperation.

To this end, ESA's geo-return principle should be brought to an end. ESA's adherence to the principle of geo-return in procurement means that the best providers are not necessarily chosen and competition is undermined. This has prevented Europe from making the best use of the competitive potential of contracting practices, as done by COTS, which has been fundamental in shaping US success in the new space economy. Similarly, Draghi (2024) listed the removal of the geo-return principle as his first short-term proposal for the space economy[90].

ESA should be able to allocate projects to those bidders offering the greatest social welfare, wherever located, not only when ESA is implementing EU programmes, but also for other ESA projects for which the spillovers to commercial space markets are high. The EU should expand its role as an ESA member to maximise the advantages of the EU's scale. This should be reflected in EU's financial contribution to ESA. The EU could commit to top up the budget for selected ESA projects, relative to their EU-wide spillovers.

With ESA's focus on civil space exploration and science, its institutional priorities do not fully align with those of the EU, which are to better coordinate and leverage civil and defence space efforts and to

90 ESA's Director General Josef Aschbacher, has argued for a *"fair contribution"* principle, with the contributions of member states adjusted *"according to the outcome of the industrial competition"*. See Josef Aschbacher, 'The competitiveness of ESA's Geo-return policy', *LinkedIn*, 20 March 2023, https://www.linkedin.com/pulse/competitiveness-esas-geo-return-policy-josef-aschbacher/.

make the development of a competitive commercial space market more of a centrepiece in its policymaking. For these reasons, the division of tasks between the EU and ESA should be clearer and more transparent. The EU should more explicitly take full ownership of its mandate to strengthen space-related defence cooperation and to stimulate the development of a commercial space market. ESA should remain in charge of coordinating and implementing European science-oriented space missions, but with proper support for dual use.

6.4.2 Space and defence

Europe's space defence budgets lag behind those of US and China and therefore cannot be used to fully leverage complementary non-defence space activities. For instance, the US Department of Defense relies increasingly on buying services from 'off-the-shelf' space capabilities (eg Starlink and its military successor, Starshield). Greater demand for these goods implies large economies of scale in both satellite bus production and launch economics. That Europe is lagging is not only an issue of frugality on the part of European governments when it comes to defence spending in general, but also represents their failure to coordinate defence spending, resulting in lower than optimal joint (Steinbach and Wolff, 2024).

With respect to space defence, Europe lacks an intergovernmental organisation like the US Space Force and lacks relevant technical capabilities at scale[91].

But even with a clear mandate for the EU to be more active in space for defence purposes, there would be major challenges. Most importantly, budgets allocated to space by EU countries, even when consolidated, do not amount enough to shape markets that are

91 While France probably has some unconventional (co-orbital, electronic or energy-based) solutions to incapacitate hostile satellites, these have never been officially proven. Moreover, France, together with several other countries, has joined a global moratorium on destructive direct-ascent tests (meaning rockets launched to destroy adversary satellites).

competitive on a global scale, most notably those dominated by the US. Public procurement connected to the commercial space industry is both too small (Figure 10 in chapter 3) and too decentralised (Figure 26 in chapter 5). As we have argued, the EU and its member states need to develop sufficiently large and well-coordinated space budgets to act as anchor customers that will provide scale, thus justifying the large *ex-ante* investments required to be active in the market (see also Nicoli *et al*, 2023).

Hence, the EU needs to take an integrated approach to its space industry through direct EU procurement via the EU Agency for the Space Programme. Even if the EU itself is not the purchaser, the EU Agency for the Space Programme acting as a coordinator and agent for national procurement exercises would enable EU countries to punch much above their individual weights in a sector for which large-scale industrial commitment is essential (Nicoli and Beetsma, 2024). Joint and/or coordinated procurement of cost-efficient frontier-technology launch infrastructure should be treated as critical for the EU's access to space infrastructure. This should be done in collaboration with ESA to capitalise on its expertise and to increase launch frequency by adding scientific missions.

The EU should also revisit its procurement practices to avoid selection of non-frontier, non-globally competitive projects bogged down by cost overruns and delays. The EU should fully line up with fixed-cost contracts and incentives for technological competition by funding more than one company from the outset. Those companies do not have to be regular incumbent contractors. The EU and ESA must prioritize engagement with firms that are both commercially viable and innovative in their technology, including those that are new to the market. This can be achieved by awarding commercial contracts that position the EU as a purchaser of services in an open market, ensuring continuous competition and innovation, as opposed to a system in which incumbent firms have a preferential status.

6.4.3 An EU space ARPA for high-gain, high-risk projects

It is especially important for Europe to support the kind of highly innovative projects with the potential to be the next big breakthroughs for the space economy. These high-gain projects typically come with high risks, disrupting the established technology and commercial landscape. Europe lacks a public funder of such high-gain, high-risk projects similar to the US Defense Advanced Research Projects Agency (DARPA). As we noted earlier, DARPA, as a branch of the US Department of Defense, focuses on supporting technological solutions for defence and security purposes; this also covers space technologies. DARPA's purpose is to fund the very early stages of new technologies that go beyond current technological solutions to do something radically new, and to make them operationally ready for public procurement and commercialisation, if possible.

The establishment of EU-ARPA's is crucial not only for broader technology-based advancement across Europe[92] but particularly for defence and space. Draghi (2024) recommended an EU ARPA for Space (SPARPA) as a medium-term proposal. Such an agency should support the development of groundbreaking projects in space-related technologies. Crucially, SPARPA should be mission-oriented, facilitating the strategic use of space to address the EU's priorities of innovation-based competitiveness, sustainability and strategic autonomy. Goals – which should be decided at political level – should also include missions in line with the objectives of the European Green Deal, such as calls for recyclable space infrastructure, management of space debris, clean fuel for space and use of space data services for climate-change impact monitoring.

Another important characteristic of the ARPA model is the capability to select high-gain/high-risk projects, with an organisational

92 Simone Tagliapietra, Reinhilde Veugelers and Jeromin Zettelmeyer, 'Guiding the EU's quest for economic competitiveness', *Politico*, 14 February 2024, https://www.politico.eu/article/guiding-the-eus-quest-for-economic-competitiveness/.

structure that will attract highly specialised project officers. An EU SPARPA, although accountable for delivering on its missions, should be given sufficient independence to achieve its goals. SPARPA should be independent to the greatest possible extent of other EU agencies and ESA, so it does not get bogged down in their specific objectives, governance structures and path-dependencies.

Beyond SPARPA as a top-down, mission-oriented agency for space technologies, EU programmes such as the European Research Council (ERC) and the European Innovation Council (EIC), which support bottom-up proposals, are equally important for supporting next-generation space projects with high potential public and private returns.

Additionally, the initiation of Important Projects of Common European Interest (IPCEIs) and strategic alliances between start-ups, small and large incumbents and upstream and downstream suppliers, will be crucial for building cohesive EU-wide innovation ecosystems in the space industry. These efforts will enhance collaborative research and innovation across borders and the space value chain. It will leverage the EU single market scale to ensure that the European space sector is well-equipped to be competitive internationally.

6.4.4 A more dynamic private space ecosystem in the EU

The EU needs new projects in areas where it can exploit and build on its comparative advantages in the global space market, riding on new technology opportunities, enabling challenges to, and partnerships with, the leading incumbents. Removing barriers that hold up the initiation and development such projects should rate high on the EU space-policy agenda.

The next disruptive breakthroughs and new space projects will typically come from new players in the space economy. However, these players face high barriers to entry, especially when it comes to accessing funding for their investments (Figure 30). This is particularly challenging for deep-tech ventures requiring large fixed investments, which are more typical of upstream and midstream space activities. A vertically integrated entry strategy across all activities, from launch to satellite operations, similar to SpaceX, would be particularly challenging because the EU lacks most of the critical ingredients that have made SpaceX successful.

A critical issue for Europe is whether, in a world of geopolitical uncertainty and rising protectionism, it should have, from a strategic autonomy perspective, its own launch capacity, particularly as current cost-effective launch capacity is highly concentrated in the US in a single private provider – SpaceX. This is a particularly difficult issue because of the extremely high fixed investment and high launch frequency required to achieve economies of scale, and because of the distance to the technology frontier Europe needs to close in this area. A cost-effective European launch capacity can only be achieved through massive public demand to reach sufficient launch frequency, and through public support for frontier launch-technology capacity building.

A major challenge is that while Europe's public sector should act as an anchor customer for space innovation, its demand remains too limited and its procurement practices often favour established players. For this, the already-discussed recommendations on scaling up and coordination of public defence and space budgets should be implemented, and the opening-up of public space contracts and public space grant schemes to new risky projects from consortiums involving new players will be pivotal.

But the EU should also address the constraints on access to private funding for these projects: another important major barrier EU space start-ups must overcome to grow and reach critical scale (Figure 30). For this, the EU should cultivate a European-scale private venture capital ecosystem. This may involve partnerships between public bodies and private venture-capital firms, the encouragement of EU-wide critically scaled specialised space venture capital firms and encouragement of co-syndication, in which several investors pool resources to fund projects.

Ultimately, the EU must also address the fundamental challenges that hamper the attractiveness for venture capital of space deals at scale. These include variance in national laws, including rules that govern the creation, growth and failure of companies. These regulations make it very difficult for start-ups to operate effectively at EU scale and beyond, and to incentivise private venture capital to invest in the international scaling-up of space start-ups.

Another obstacle for both space startups and incumbent firms is access to specialised skills. This calls for support for capacity development related to space economy skills at universities and other higher education and research institutions. This should include, for example, dedicated space-related master's programmes and schemes that facilitate exchanges between educational institutions, startups and established companies, both within and beyond the EU.

6.4.5 An international open approach

As the EU develops an industrial policy for the space economy, it should maintain an open attitude towards international collaboration and market opportunities. The United States, with its vast market and leading firms, should remain an indispensable partner and market for European space projects and programmes. Collaboration with NASA, DARPA and the US Air Force should be a high priority for the EU, which should not be a mere subcontractor to the US but a partner valued for its unique strengths. ESA should work as a forum for joint scientific initiatives with non-EU partners, such as the UK, and with other third-party space agencies, such as NASA. The EU Agency for the Space Programme should work as a forum for joint initiatives on space defence and commercialisation.

But because of the trend towards more protectionism and unpredictability in US policymaking, making the US unreliable as a partner, diversification remains crucial to ensure EU strategic autonomy. Other partnerships, such as with the UK and Canada, should be nurtured and collaborative efforts, should be expanded to other regions, including Asia. A dual focus on building internal strength and external partnerships will best position Europe to capitalise on global market opportunities and technological advancements in the space sector, and to combine strategic autonomy with competitiveness and welfare.

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Relaunching Europe's space economy

Reinhilde Veugelers, Kamil Sekut and Francesco Nicoli

The global space sector is evolving rapidly. No longer limited to scientific missions and Cold War rivalries, it has become a critical arena for commercial innovation, military strategy and geopolitical influence. Satellite launch costs have tumbled, significantly expanding the scope for new space-related applications.

This Blueprint assesses the state of Europe's space sector, the challenges it faces and how policy could help it in moving forward. It introduces the concept of the new space economy, outlines the major global trends reshaping the sector and analyses the two most important forces driving this transformation: governments and a burgeoning private space sector. Recommendations are offered on how Europe can foster space innovation and support commercialisation, and how it can ensure strategic autonomy in critical space capabilities.

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