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Entrepreneurship and Private Investment in the European Space Sector

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Table of Contents

1. A New Space Entrepreneurial Movement

1.1 The New Space ecosystem

Space has long been recognised as a key sector for sovereignty, scientific progress and national prestige. Throughout the Cold War era, the establishment of an industrial base for the development and operation of space infrastructures became a major political concern for both the United States and Soviet Union in their chase for global dominance. At that time, governments focused mostly on the strategic relevance of the space sector rather than on its economic value.

The situation changed progressively with the emergence of commercial markets in some areas (satcom, imagery, launch services) fostered by public policies. Notwithstanding, the largest part of economic activities in the space sector still consisted in the implementation of programmatic agendas of public agencies by industrial companies through cost-plus contracts. High barriers to entry and uncertain profitability (public approach to procurement, capital intensive projects, launch costs, indeterminate demand, etc.) held back the emergence of innovative business ventures and investment from private actors has been, so far, limited.

Today, this *status quo* is increasingly challenged. Various studies have demonstrated that public investment in space enabled the emergence of a sizeable and dynamic market for space-based services and products and space capabilities are now widely considered as a key lever for multiple economic, societal and environmental challenges. In this new context, a disruptive commercially-driven approach to space has emerged marked by ambitious announcements and endeavours aiming to engage in space markets with innovative schemes and business models. In this new ecosystem, private actors play a different, more prominent, role both in the implementation of public programmes and conduct of space business independently from governments.

This disruptive sectorial dynamic, often referred to as *New Space*, features various interrelated trends leading the space sector towards a more business and service-oriented step. Although no broadly accepted definition of *New Space* exists today, some major trends can be isolated:[1]

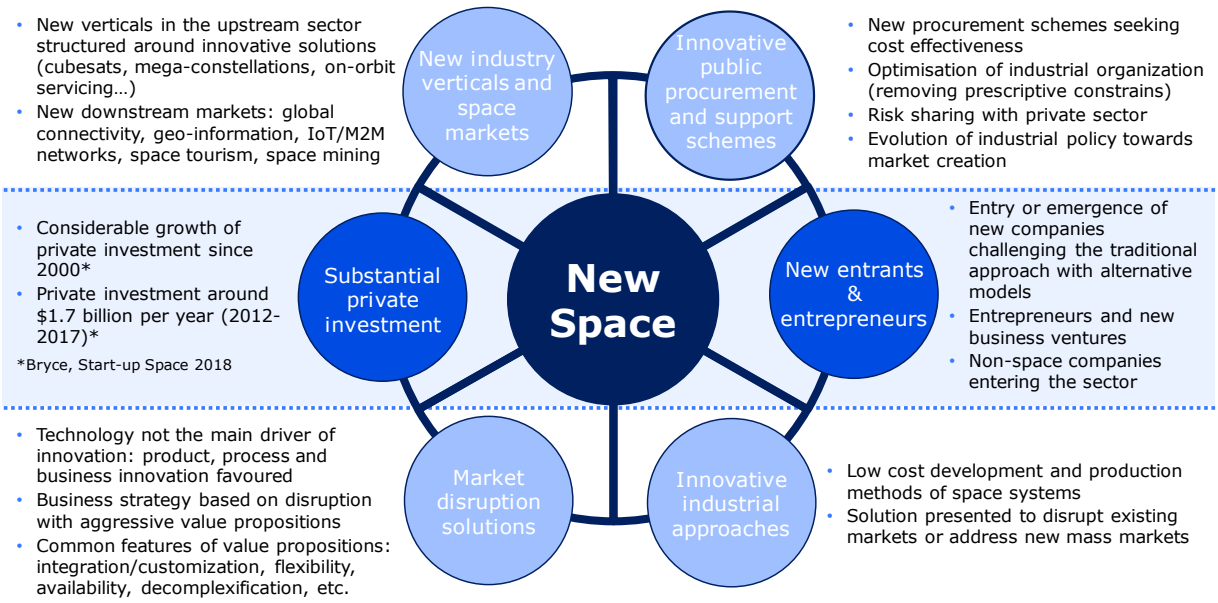

Figure 1: Key trends driving the New Space sectorial dynamic

1 ESPI, The Rise of Private Actors, Executive Summary, 2017

Today, the vast majority of space activities are still driven by governments with private industries acting as contractors for public programmes and massively relying on public funding. Notwithstanding, a previous ESPI study demonstrated that the trends observed recently are tangible and could lead to a deep transformation of the space sector characterised by a growing investment and involvement of private actors coupled with the emergence of a more business-oriented leadership.[2]

In this context, and although the success and sustainability of the *New Space* model has yet to be proved, new space ventures have become very attractive to investors. Financial markets see a strong potential: Bank of America Merrill Lynch estimated that the value of the space sector could be as high as US$2.7 trillion in 30 years.[3] The financial institution goes even further, stating that "we are entering an exciting era in space where we expect more advances in the next few decades than throughout human history".[4]

The confidence of investors in the capacity of new space ventures to grow and become profitable companies triggered a massive increase of private investment in space start-ups since 2000 to reach around $1.7 billion per year (average annual investment on the period 2012-2017).[5] This trend is wide-encompassing and start-ups appear to be entering the sector across the whole space value chain.

Several factors are raising the interest of financial markets in the space sector. Among others:

- Entry of high profile companies and entrepreneurs;
- Strong innovation dynamic with drastically new concepts;
- Lower entry costs and quicker time to market (launch services, miniaturised systems, COTS, etc.);
- Cross-fertilization of space and ground technologies (autonomous vehicles, 5G, IoT/M2M networks, precision agriculture, smart cities, etc.);
- Higher penetration of space-based services and products and anticipated growth of the demand.

The current dynamic offers an interesting opportunity for governments to consider more ambitious partnerships with private businesses, contributing to the growth of the sector and to the amplification of the socio-economic impacts of space activities. As observed today the *New Space* ecosystem offers more a favourable ground to share costs and risks between private and public actors provided that a profitable business can be developed and that agencies can preserve their strategic role. Reconsidering traditional procurement mechanisms to explore new partnership schemes based on a slackening of top-down control over industrial processes could also lead to a dramatic optimisation of cost-effectiveness in space programmes.

Fostering the emergence of a more business-oriented leadership in the space sector is nowadays a dominant consideration for governments who are increasingly eager to explore new approaches to support the economic growth of the sector and take advantage of new possibilities offered by this new dynamic for space programmes.

2 ESPI, The Rise of Private Actors, Executive Summary, 2017
3 Bank of America Merrill Lynch, To infinity and beyond - Global Space Primer, 30 October 2017, https://go.gudants.com/q/db/a2/1e1ffc185c1d44bd.pdf
Interestingly the firm's expectation is nearly triple Morgan Stanley's estimate of US$1.1 trillion by 2040. https://www.morganstanley.com/ideas/investing-in-space
4 ibid
5 Bryce Space and Technology, Start-Up Space 2018.

1.2 Assessing the trends in Europe

The European Commission (COM),[6] as outlined in the Space Strategy for Europe 2016, took a firm position seeking to foster a globally competitive and innovative European space sector. To ensure this, the COM wish to "support […] research and innovation and the development of skills", and "foster […] entrepreneurship and new business opportunities". More specifically the COM aims to "support the competitiveness of the whole supply chain and actors from industry to research organisations" and to "foster the emergence of an entrepreneurial ecosystem, opening up new sources of financing, creating new business opportunities, and [ensuring] this will benefit businesses in all Member States".

In 2016, the European Space Agency (ESA) and the European Union (EU) issued a joint memorandum on "The future of European space".[7] Both ESA and the EU shared the goal to "foster a globally competitive European space sector, by supporting research, innovation, entrepreneurship for growth and jobs across all Member States, and seizing larger shares of global markets".[8] This was reaffirmed in ESA Resolution "Towards Space 4.0 for a United Space in Europe" which came out of the 2016 Ministerial Council meeting.[9] Among other objectives, ESA's long-term plan and industrial policy aims to:

- "facilitate the entry of new economic actors and the integration of its latest Member States";
- "support private investment and entrepreneurship, in particular through start-ups and small or medium-sized enterprises (SMEs), and carrying out the SME-friendly policy adopted by the Industrial Policy Committee so as to favour their contribution to the success of ESA programmes"; and
- "[promote] public-private partnership schemes that include the sharing of risks and rewards, prioritizing pre-operational space activities with a potential for industrialization and commercialization".

In line with this shared strategic objective, ESA and the EU, but also governments and their national institutions, introduced a number of initiatives including, among many others, Business Incubation Centres (BIC) to foster successful entrepreneurship in space-related business, innovative mechanisms to engage with space industry (e.g. request for ideas and public-private partnerships), instruments to support commercialization of space technologies and synergies with non-space sectors, cooperation frameworks with investors or adaptation of R&D programs to help new and small companies access available public funds.

The impact of these initiatives is usually monitored individually according to relevant indicators (e.g. number of start-ups incubated, funding allocated) but the overall entrepreneurship and private investment trend in the European space sector has not yet been assessed in a comprehensive study comparable to the well-known Start-up Space report produced by Bryce Space and Technology in 2016 and updated in 2017 and 2018.[10] Yet, a more complete overview of the state of affairs in Europe would be extremely valuable to evaluate the impact of public policies and to understand how the entrepreneurship and private investment dynamic can be further coordinated and supported.

It is in this context that the European Space Policy Institute (ESPI) has initiated this study. Information provided in this report are based on two complementary tools:

- The ESPI investment database gathering all available data on private investment in European space start-ups for the period 2014-2018;
- The ESPI space entrepreneurship survey to collect the views of European space start-ups on their business situation, on the European ecosystem and on their expectations for the future.

6 European Commission, Space Strategy for Europe, COM(2016) 705 Final, Brussels, 26 October 2016.
7 European Space Agency, Shared Vision and Goals for the Future of Europe in Space, 26 October 2016, https://www.esa.int/About_Us/Welcome_to_ESA/Shared_vision_and_goals_for_the_future_of_Europe_in_space (accessed 06.09.2018).
8 Ibid
9 European Space Agency, Council Meeting Held at ministerial level on 1 and 2 December 2016 - Resolutions and Main Decisions, Lucerne, 02 December 2016
10 Bryce Space and Technology, Start-Up Space 2018.

2. Private Investment in European Space Start-ups

2.1 General overview

Over the period 2014-2018, 113 private investment deals concerning European space start-ups were recorded for a total amount of €562.7 million. This value does not include investment in space ventures after they have successfully reached maturity (see European definition of start-up Annex A.3). This concerns, among others, the acquisition of O3b Networks by SES or private placements in GOMspace after initial public offering. Involving megadeals in the tens or hundreds of millions of euros, the total value of private investment in European space ventures, including mature ones, would reach €1,783.6 million on the period.

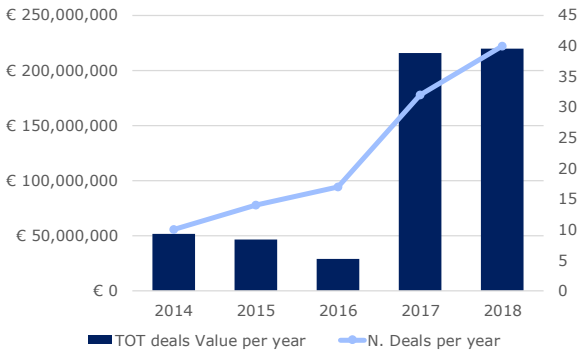

Figure 2: Number and value of deals per year

The period 2014-2018 has been marked by a steady growth of private investments in European space start-ups. A new record high was hit in 2018 both in terms of number of deals and of total value: 40 private transactions were recorded (+25%) for a total value of €219.5 million (+2%). This is a conservative estimation as the value of some transactions was not disclosed.

A significant share of the private investment value is actually concentrated in only a few transactions. In 2017, 65% of the total investment was mobilized in only four deals, each greater than €20 million, for a total of €135 million. The two largest operations accounted together for €85.5 million, with Arralis receiving €50 million in Venture Capital (VC), and Clyde Space being acquired for €35.5 million. Similarly, in 2018, five deals surpassed €20 million (Figure 5), for a total of €141.3 million, representing 64% of the total private investment in European space start-ups over the year.

The distribution of investment value by category over the period 2014-2018 (Figure 3) shows that Venture Capital (VC) remains the main form of private funding for start-ups, with a total of 48 deals and €365.8 million invested in the period (65% of the total amount).

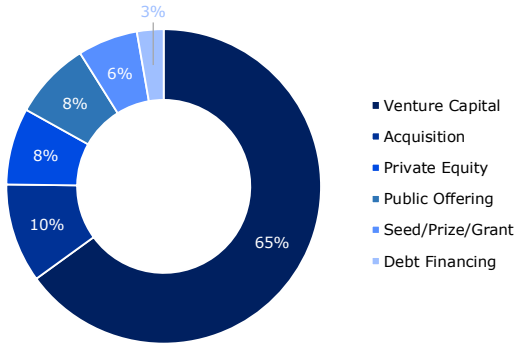

Figure 3: Share of total investment by category (2014-2018)

The vast majority of these deals involve early stages VC rounds for young start-ups, especially Series A and B. VC investments are characterized by a high-risk/high-return model, typical of high-tech sectors where start-ups are based on innovative technology and/or business model. As a type of private equity, venture capital investors gain partial control rights in company decisions.

This trend was confirmed in 2018 (Figure 4) with a total venture capital invested in the European space sector in the order of €181.3 million (+56%). This year, the share of VC reached 83% of the total value of private investment.

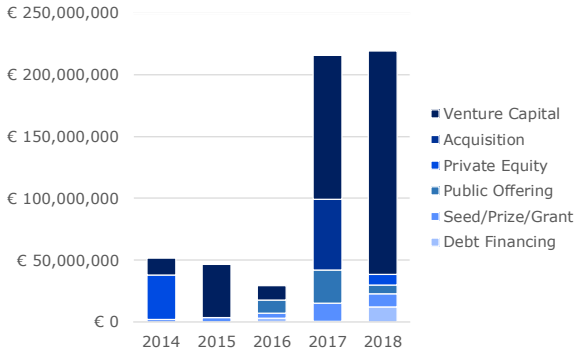

Figure 4: Value of investment by category and year

On the other side of the spectrum, debt financing represented only 3% of the total investment.

This instrument is, contrary to VC, usually reserved to start-ups with some operating history ready to take additional financial risk to grow.

Seed financing, prizes and grants (private only) involve smaller transactions for start-ups at a very early stage to help kicking-off the business. This category amounted to €34.8 million for 39 operations over the period.

Other investment categories involve a few big operations. For example, acquisitions represent 10% of the total investment value with only 4 operations recorded on the period. The value of the deals was announced for only two of these operations, namely the acquisition of Wireless Innovation by Lyceum Capital and Clyde Space by ÅAC Microtec. Together these two deals accounted for €57.3 million.

Similarly, 4 public offerings were documented, involving ÅAC Microtec and GOMSpace in 2016, the German Mynaric in 2017 and the Luxembourgish Kleos Space in 2018, for a total value of €44.9 million. Lastly, a vast majority of private equity value on the period concern an investment in O3b Networks by SES in 2014 (i.e. O3b was still a start-up), and an investment in Unseenlab in 2018.

"In 2018, 40 deals were recorded for a total of €220 million"

Figure 5: Top 5 transactions in 2018

Private investment in space start-ups is 4 to 8 times smaller in Europe than in the United States, according to the boundaries of the assessment (i.e. definition of "start-ups"). Consistent with the difference in space market sizes, this ratio confirms the good orientation of Europe toward the development of commercial space.

Beyond the difference between European and U.S. space sectors economic weight, a number of factors can explain lopsided trends:

- European initiatives to stimulate private investment in space are rather recent in comparison to the United States;
- Regulatory environments and cultural behaviour in Europe are considered, in general, less prone to entrepreneurship. Space start-up founders often report a less speedy and more risk-adverse approach to investment in Europe that can slow down or limit entrepreneurship trends;
- Leadership from space enthusiast tycoons with access to considerable funds likely fostered the emergence of other endeavours in the United States;
- European market fragmentation and lower demand (in particular on institutional space markets) affects the potential viability of business models.

2.2 Distribution of investment in Europe

Figure 6 shows the geographical distribution of the total value of private investment operations in space start-ups according to the location of their headquarters.

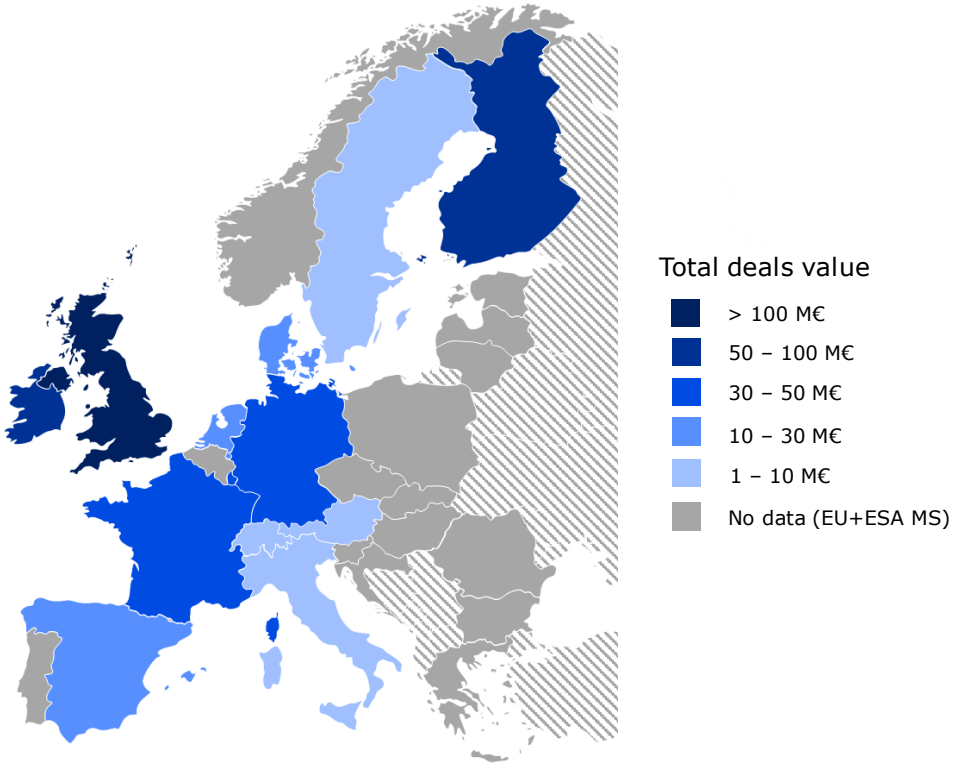

Figure 6: Distribution of private investment value per country (location of start-up headquarters)

The distribution of investment by start-up country shows a discrepancy between the level of entrepreneurship and public space budgets. Although France and Germany still count with a good level of investment, it is in the United Kingdom, Ireland and Finland, three countries with much smaller space budgets, that the highest investment volumes were recorded.

Many factors are at play here and each country presents a different profile.

With both a strong start-ups and investors base, the United Kingdom, stands out as a clear leader of the space entrepreneurship trend in Europe. The country counts with a large number of start-ups addressing different space markets and with many investors active in the space sector. Over the period, a total of 50 deals accounting for €343.6 million were recorded in the United Kingdom. The country represents, alone, around half of the European market of private investment in space start-ups.

In the case of Finland, however, most of the investment is related to a single successful company: ICEYE (see Annex 1 – Selected European success stories). Over the period, this start-up alone raised, in a series of investment rounds, more than €56 million. Ireland also owes its position to a single megadeal of €50 million involving an undisclosed consortium of Hong Kong-based investors and the Irish start-up Arralis.

Luxembourg continues to reap the rewards of its ambitious strategy to foster entrepreneurship and private investment in the country. Over the period, more than €40 million of private investment were recorded in Luxembourg with Kleos Space and O3b leading. This is a conservative estimate that excludes private investment in foreign start-ups that set up an office in Luxembourg like iSpace.

France and Germany also reported more than €40 million of investments over the period. Although the level of private investment in space start-ups may likely be lower due to the presence of well-established players, a steady growth of the level of entrepreneurship since 2014 can be observed.

Important deals were also recorded in other countries like Spain, Denmark, Italy, Switzerland, Sweden, Austria and the Netherlands, showing a widespread entrepreneurship dynamism across Europe.

Figure 7 shows the geographical distribution of investors (including foreign investors) having financed European space start-ups.

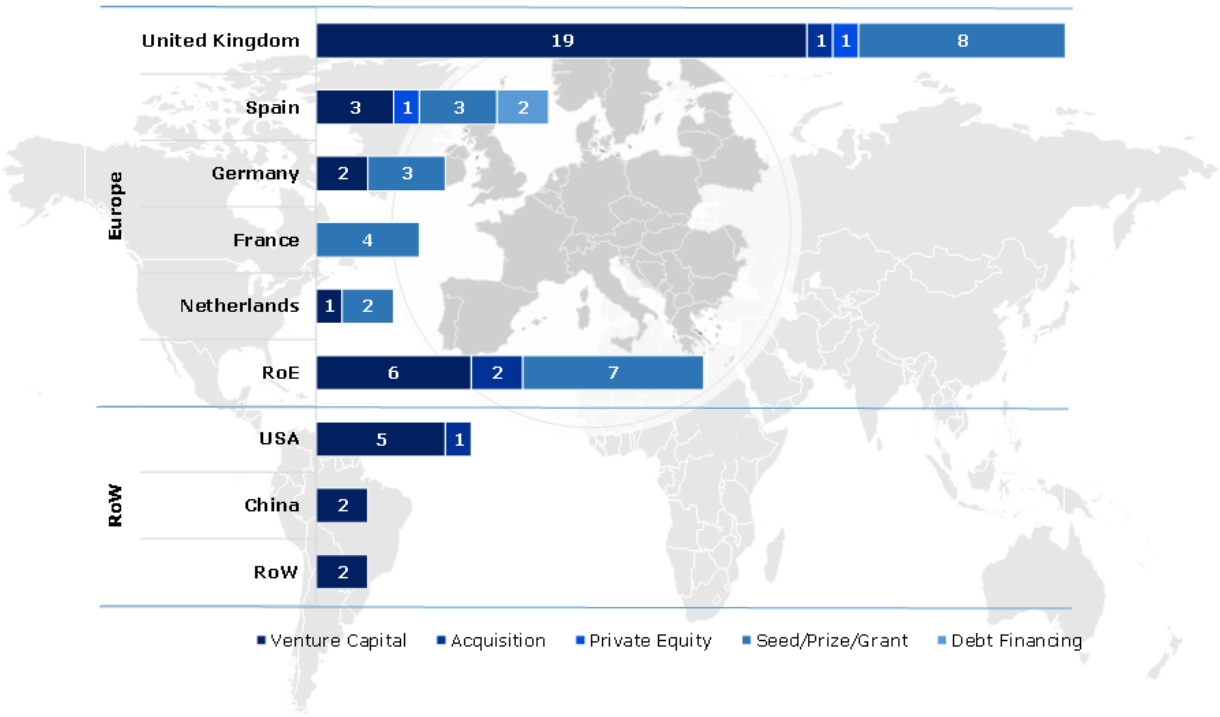

Figure 7: Geographical distribution of investors

Spotlight on the United Kingdom's space entrepreneurship policy

- **June 2009**: The UK Government sets up the *Space Innovation and Growth Team* (Space IGT), a joint initiative with industry and academia to prepare a long-term strategy to foster the development of the UK space industry.
- **February 2010**: The UK Space Innovation and Growth Strategy is launched. The ambition set for the UK space industry is to capture 10% of the global space market (£40 billion) and reach 100,000 jobs by 2030. To optimize efforts and resources the creation of a dedicated UK Space Agency is recommended.
- **March 2010**: The *UK Space Agency* (UKSA) is established as an executive agency of the Department for Business, Innovation and Skills with a specific mandate to foster the growth of a competitive UK commercial space sector.
- **2013**: *InnovateUK,* the UK's innovation agency which offers support and funding to help business develop new products and services and bring them closer to market, establishes the Satellite Applications Catapult in the Harwell Science and Innovation Campus to propel the UK's satellite industry by exploiting satellite infrastructures and applications. In the same year, ESA installs a Business Incubation Centre in the Campus.
- **2015**: ESA opens the European Centre for Space Applications and Telecommunications (ECSAT) in Harwell. The UK government announces that the value of the UK space sector tripled since 2000.
- **2017**: UKSA Corporate Plan 2017-2018, continuously iterated trough National Space Policy and strategy documents, expressly aims to increase UK's attractiveness for private space ventures.
- **2018**: Harwell Space Cluster counts with more than 80 space start-ups employing 800 people. In addition, UKSA now supports 22 incubators across 15 locations as part of the UK Space Incubator Network.

2.3 Investment across the space value chain

The space value chain can be divided into segments.[11] The upstream part of the space value chain includes all business activities related to the development, production, deployment and operation of space systems. This includes:

- **Build**: development and manufacturing of space systems (incl. sub-systems, equipment, components or materials) and/or provision of related software and engineering services;
- **Launch**: development and manufacturing of launch systems and/or provision of launch services;
- **Data**: operation of space systems to lease or sell satellite capacity or data.

The downstream part of the space value chain includes all business activities related to the exploitation of space systems' capabilities or data to provide space-enabled products and services to end-users:

- **Downlink**: development and manufacturing of the ground support infrastructure and services required to exploit a space system (e.g. relay systems, communications, ground terminals, cryptography);
- **Store**: provision of solutions for satellite data storage and processing;
- **Analyse**: provision of value-adding solutions for satellite capabilities and data exploitation (e.g. big data analytics, machine learning and artificial intelligence, algorithms);
- **Product**: provision of space-enabled products to end-users (e.g. mapping & 3D, data platforms, location and tracking, insight and monitoring).

Companies with business activities beyond earth orbit (e.g. space exploration, space resources, space logistics, space research) can be clustered in a parallel category.

Figure 8 shows the distribution of investment value according to the core business of start-ups.

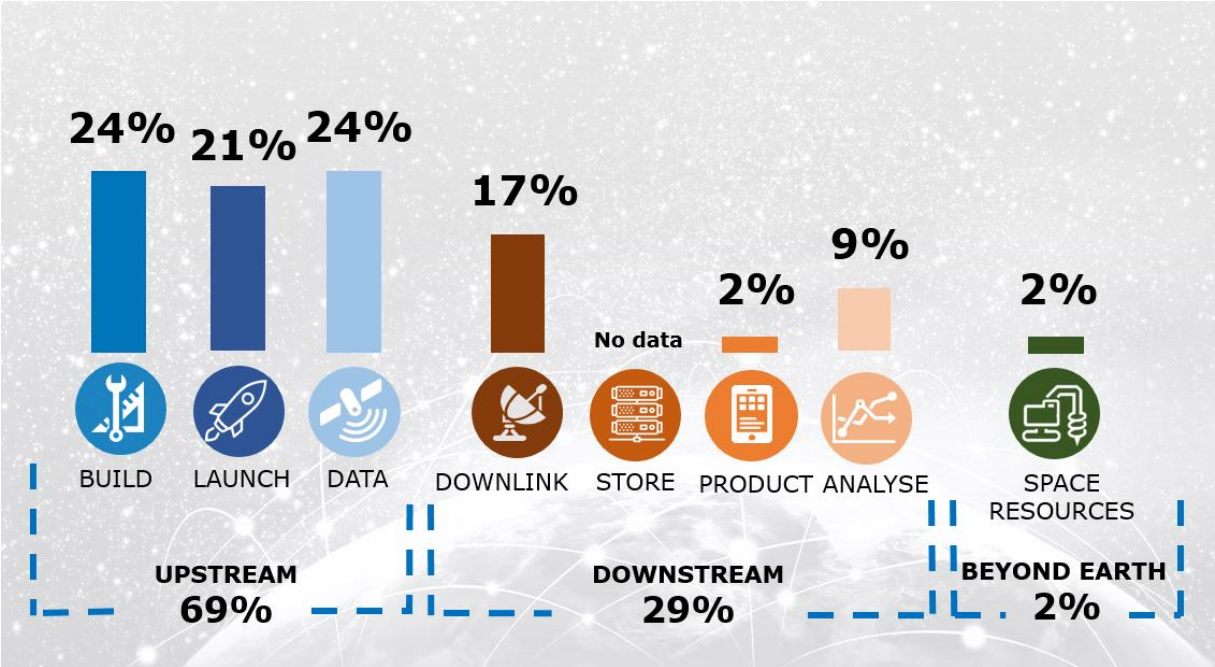

Figure 8: Breakdown of investment value by space value chain segment

11 ESPI selected the Seraphim SpaceTech Ecosystem Market Map (available at: https://seraphimcapital.co.uk/insight/news-insights/introducing-seraphim-spacetech-market-map)

Considering the position of start-ups in the space value chain, the study found that investment has been primarily directed towards the upstream segment.

Major deals in this segment recorded in 2018 include Orbex (Launch, €34 million), ICEYE (Data, €29 million), and Oxford Space Systems (Build, €7.6 million).

With the emergence of new vertically integrated business models (companies covering all activities from satellite manufacturing to space-based services delivery), a number of investments in the upstream sector ultimately impact the downstream sector as well by supporting companies who commercialize services enabled by those same satellites (e.g. ICEEYE, Hiber, Earth-I).

As for the downstream segment, the largest amount of investment was directed towards downlink related industries. In particular, two deals make up more than half of the investment in the downlink sector over the reporting period: Mynaric's IPO in 2017 and an investment in Goonhilly Earth Station,[12] with the two deals amounting to more than €27 million each.

It appears that the investment in the upstream segment is more than twice greater than the investment in the downstream segment. This conclusion is in line with comparable assessment from other studies. However, it is important to note that a strong bias exists due to the difficulty to track investments in the downstream sector which involves companies whose service and product portfolio is not entirely embedded in the space value chain. Indeed, companies providing storage or processing capabilities rarely address the space sector as a core customer. Comparably, space capabilities or data are often an input among others for companies delivering solutions to end-users.

A similar situation can be observed, although to a much smaller extent, in the upstream segment for companies offering equipment, components or engineering services to customers involved in a range of different industries.

As a result, a number of private investments in European start-ups with some space-related business are not included here due to the difficulty to identify these companies and establish a clear link between the investment and the development of space products and services. This also suggests that the space sector benefits greatly from investments in other sectors, particularly in the downstream segment. With a growing cross-fertilisation between space and terrestrial technologies, the distinction between investment within and outside the space sector is poised to become increasingly blurred.

The space sector benefits greatly from investments in other sectors, particularly in the downstream segment.

12

3. Perspectives on the European Space Entrepreneurial Ecosystem

3.1 European space start-ups profile

This chapter provides an overview of the results of the ESPI Space Entrepreneurship Survey 2018. The survey was issued to 300+ European space start-up with a response rate around 20%. With more than 60 replies from space start-ups located in 16 European countries, the survey provides a quite representative sample.

ESPI survey was adapted from the European Start-up Monitor 2016 (ESM16) survey[13] to allow a benchmark of space start-ups with other European start-ups. The survey consisted in 40+ questions addressing 4 themes:

- *Business organisation*: location, business line, employees, context of foundation;
- *Business situation*: revenues, innovation, prospects;
- *External support*: financial and non-financial support received and planned;
- *Business environment*: views on the European entrepreneurial ecosystem, expectations from public authorities.

The survey was based on multiple answers questions and opinion scoring. Aggregated results are provided below together with additional information collected through open comments of respondents on their replies.

The average European space start-up is a young SME[14] led by 2 to 3 founders and employing 9 people.

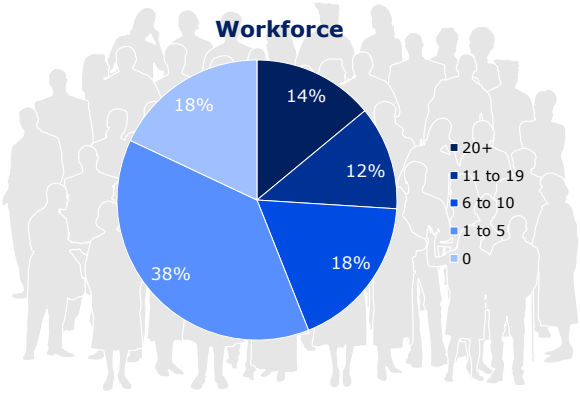

Figure 9: Number of employees (excl. founders)

The largest respondent to ESPI survey currently employs 78 workers while 18% of respondents have no employee, relying exclusively on the founder(s)'s workforce. Only 14% of the companies have more than 20 employees and the biggest share of the ventures (38%) currently employs between 1 and 5 staffs.

The average start-up is led by 2 to 3 founders and employs 9 people.

A vast majority of these start-ups (84%) plan to recruit at least one additional employee within the next 12 months.

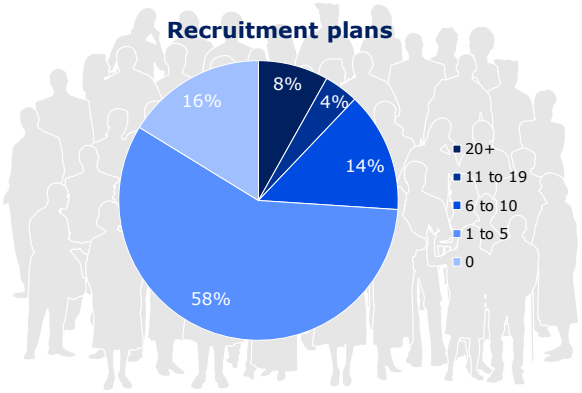

Figure 10: Number of planned recruitments

A majority of start-ups (55%) plan to recruit a maximum of 5 new staffs. About 26% of respondents shared more ambitious plans with at least 6 recruitments. A small but significant number of start-ups plan a massive recruitment of more than 20 new permanent positions suggesting high growth expectations.

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13 German Startups Association, Kollmann et al., European Start-Up Monitor 2016
14 European Commission recommendation concerning the definition of micro, small and medium-sized enterprises, May 2003

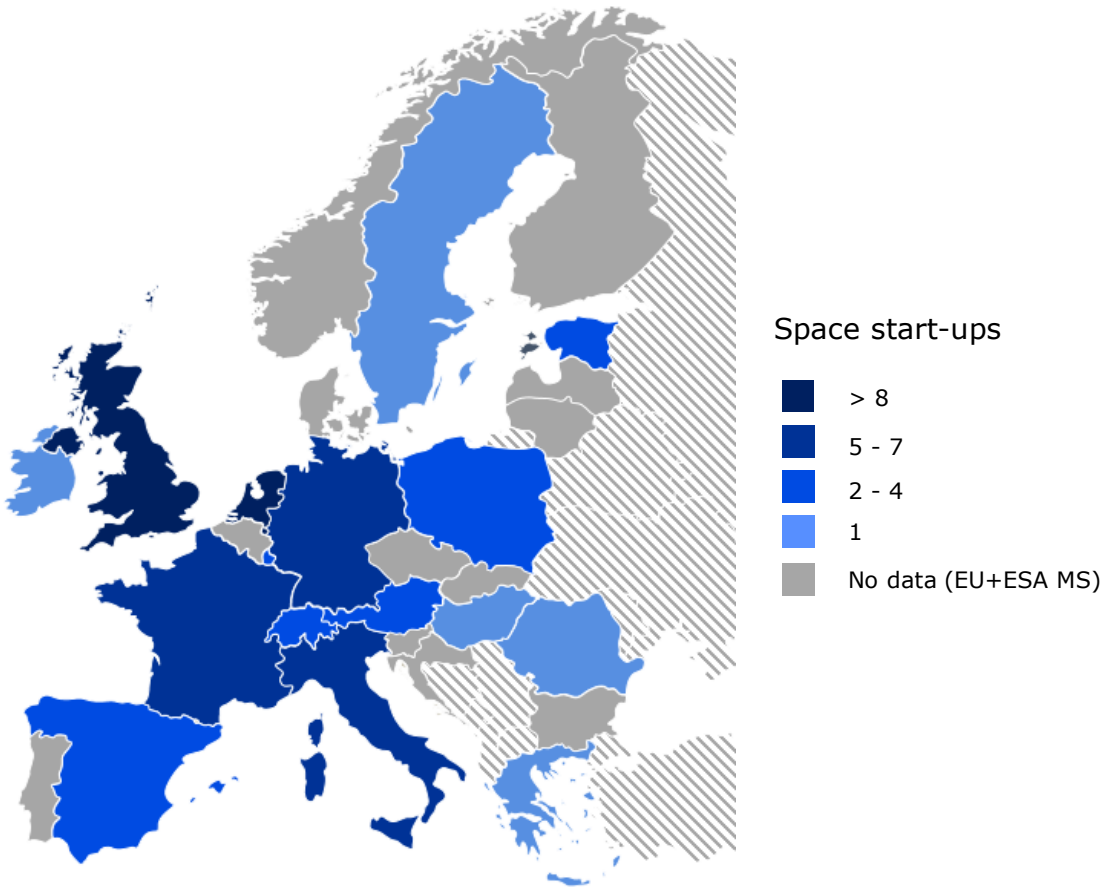


Figure 11: Distribution of respondents to ESPI survey per country (headquarters location)

The geographical distribution of the respondents to ESPI survey (Figure 11), mirrors the results of the private investment database (Figure 6). The majority (68%) of start-ups are established in a handful of countries namely the United Kingdom, the Netherlands, Germany, Italy, and France. Other countries count with a smaller number of start-ups but, overall, ESPI survey collected information from start-ups located in 16 different European countries. Results of the survey also confirm that the number of start-ups headquartered and operating in the United Kingdom exceeds by far other European countries.

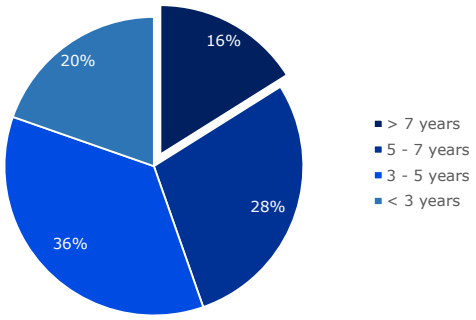


Figure 12: Age of start-ups

Out of 64 start-ups having replied to the survey, 56% were founded in the last five years, and a total of 85% of them are less than seven years old at the time of the survey submission.

The high number of companies founded since 2011 does allow to directly conclude on a major growth of the number of new space ventures founded since then. The situation highlights, instead, the typically high failure rate of start-ups. Some highly successful ventures can also experience a fast development and successfully leave the "start-up" status after only a few years. Statistics on entrepreneurship trends in other high-tech sectors suggest that the first factor outweighs considerably the second.

This being said, a closer look at the business of respondents shows that a majority of them structure their value proposition around new technologies and concepts (e.g. cubesats and system miniaturization, new materials, new launcher concepts, big data and digitization, analytics…) suggesting that the current dynamic observed in the space sector offers a fertile environment for entrepreneurs to contemplate possible business opportunities (assumption confirmed by start-up views on business opportunities – Figure 20).

In line with the average age of the companies, the majority (55%) of them is still at an early stage of development (Figure 13).

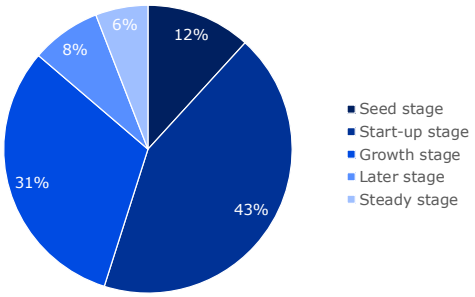


Figure 13: Business stage of start-ups

12% of them are at seed stage meaning that the start-up activity is usually focused on concept development and that commercial operations have not started yet. 43% of start-ups concluded their product(s) development phase and are starting to address their target market and to generate revenues. At such early stage, business profitability is not yet established and risk of failure remains high.

Interestingly, despite their youth, 45% of start-ups declare being already at a growth, later or even steady stage of business development, which would suggest a somewhat fast scaling-up pace. These more mature start-ups usually met already one commercial success and are seeking growth, expansion (diversification, internationalisation…) or stabilisation of their business model. Risk of failure at these later stages is usually lower, although it can remain high.

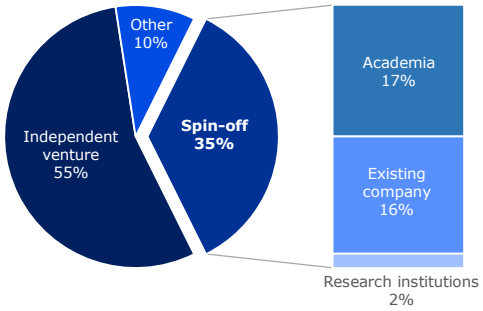


Figure 14: Context of foundation

Focusing on the origin of these companies, Figure 14 shows that 55% of the respondents were founded as independent venture, and 35% as a spin-off, with 17% of the companies having emerged from the academic sector and 16%8 from existing companies. The remaining 10% include various origins such as ventures established following a company take over, as well as created to run not-for-profit associations.

"34% of European space start-ups have no operating revenue yet and 16% declare revenues above €1,000,000"

The disparity of start-up profiles can also be appreciated in terms of revenues (Figure 15). While a majority of European space start-ups generated a revenue from their business activities over the last fiscal year, with 50% declaring a revenue below €1,000,000 and 16% above, still 34% of start-ups had no operating revenue yet. A third of start-ups rely therefore exclusively on financial support and seed investment to function.

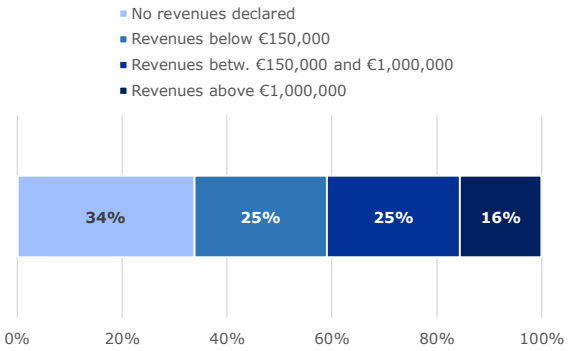


Figure 15: Start-ups declared revenues (FY17)

3.2 Business, market and competition environments

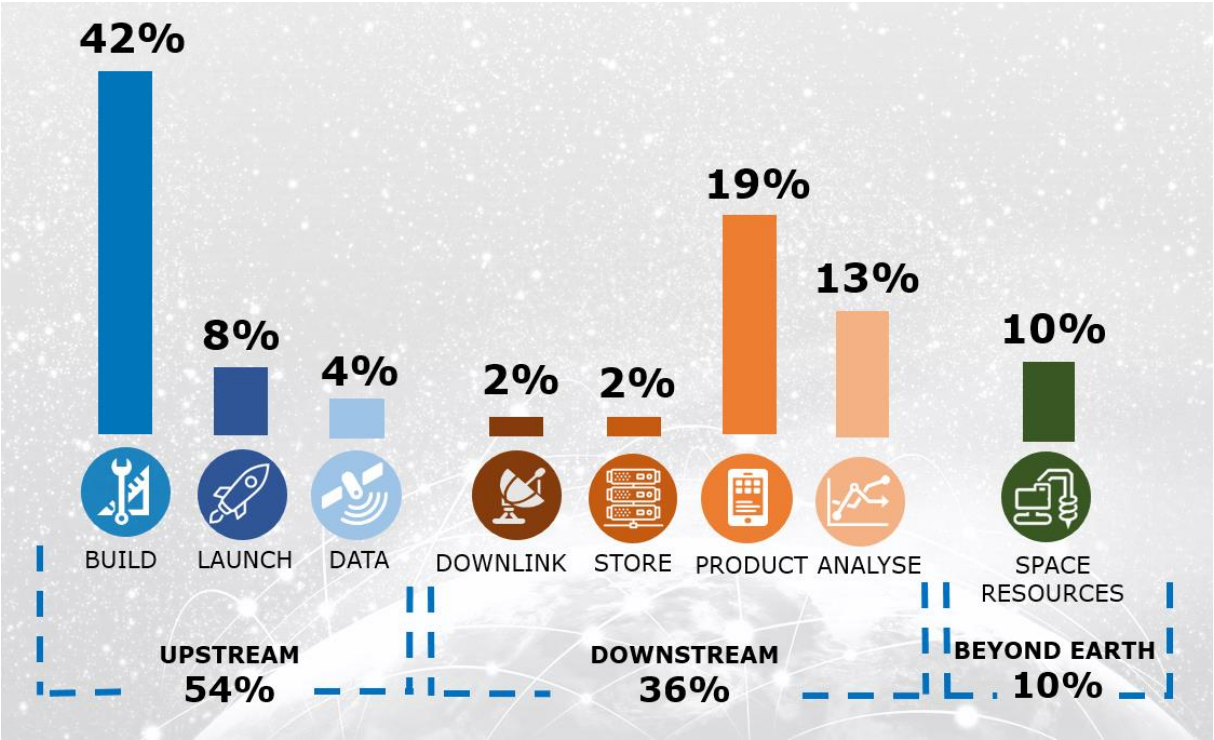


Figure 16: Core business, percentage of respondents

Looking at the core business of European start-ups (Figure 16), 54% operate in the upstream segment of the space value chain, while 32% focus on downstream products and services. In particular, more than 40% of the respondents are part of the Build segment (space and launch systems hardware, software and engineering services), followed by the downstream sectors Product and Analyse (space-based analytics and end-users' products and services).

Here again a statistical bias exists due to the inherent difficulty to identify start-ups in the downstream sector which involves companies whose product portfolio is not entirely embedded in the space value chain. Start-ups seeking to conduct business beyond Earth (e.g. space exploration, space resources, space logistics, space research) are overrepresented in comparison to the distribution of private investment actually received (Figure 8) suggesting some discrepancy between the enthusiasm of entrepreneurs and investors in this rather visionary domain.

European space start-ups are largely innovation-driven (Figure 17), seeking to structure their business and value proposition around new concepts. Respondents declare pursuing innovation at a global scale and for most of the components of their business:

- 71% of respondents offer a product that is a worldwide innovation;
- 60% use globally pioneering technologies;
- 47% consider their business model is unique in the World;
- 41% implement highly innovative industrial processes;

When innovation is not at a global scale, it is at least at a European or national scale. Only a minority of start-ups offer a product that already exists.

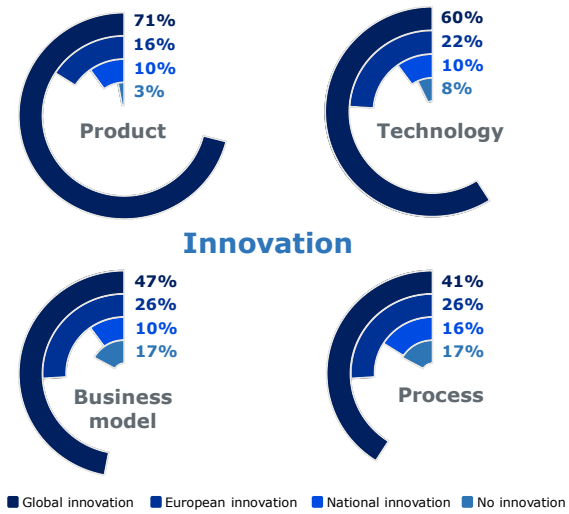


Figure 17: Innovation, share of respondents

A vast majority of start-ups (63%) also seek to address global markets with their product and only 8% confine it to their domestic market.

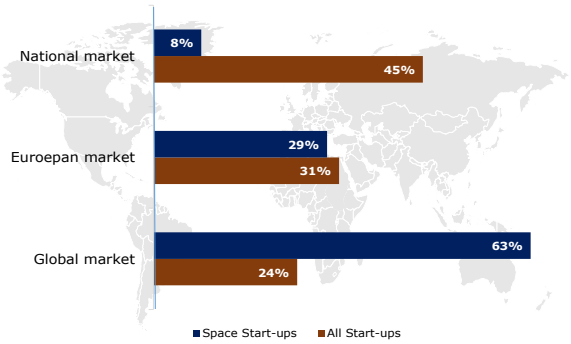


Figure 18: Market addressed by European space start-ups

A comparison of ESPI survey results with the findings of the European Start-up Monitor 2016 (ESM16)[15] which addresses all European start-ups, shows that Space start-ups are radically more innovative and international than other European start-ups.

Innovation and global reach are actually two intrinsic specificities of space entrepreneurship:

- **Innovation**: only 52% of all European start-ups offer a product that is a global innovation (Space: 71%);
- **Global reach**: only 24% of all European start-ups offer their solution on global markets (Space: 63%).

"Space start-ups are radically more innovative and international than other European start-ups"

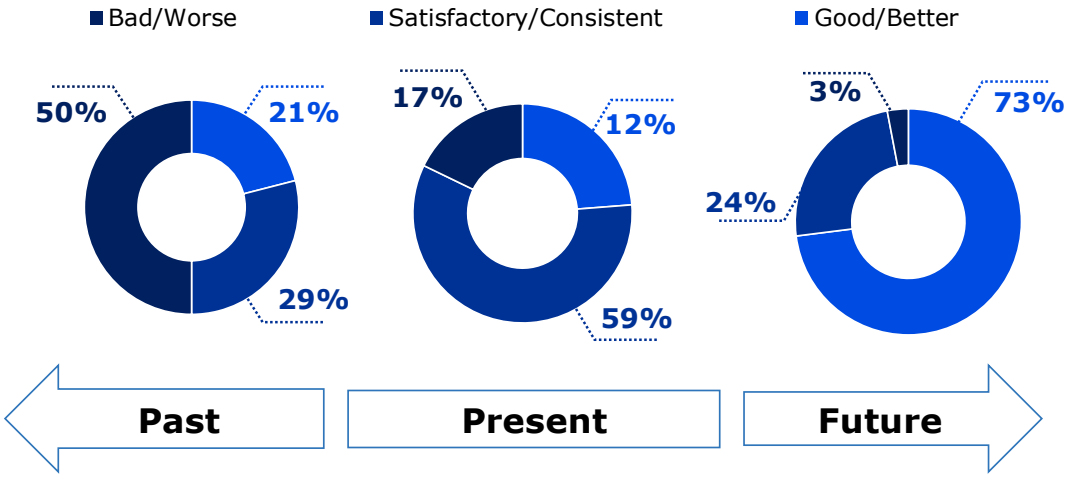


Figure 19: Past, current and expected future business situation, share of respondents

Start-ups shared a rather positive and optimistic evaluation of their overall business situation, with 83% estimating that their company is currently experiencing a satisfactory or good state of affairs and 73% foreseeing an even better scenario in the future. Likewise, one start-up out of two considers to be in a better situation than in the past. Only a small share of start-ups consider that their situation is stable (29%) and/or will remain stable in the future (24%).

This optimistic outlook on business development and growth mirrors the intention of a vast majority of European space start-ups (84%) to hire in the next 12 months (Figure 10). Yet, with plans to hire, together, around 280 employees over the next year and a current workforce of about 600 employees (incl. founders), these ambitions seem somewhat difficult to achieve without a considerable business growth.

15 German Startups Association, Kollmann et al., European Start-Up Monitor 2016

With regards to market dynamics, survey results show that a majority of space start-ups' consider the space sector rich in opportunities both for innovation (62%) and commercialisation (60%). Space ventures are however less confident than other European start-ups who consider their own industry and market richer in opportunities (respectively 75% and 81% for innovation and commercialisation opportunities).

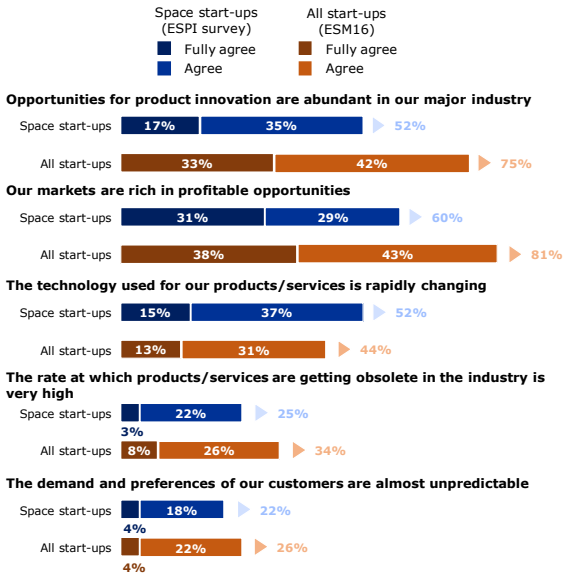


Figure 20: Views on market dynamics (space vs all start-ups)

The rate of obsolescence and predictability of customers' demand and preferences are a smaller concern for space start-ups than for others, in line with the usually slower pace of change in the space sector. On the other hand, new ventures in the space sector are confronted with a faster rate of technology development suggesting a discrepancy between the pace of innovation and the pace of adoption. This situation is probably an important factor contributing to the challenge faced by space start-ups to acquire customers and secure sales (see Key challenges and expectations from politics, Figures 24 and 25).

This also highlights the well-known reluctance of customers in space markets to adopt new, unproven, solutions (i.e. heritage) and the importance to support product development up to the first commercialization (first contract) or at least up to demonstration in orbit for space systems. This seems especially vital for new ventures structuring their value proposition around highly innovative products, technologies, processes and business models.

Difficulties faced by European space start-ups with the demand side are further amplified by a strong bargaining power of customers. While only 27% of European start-ups, regardless of their industry, consider the bargaining power of their customers rather high, it is the case of 53% of space ventures. In addition to the reluctance to change identified previously, various factors can explain this strong bargaining power: a market that is not yet mature (low demand, lack of awareness), a demand that is concentrated (core market made up of a few customers) or a situation of oversupply (offer higher than demand) among many others.

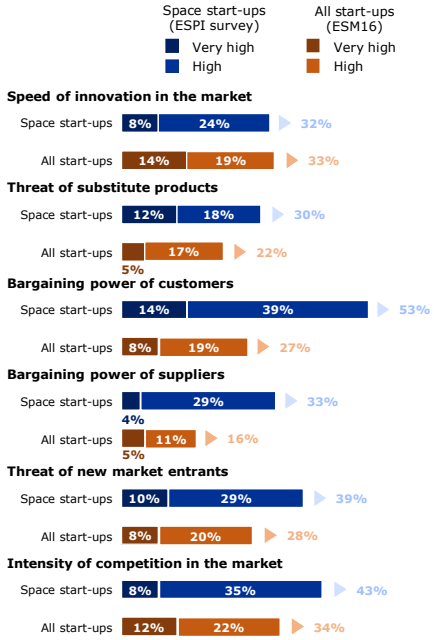


Figure 21: Views on market forces (space vs all start-ups)

Space start-ups actually perceive their business environment as rather hostile. A significant share of them identified additional threats including an intense competition (43%), a strong bargaining power of suppliers (33%) and the potential entry of new entrants (39%) or substitute products (30%) on the market. A larger share of space ventures is concerned by these threats than in other industries. This assessment contrasts very much with the optimistic outlook on the future of their business development and growth. This also suggests that European space start-ups consider to be well equipped (or backed) to succeed, even in a complex competitive landscape. Anyhow, if potential investors share a comparable assessment of the space business environment, this could represent a major barrier to access to finance.

3.3 Financial and non-financial support to entrepreneurship

Start-ups rely extensively on financial and non-financial support from various private and public actors. Overall, 89% of start-ups benefited at least from one type of backing and 38% benefited from both financial and non-financial instruments. 80% of start-ups are actively seeking some kind of support and only 14%, usually operating in specific business environments, conduct their activity independently from any external help, past or future.

"89% of start-ups benefited at least from one type of external backing"

Financial support

60% of start-ups have already benefited from at least one type of financial support from a public or private organisation. Survey results (Figure 22) show that governmental support (not included in ESPI investment database) is the most common form of financial help for European space start-ups with 27% of them having already benefited from public instruments (mostly grants) and 45% planning to.

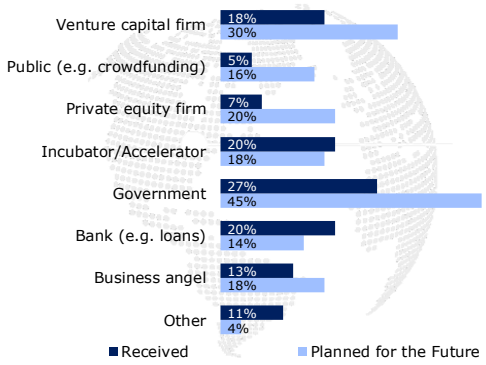


Figure 22: Financial support, share of start-ups

On the private side, banks, incubators and accelerators are the most used sources of capital. This type of financial help involves usually small loans or prizes to boost early developments. Venture capital firms, business angels and private equity firms, which correspond to 73% of the total private investment in the European space sector (Figure 3), are underrepresented here. This underlines that a large portion of the cash mobilised benefits to a few selected start-ups only. At the end of the spectrum, crowdfunding does not seem to be a viable option for space projects that usually involve solutions for companies or governments rather than products intended for mass markets.

"80% of start-ups are actively seeking financial or non-financial support"

Overall, 78% of start-ups still seek financial support. Governmental support schemes are here again the favoured option (45%), confirming the prominent role of public funding in the European space entrepreneurship ecosystem.

Non-financial support

56% of start-ups already benefited from non-financial backing including competitions (e.g. hackathon), networking events, accelerators, incubators or independent expertise. This form of support seems however less sought-after than financial help with only 60% of start-ups looking for it. Among existing instruments, networking events (30%), incubators (29%) and competitions (23%) are the forms of non-financial support most benefited from.

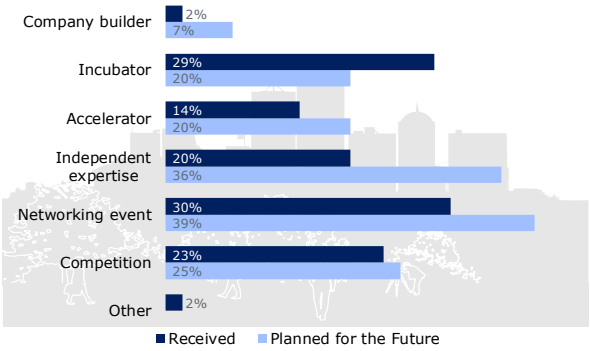


Figure 23: Non-financial support, share of start-ups

For the future, start-ups seem most interested in networking events (39%), independent expertise (36%) and competitions (25%). This mirrors the very positive opinion that start-ups have over these instruments. 82% of start-ups consider that networking events are beneficial. This share rises to 91% for independent expertise and as high as 100% for competitions. Such enthusiasm is not shared for incubators and accelerators with 23% of start-ups considering that these instruments bring limited benefits. These results reflect the great importance of networking for start-ups to get to know potential mentors, partners, investors or customers. This also supports the recommendation of the European Investment Bank to organise a dedicated annual networking event for European space start-ups.[16]

16 European Investment Bank, The future of the European space sector, January 2019

3.4 Key challenges and expectations from politics

When asked to rank their main business challenges (Figure 24), European space start-ups highlighted their difficulty to acquire customers and sell their solution (27%), to raise capital (15%), and to manage liquidity and/or cash flow (14%). On the other side of the spectrum, start-ups tend to perceive acquisition of staff (7%), growth (6%) and internationalisation (5%) as less challenging.

Benchmarking space start-ups' views with other European start-ups (ESM16), underlines a profound difference in the perception of challenges. Customer acquisition, also the top challenge for other start-ups, appears to be a much more significant concern for space ventures. This is also the case for capital raising and management of liquidity and cash flow which are not even in the top 3 challenges of other start-ups. The challenge to raise capital reported by space start-ups is consistent with the fact that 78% of them are actively seeking financial support. The slightly greater difficulty of space ventures in this field can be explained by various factors including the early stage of business development of space start-ups in the survey sample, the difficulty to convince investors of the viability of disruptive business plans but also the limited number of investors active in the space sector in Europe.

On the other hand, space start-ups are not confronted with some of the difficulties that other start-ups face for product development and growth. This suggests that public instruments based on technical patronage and R&D grants, widely used in the space sector, are effective in early stages to support product development but show some limits when getting closer to the market. In light of the strong challenge faced by European space start-ups to acquire customers and secure sales, complementary public instruments positioning institutions on the side of the demand (connecting innovation to governmental needs) would certainly be beneficial.

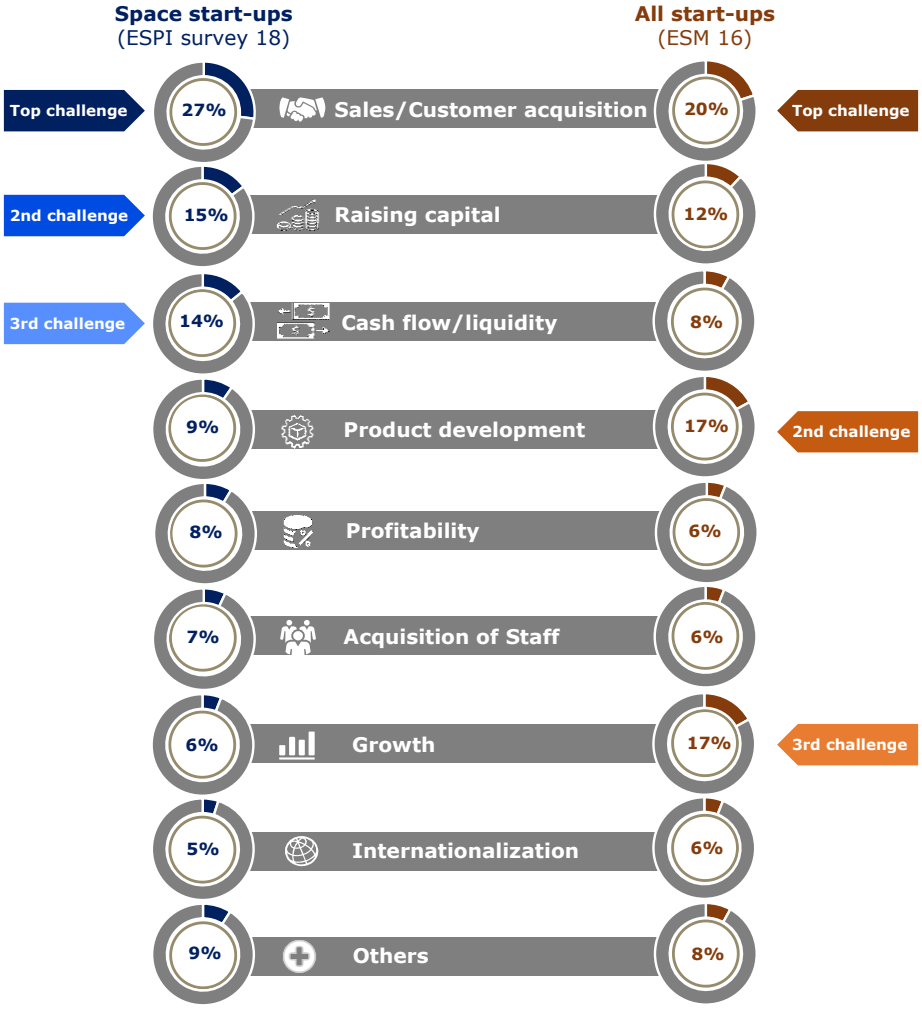


Figure 24: Business challenges of space start-ups (left) and other European start-ups (right), share of respondents

The following figure ranks expectations of European space start-ups from politics and benchmarks them with those of all start-ups, regardless of their industry.

Comparably to other European start-ups, space ventures also consider that some efforts should be made in the field of red tape reduction to relieve these very small and young companies from what is perceived as an administrative burden diverting workforce from core business activities. In the same vein, space start-ups, alike others, call for a reduction of taxes.

The main difference between the space sector and other industries lies in expectations in all other fields. European space start-ups clearly have higher expectations from governments than others. At least a third of respondents estimated that improvements could be made across all themes addressed by the survey.

It emerges that space start-ups desire a much more entrepreneurship-friendly environment which would feature:

- Improved exchanges between politics, start-ups and established companies;
- Better cultural acceptance for entrepreneurship and understanding of the need of start-ups.

This underlines that entrepreneurship trends observed today are rather recent and new for the space sector and that some time will be needed to witness a deep change in the cultural approach to business.

Survey results also show that start-ups in the space sector need (or expect) more support from governments than others for the conduct of their business as well as for access to finance. More than half of space ventures expect some support from public authorities to get venture capital while it is the case of only 30% of other European start-ups.

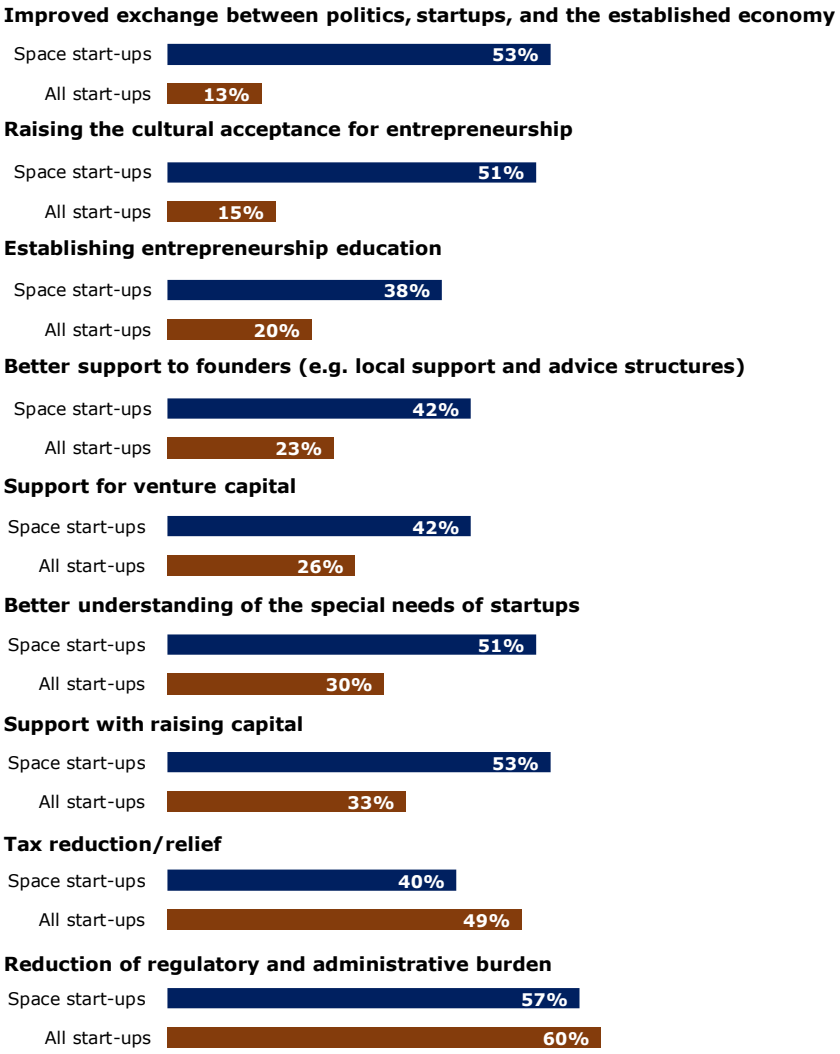


Figure 25: Start-ups expectations about politics (space vs all start-ups)

4. Key Takeaways

4.1 Statistics and indicators

Private investment statistics

220M€
raised by European **space start-ups** in 2018

x4
increase of private investment value since 2014

83%
of private investment in the form of venture capital

64%
of private investment concentrated in the top 5 transactions

European space start-up indicators

55%
are at an early stage of business development

80%
are actively seeking financial or non-financial support

the average start-up comprise **2** to **3 founders** and **9 employees**

86%
plan to **hire** in the **next 12 months**

71%
offer a product that is a **worldwide innovation**

57%
offer their product or service on a **global market**

38%
have **no** sales **revenues yet**

38%
declare revenues in **excess of €150.000**

73%
foresee an **improvement** of their business situation

27%
customer acquisition is considered their **main challenge**

40%
have **never received** an **external financial**

58%
wish a **reduction** of administrative and **regulatory burden** from public authorities

Figure 26: Key indicators from ESPI Space Entrepreneurship survey 2018

4.2 Findings

As a result of ESPI analysis of private investment and entrepreneurship trends in the European space sector, the following key findings can be highlighted:

***1 -** Private investment in European space start-ups exhibits a massive growth since 2014*	• A new record high was hit in 2018 with €219.5 million invested. • This is a conservative estimate since the value of some announced transactions was not disclosed. • Private investment in space start-ups is 4 to 8 times smaller in Europe than in United States. Consistent with the difference in space market sizes, this ratio confirms the good orientation of Europe toward the development of commercial space.
***2 -** Investment value is mostly concentrated in a few large transactions*	• in 2018, five deals exceeded €20 million reaching together €141.3 million and representing 64% of the total investment value over the year. • Venture Capital (VC) is the main form of private funding for space start-ups (65% of the total amount in 2014-2018).
***3 -** Space entrepreneurship dynamism is widespread across Europe with a few top countries*	• Space investment deals worth >€1 million were recorded in 13 European countries. • Among top European countries, the United Kingdom stands out as particularly successful to foster entrepreneurship and private investment in the space sector.
***4 -** There is a limited correlation between national public space budgets and the intensity of domestic entrepreneurship*	• Each European country presents a different space entrepreneurial profile. • Multiple forces are at play, including: ○ Domestic entrepreneurial and financial ecosystems ○ National policies and approaches to space entrepreneurship ○ Industry forces (suppliers, competitors, substitute products, access to technology, etc.) ○ Market forces (demand volume, market structure, etc.) ○ Macroeconomic forces (regulations, capital markets, economic infrastructure, etc.)
***5 –** Investment in the space sector is fuelled by synergies with other sectors*	• For many start-ups, space is only one constituent of their value proposition / business model (one market among others, one input among others). • This is particularly true in the downstream segment of the space value chain. • With a growing cross-fertilization between space and terrestrial technologies, distinction between space and non-space investment is poised to become increasingly blurred.
***6 -** European space start-up profile*	The average European space start-up… • … is led by 2 to 3 founders and employs 9 people • … plans to recruit 5 people in the next 12 months • … generates an annual revenue of €500,000
***7 -** Space start-ups are radically more innovation- and global-oriented than other European start-ups*	• Space start-ups pursue innovation at a global level for each business component: Product (71%), Technology (60%), Processes (41%), Business model (47%) / In comparison, only 52% of "non-space" start-ups offer a product that is a global innovation. • 63% of space start-ups address global markets / In comparison, only 24% of "non-space" start-ups address global markets.
***8 -** The space sector offers a fertile ground for entrepreneurship*	• Start-ups consider the space sector rich in opportunities both for innovation (62%) and commercialization (60%). • Most ventures structure their value proposition around New Space trends (e.g. cubesats and system miniaturization, new launcher concepts, big data and digitization, analytics, etc.).

9 – *As compared to other sectors, space start-ups perceive their business environment as rather hostile but are confident in their growth perspectives*	• Space start-ups are more concerned by their business environment than other start-ups (e.g. threats of new entrants or substitute products, bargaining power of customers and suppliers, intensity of competition). • This contrasts very much with the positive evaluation of their business situation (83% consider to be in a satisfactory or good situation) and with their optimistic outlook on the future (73% foresee an even better situation in the future). • This suggests that European space start-ups consider to be well equipped (or backed) to succeed, even in a difficult business environment. • Would European investors share the opinion that the space sector is a difficult business environment, this could represent a major barrier to access to finance.
10 - *Space start-ups expect financial and non-financial support, in particular from public sources*	• 89% of start-ups benefited at least from one type of external backing and 38% benefited from both financial and non-financial instruments. • 78% of space start-ups are actively seeking financial support, including governmental support for 45% of them, confirming the prominent role of public funding in the sector.
11 - *Space start-ups highly value networking and mentoring*	• Among non-financial support instruments, space start-ups are most interested in networking events (39%), independent expertise (36%) and competitions (25%) due to a very positive opinion of the benefits of these instruments. • This highlights the great importance granted by European space start-ups to networking to meet and exchange with potential mentors, partners, investors or customers. • This finding supports the recommendation by the European Investment Bank to organize a dedicated annual event for space start-ups.
12 - *For space start-ups gaining customers and securing sales is a greater challenge than raising capital*	• Key challenges for European space start-ups: ○ Gain customers and secure sales (27%) ○ Raise capital (15%) ○ Manage liquidity and/or cash flow (14%) • Customer acquisition, also the top challenge for other start-ups (20%), is a more significant concern for space ventures. • This challenge mirrors the start-ups perception of a very strong bargaining power of customers in the space sector.
13 - *Space start-ups have higher expectations from politics than other start-ups*	• Space ventures expect (or need) more support from governments than other start-ups for the conduct of their business and for access to finance: ○ For example, 53% of space ventures count on public support to raise capital, while only 33% of non-space start-ups do. • Space start-ups desire a much more entrepreneurship-friendly environment featuring: ○ Improved exchanges between politics, start-ups and established companies; ○ Better cultural acceptance for entrepreneurship and understanding of the need of start-ups. • Space ventures also call for a reduction of administrative burden (60%) and tax (57%) but not more than other start-ups.

4.3 The role of public actors

European space start-ups have high expectations from their institutions. Requests for support span across the full spectrum of public action ranging from reduction of red tape and tax to access to finance, mentoring and networking. Unsurprisingly, and in line with the rest of the sector, space start-ups tend to rely more on public actors to initiate and develop their business. This is not a European exception. The central role played by public agencies in the emergence and development of new U.S. ventures, even the most disruptive and commercially-oriented, is well documented.[17]

Well aware of the important role that public actors must play to foster entrepreneurship and private investment trends in the space sector, all European institutions have been particularly proactive to operate a cultural change and launch new initiatives adapted to the needs of start-ups. This considerable effort is shared by the European Space Agency, the European Union, national institutions and other public bodies. In line with their respective strategies, the approach adopted by public actors consists principally in:

- *Stimulating business opportunities*; e.g. competitions, strategic partnerships, etc.
- *Supporting product and technology innovation*: e.g. public grants, incubators, independent expertise, etc.
- *Helping to raise capital:* e.g. public funding (grants, loans, subsidies, prizes), partnerships with investment firms/institutions, etc.
- *Building networks:* e.g. hubs, conferences, business missions, etc.

European institutions are continuously exploring new mechanisms. In the field of access to finance for example, recent public actions include, among others, the introduction by the EU of a dedicated equity instrument (InnovFin Space Equity) or the creation of national equity funds such as the new Luxembourg Space Fund or the CosmiCapital fund launched by CNES. Pioneer in the support to entrepreneurship with the introduction of Business Innovation Centres in 2000, ESA also recently signed a cooperation agreement with the European Investment Bank, marking yet another milestone.

Today, European institutions actively support entrepreneurship in the space sector and, although there is still room for improvement, their effort is now yielding concrete results. Notwithstanding, existing instruments support principally the *offer side*. They are particularly effective in early stages of product and business developments but show some limits when getting closer to the market. In light of the strong challenges faced by start-ups to gain customers and secure sales, a complementary support on the *demand side* would be beneficial. With the objective to connect business innovation to the market, three complementary actions could be recommended:

- *Stimulate the demand for space-based solutions in Europe:* Public actors already actively promote the market uptake of space-based solutions but much could still be done to leverage institutional demand. In the United States, public markets are a pillar for the business development of new space ventures. The use of anchor tenancy,[18] an arrangement bridging public needs and support to business, proved to be a very effective instrument to bring up confidence of entrepreneurs and investors. It has no equivalent in Europe.
- *Promote a European single market*: Large markets are essential for new space ventures to transform commercial opportunities into profitable and sustainable businesses. In Europe, national demand rarely offers the required critical mass. A European single market for space - based on demand aggregation and compatible regulatory frameworks - should be promoted.
- *Drive the demand to support innovation and growth in Europe*: Benefits from an aggregated European demand would be maximised by a policy promoting a European offer when suitable. Although the relevance of such approach is undisputed, the difficulties faced by the EU to explore its application in the field of access to space highlight how much competitive partiality is contrary to the fundamentals of the EU (i.e. Open Competition, Technology Neutrality, etc.). Yet, here again, the principles of the Buy American Act, which makes obligation to the U.S. federal administration to give preference to U.S.-made products, extensively applied in the space sector, has no equivalent in Europe.

17 ESPI, The Rise of Private Actors, Executive Summary, 2017

18 Title 51 of the United States Code, entitled National and Commercial Space Programs, defines Anchor Tenancy as "an arrangement in which the United States Government agrees to procure sufficient quantities of a commercial space product or service needed to meet Government mission requirements so that a commercial venture is made viable"

Annexes

A.1 Selected success stories

ICEYE

ICEYE-X1 bake-out, Credit: ICEYE

ICEYE is a 2014 European start-up, based in Finland. The company is currently building a constellation of small satellites equipped with Synthetic-Aperture Radar (SAR), after having been the first company in the World to successfully integrate SAR technology in a microsatellite, something many dismissed as impossible.[19]

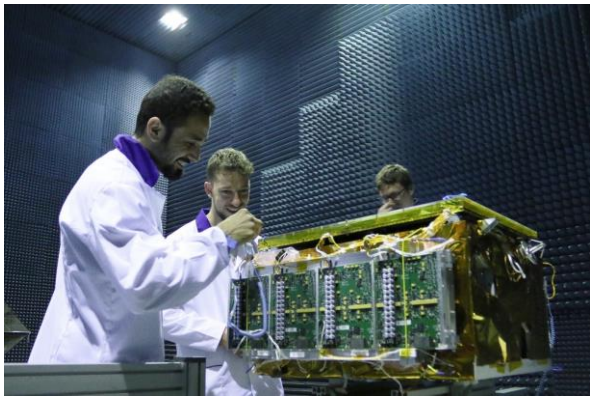
Novel use of Synthetic-Aperture Radar in a microsatellite

The company launched its first satellite, ICEYE-X1, aboard an Indian PSLV in January 2018. The satellite is a technology testbed for the future constellation. ICEYE-X2 is scheduled to launch in 2018, before the beginning of the deployment of the ICEYE constellation in 2019.[20]

Since its foundation, ICEYE has attracted the attention of international investors, mostly from the US and the UK, raising in 2018 alone EUR 29 Million, for a total of EUR 47.3 million raised in less than 5 years of existence.

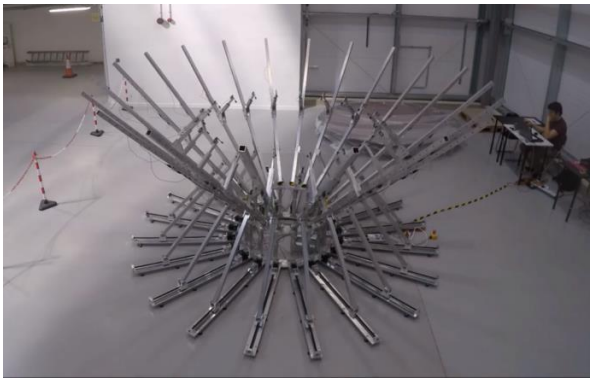
Investors share enthusiasm about the future of the company: Rohit Sharma, venture partner at the American True Ventures and ICEYE board member explained that "ICEYE is developing and deploying SAR satellite technology that has been dreamed about for decades, but which was thought to be impossible to deliver", "we are excited to accelerate our three-year-old partnership with ICEYE and lead their current round of financing as they continue to change the way Earth observation data is gathered, analysed, and delivered."

A race to develop commercial radar imagery from space has been going on since 2016,[21] and ICEYE seems well positioned to lead it, with a spacecraft already in orbit, technology validated, two launches scheduled for late 2018, the deployment of nine satellites in 2019, the backing of important investors and the trust of customers as ExxonMobil and ESA.



Testing in anechoic chamber, Credit: ICEYE

19 D. Werner, ICEYE achieves the 'impossible' with miniature radar satellite, 22 May 2018, https://spacenews.com/qa-iceye-achieves-the-impossible-with-miniature-radar-satellite/
20 Iceye, Satellite Missions https://www.iceye.com/resources/satellite-missions
21 D. Werner, A New Hope for Commercial Space-based Radar, 28 March 2016 http://www.spacenewsmag.com/feature/a-new-hope-for-commercial-space-based-radar/



Antenna's skeleton, Credit: OSS

Founded in late 2013, Oxford Space Systems (OSS) is an award-winning British start-up specialized in deployable space hardware, in particular origami-inspired antennas, booms, and panel systems. The company is currently targeting to supply the microsat market, targeting craft ranging from 15 to 750 kg, cooperating with major actors, such as the UK and European Space Agencies, Airbus Defense & Space, Thales Alenia Space as we as a number of US and Asian companies.[22]

OSS has received EUR 13,5 million in investments since 2014, of which almost EUR 10 million just in 2018. The company has attracted investment primarily from UK-based venture capital funds as well as the US Space Angels Fund.

Origami-inspired space deployable antennas & panels systems

The rationale behind the start-up is explained by its CEO, who, at the end of the last round of funding, explained that "[he] launched the company after realizing that deployable antennas and structures are often a neglected area of a spacecraft – an area ripe for innovation, especially when applying new proprietary materials."

With an incredible cycle from company formation to successful in-orbit validation in less than 30 months, OSS shows well thought-through ambitions, re-imagining the design and engineering of space hardware to make it simpler, cheaper and aligned with New Space ventures.

The company knows it has to compete with major actors as Harris and Northrop Grumman in the antenna arena, but believes it's agile, entrepreneurial focus demonstrates great determination and results, attracting experienced backers and the thrust of investors. And most importantly, a growing number of customers for its hardware.

A wrapped-rib deployable antenna, Credit: OSS

22 Oxford Space Systems https://oxford.space/

Propulsion modules checks into the vacuum chambers, Credit: ENPULSION

Founded in 2016 as a spin out from FOTEC, Enpusion is an Austrian start-up specialized in thrusters for small satellites, building its products on decades of experience on propulsion systems.

Specialists in smallsat Field Emission Electric Propulsion (FEEP)

The company is scaling up to mass produce and commercialize Field Emission Electric Propulsion (FEEP) thrusters. Among the New Space companies focused on electric propulsion for micro and small satellites, Enpulsion is one of the first to have reached the market with a functioning product, mastering a technology (the FEEP) which has been hard to transform from prototype to working product so far.[23]

After one year from its foundation, in 2017 Enpulsion has received a total of EUR 1.2 million in a single seed funding round, led by the entrepreneur and investor Alon Shklarek, followed by further contributions by both the European Union and the European Space Agency.

At the end of 2017, Enpulsion had already received 150 pre-orders from worldwide customers, and in April 2018 its technology has finally been validated in orbit.[24]

Currently shipping two thrusters per week,[25] in June 2018 Enpulsion has inaugurated a new production facility, which will allow to build up to two thrusters per day.[26]

In 2018, its IFM Nano Thruster will fly again as part of ICEYE's-X2 and-X3, providing further commercial validation of this technology. For 2019 Enpulsion will launch a new product. By clustering the proprietary indium ion emitters, a scaled-up thruster – the IFM Micro Thruster – is created to target the even larger market of small and medium-sized space crafts. The next development step for their IFM Nano will also hit the market in 2019 – IFM Nano Thruster SE which expands controllability towards active thrust vector control, without moving parts. It can therefore steer, correct for CoG mismatch or can enable advanced missions requiring precise thrust pointing.

ENPULSION trust, Credit: ENPULSION

23 C. Henry, Austrian startup ramping to mass produce tricky electric propulsion thrusters, 26 October 2018, https://spacenews.com/austrian-startup-ramping-to-mass-produce-tricky-electric-propulsion-thrusters/

24 Enpulsion, FEEP First Successful In-Orbit Demonstration of a FEEP Thruster, 26 April 2018, https://www.enpulsion.com/news/17-FEEP-First-Successful-In-Orbit-Demonstration-of-a-FEEP-Thruster.html

25 Enpulsion, https://www.enpulsion.com/

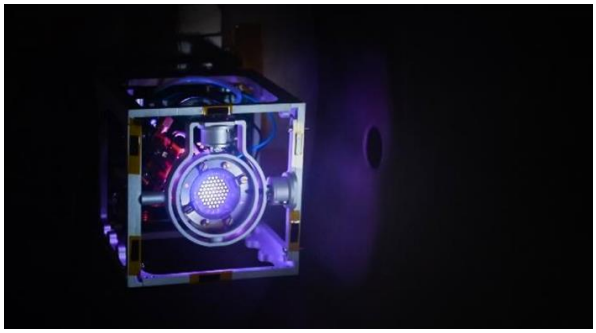
26 Enpulsion, Disruption Delivered, 08 June 2018,

CTO Dmytro Rafalskyi installing one propulsion modules into our vacuum chambers, Credit: ThrustMe

Smallsat electric propulsion developers

Founded in 2017, this French start-up is a potentially disruptive European player in electric propulsions for smallsats. With validated technology, ThrustMe's first stand-alone propulsion system supports spacecraft between 10 and 50 kg, while the company is already working on developing a complete system of thrusters, power electronics and propellant feed system to support spacecraft in the 200-300 kg range. Claiming to have built thrusters 40% the size of competitors without compromising on thrust, ThrustMe is "one of the most innovative and promising start-ups in Europe", according to Jean-Jacques Dordain, former ESA Director General and member of the start-up advisory board.[27]

With in-orbit validation expected in 2019, the less than 2 years-old company is in the meantime gaining the trust of investors and institutions alike, receiving in 2017 EUR 1.7 million investments in its first seed round, and EUR 2.8 million in 2018 from the European Union Horizon 2020. The rationale behind the investment, says Hélène Huby - investor and board member of the company, and former Airbus Defense and Space Head of Innovation - is the suitability of ThrustMe's propulsion systems for the growing number of constellations of small satellites.



A thruster undergoing a test, Credit: ThrustMe

27 ThrustMe, http://thrustme.fr/

A.2 Respondents to ESPI Space Entrepreneurship survey 2018

ESPI is grateful to the many European space start-ups who took part to the survey and provided substantial information for this report.

The following table excludes the names of start-ups who wished to remain anonymous.

Company	Headquarters	Core business
AIKO	Turin, Italy	Upstream / Build
ANYWAVES	Toulouse, France	Upstream / Build
B2Space	Bristol, United Kingdom	Upstream / Launch
BAKE IN SPACE	Bremen, Germany	Beyond Earth / Space Exploration
Berlin Space Technologies	Berlin, Germany	Upstream / Build
BlackShore	Noordwijk, the Netherlands	Downstream / Analyse
Blue Dot Solutions	Gdansk, Poland	Downstream / Product
Bright Ascension	Dundee, United Kingdom	Upstream / Build
C3S	Budapest, Hungary	Upstream / Build
CisLunar Industries	Luxembourg, Luxembourg	Beyond Earth / Space Resources
Crystal Space	Tartu, Estonia	Upstream / Build
EnBio	Dublin, Ireland	Beyond Earth / Space Exploration
eoVision	Salzburg, Austria	Downstream / Product
Eye On Orbit	Delft, the Netherlands	Upstream / Build
HeraSpace	Madrid, Spain	Downstream / Analyse
ISP International Space Propulsion	Marlborough, United Kingdom	Other
LEAF SPACE	Milano, Italy	Downstream / Downlink
Lens Research & Development	Noordwijk, the Netherlands	Upstream / Build
Leoni Corporate Advisors	Milan, Italy	Other
Libre Space Foundation	Athens, Greece	Upstream / Build
Omnidea-RTG	Stuhr, Germany	Upstream / Build

Oxford Space Systems	Harwell, United Kingdom	Upstream / Build
PICOSATS	Trieste, Italy	Upstream / Build
Pixstart	Toulouse, France	Downstream / Analyse
PocketSpacecraft	Bristol, United Kingdom	Beyond Earth / Space Exploration
Satlantis Microsats	Bilbao, Spain	Upstream / Build
SatRevolution	Wrocław, Poland	Upstream / Build
satsearch.co	Delft, the Netherlands	Upstream / Data
Silex Clouds	Rome, Italy	Downstream / Analyse
Skyrora Limited	Edinburgh, United Kingdom	Upstream / Launch
SnapPlanet	Toulouse, France	Downstream / Product
Space Sling Technologies	Sofia, Bulgaria	Beyond Earth / Space Exploration
Space Structures	Berlin, Germany	Upstream / Build
Spacearth Technology	Rome, Italy	Upstream / Build
SpaceCarreers.uk	United Kingdom	Other
Spacemind - NPC New Production Concept	Imola, Italy	Upstream / Build
SpacePharma	Courgenay, Switzerland	Downstream / Product
Spaceport Sweden	Stockholm, Sweden	Upstream / Launch
SpaceTech	Immenstaad, Germany	Upstream / Build
Stargazers.space	Paris, France	Downstream / Product
ThrustMe	Paris, France	Upstream / Build
Valispace UG	Bremen, Germany	Upstream / Build
VEOWARE SPACE	Guildford, United Kingdom	Upstream / Data
Viridian Raven	Noordwijk, the Netherlands	Downstream / Analyse
Waterwatch Cooperative	The Hague, the Netherlands	Unknown

A.3 Methodology notes

European space start-up definition

This study focuses on European space start-ups and aimed to collect data on private investment received by these companies and to gather views of these companies on their business, on the environment in which they evolve and on their expectations from public actors. The following definitions and categories were applied to delineate the perimeter of analysis.

- **Start-up:** A start-up is defined in Europe as a company younger than 10 years, whose business tend to feature innovative concepts and models and who has not yet reached business maturity (defined according to business stage: Public Offering, annual turnover or number of employees). For the purpose of this study and given the usually longer timeframe required in the space sector to reach business maturity (as compared to other industrial sectors), ESPI included companies founded after the year 2000. Business maturity (end of the start-up stage) is considered achieved if the company meets one of the following criteria (adapted from start-up[28] and SME[29] definitions by the COM):
    - Acquisition or Public Offering: the company has been acquired or listed on a stock market;
    - Turnover: the annual turnover of the company exceeds €50 million or the annual balance sheet total exceeds €43 million.
    - Number of employees: the total number of employees exceeds 250
- **Space company:** A company is considered a space company if the main business of the company (in revenue share) is part of the space value chain. For this definition, the study followed the space market segmentation provided by Seraphim's Spacetech Market Map 2018,[30] which divides space activities into three segments:
    - Upstream: Build, Launch, Satellites;
    - Downstream: Downlink, Analyze, Store, Product;
    - Beyond Earth: Space Exploration, Space Resources, Space Logistics, Space Research.
- **European company:** A company was considered European when the headquarters of the business organization are based in Europe (EU Member States + ESA Member States), or if a majority of its business operations is conducted in Europe, a feature that implies, for instance, the eligibility for EU funds as those provided by the Horizon2020 program.

In a number of cases, the classification of a company as a European space start-up required an arbitration because of the business setup (e.g. multiple headquarters addressing different regional markets), the situation of the company (e.g. dormant company founded before 2000 but with a net business acceleration after 2000 and following a start-up behaviour) or the nature of business (e.g. space is part of the products and services portfolio but not a core market).

For example, the study partially includes, or totally excludes, deals involving companies that reached business maturity during the period considered (2014-2018). This is for example the case of O3b Networks (today part of SES as SES Networks): the company is counted for a single investment in 2014 despite additional investment in 2016 and 2017. According to the definition adopted for this study, the company reached business maturity in 2015, because of annual revenues exceeding by far €50 million. Comparably, companies like GOMSpace and AAC Microtec were excluded after 2016, as they both started to be publicly traded, and that their business structure did not match anymore a start-up model. The British company Reaction Engines was included despite its age, as the company is still actively trying to develop the product for which it was founded, the SABRE engine.

28 European Commission, EU Start-Up Monitor, 2018
29 European Commission recommendation concerning the definition of micro, small and medium-sized enterprises, May 2003
30 Seraphim Capital, Introducing the Seraphim SpaceTech Market Map, March 2018

Investor and investment categories

To ensure coherence with existing authoritative studies, ESPI selected the categories used in Bryce's *Start-Up Space* report series to classify sources and types of investment.[31]

Investor categories

- **Angel Investors:** individuals or families (to include family offices) that have accumulated a high level of wealth and seek potentially high returns by investing in ventures during their early stages. Such investors may also operate with venture capital firms or other so-called angels. They will typically invest via straight equity, ranging in value from $50,000 to over $1,000,000. There is also a class of "super angels", who work in deals of $100 million or more (Jeff Bezos, as one example).
- **Venture Capital Firms:** VC firms represent groups of investors that invest in start-up, early stage, and growth companies with high growth potential, and accept a significant degree of risk. The trade of risk for potential high returns results in a high failure rate. Their investment form is equity, typically preferred stock, and comes in a series of rounds, traditionally Series A, B, C, etc.
- **Banks:** Banks are financial institutions that can support investment through a variety of instruments including, in particular but not only, loans and debt financing.
- **Private Equity Firms**: Private equity firms or groups are formed by investors to directly invest in companies. They typically invest in established companies, rather than start-ups, through large transactions and often acquire an entire company or a group of related companies that can merge.
- **Corporations**: Corporations have different methods of engaging in investment. They frequently provide the funding necessary to bring space-based programs to initial operating capability, as well as to sustain ongoing programs; they can also fund ventures, typically via straight equity, but also debt, and in the latter case with the option to convert to equity; and they also sometimes act via a corporate venture fund. Lastly, corporations may likewise acquire firms, including start-up space ventures, of which there have been several examples in recent years.
- **Accelerators & Incubators**: Although they are ultimately distinct types of actors, accelerators and incubators are similar in several core ways. Both aim to support start-ups, offer mentoring in developing their business, and both offer means to attract investment. Broadly concerning their differences, "accelerators 'accelerate' growth of an existing company, while incubators 'incubate' disruptive ideas with the hope of building out a business model and company".[32]

Investment categories

- **Seed/Prize/Grant**: Funding received by a start-up typically at an early stage of development. This category includes a variety of funding instruments that are usually obtained as the result of a selection process (application, competition) and involve limited obligations from the company.
- **Acquisition**: Situation whereby one company purchases most or all of another company's shares in order to take control. An acquisition occurs when a buying company obtains more than 50% ownership in a target company.
- **Debt Financing**: Process of raising money by selling debt instruments to individuals and/or institutional investors (e.g. banks). In return for lending the money, the individuals or institutions become creditors and receive a promise that the principal and interest on the debt will be repaid.
- **Private Equity:** Investment consisting of capital that is not listed on a public exchange. Private equity is composed of funds and investors that directly invest in private companies.
- **Public Offering**: Process of offering shares in a private corporation to the public. The first time, the operation is called an Initial Public Offering (IPO).
- **Venture Capital**: Funds invested by VC firms, usually with medium-term stakes, for high profit, high risk activities.

31 Bryce Space and Technology, Start-Up Space 2018.
32 Forrest, Conner. "Accelerators vs. incubators: What startups need to know." 25 June 2018. TechRepublic, 14 Dec 2018 <https://www.techrepublic.com/article/accelerators-vs-incubators-what-startups-need-to-know/>

ESPI Private Investment Database

The assessment of private investments provided in this report is based on a dataset including exclusively publicly available data on announced operations and deals.

Information is collected by screening a high number of sources including investment firms', incubators' and accelerators' portfolios, articles and specialized news outlets or specialised sources such as CrunchBase. Cross checking was systematically performed.

ESPI database includes deals for the period 2014-2018.

ESPI Space Entrepreneurship Survey

The analysis of the European entrepreneurial ecosystem is based on the results of a dedicated survey to European space start-ups. To allow for a benchmarking of results with other start-ups ESPI survey was adapted from the European Start-up Monitor 2016 survey,[33] and consisted in 40+ questions organized into five main sections including:

- Identity of the respondent and of the company;
- Business of the company, including views on expectations for the future;
- External financial support received and planned to be received in the near future;
- External non-financial support received and planned to be received in the near future;
- Views on the business environment of the company with a focus on the European entrepreneurial ecosystem, challenges, obstacles, and expectations for governmental support.

Responses have been aggregated through multiple answers questions, scores and open comments of the respondents providing additional insights on their reply.

ESPI sent this survey to 300+ companies matching "European space start-up" criteria and received a total of 64 completed responses from 16 countries.

33 German Startups Association, Kollmann et al., European Start-Up Monitor 2016

About ESPI

The European Space Policy Institute (ESPI) is an association ruled by Austrian Law, based in Vienna, funded at its inception (2003) by the Austrian Space Agency and ESA, and now supported by 17 members that include European national space agencies, the European Commission, and main European space services companies and manufacturers.

The Institute provides decision-makers with an informed view on mid-to-long-term issues relevant to Europe's space activities. In this context, ESPI acts as an independent platform for developing positions and strategies.

ESPI fulfils its objectives through various multidisciplinary research activities leading to the publication of books, reports, papers, articles, executive briefs, proceedings and position papers, and to the organisation of conferences and events including the annual ESPI Autumn Conference. Located in the heart of Vienna, the Institute has developed a privileged relationship with the United Nations Office for Outer Space Affairs and with a network of researchers and experts in Europe and across the globe.

More information on ESPI is available on our website: www.espi.or.at

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Data and information provided in this report are based on ESPI investment database and on the results of an ESPI survey, complemented with stakeholders and expert interviews. The list of external contributors is provided in Annex to this report.

ESPI is grateful to Bryce Space and Technology for the support provided and to the many European space start-ups who took part to the survey and provided substantial information for this report.

Mission Statement of ESPI

The European Space Policy Institute (ESPI) provides decision-makers with an informed view on mid- to long-term issues relevant to Europe's space activities. In this context, ESPI acts as an independent platform for developing positions and strategies.

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