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SPACE ECONOMY INVESTMENT TRENDS: OECD INSIGHTS FOR ATTRACTING HIGH-QUALITY FUNDING

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Space economy investment trends: OECD insights for attracting high-quality funding

Over the last decade, the space economy has seen significant shifts, welcoming new entrants and types of capital. Annual launch activity has increased, in large part thanks to the influx of private investment. This raises questions about the future development of the sector. Drawing on OECD insights within science, technology, and innovation, this policy paper examines public and private investment trends in the space economy and discusses how public policy decisions and instruments can contribute to attracting more and higher-quality private investment.

Keywords: Science and technology, innovation, space economy, industrial policy

JEL codes: L26, O14, O31, O38

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Executive summary

Access to private sources of capital has greatly improved in the last decade, but public sources of funding remain crucial in key space industry segments

Public procurement and support still account for a major share of space R&D expenditure and commercial revenues, in particular in space manufacturing. Available data from several OECD countries indicate that institutional markets represent up to 60-70% of revenues for space manufacturing and launch segments, but (much) less than 10% for satellite operations or satellite television. A large share of business expenditure on R&D in the same industry segments is externally funded by public sources.

The combination of certain space activities' R&D and investment intensity and technology risk negatively affects their ability to attract private capital. A review of OECD statistics and space industry surveys on R&D and investment intensity indicates that certain space industry segments are particularly capital-intensive compared to other industries. Furthermore, there are substantial uncertainties concerning R&D outcomes in several space industry segments, most notably in space manufacturing and launch, making the business case and future profitability of several applications and actors uncertain. These factors can make it difficult for space companies to attract capital, especially when faced with competition from more conventional investment opportunities.

Volumes of equity finance directed to space firms have grown, but funding is concentrated among a small number of actors and the sector faces competition from lower-risk and faster-growing technological solutions. Equity finance is a good funding opportunity for fast-moving and innovative start-ups. However, equity finance tends to prefer low-risk and quickly scalable, intangible technologies to projects with low technological maturity, long lead times and/or uncertain market prospects. Until recently, very low interest rates boosted venture and equity investments in future-growth industries like space, but since interest rates' return to more normal levels in 2022, many investors are looking for quicker returns on investment.

Government policy and programmes may contribute to attracting private investment in multiple ways

Evidence from other STI domains suggests that government support and procurement programmes are conducive to mobilise private investment. Involvement in government programmes can increase a space firm's visibility and credibility vis-à-vis private investors. The existence of stable, long-term government demand for the firm's goods and services can also be beneficial for attracting private investment. However, it is important to ensure that commercial and public party interests are aligned, e.g. when it comes to protecting "legitimate commercial interests" in the public procurement and potential subsequent sharing of satellite data or space-related intellectual property.

Further public partnerships with industry could also be a way forward. Successful partnerships lower project risks by distributing them across several actors and allocating them to the actor best equipped to dealing with them (e.g. the private partner taking a greater share of development and construction risks, while the public partner ensures some of the market demand). In turn, this could make more projects and activities attractive to private investors. There are many examples of both successful and failed partnerships for R&D and public-private-partnerships to develop and operate space infrastructure. However, several conditions need to be met for the most ambitious partnerships to be successful, including competition for and in the market and adequate resources and expertise in the public agency dedicated to project negotiation and monitoring.

The recent influx of private capital has democratised access to space, but the quality and longer-term effects of investment also need to be considered

Faced with a maturing private space sector, a dramatic increase in activity and an increased number and range of partnerships and collaborations, space agencies and other procurement agencies will need to have adequate and sustained skills and resources to monitor changes and interact with commercial actors. **The influx of private investment in the space economy in the last two decades has brought disruptive innovation and applications to new users but can also have negative effects, some of which we are just starting to observe**. For instance, increased space activity contributes to orbital congestion, space debris and atmospheric and terrestrial pollution. The unprecedented use of resources such as orbital space and the electromagnetic spectrum furthermore creates tensions between first- and fast-moving incumbents and newcomers.

When promoting private investment and partnering with private actors, governments may do well to consider how this corresponds with broader strategic objectives, e.g. space sustainability, in the medium and longer term. The Japan Aerospace Exploration Agency and the European Space Agency have procured active debris removal missions from private firms, scheduled for 2024 and 2026, respectively. The United Kingdom launched a Space Sustainability Plan in 2022, with measures ranging from regulations to research grants.

Reviewing regulatory procedures to address risks and accommodate a greater diversity of private sector actors, such as young and small firms, could be necessary. Government agencies are already addressing the needs of such actors through dedicated calls for proposals, dedicated grants and incubation services, development and testing services, etc. Nevertheless, manoeuvring government procurement contracts and regulatory requirements still favour large incumbents with resources and knowhow, and reducing red tape could improve access. For example, US regulators are streamlining their licensing rules to make the process easier, faster and less expensive, to attract innovative actors (often funded by equity finance). One interesting initiative is the UK “sliding scale” policy, which reduces or waives requirements to hold in-orbit third party liability insurance for low-risk missions.

Considering the importance of government programmes for space activities, more evidence is needed on their effects

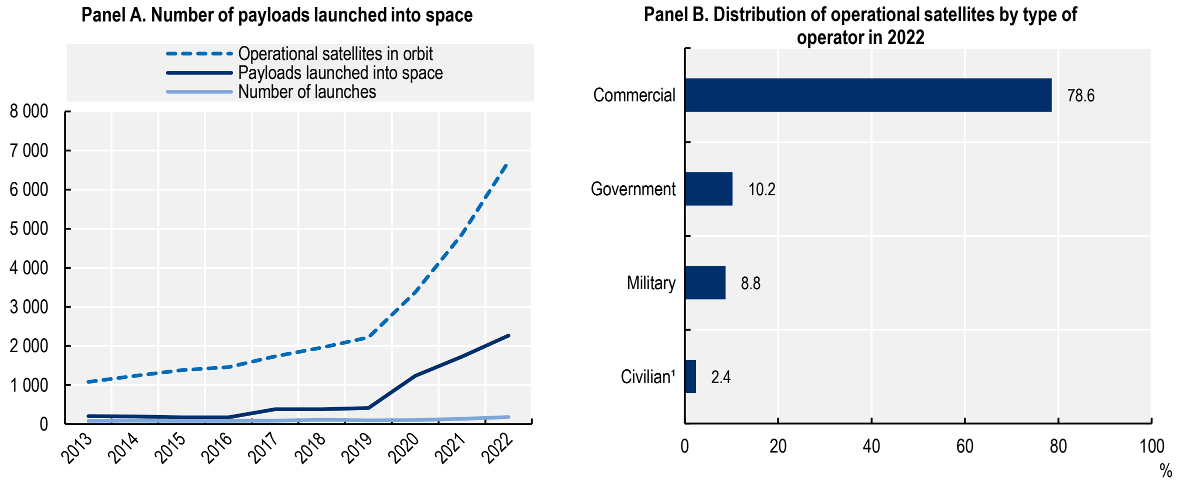
Several space agencies with responsibility for procurement are already collecting and sharing valuable space industry data and policy evaluations, **but more research is needed on the “additionality” of public space programmes, i.e. their effect on firm inputs, outputs and behaviour**. The OECD Space Forum will continue contributing to these efforts by providing definitions and guidelines on how to measure the space economy and by analysing space-related policy instruments.

1 Introduction

The space economy has changed dramatically in the last ten years. The lowering of production and launch costs in the early 2000s (OECD, 2014[1]; 2019[2]) has attracted new types of actors as well as new types of capital, leading to an explosive growth in the number of satellites launched into orbit.

Figure 1.1 shows the intensification of launch activity between 2013 and 2022, starting with the launch of the first commercial nanosatellite constellations, consisting of dozens of satellites with a very low mass (equal or inferior to 10kg) Since 2019, global launch activity is dominated by the deployment of satellite broadband constellations in the low-earth orbit. In early 2024, the constellations of two commercial operators, US' SpaceX and UK's OneWeb, count more than 5 000 and 600 satellites respectively, representing more than half of *all* operational satellites on orbit.

Figure 1.1. Increasingly crowded orbits



1. Civilian operators typically include universities and radio amateurs. Note: Each category of actors also includes partnerships and dual-use missions (e.g. public-private, military-commercial).

Source: OECD (2023), *The Space Economy in Figures: Responding to Global* Challenges, https://doi.org/10.1787/fa5494aa-en, based on data from the US Space Force and the Union of Concerned Scientists Satellite Database.

This remarkable growth in activity was funded by government R&D support and strategic public procurement (e.g. the Commercial Orbital Transportation Services programme by the US National Aeronautics and Space Administration (NASA)), considerable investments by billionaire market entrants from the internet economy (e.g. SpaceX), and unprecedented amounts of equity finance (as will be shown in the next section).

Still, it raises several questions for policy makers when designing economically sustainable and forward-looking policies.

- How does the level of private investment compare to public sector support? And is it a reliable source of funding over time?
- Which are the characteristics of private investments in terms of scope and duration of support? Does this differ from public sources of funding?
- How can public policy decisions and instruments contribute to attracting more private investment, in areas where this is desirable?

This report aims to provide initial answers to these questions, building on OECD statistical analysis and policy evidence in the science, technology and innovation (STI) domain, as well as available data from space industry surveys. The sections are structured as follows:

Section 2 tracks different types of investments in both official statistics and national micro-data to better understand structural investment characteristics of the space economy and/or of related industries and assess the levels of available capital.

- Section 3 looks more closely at STI policy instruments used to attract and sustain investment in space and science, technology and innovation domains and suggests several policy options for decision makers.

2

How does the level of private investment compare to public support in the space economy?

This section looks at which segments of the space economy are in greatest *need* of investment for physical capital and research and development (R&D), and then reviews available evidence of public and private sources of funding and support, relying both on OECD statistics and a growing amount of data from space industry surveys. What comes out of the analysis is that the space economy is deeply heterogeneous, with a clear separation between upstream and downstream segments.

- Space manufacturing in the upstream segment stands out as particularly R&D- and investment-intensive, highly reliant on government procurement and R&D support.
- Activities associated with space operations in the downstream segment can also be very capital-intensive. Certain downstream activities are strongly reliant on government procurement.
- Revenue growth is stagnant for space manufacturing and launch, as well as for certain downstream activities (direct-to-home television in particular), indicating that in-house sources of equity may be limited, unless the firms have other more profitable activities (e.g. defence branches of conglomerates Airbus and Boeing) or are attached to rich investors (such as Amazon or SpaceX).

The availability and volume of private investment have increased considerably in the last 15 years, playing a growing role for certain actors, typically fast-moving start-ups with scalable activities. Private investment therefore plays an essential role in nurturing innovation. But this accounts only for a small fraction of actors and investment needs, the bulk of which is covered by public support.

Defining and measuring space investment

In the space economy and other industries, “investment” means different things in different contexts and this section provides some key definitions and reviews notable measurement issues.

Financial investment refers to the act of acquiring assets or items (e.g. stocks, equities, real estate) to generate income over time. An investment company is typically a “corporation whose activities consist exclusively or substantially of making investments (i.e. holding property and collection of income therefrom) and whose buying and selling of shares, securities, real estates or other investment property is only incidental to this purpose” (OECD, 2022[3]). In contrast, in national accounting, investment equals “gross fixed capital formation” (GFCF), which comprises total expenditures on tangible and intangible products (e.g. machinery, buildings, software, patents) intended to be used for future production (Lequiller and Blades, 2014[4]). R&D expenditure was formally recognised as GFCF in the 2008 update of the System of National Accounts (SNA). In this report, we will specifically look at financial investments, R&D investments and other fixed capital investments (e.g. facilities, equipment).

Furthermore, some specifications on *private sector* investment are needed. First, it is important to note the difference between private sector *performance* and *funding*, e.g. R&D performed by business firms is not necessarily privately funded. Public actors support a significant share of private sector R&D and other capital investments through tax incentives, subsidies, debt and equity financing. Second, government programmes and actions can influence *private incentives* to invest – predictable and long-term supply-side schemes such as procurement can attract private capital as it gives more certainty on the return on investment. Relevant public actors and funding instruments will therefore also be covered in the following sections.

Space manufacturing investment needs are higher than those of most other high-tech industries

It is important to understand the type of financial challenges and hurdles the space industry faces for governments to provide effective support. For example, revenues and venture capital investments are sometimes used to estimate private R&D investments (see for instance Brukardt, Klempner and Stokes (2021[5])), but without detailed knowledge about structural investment characteristics of different space industry segments, this may lead to over- or under-estimation. Furthermore, in the private market for capital, space entrepreneurs compete for support against other sectors/technologies, and the ratio between upfront capital needs and expected (short-term) returns can be a determinant factor of success in obtaining funding.

The first step is to define space activities and locate them in official statistics. The *OECD Handbook on Measuring the Space Economy* (OECD, 2022[6]) divides space activities into the upstream and downstream segment (Figure 2.1). These activities are dispersed across several higher-level industry categories in the *International System of Industry Classification* (UN Department of Economic and Social Affairs, 2008[7]), the most important of which are the following:

Upstream activities:

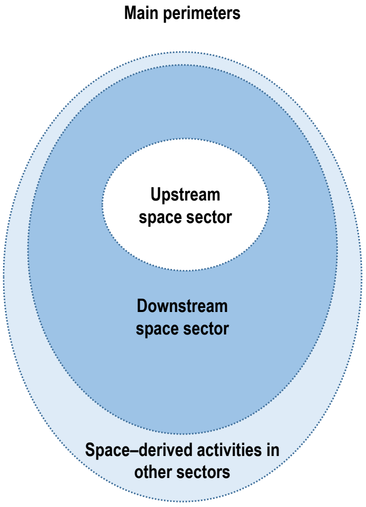
- space research and development (72: scientific research and development)
- testing and engineering services (70: architectural and engineering activities: technical testing and analysis)
- space manufacturing (31: manufacture of air and spacecraft and related machinery)
- space launch (51: Air transport).

Downstream activities:

- operation of space systems (61: telecommunications)
- supply of devices and products supporting consumer markets (e.g. GNESS chipsets and devices (26: manufacture of computer, electronic and optical products)
- supply of services supporting consumer markets (e.g. DTH providers, data-derived commercial services) (60: programming and broadcasting activities; 63: information service activities).

Figure 2.1 shows the different segments of the space economy in three concentric circles, with the upstream space segment in the centre, surrounded firstly by the much bigger downstream segment, which depends on the exploitation of space data and signals, and secondly, by “space-derived activities”, which are derived from space technologies but not dependent on them to function. These three perimeters jointly constitute the space economy.

Figure 2.1. Main perimeters of the space economy



Scope	Activities
Upstream space sector = scientific and technological foundations of space programmes, manufacturing and production of space infrastructure	Fundamental and applied research; scientific and engineering support; dedicated ancillary services (e.g. insurance); supply of materials and components; design and manufacturing of space equipment and subsystems; integration and supply of full systems; space launch
Downstream space sector = daily operations of space infrastructure and “down-to-earth” activities that directly rely on the provision of a space capacity (satellite technology, signals or data) to exist and function	Operations of space and ground systems; supply of devices and products supporting consumer markets (e.g. GPS-enabled devices, set-top boxes, selected GIS); supply of services supporting consumer markets (e.g. satellite television broadcast)
Space-derived activities in other sectors = new activities in various economic sectors that derive from or have relied on space technology transfers	Activities/products/services derived from space technology, but not dependent on it to function (e.g. ad-hoc space technology transfers in the automotive or medical sectors).

Source: OECD (2022[6]), *Handbook on Measuring the Space Economy, 2nd Edition,* http://doi.org/10.1787/8bfef437-en.

Identifying investment patterns and needs in the space economy

Industry surveys and official statistics tend to track investments in R&D and in physical capital such as equipment and facilities.

Judging from industry aggregates (as shown in Box 2.1), upstream and downstream space segments have quite different characteristics in terms of R&D intensity. Activities in the upstream segment tend to be extremely R&D-intensive. In fact, according to recent OECD research, the manufacture of air and spacecraft and other machinery has the highest R&D intensity of all recorded 4-digit ISIC economic activities (Galindo-Rueda and Verger, 2016[8]). In the downstream segment, the situation is less clear. The manufacture of electronic and optical products is highly R&D intensive, the other activities less so.

Box 2.1. Tracking investment in official statistics

The intensity of R&D and other fixed capital investments (investment intensity) is typically measured as a share of gross value added (GVA) – an industry’s contribution to the gross domestic product (GDP) – or gross output (industry sales as well as the inclusion of other forms of mixed income). GVA is preferred by statisticians because it is less sensitive to sector-specific reliance on material inputs like raw goods and better incorporates structural industry characteristics ((Galindo-Rueda and Verger, 2016[8]). This report uses GVA when possible and reverts to gross output when GVA data are unavailable.

The following tables and graphs include data for aggregated ISIC categories where the main space activities are located. Specific space industry data have been included where available.

Table 2.1 presents the R&D intensity for the space-related ISIC categories listed above.

Table 2.1. R&D intensity in selected ISIC rev. 4 categories

ISIC activity	2-digit classification	R&D as % of GVA (OECD weighted average), 2015 values
M: Professional, scientific and technical activities	72: Scientific research and development	30.39
	69-75X: Professional, scientific and technical activities except scientific R&D (ISIC 69 to 75 less 72)	1.76
C: Manufacturing	**3031: Air and spacecraft and related machinery**	**31.69**
I: Information and communication	59-60: Audiovisual and broadcasting activities	0.32
	61: Telecommunications	1.45
	62-63: IT and other information services	5.92
C: Manufacturing	26: Computer, electronic and optical products	24.05

Note: The taxonomy is based on data from 2011. The choice of reference year was largely determined by the availability of ISIC Rev.4 data for R&D and value added, combined with value added data based on System of National Accounts (SNA) 1993. This previous version of the SNA does not treat R&D as a produced asset (introduced in 2008 SNA). In 2008 SNA, the inclusion of R&D as a capital asset boosts value added, especially in R&D-intensive industries.
Source: Based on Galindo-Rueda and Verger (2016[8]), "OECD Taxonomy of Economic Activities Based on R&D Intensity", *OECD Science, Technology and Industry Working Papers*, http://doi.org/10.1787/5jlv73sqqp8r-en.

These findings are supported by the most recent data from space industry surveys (e.g. (CSA, 2023[9]; know.space, 2023[10]; SJAC, 2023[11]; Korean Ministry of Science and ICT, 2022[12])) presented below in Table 2.2, which show a consistently higher R&D intensity in the upstream segment than in downstream segment activities.

Table 2.2. R&D intensity in selected space activities and OECD countries

Data from 2021 or latest available year

Country	Activity/segment	R&D intensity	
		R&D as % of GVA	R&D as % of income
Canada	Space industry average	53	11.2
	Upstream space industry	56	27.2
	Space manufacturing	59	..
	Downstream space industry	50	3.9
Japan	Space industry average[1]	..	1.7
	Space manufacturing	..	1.2
	Space ground segment (testing and downstream component manufacturing)	..	0.3
	Space-related software	..	2.2
Korea	Space industry average	..	5.9
United Kingdom (2020)	Space industry average	11.2	4.5
	Upstream space industry	25.4 (2016)	14 (2016)

Notes: ..= data not available; 1. Does not include downstream applications such as the exploitation of satellite data and signals. Countries are selected based on the availability of data in their space industry surveys. Countries apply comparable definitions for R&D, gross value added and income. All countries except Japan have comparable definitions for upstream and downstream.
Source: OECD research based on national industry surveys.

Investments in fixed capital are equally high in the space economy, as upstream space activities have low production volumes and high needs for equipment and physical space. Testing facilities for prototype development and flight-qualification may include wind tunnels; propulsion test cells; vacuum chambers; cryogenic chambers; microgravity, acoustic and vibration testing facilities, etc. (OECD, 2016[13]). Smaller firms often rely on public or private testing services, while bigger actors have at least some of these facilities in-house. An extreme example is the US space manufacturer and launch provider SpaceX, which leases some 1 732 hectares (or 17.3km^2) of space for its Rocket Development and Test Facility in McGregor, Texas. The site is used for research and development of new rocket engines and thrusters and for testing final manufactured engines and various components (Benavidez, 2021[14]).

Judging by these (limited) examples, space activities seem to be more capital-intensive than their industry aggregates, both in upstream and downstream segments. Certain downstream activities, ground- and space-based satellite operations, also require considerable tangible investments. With the lowered cost of access to space and the digitalisation of the economy, digital intangible assets are also becoming more important (OECD, 2019[2]).

Types of funding for space activities

This section examines the types of public and private sources of capital for space activities, starting with government space budgets and civil R&D allocations, then moving to private third-party sources (e.g. venture finance) and finally, space industry revenues.

Public funding

Government space budgets support R&D, procure goods and services and finance government space activities. They affect private investments in the sector in several ways:

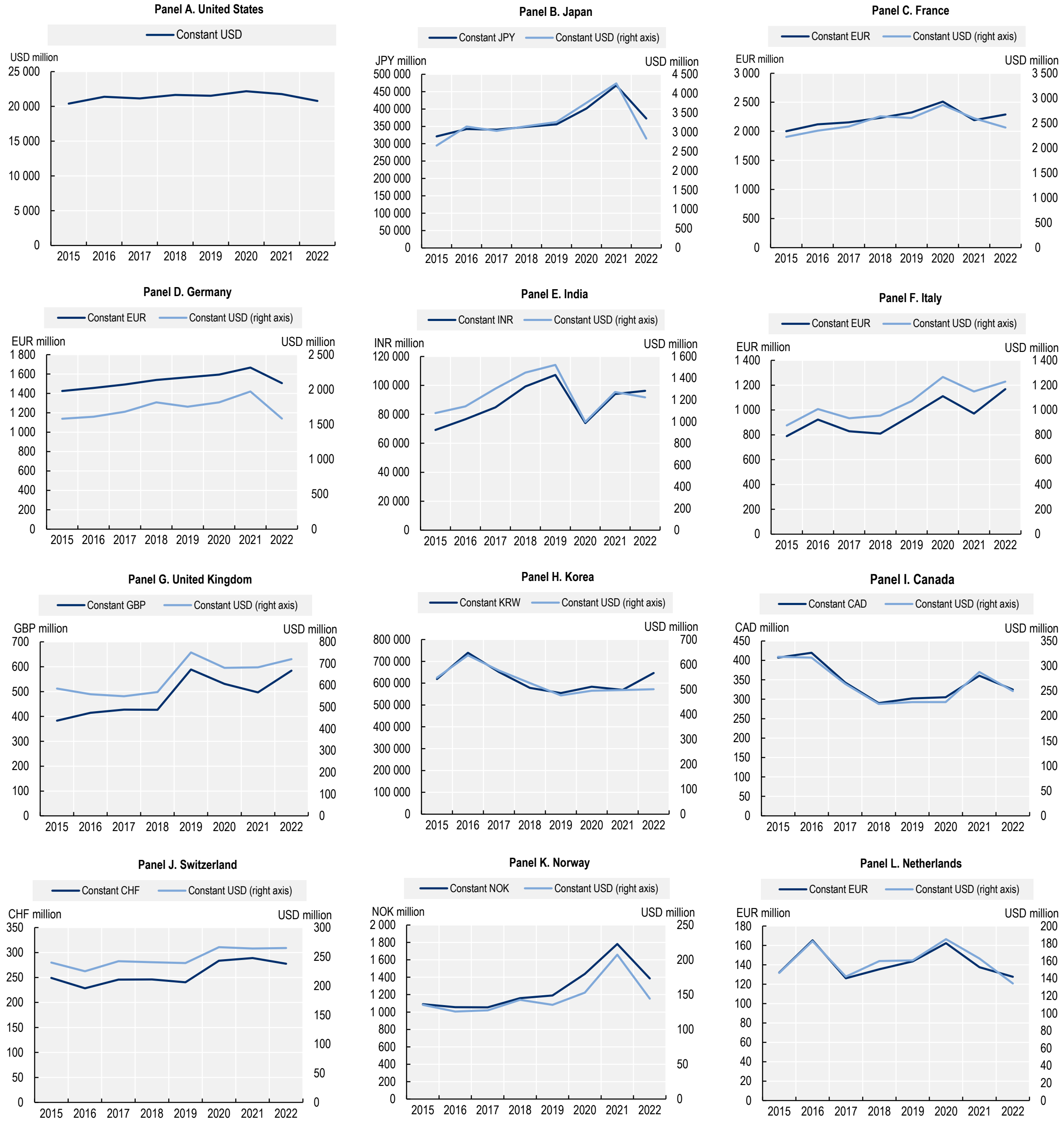
- by financing high-risk activities (e.g. R&D)
- by creating a market for goods and services.

It may be challenging to get a complete and holistic overview of budgets. Many activities are military or dual-use, making it difficult to track public investments. Furthermore, government space activities tend to be fragmented in different services, as they become increasingly integrated into daily operations. Other government actors also provide financial support, sometimes quite substantial. This may include loans and tax benefits from innovation agencies or local/regional authorities, trade finance, etc. The 2021 operating expenses of the US regional agency Space Florida, for instance, amounted to USD 70 million, most of which was devoted to “business development activities”, which include several loans to firms (Space Florida, 2021[15]).

Over the 2015-22 period, government space budgets have followed different paths in the OECD area and beyond (OECD, 2023[16]). Budgets have tended to stagnate or stabilise in established space nations (e.g. Canada, France, the Netherlands, United States), whereas a number of countries have considerably increased funding since 2015 (e.g. Korea, Norway, Switzerland, United Kingdom), having joined programmes at the international level such as Galileo or Copernicus, and/or as part of national strategies (Figure 2.2). Among the countries in the chart, the COVID-19 pandemic sometimes caused an increase in spending (e.g. France, Italy), due to advance payments, industry recovery packages, etc. This trend has not necessarily been sustained. In other countries, COVID-19 could also lead to decreased spending (e.g. India, followed by a quick recovery).

Figure 2.2. Evolution of selected government space budgets

Constant local currencies and USD (base year 2015)



Notes: United States data include civilian budgets for the National Aeronautics and Space Administration and space programmes in the Departments of Commerce, Transportation and the Interior. Data for France, Germany, Italy, Netherlands, Norway, Switzerland and the United Kingdom include contributions to the European Organisation for the Exploitation of Meteorological Satellites and the European Space Agency. Data for Norway, Switzerland and the United Kingdom also include subscriptions to selected European Union programmes (e.g. EGNOS/Galileo, Copernicus). Source: OECD calculations based on official government information.

In the short- and medium-term future, more growth in government space budgets may be expected. First, as an increase in budgets of existing actors, also more established ones, with the militarisation of the space environment and its assets. Increased activity at the European level will also affect funding levels. An interesting development is the diversification of science and exploration programmes, with the People's Republic of China [hereafter 'China'] and India and other emerging actors becoming more active. Second, the public market of space activities is expanding at the global level, as more of the world's economies enter the space economy. These emerging actors rely on external products and knowhow, but they also seek to build domestic capabilities.

In some space industry segments, public procurement and support account for a major share of revenues, as well as the share of business expenditure on research and development (BERD) that is externally funded. However, there are clear differences between the upstream and downstream segments.

Public market shares of revenues refer to revenues derived from sales to public actors at international, national, regional and local levels of governance, to higher education institutions and other non-profit actors. This may include R&D subsidies.

According to available data, some 5-20% of downstream revenues are secured by public actors (noting that for some applications, earth observation for instance, this share is much higher – judging by the latest data from the European Association for Remote Sensing Companies, public and non-commercial actors accounted for about 70% of revenues in 2021 (EARSC, 2022[17])). In contrast, in upstream space activities, dominated by manufacturing and launch activities, public organisations sometimes account for some 60-70% of markets in both Europe and Asia. Below is a breakdown of data from 2021.

- 40% of total upstream segment revenues in Canada (CSA, 2023[9])
- 69% of private sector domestic upstream revenues in Korea (Korean Ministry of Science and ICT, 2022[12])
- 70% of revenues in the upstream segment in Europe (Eurospace, 2022[18])
- 67% of domestic revenues in Japan (mainly upstream segment) (SJAC, 2023[11]).

In addition, some 16% of US (mainly upstream) commercial respondents to the 2014 US industrial base deep dive survey declared themselves "dependent" on US government space programmes (US Department of Commerce, 2014[19]). More precisely, variability in US government space-related demand would "somewhat or significantly adversely affect" 18% of the near 4 000 survey respondents, potentially leading them to pursue other markets and product lines, to loss of key personnel, decreases in R&D expenditure or even insolvency (US Department of Commerce, 2013[20]).

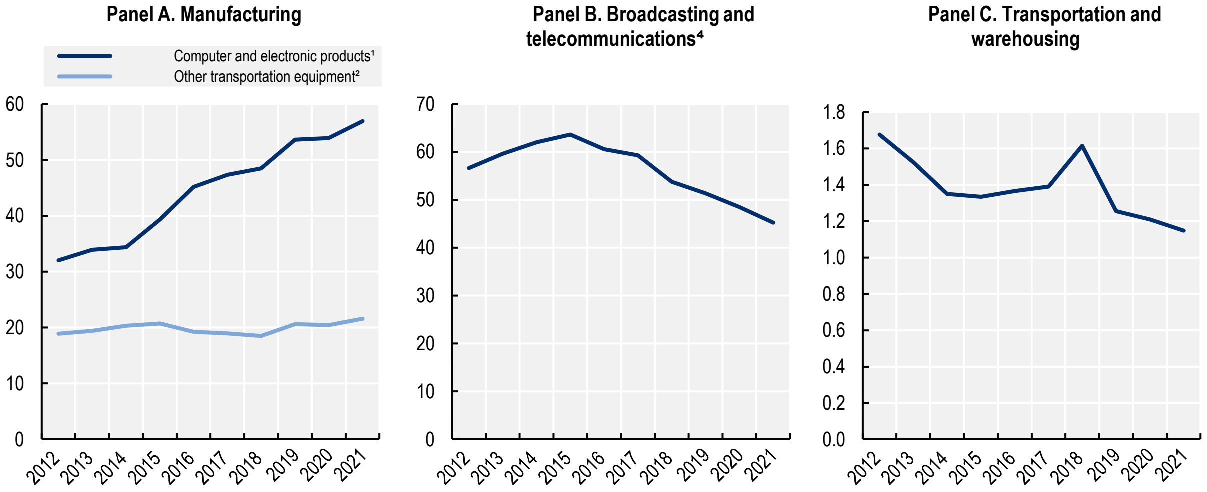
Externally funded BERD refers to the share of business firm expenditure on R&D that is funded by external sources. Limited data availability does not allow for the distinction between upstream and downstream segments but considering the differences in R&D intensity between the segments seen previously, it can be presumed that the bulk of external R&D is expended in the upstream segment. In 2020 and 2021, externally funded R&D accounted for 51% of BERD in the United Kingdom and 24% in Canada (CSA, 2023[9]; know.space, 2023[10]). No data is available for other space industries, but it is worth noting that external funding of BERD is uncommon in Japan. For instance, the Japan Aerospace Exploration Agency (JAXA) does not have the formal authority to allocate R&D subsidies to or invest in private companies (Uchino, 2019[21]). This may contribute to explaining the relatively lower R&D intensity of Japan in Table 2.2 in the previous section.

Private sources of investment

Private sources of capital and investment are either internal – based on profits or owner's funds – or external. Owners' own resources may in some cases play a significant role, with two of the world's richest people, Elon Much and Jeff Bezos, each owning a space company. In terms of profitability and revenues, the dramatic increase in launch activity, as previously illustrated in Figure 1.1, has not yet translated into higher revenues (or sales), with upstream segments of the space industry displaying generally modest or negative growth rates in the United States and Europe. Estimates by the Bureau of Economic Analysis (BEA) for the US space economy indicate that the average annual growth rate for the 2012-19 period of 1.6% was below the overall US growth rate (Highfill, Jouard and Franks, 2022[22]). The BEA's estimates come from the US Space Economy Satellite Account (SESA) that provide robust trends that can be compared with other US industry sectors.

Figure 2.3. Gross output of selected industry segments of the US space economy

Chained billion USD (2012 base year)



1. Includes manufacturing of satellites; ground equipment; search, detection, navigation, and guidance systems (GPS/PNT equipment);.2. Includes manufacturing of space vehicles and space weapons systems; 3. Includes direct-to-home satellite television services.

Note: Industry gross output represents the market value of the goods and services produced by an industry and is similar in concept to revenue.

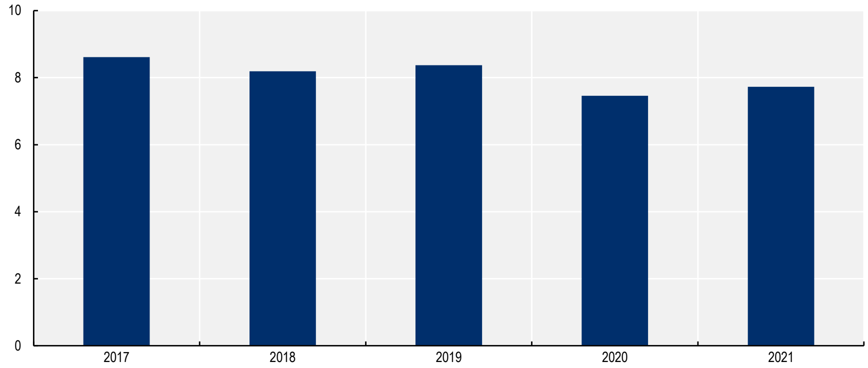
Source: Highfill and Surfield (2023[23]), "New and revised statistics for the US space economy, 2012-21", https://apps.bea.gov/scb/issues/2023/06-june/pdf/0623-space-economy.pdf.

Figure 2.3 shows the gross output of the specific US space economy industry segments "manufacturing" (panel A), "broadcasting and telecommunications" (Panel B) and "transportation and warehousing" (panel C) over the 2012-21 period. The manufacturing of space-related computer and electronic products (including for instance satellites, ground equipment and, most notably, GPS/PNT equipment) had the strongest growth over the period. Meanwhile, the manufacturing of launch vehicles and launch services saw a much more modest growth, while launch services (transportation) experienced negative growth. A significant trend is the decrease in gross output in satellite television, historically the biggest space economy segment.

In Europe, final sales recorded by space industry association Eurospace, covering launcher and satellite application systems; scientific programmes; and ground systems and services, indicate a decline in real terms over the 2017-21 period (Figure 2.4).

Figure 2.4. European upstream final sales

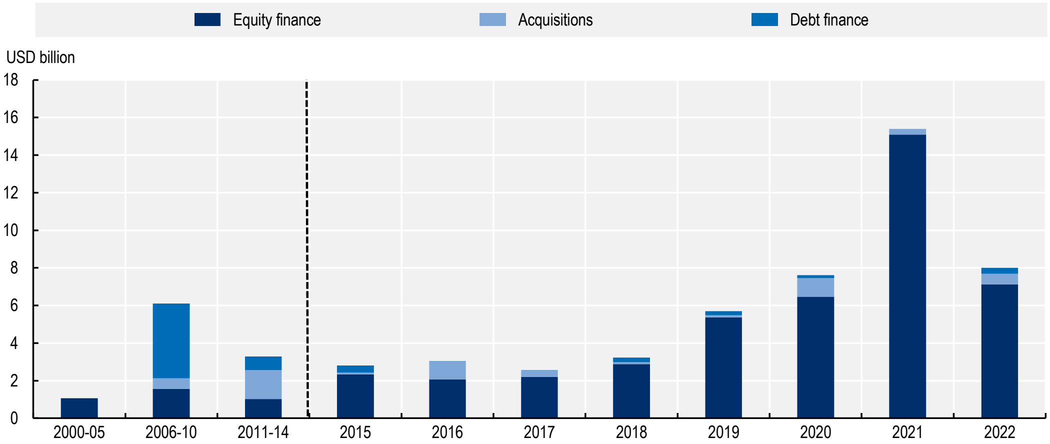
Constant EUR billion (base year 2015)



Note: The deflator used is the Domestic Producer Prices Index (manufacturing), with a weighted average of all Eurospace reporting countries (AUT, BEL, DNK, EST, FIN, FRA, DEU, GRC, HUN, IRL, ITA, LVT, LTU, LUX, NLD, NOR, POL, PRT, SVK, ESP, SWE, CHE, GBR), excluding Bulgaria and Cyprus. The weights are based on the previous year's Gross Domestic Product expressed in purchasing power parities.
Source: Eurospace (2022[18]), "Facts and figures 2022: The European space industry in 2021", https://eurospace.org/wp-content/uploads/2023/07/facts-figures-report-2022-web-release.pdf and OECD (2024[24]), "Producer price indices (PPI)" (indicator), https://doi.org/10.1787/a24f6fa9-en (accessed on 09 February 2024).

A surge in private third-party investment has greatly contributed to recent activity growth in the sector. Private third-party investment includes external sources of equity, debt and acquisition finance, measured in current USD million. Such transactions are tracked by several investment firms and consultants, typically based on deal databases such as Crunchbase and public announcements. Data from BryceTech (2023[25]) in Figure 2.5 show a strong increase in equity finance (seed, venture, private equity, initial public offerings) worldwide between 2000 and 2021.

Figure 2.5. Investment in commercial space ventures



Note: "Space ventures" are defined in the report as space companies that began as angel- and venture capital-backed start-ups.
Source: Based on BryceTech (2023[25]), "Start-Up Space 2023: Update on investment in commercial space ventures", https://brycetech.com/reports/report-documents/Bryce_Start_Up_Space_2023.pdf and similar reports for earlier years.

It is worth noting that the bulk of this investment benefits a very limited number of companies, mainly headquartered in the United States. According to this data, the company owned by Amazon's Jeff Bezos, Blue Origin, received 74% of seed investments recorded between 2000 and 2021 (BryceTech, 2022[26]). Similarly, four firms – SpaceX, OneWeb, Blue Origin and Virgin Galactic (three of which are owned by billionaires and one that has the UK government as minority shareholder) – received 66% of total investment in 2019 and 42% in 2022. From a geographical distribution standpoint, 73% of investment was directed towards companies based in the United States in 2022, a lower share than previous years (BryceTech, 2023[25]).

The European Space Policy Institute keeps track of investment flows to space start-ups in Europe. Some EUR 2.9 billion in investments was recorded between 2014 and 2022, the great majority of it registered towards the end of the period and mostly in the form of equity finance (ESPI, 2023[27]).

The growth in equity finance may signal a changing ecosystem of space entrepreneurs, underpinned by digitalisation and lowered cost of access to space. But this trend needs to be seen against the backdrop of the historically low interest rates culminating in 2021, which fuelled unprecedented growth in venture capital investments overall. The increase in interest rates lead to a drop in private third-party investment in 2022. Nevertheless, available space investment reports for 2023 (with a slightly different methodology) indicate a 18% rise between 2022 and 2023, driven by investment in broadband satellite infrastructure development and launch, as in previous years (Space Capital, 2024[28]).

In conclusion, the growing role of equity funding in the space economy should be welcomed but not overstated. It has played a crucial part in enabling the entry of "new space" newcomers from other sectors, allowing disruptive innovations such as reusable launchers and microsatellites that have radically reduced the costs of access to space and fuelled additional market entries and innovations (OECD, 2023[29]). It is a good funding opportunity for fast-moving and innovative start-ups but remains relatively risk-averse (Haskel and Westlake, 2017[30]), and do not necessarily support projects with low technological maturity, long lead times and/or uncertain market prospects. Furthermore, small actors could be at a disadvantage when it comes to the vetting process and for administrative costs; first, because they have limited resources to prepare a dossier, and second, because the due diligence process on the venture capitalist side is equally time-intensive irrespective of whether the size and growth potential of the considered company is big or small, and that therefore quickly scalable projects are preferred (Machado, 2021[31]; OECD, 2022[32]).

While the volume of private investment has decreased since record levels in 2021, it will most likely be more substantial than in previous decades, because of the changing, more digital, nature of market entrants, which tend to rely on such funding modes. However, public investment continues to dominate in the space economy. The reasons why will be treated in the next section.

3

Barriers to invest and policies to attract and raise private space investment

This section identifies the main barriers to space investment and then discusses policy options that encourage more private sector investment and risk-sharing.

Barriers to invest in the space economy

Barriers to investing can be divided into two groups: barriers to entering the sector (particularly for small and young firms) and barriers to investing in certain assets (most notably R&D).

Barriers of entry affect certain actors more than others. Small and new-technology actors may struggle more to raise capital (as opposed to billionaire entrepreneurs and incumbents) and have less resources available to address regulatory hurdles. The list below is mainly taken from Machado (2021[31]) for high-risk/high-reward research, but it is also valid for the space economy.

- **High capital requirements:** The supply of small volumes of equity can be particularly problematic for small actors and new technologies, as venture capitalists' transaction costs in assessing, monitoring and managing investments vary little with the size of the investments. Accordingly, smaller investments become less attractive.
- **High legal/regulatory barriers:** Small firms can incur high costs relative to their turnover in information search, screening and administrative processes (e.g. security clearances, spaceflight qualification, licensing, insurances, export restrictions).
- **Large sunk costs:** A notable share of investments would be unrecoverable in case of an exit, because the invested capital is industry-specific and with no or limited resale value (e.g. licenses, non-transferable R&D costs, very specialised equipment). For more on sunk costs, see for instance Rimini et al. (2020[33]).
- **Long lead times:** The high capital cost of investment and the long timescale for deployment and returns tend to make investors risk-averse with respect to new technologies. This issue is further elaborated in the bullet points below on barriers to R&D investments.

There are also several specific barriers to investing in R&D, famously identified by Kenneth Arrow in the 1950s, which justifies considerable public intervention and support in this area.

- **Knowledge spillovers:** Economic theory gives private actors few incentives to invest in R&D, because they cannot fully appropriate the ensuing knowledge (which is non-rivalrous and only partially nonexcludable). Indeed, others may use it without necessarily paying for it, and it is not depleted by sharing.

- **Long temporal dimension:** Space research and technology development typically requires a long time horizon to achieve results. Ansar and Flyvbjerg (2022[34]) analysed 203 space missions by SpaceX and NASA conducted between 1963 and 2021 (with SpaceX missions starting in 2003) and found that SpaceX projects lasted on average about four years, compared to some seven years in average for NASA projects (with big variation between projects, e.g. the development of the Space Shuttle programme lasted 13 years from official kick-off to first launch). Considering the broad range of activities and different profiles of the two actors, this gives a useful indication of the upper and lower thresholds of lead times for upstream space technology development.
- **Uncertainty:** The final success of the research and development activities is highly uncertain.

Changes in the sector, e.g. in the cost of access to space and in the number of launch opportunities; the miniaturisation and standardisation of technology; the increased reliance on off-the-shelf products; etc., is somewhat reducing development costs and lead times, but they remain considerable challenges to overcome for actors looking to raise funds from risk-averse investors. This is something public actors need to keep in mind when formulating policies and staking out realistic policy objectives.

Types of policy responses to address investment barriers

Governments have different instruments at their disposal to support the space economy and address these barriers. Responses include supporting access to finance; providing specific technology extension and advisory services; strengthening intellectual property rights (notably the patent system); sharing risk in different types of partnerships; and more indirectly, ensuring stable demand through public procurement. Employing space agency capabilities to catalyse investment is increasingly a strategic objective (Box 3.1).

Box 3.1. UK Space Agency: Catalysing investment and monitoring improvement

The UK Space Agency's (UKSA) value proposition describes the Agency's delivering of the National Space Strategy over the 2022-25 period, based on feedback from both UK and international stakeholders. Each of the elements is mutually reinforcing, with UKSA priorities and programmes typically contributing to all three, by

- catalysing investment, deploying funding and resources to multiply the value of non-government contracts and private capital secured by UK space organisations to maximise the space economy's long-term growth
- delivering missions and capabilities, independently and with others, that use space science, technology and applications to meet national needs and help humanity to understand our universe
- championing space, encouraging other sectors to use space to deliver better services, tackle the climate emergency, inspire STEM (Science, Engineering, Technology and Mathematics) education and lifelong learning, and advocate for sustainable space activities.

The Agency monitors improvements in three key metrics and assess each priority's contributions to them where relevant:

1. the total value of investment and contract revenue the UK Space Agency helps the UK space sector to raise. This is the North Star Metric: the most important measure to ensure the Agency remains on course
2. the Agency's confidence that programmes to deliver missions and capabilities will realise their benefits

3. the amount of time members of the public spend participating in the Agency's activities to champion space.

Source: UKSA (2022[35]), *UK Space Agency Corporate Plan 2022-25*, https://www.gov.uk/government/publications/uk-space-agency-corporate-plan-2022-25.

Supporting access to finance

The type of finance that is available and preferable to firms will depend on their size, their age, the maturity of their technology, R&D intensity, etc. Some of the most common measures put in place by public authorities (e.g. R&D tax credits) will likely be important to particularly R&D-intensive space industry segments such as manufacturing, but they are applied in a non-discriminatory manner across sectors and are not specifically addressed in this report. Specific types of debt finance (e.g. export credits) seem to benefit established actors, whereas venture finance is particularly well suited for a small subset of fast-moving and high-risk start-ups. However, more evidence is needed on the effects of these instruments in the space economy.

R&D subsidies

R&D subsidies are a common way to support additional private R&D investment in OECD countries. However, it remains a question whether public R&D subsidies replace (or crowd out) private funding or catalyse *additional* funding and/or other positive externalities (see for instance Guellec and van Pottelsberghe de la Potterie (2001[36]), OECD (2006[37]) and Westmore (2014[38])). According to current research for the entire STI domain, there seems to be a neutral or positive long-term relationship between government support and business-funded R&D (Westmore, 2014[38]). However, this is mainly true for non-defence related sectors. In terms of policy design, long-term stability of measures seems to have a certain positive effect on input additionality (Westmore, 2014[38]). Furthermore, holistic analyses of the overall *policy mix* of instruments show that the existence of demand-side policies (e.g. regulation, procurement) can affect the supply of both internal R&D funding, debt and venture finance. Finally, there is new evidence that the structure of compensation schemes may affect innovative performance (Zivin and Lyons, 2020[39]), with winner-takes-all style incentives encouraging more innovation than incentives that reward a greater number of participants, because they provide no "insurance" for inferior proposals.

At the OECD level, hundreds of millions of USD in R&D subsidies are yearly allocated to the space industry, through international research programmes (e.g. the European Space Agency and European Union research framework programmes, see for instance de Concini and Toth (2019[40])) and national efforts. As an illustration, the US National Aeronautics and Space Administration (NASA) allocates some 3% of its R&D budget just to *small* business firms every year: In 2022, the Agency awarded almost USD 300 million in contracts within the framework of the Small Business Innovation Research programmes (SBIR) (NASA, 2023[41]).

In terms of the effects of this funding, multiple studies have measured the spillover effects of funding from the European Space Agency (e.g. in Denmark, France, Norway, Portugal, Switzerland, the United Kingdom). They all identify positive effects in terms of additional sales and knowhow, but the studies are not designed to identify net effects (what would have happened in the absence of intervention). Also, they provide no information on input additionality (additional sources of R&D expenditure). A 2008 evaluation of NASA's SBIR programme found that NASA projects generated less additional funding than those of other agencies – attracting no venture capital and with non-SBIR funding coming mainly from other federal government and internal sources (National Research Council, 2009[42]). A 2016 follow-up report found that NASA lacks the outcomes data necessary to meaningfully evaluate SBIR programme effects (Committee on Capitalizing on Science, Technology, and Innovation: An Assessment of the Small Business Innovation Research Program--Phase II et al., 2016[43]).

Debt and trade finance

Debt finance is important for all actors and sectors. It is the preferred source of finance of SMEs, as it is relatively affordable, and banks do not interfere too much in the operation of the firm (Thompson, Boschmans and Pissareva, 2018[44]). However, access to debt finance tends to be more difficult for small and young firms, especially during economic downturns, facing both higher interest rates and greater demand for collateral (OECD, 2013[45]). Whereas traditional debt finance may be poorly adapted to high-risk ventures without collateral or with a limited credit history (start-ups, intangibles), both public and private institutions (for instance the European Investment bank) also provide targeted venture debt products for start-ups.

To improve access to and reduce costs of debt finance, public actors may also provide credit guarantee schemes, where the government takes on all or parts of credit in case of non-payment. A 2017 OECD study reviewing evaluations of schemes targeting SMEs in the OECD area finds evidence of financial additionality, but less evidence of financial sustainability (OECD, 2018[46]). Evidence is mixed when it comes to economic additionality; some schemes have a positive effect on employment levels, while effects on company performance (e.g. investments, productivity) are less documented. Some studies even find an association between loan guarantees and increased default risk. While widely used during Covid-19, credit measures are increasingly catering to specific subgroups (innovative firms, start-ups, etc.) to address structural constraints in access to finance (OECD, 2022[32]). The authors have found no specific evidence of the effects of debt finance instruments in the space economy.

Trade finance, most notably export credits, plays a particular role in capital-intensive sectors and are used to enable fluid and secure cross-border transactions. They include relatively affordable loans, deferred payments or insurances/guarantees to the exporter in case of non-payment. Export credits became particularly important for the space economy after the 2008 financial crisis, when private sources of finance dried out. It is estimated that the US Export-Import Bank (EXIM) backed some 60% of US satellites sales and launch services in the 2008-15 period (Erwin, 2020[47]). The same bank was in 2023 considering more than USD 5 billion’s worth in short- and medium-term proposals (Foust, 2023[48]).

Over the last decade, there have been at least a dozen export credit agreements of several hundred USD million each, to finance transactions of established space manufacturers. This involves loans or guarantees from credit agencies in Europe (e.g. France, United Kingdom), North America and China. Export credit agencies in France, Germany and the United Kingdom have for instance supported sales of two Airbus satellites to Malaysian operator Measat, most recently in 2021 (Natixis, 2021[49]). Chinese export credit agencies have supported deals with several lower-income countries (e.g. Belarus, Laos, Nigeria). These deals have all concerned satellite communications, but the US Export-Import Bank has also observed an increasing demand in other segments, such as earth observation and in-orbit servicing, in addition to data products and services (Erwin, 2020[47]). Trade finance will most notably play a role in financing some of the announced broadband mega constellations in the low-earth orbit. The USD 5 billion Lightspeed project (original estimate before the rise in inflation), involving French manufacturer Thales Alenia Space and Canadian operator Telesat, is currently negotiating financing with export credit agencies. The operator has already received CAD 1.4 billion in support from the Canadian government (debt and equity) (Telesat, 2021[50]). The future attractiveness of export credits will depend on the availability and affordability of other finance options as well as the pressure on buyers (OECD, 2021[51]).

Publicly backed venture finance

Venture capitalists may be better suited to finance high-risk start-ups than banks, but there are still barriers for small actors and high-risk ventures. SMEs face high costs of compliance with investor protection regulations, and the due diligence costs to investors of monitoring SMEs with more limited scaling opportunities compared to those of bigger firms, represent an obstacle for SMEs (Thompson, Boschmans and Pissareva, 2018[44]; OECD, 2022[32]). Specifically for space industry start-ups, lead times may still be a bit long, compared to average venture capital ownership periods of five years. Also, in certain segments, immaturity of markets may discourage investors. When looking at the composition of space venture capital funding rounds, investors clearly prefer later-stage ventures (as in other sectors) (BryceTech, 2023[25]). The situation may be a bit different for more specialised investors originating in and/or with a deep knowledge of the space economy, and where their stake would reflect their knowledge.

To improve access to venture capital for space entrepreneurs, several space agencies and countries have in the last couple of years announced their support of dedicated public space venture capital funds. In 2018, the Japanese government announced the creation of a fund with a pool of JPY 100 billion yen (USD 940 million) to be offered over five years to space economy firms, provided by the Development Bank of Japan, the Industrial Innovation Organisation, and other organisations. The same year, the French space agency CNES created CosmiCapital (fund size EUR 70 million), managed by Karista, an early-stage private venture capital firm. Two other European funds were announced in 2020: Primo Space, with European Investment Fund and CDP Venture Capital SGR as cornerstone investors and backed by Italian Space Agency (ASI)) (EUR 58 million) and Orbital Ventures, supported by the Luxembourg government (EUR 70 million). In 2022, the European Commission announced the launch of the Competitive Space Start-ups for Innovation Initiative (CASSINI) fund, regrouping some EUR 1 billion of support measures for start-ups and SMEs until 2027. Finally, in 2023, Korea launched a fund of funds of KRW 10 billion (USD 39 million), half of which is to be provided by private investors, to support space start-ups over the 2023-27 period.

Managing intellectual property

With government agencies so active in space R&D support, managing the ownership and diffusion of the ensuing intellectual property is crucial. The objectives of the inventor, public agencies and potential private investors are not always aligned.

In Europe, European Union research programmes generally grant ownership to the inventor but expect them to render the intellectual property public. The European Space Agency also grants ownership to the inventor as a general principle (if it is an external contractor), with the ensuing licensing regime varying according to the funding regime of the programme (fully or partially paid by the Agency) and who requests access to the intellectual property. For instance, contractors have the right to deny access to commercial users if this is proven contrary to its “legitimate commercial interests” (ESA, 2014[52]).

As the space ecosystem grows bigger and more diverse, space agencies and administrations need to identify and consider the complementary strengths of big and small actors and design policy instruments that address the different needs of these actors, clarifying issues such as asymmetric relationships in collaborative projects, intellectual property rights, etc.

A different, but related, issue concerns government sharing of commercially sourced earth observation data. In the United States, where commercial satellite data buys are increasingly common, data licensing can be a source of contention between commercial data providers and government users, with data providers listing open licenses as an obstacle to raising third-party funding (due to investor concerns about returns on investment), while government agencies argue that data purchased with taxpayer money should be made public (US Office of Science and Technology Policy, 2022[53]) or at least made to benefit a larger subset of society than just the contractors.

In Europe, similarly as with intellectual property licensing, data providers to the European Space Agency have the right to protect their “legitimate commercial interests” under specific circumstances (ESA, 2014[52]). This falls in line with the main messages of the *OECD Recommendation concerning Access to Research Data from Public Funding* (2022[54]) which encourages governments to ensure access to data is as “open as possible”, while “*recognising and protecting legal rights and legitimate interests of stakeholders, including private-sector partners”.*

Sharing risks through different types of partnerships

A growing number of space agencies are entering partnerships with private actors to transfer knowledge, share risks and increase taxpayers’ value for money. When significant risks are either shared among several partners and/or allocated to the party best equipped to handle it, it may attract more private investment.

These partnerships may be extended co-funding agreements or more traditional public-private partnerships (PPPs). An interesting public-private collaboration project with possible parallels to the space economy is the Circular Bio-based Europe Joint Undertaking (CBE JU, previously BBI JU). Since 2014, this EUR 3.7 billion partnership between the European Union and BIC has supported European bio-based industries. Each euro of public money has so far generated EUR 2.8 of private investment. (CCE JU, 2023[55]).

R&D partnerships

Space agencies increasingly engage in what they refer to as R&D “partnerships”. Sometimes also called “public-private partnerships”, these projects in reality correspond to various types of collaborative R&D, carried out jointly and co-financed by public and private partners. The objective of R&D partnerships may be to develop a highly innovative product and/or to enhance the technological capabilities of the private partners. There are several examples of such partnerships in the space economy (further elaborated in Undseth, Jolly and Olivari (2021[56])), with slightly different objectives.

Mission-oriented partnerships support government prerogatives and priority areas that were previously fully funded through public procurement with the objective to save costs and spur innovation, such as exploration, space debris removal and military communications. Examples include the NASA Commercial Orbital Transportation Services (COTS) programme to develop and demonstrate private sector transportation systems to low-Earth orbit in the United States and the JAXA-Astroscale partnership for active debris removal in Japan.

Market-oriented partnerships for innovation subsidise business R&D to support the development of commercial products and services. These arrangements resemble traditional R&D subsidies, but generally require a greater transfer of risks to the private partner. In Europe, most of these partnerships aim to develop commercial applications, particularly in satellite telecommunications. The European Space Agency’s Advanced Research in Telecommunications Systems (ARTES) programme has supported several partnerships for innovation, such as the European Data Relay System, Alphasat and smallGEO.

In the United States, both NASA and the Defense Advanced Research Projects Agency (DARPA) have entered partnerships with the private sector to develop commercial capabilities in on-orbit servicing and in small payloads transportation. These partnerships have sometimes faced difficulties (with the private partner withdrawing), linked in part to the major technical challenges associated with developing new capabilities.

Public-private partnerships (infrastructure)

Public-private partnerships (PPPs) are typically employed in technologically and commercially mature segments of the space economy such as telecommunications or earth observation. There are numerous examples of PPPs in military satellite communications, earth observation and one prominent failed PPP in satellite navigation (Galileo). Successful PPPs tend to share some of the following characteristics, as formulated in (Burger and Hawkesworth, 2011[57]):

- Risks can be defined, identified and measured, and the right type of risk can be transferred to the private sector (e.g. penalties of late delivery).
- There is competition for and in the market, i.e. in the bidding phase and operation phase, and there are considerable benefits from combining the construction and operating phases of the project.
- The quality and quantity of the service output can be clearly defined and measured.
- Government has sufficiently skilled staff to monitor the private partner and manage its own responsibilities and risks.
- The technology needed for the project does not change rapidly and significantly during the duration of the PPP contract (typically 20-30 years).

Creating stable demand through public procurement

Finally, demand-side conditions have been shown to be a strong predictor of risk finance activity, as they can provide greater certainty about the potential returns on an investment.

Procurement of R&D, goods and services accounts for the lion’s share of large institutional space budgets. How this procurement is conducted, has a significant impact on the space industry (Undseth, Jolly and Olivari, 2021[56]; Nicolas and Robinson, 2022[58]). Several space agencies are making changes to their procurement policies, focusing increasingly on enabling the growth of the private sector through outsourcing, “service buys” and different types of partnerships with other actors.

Around the world, public agencies are gradually transferring activities and tasks to the private sector. This may involve the transfer of capabilities and production (e.g. China, India and Korea) as space agencies turn their focus to other higher-risk, public-good missions such as science and exploration. In OECD countries, there is pronounced transfer of development “risks” to the private sector. At NASA, there is a marked increase in the use of “fixed-price” contracts, although diverse types of cost-reimbursement contracts remain more common. In 2022, fixed-price contracts accounted for some 33% of NASA’s total procurement dollars awarded to business firms (NASA, 2023[41]). In a similar vein, the use of service buys, where public organisations buy services from private operators without having to be concerned with building and operating the infrastructure, is spreading from satellite communications and earth observation to other applications. Recent examples include explorative space transportation (NASA’s programme for commercial lunar payload services), purchase of commercial meteorological data (meteorological satellite agencies in the United States and Europe) and orbital debris removal services (European Space Agency, the United Kingdom and Japan).

Government agencies are furthermore increasingly using “new” procurement mechanisms, such as Other Transaction Authority agreements (OTAs) in the United States or simplified contracts at the European Space Agency. OTAs include for instance Space Act Agreements (used for the COTS programme) and Broad Agency Announcements, which are exempt from the administrative requirements of federal procurement laws and regulations (FAR). The US Defense Advanced Research Projects Agency has reported that in some cases, by using open transaction authority agreements, project funding could come through in as quickly as 2-3 months (Kennedy, 2018[59]).

Reducing regulatory "red tape" where desirable

Several of the barriers to entering the space economy are particularly high for small and young firms, which have limited knowhow, human and economic resources to address administrative and regulatory requirements. For example, actors launching from the European spaceport in French Guiana need a USD 60 million liability insurance (absolute for damages on the ground or in airspace and "fault-based for damage caused in outer space) (Legifrance, 2008[60]). The licensing process is onerous and costly. Government agencies are making efforts to facilitate access to SMEs and start-ups to their R&D programmes, e.g. by reducing or waiving co-funding thresholds, but administrative red tape may still be prohibitive for small actors. Some insights suggest that existing space R&D programmes favour larger incumbents, e.g. those subject to the requirements of the US federal procurement laws and regulations (FAR), for instance (Kennedy, 2018[59]).

In the United States, work is ongoing to accelerate licensing procedures to attract innovative actors (often funded by equity finance). The US Federal Communications Commission is streamlining its licensing rules for small satellites to make the process easier, faster and less expensive. Similarly, the US National Oceanic and Atmospheric Administration now takes 15 days to issue a remote sensing licence, compared to 50-100 days in 2020, thanks to a more standardised treatment of companies and capabilities (Rainbow, 2023[61]). Another interesting initiative is the UK "sliding scale" policy, which reduces or waives requirements to hold in-orbit third party liability insurance for low-risk missions (UK Space Agency, 2018[62]). Funding agencies are also increasingly proposing new types of contractual arrangements for R&D procurement and collaboration that impose lesser burdens on firms (e.g. US Other Transaction Authority agreements and simplified contracts).

It is worth noting that societal and industrial needs for entrepreneurship and innovation must be balanced against reasonable regulatory and societal needs. One could indeed argue that the space economy is not regulated *enough*, with the orbital environment suffering under growing amounts of space debris (as described in OECD Undseth, Jolly and Olivari (2020[63])).

Final considerations

The growth in private space activities is bringing innovative ideas and applications to the space economy, giving governments more options and collaborative partners. But it also requires public organisations to acquire new skills and become more agile.

- Governments will increasingly need to align strategic objectives that do not necessarily pull in the same direction. For instance, from an environmental sustainability perspective, more commercial activity in orbit can increase orbital congestion and pollution. Also, supporting innovation and entrepreneurship may eventually lead to more innovation, but relying on incumbents and tested technology could reduce economic and technological risks.
- More service buys and complex partnerships will require adequate resources and expertise in the public agency responsible for project negotiation and monitoring.
- Several space agencies are already producing valuable evaluations of space programmes, but more data and evidence is needed on the space industry and on the combined effects of space policy instruments. To identify the overall effects and control outcomes, a thorough mapping would be needed, including those instruments that do not specifically address space firms (e.g. R&D tax credits).

The OECD Space Forum will contribute further to these efforts by providing definitions and guidelines on how to measure the space economy (see OECD (2022[6])) and by compiling space-related policy instruments in the STIP Compass for Space Policies.

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