INNORBIT

CAPACITY & SUPPORT FOR SUSTAINABLE SPACE INNOVATION

Empowering innovation intermediaries to generate sustainable initiatives to incentivise and accelerate the commercialisation of space innovation

D1.1 The European space support landscape: Insights from Central Eastern and South Eastern Europe

This project has received funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no 101004212.

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COORDINATION AND SUPPORT ACTION

D1.1 The European space support landscape: Insights from Central Eastern and South Eastern Europe

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Executive Summary

InnORBIT is an initiative that seeks to develop and promote space entrepreneurship in a group of countries clustered in South East and Eastern Europe. In the context of strengthening intermediaries along the innovation value chain, this report "The European space support landscape" aims to explain succinctly the state of play in some of the countries from Central Eastern Europe (CEE) and Southeastern Europe (SEE), providing insights about the innovation ecosystem. The project, which is divided into four phases and two pilot rounds, will aim to establish and encourage the emergence of local initiatives in the region which will enrich entrepreneurship in the space sector. This will be done by helping local intermediaries (entrepreneurship clusters, innovation hubs, and start-ups and SMEs associations) to incorporate and run local support initiatives and good practices applied to their innovation ecosystems.

This study addresses the first pilot stage, where InnORBIT's capacities on space entrepreneurship ecosystems in Greece, Romania, and Croatia will be deployed, based on this analysis and other preliminary studies. The development of this pilot will be evaluated for further replication to the rest of the SEE and CEE countries, as the final objective of the project, namely providing solutions for supporting 50 start-ups and scale-ups to grow and commercialise their space solutions via 20 sustainable initiatives with the development of their native ecosystems.

The first part of the document covers the situation of the region from a macro-economic and research policy point of view. Some countries in the region have been active in space in the past, but the change in the political theatre has led to the decline of these activities. Causal links are established between the situation of space entrepreneurial ecosystems and the presence of the European Space Agency (ESA) and its Business Incubation Centres (BIC). The study continues with the **in-depth case studies of four countries: Croatia, Greece, Romania and Slovenia**[1]. Extensive mapping of their local innovation ecosystems has been carried out, exceeding the initial target as for the statement of work, in order to gather information and assess it in a comparative framework, assigning quantitative values to the state of the spatial ecosystem in each country. Hence, local conditions, stakeholders and dynamics have been analysed to determine potential needs that may facilitate or impede the development of the space ecosystem in SEE and CEE. Some relevant information has also been collected at a European level that could be of use. The deep dives have been based on:

- Desk research.
- In-depth knowledge of the innovation ecosystem in each country studied, by means of having innovation intermediaries among the consortium members in these particular countries.
- Consultations with key stakeholders selected for their significance for the development of the spatial ecosystems in SEE and CEE, in each of the four countries analysed, **with 20 expert interviews conducted.**

The findings discovered during the deep dives have been grouped under "identified challenges for space entrepreneur ecosystems", and focus on the lack of a solid cooperation network, as well as on the funding culture, particularly space funding which requires a well-defined strategy. One of the most potent ways to increase the size of one's ecosystem is by having a large aerospace company operate locally. While the countries are inherently limited by their GDPs and GDPs per inhabitant, there is a lot of margin for improvement on the front of space spending, which remains rather low even as a percentage of GDP.

Consequently, **recommendations revolve around fostering the culture of cooperation and the promotion of entrepreneurial networks**, through simple use cases, capacity enabling, which could come through intermediaries. With regards to funding, we emphasise that public spending on space should be increased alongside improved access to and availability of private financing.

[1] Slovenia is not in the 1st pilot, but in this study

1 Fostering space entrepreneurship in Central Eastern and Southeastern Europe

InnORBIT is an EU-funded programme to foster space entrepreneurship in Central Eastern and South-eastern Europe. The programme consists of a study of the current situation in the region, the setting-up of local initiatives to support and fund start-ups operating in the space domain, training for the local intermediaries, as well as the definition of a reproducible model for establishing such start-up support structures.

The objectives of this report will be to map and assess existing local ecosystems for the support of space-related start-ups. It will present a general overview of space-related research in Central Eastern Europe (CEE) and Southern Eastern Europe (SEE), the intensity of private research and development (R&D) in space technologies, and the place of the space economy within each country. Therefore, a series of "deep dives" will be presented, in four representative countries, namely Croatia, Greece, Romania, and Slovenia, with particular emphasis on the first three, as they will be the location of the InnORBIT innovation intermediaries pilot programme. Finally, a synthesis will be extracted from the learnings gathered in the deep dives, to identify the CEE and SEE ecosystems strengths and weakness, and conclude with some practical policy suggestions.

Historically, Central and Eastern European countries were involved in the space adventure from their very first days through their belonging to the Soviet Union or the Warsaw Pact. Although most of the Soviet space effort was concentrated in present-day Russia, Kazakhstan and Ukraine, the *Interkosmos* programme offered many CEE nations their "first astronaut", such as Vladimir Remek in Czechoslovakia, Georgi Ivanov in Bulgaria, or Bertalan Farkas in Hungary, as well as opportunities for cooperation on unmanned scientific spacecraft, such as the Copernicus-500 mission to study Sun-ionosphere interaction, a joint venture between the USSR and the Polish People's Republic. Thirty years after the dissolution of the Soviet Union, has the Soviet space effort left any legacy in CEE and SEE nations, and if so, what is the status of their space programmes today? Additionally, how are these countries pursuing a path of economic growth and what does it mean for their "NewSpace" efforts?

Figure 1: The countries considered in the study. In dark grey, the pilot countries, in light grey, the other potential ecosystems

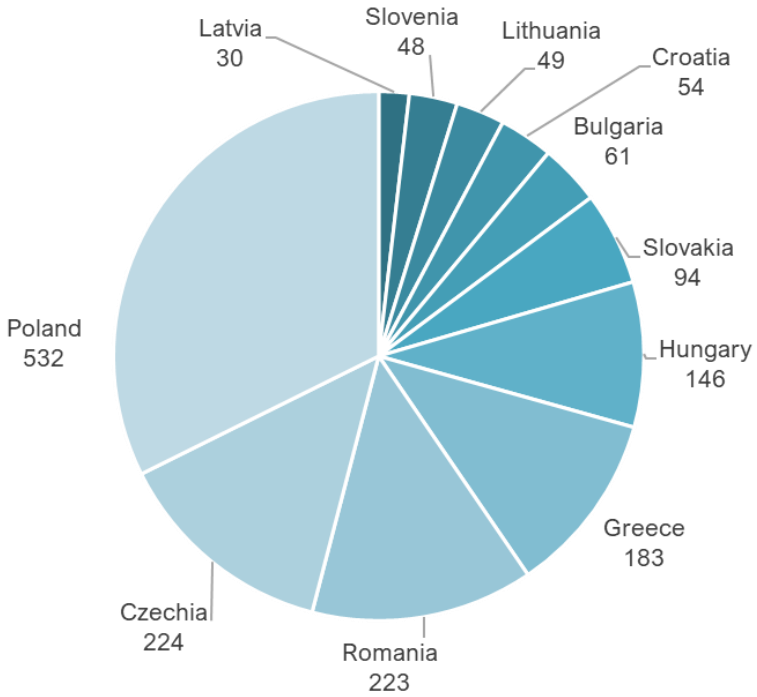
1.1 The economic big picture

As many scientific and innovation metrics depend on macroeconomic factors such as total gross domestic product (GDP) or GDP per capita, we will open this chapter with an overview of the standing of Central and Southeastern Europe from an economic standpoint. As we are about to see, Central and Southeastern Europe form a **very diverse group of countries** in terms of economic indicators.

1.1.1 Less wealthy but growing fast

As the European Union is unfortunately still a fragmented market, the total size of the economies of each country is often a decisive factor for the growth of start-up, who must first attempt to conquer their national markets instead of directly grow on an EU level. The GDP of CEE/SEE stands at 1.674 trillion EUR for 2019, representing 12% of the EU27's almost 14 trillion EUR GDP. With a 2019 GDP of 532 billion EUR, Poland is the largest economy of CEE/SEE and represents 32% of the economic output of the region. It is followed by Romania (223 billion EUR), Czechia (223 billion EUR) and Greece (183 billion EUR).

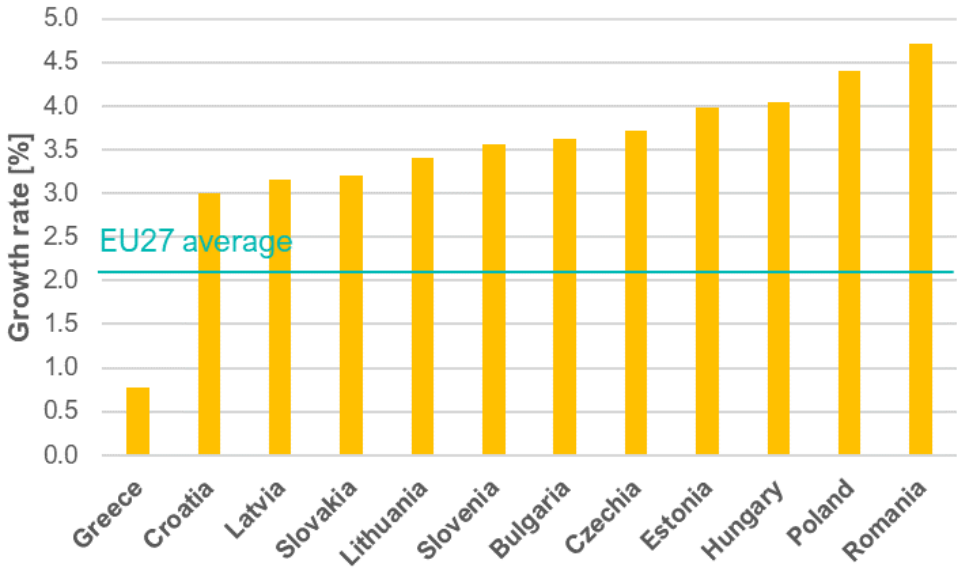
Figure 2: Gross domestic product in Central and South-eastern European countries (billion EUR, 2019, unadjusted GDP). Source: Eurostat



Aside from raw size, **the growth rate of a country determines the relative importance of "new wealth" versus "old wealth"**, in the sense that an important growth rate offers more opportunities for an individual to grow its own fortune through labour and innovation, and thus participates to the renewal of the composition of an economy[2]. Conversely, a small growth rate mechanically indicates that fewer new companies are emerging. **Growth rates are quite uneven amongst CEE/SEE countries**. **Central and Eastern Europe tend to show dynamic levels of growth**, with Romania showing an average growth rate of 4.72% in the 2015-2019 period. It is followed by Poland (4.40%) and Hungary (4.04%). All the other countries except Greece showed growth rates above 3%, significantly higher than the EU27 average of 2,16%. Greece is a notable outlier with a figure of 0.78% of average growth in the 2015-2019 period.

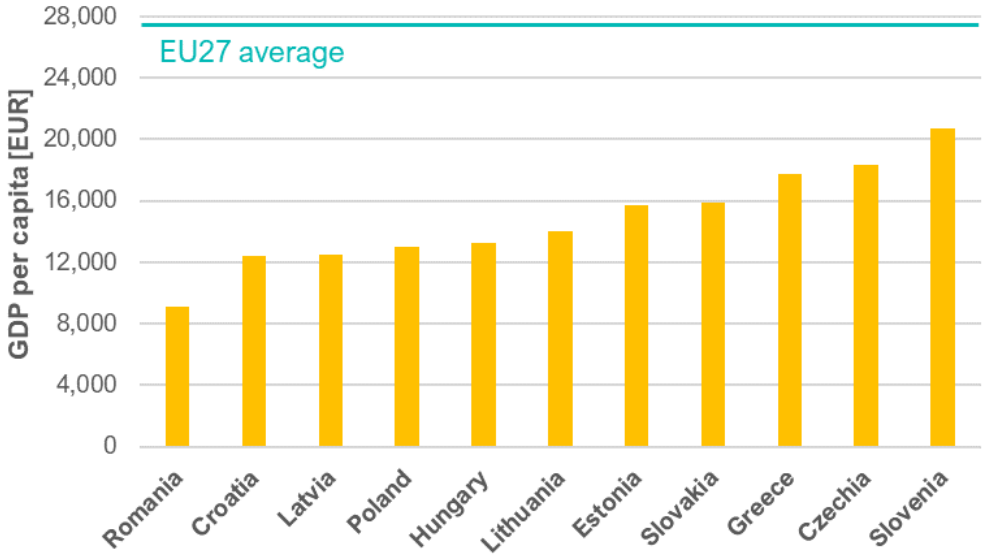
[2] Thomas Piketty, "Capital in the XXIst Century", 2013, Seuil, ISBN 978-2021082289.

Figure 3: GDP growth rate in Central and South-eastern European countries, 2015-2019 average. Source: Eurostat + SpaceTec Partners analysis



Significant differences also exist in terms of GDP per capita as well. **Slovenia is the most prosperous country of the group by some margin**, with a GDP per capita of EUR 20,700 per inhabitant in 2019. In the second and third positions, Czechia and Greece show a GDP per capita of EUR 18,330 and EUR 17,750 per inhabitant, respectively. **At any rate, all CEE/SEE countries are well below the EU27 average of EUR 27,970 per inhabitant.** Bulgaria, the Union's poorest member, stood at 6,840 € per inhabitant in 2019.

Figure 4: GDP per capita in Central and South-eastern Europe (real GDP, 2019 figures). Source: Eurostat

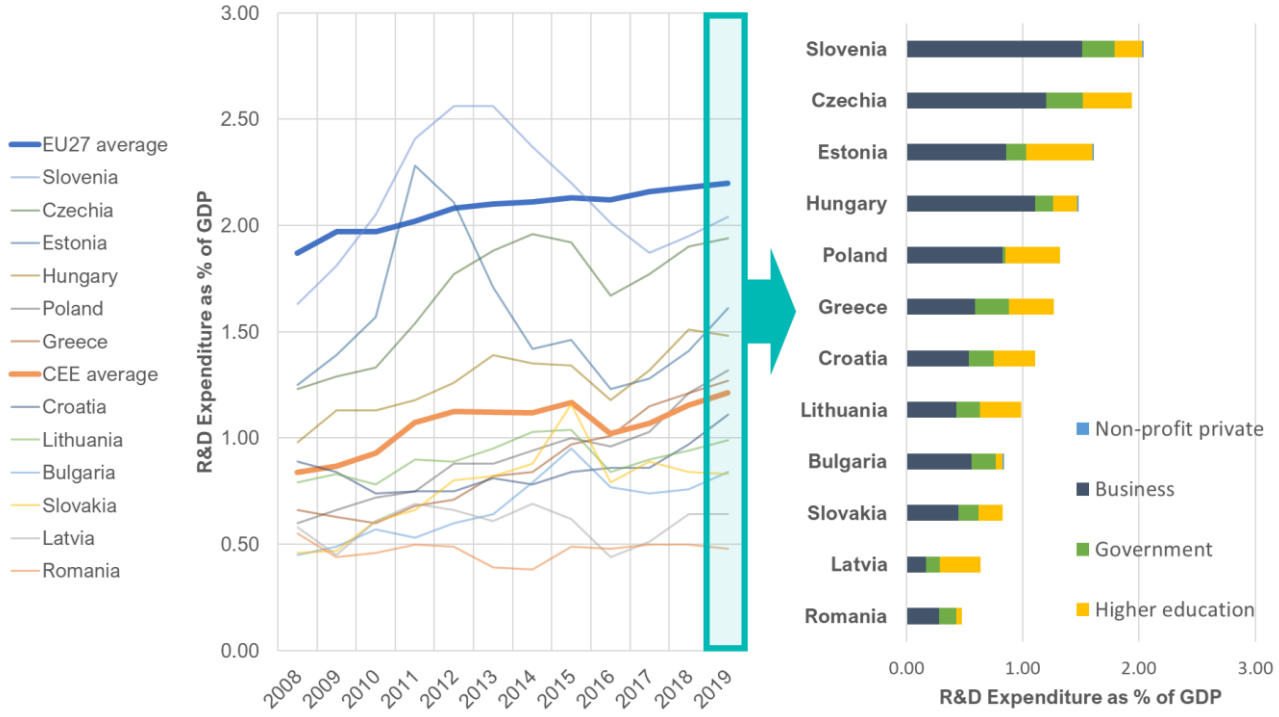


The situation of Central and Eastern Europe is one where countries are significantly less wealthy than their Western and Northern counterparts, but showing steady and consistent growth. Greece shows a different path, one of a country with a relatively high wealth to start with, but sporting very little positive growth.

1.1.2 The research and development challenges in CEE/SEE

A good proxy for the place of knowledge in a country is **the fraction of GDP that is being spent on research and development activities**. On that front, the EU27 spent 2.2% of its GDP on research and development[3]. For comparison, Israel spent 4.9%, the United States, 2.7%, and China, 2.1%[4]. From 2015 on, all CEE countries spent less than the EU average, although important differences can be noted between these countries. Slovenia is consistently the strongest player of the surveyed CEE countries by this metric. From 2010 to 2015, Slovenian spending on research and development was even better than the EU average and peaked at 2.56% of GDP in 2012 and 2013. On the other hand of the spectrum, Romania's numbers are the smallest, and never exceeded 0.6% of GDP. The CEE average stood at 1.21%, well below the EU average. The EU and CEE averages grow at about the same rate, so **there is no sign of CEE/SEE as a whole "catching up" with Western Europe**. However, individual countries like Slovenia, Czechia, Hungary, and Estonia are showing a strong increase in the last 3 years. The sectors in which R&D is spent in roughly the same proportion between private, governmental, and higher education, with private R&D representing the bulk of R&D spending.

Figure 5: Research and development expenditure (all sectors), as a percentage of gross domestic product over the 2008-2019 period [left]. Breakdown by sector for 2019 figures [right]. Source: Eurostat + SpaceTec Partners analysis



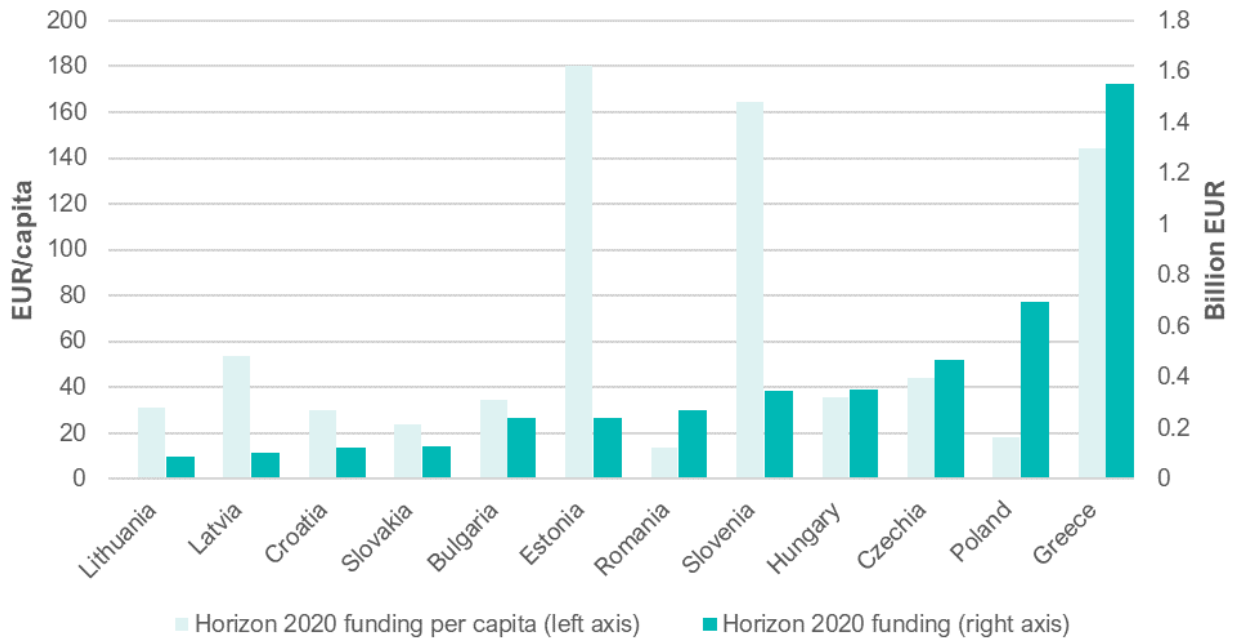
How do these figure for the financing of research compare on an international level? For the European Union, a good indicator of scientific performance might be the amount of Horizon 2020 funding received in each country. These grants are indeed highly competitive and fund proposals of global scientific relevance. **Estonia, Slovenia and Greece are strong outliers in terms of winning Horizon 2020 grants**, as shown in Figure 6 below, comparing the raw and per capita amount of Horizon 2020 grants received in each country. All three

[3] Eurostat, "Research and development expenditure, by sectors of performance" database, 2019 figure, https://ec.europa.eu/eurostat/web/products-datasets/-/tsc00001.

[4] The World Bank, "Research and development expenditure (% of GDP), 2018 figures, https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=IL-US-CN.

aforementioned countries were granted more than 140 EUR of Horizon 2020 funding per capita, a figure that is significantly higher than the EU average of 110 EUR per capita. It should be noted that Greece's absolute Horizon 2020 funding figure of 1.55 billion EUR is high on its own. All other CEE countries have rather modest results by these metrics. Indeed, the CEE/SEE average is 40 EUR of Horizon 2020 funding per capita, far below the EU average[5].

Figure 6: Horizon 2020 funding per country (absolute and per capita numbers). Source: European Commission + SpaceTec Partners analysis



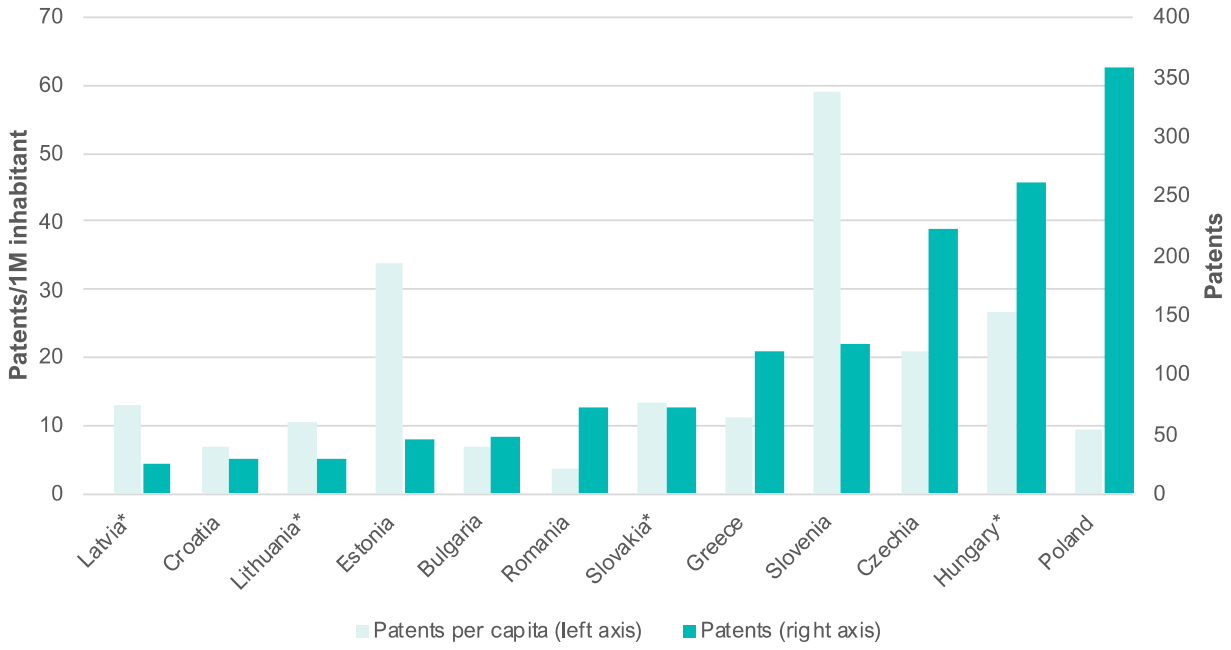
Another interesting "result"-focused metric is the number of patents filed in each country. At this game, Slovenia is once again distinguishing itself with about 60 patents per million inhabitants. Greece's position here is a lot more modest, with 11 patents per million inhabitants, slightly inferior to the CEE/SEE average of 12 patents per million citizens. **Greece's strong research performances are thus not mirrored in this more industrial metric**. In terms of absolute numbers, Poland and Hungary lead the way, with about 350 and 280 patents, respectively.[6] Estonia's position is once again to be noted, having produced about 35 patents per million inhabitants, second only to Slovenia within CEE/SEE. The numbers remain overall quite modest on a global scale. For instance, South Korea, Japan, and Switzerland filed 3,148, 2,005, and 1,081 patents per million inhabitants, respectively, making up the world top 3 in this metric. With 884 patents per million inhabitants, Germany is in sixth place worldwide and first within the EU and is slightly ahead of the United State's, which filed 871 patents per million inhabitants in 2018[7].

[5] European Comission, "Horizon 2020 country profiles" https://ec.europa.eu/info/research-and-innovation/statistics/framework-programme-facts-and-figures/horizon-2020-country-profiles_en.

[6] EU Open Data Portal, "Total Patent Cooperation Treaty (PCT) applications, last updated 2020, http://data.europa.eu/89h/jrc-10113-rio_oecd_patents.

[7] World Intellectual Property Organisation, "World Intellectual Property Indicators 2018", https://www.wipo.int/publications/en/details.jsp?id=4369.

Figure 7: Patents filed in 2018 (asterisk: 2017) in absolute and per capita numbers. Source: OECD + SpaceTec Partners analysis



1.1.3 Start-ups and entrepreneurship: the Baltic exception

The high-level economic and scientific picture having been painted, let us now look at start-ups and entrepreneurship in and on itself. A first metric **to consider is the number of "Unicorns" (USD 1B+ valued venture capital-backed companies)** in each country. Indeed, the emergence of a unicorn is a sign that, in some cases, a brilliant idea can be transformed into a profitable company. The reason why this transition is not automatic is precisely due to the multifactorial nature of the problem. Aside from an idea, there needs to be business support structures, available expertise in both technical and business fields, networks, and more importantly still, capital. The emergence of many unicorns is by extension a sign of a thriving ecosystem.

Of the twelve CEE/SEE countries, Estonia, Croatia, Latvia, and Lithuania have one unicorn each. The Czech Republic, Poland and Romania have two. By comparison, Sweden has 15 unicorns, the Netherlands, 19, and Germany, 39. The CEE/SEE figures remain rather low compared to these Western and Northern European countries even when adjusting for population. When adjusting for GDP, however, the figures remain low but become a lot more comparable, highlighting the importance of raw economic size.

Considering the total number of start-ups per inhabitants, the three Baltic nations grab the top three spots. Estonia distinguishes itself with 1,189 start-ups per 1M inhabitants, which is far larger than the CEE/SEE average of 289 start-ups per 1M inhabitant. Lithuania comes in second place with 723 start-ups per 1M inhabitant. Lastly, with 317 start-ups per 1M inhabitant, their performance of Latvia is similar to that of other CEE/SEE nations.

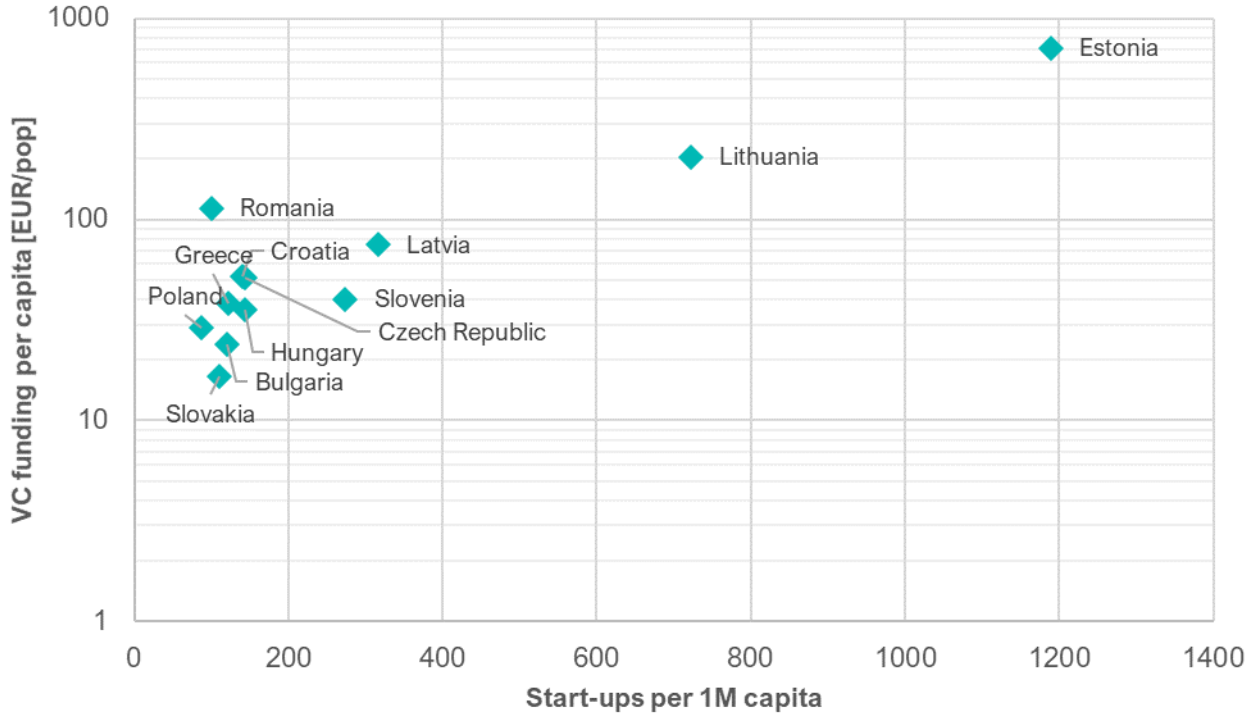
Another metric to consider is the amount of venture capital (VC) funding acquired by start-ups, per capita, which has a loose connection with the number of start-ups per capita. On this metric as well only Estonia stands out with 713 € per inhabitant. The average for CEE/SEE is 116 € per inhabitant, with most countries showing between 10 and 100 € per inhabitant.

The average CEE/SEE figures are relatively low when compared to tech-heavy countries in Western and Northern Europe. For instance, Germany, Sweden and the Netherlands have 457, 668, and 1,946 start-ups per 1M capita, respectively, and 2,083, 5,559, and 5,123 € of VC funding per capita, respectively. On the other

hand, Estonia's performance is all the more impressive, achieving a higher number of start-ups per inhabitant (but much fewer unicorns) than Sweden with comparatively less VC funding.

Overall, metrics for start-up creation and funding in Central Eastern and South Eastern Europe are about an order of magnitude smaller than in Europe's top entrepreneurial countries. Looking at the rate of creation of new start-ups, **most CEE/SEE countries show growth rates inferior to that of WE/NE countries[8], indicating further distancing rather than catching up**. Only in Poland and Estonia are start-up creation rates similar to that of Western and Northern Europe.

Figure 8: VC funding and start-ups per capita in CEE/SEE. Source: Dealroom + SpaceTec Partners analysis



It can be remarked that out of the three overachievers in terms of Horizon 2020 funding, Greece, Slovenia, and Estonia, only the latter has shown to be able to "transform" this performance in terms of start-ups.

This highlights a perhaps more general problem within Europe, which is leading the world in the creation of new knowledge in academia, but consistently struggles to use that advantage in an entrepreneurial way. It also highlights the fact that institutional support for fundamental science is a necessary but not sufficient condition for the emergence of successful technology startups, for if it were, there would not be such important differences between the academic and entrepreneurial performance of countries.

[8] Dealroom, https://dealroom.co/.

1.2 Central and Southeastern Europe in Space

Unfortunately for the ex-Soviet countries of CEE/SEE, the space exploration activities of the USSR did not leave a lasting legacy in these places, most of these activities having been concentrated in present-day Russia, Ukraine and Khazakstan. These countries thus had to build their space industry from scratch, a process that is still very much ongoing for most of these nations. The European Space Agency (ESA) is doubtlessly the central actor of space in Europe and has been vital to developing the space industry in CEE/SEE countries, complemented with the funding programmes of the European Union, both providing essential support in space R&D. Regarding space entrepreneurship more specifically, ESA operates a network of **Business Incubation Centres (BIC), which have particular importance in the landscape of European space startups**, and particularly so in countries without a developed pre-existing industrial base. At the same time, the European Union has funded a series of space hubs programmes, including InnORBIT, supporting space entrepreneurship across Europe. Previous activities of the EU include as well the Galileo Hackathons or the Copernicus Accelerator, which are regrouped and further expanded into the CASSINI space entrepreneurship initiative.

As with other fields of technology, time and consistency in needed for investments in the space sector to materialise. Thus, **this subsection starts with a ranking of European countries according to several successive chronological criteria**:

1. The number of ESA BICs
2. The foundation of the first BIC
3. The date of entry into ESA

The ranking can be seen in Table 1 below. The existence of a formal national space agency[9] is also noted for reference. CEE/SEE countries are highlighted with a tick mark on the first column.

With this ranking, five categories emerge: countries with more than one BIC, long-standing ESA member and core EU countries; countries with one BIC, usually having a formal national agency, countries that are ESA member but do not (yet) have a BIC; countries that have associate membership status of ESA; and lastly, countries that have neither a national space office and are not ESA members.

Countries with **more than one BIC** are in the darkest shade of teal. It is without surprise that most **heavyweights of European space**, countries with solid space heritage and strong space industries, are present in this category. These favourable environments foster the creation of start-ups and justify the creation of support structures such as BICs. Germany's large population and strong entrepreneurial activity have justified the opening of no less than three BICs. Interestingly, Italy has only one BIC, and is thus in the next category, despite fully conforming to the "European heavyweight" statement above, but as pointed out by a study from PwC[10], Italy's space landscape is more government-driven and inward-looking and the overall regulatory framework is noticeably less entrepreneur-friendly.

In a medium teal shade, **ESA member states with one BIC**. The Netherlands' privileged position in having the first-ever BIC stems from the location of ESTEC, ESA's engineering centre and its largest compound, in the town of Noordwijk. **Four CEE/SEE countries are in this category, Czechia, Estonia, Hungary, and Greece**. With its Prague-located BIC founded in 2016, the Czech Republic is the one with the longest-standing BIC in CEE/SEE, and can already showcase several success stories. On the other side, Greece saw its first ESA BIC being founded near Athens in 2021, although being quite well integrated with European space activities, as attested by its 2005 ESA entry date. As seen in the previous section, Estonia and Hungary fare quite well on

[9] That is, a distinct body in charge of funding a country's national space activities. Smaller countries may opt to fund these activities directly from the relevant Ministry.

[10] Publication Office of the European Union, "Mapping, analysis and characterisation of space hubs in the EU", Final report, written by PwC, July 2019, https://op.europa.eu/en/publication-detail/-/publication/891052ff-ae91-11e9-9d01-01aa75ed71a1.

metrics related to research and development spending alongside the Czech Republic and Greece, and it is natural to assume, all other things being equal, that this transfers into the subfield of space technology.

Table 1: European countries and their level of involvement in the ESA entrepreneurial programme[11]

CEE	Country	National Space Agency	ESA relation	ESA BIC?
	Germany	Deutsches Zentrum für Luft- und Raumfahrt (DLR)	Member state since 1977	1. Darmstadt – Since 2007 2. Oberpfaffenhofen – Since 2009 3. Friedrichshafen – Since 2018 4. Bremen – Since 2018
	France	Centre National d'Études Spatiales (CNES)	Member state since 1980	1. Toulouse – Since 2013 2. Brest – Since 2018
	Spain	Instituto Nacional de Técnica Aeroespacial (INTA)	Member state since 1979	1. Barcelona – Since 2014 2. Madrid – Since 2015
	Netherlands	Netherlands Space Office (NSO)	Member state since 1979	Noordwijk – Since 2004
	Italy	Azienda Spaziale Italiana (ASI)	Member state since 1978	Rome – Since 2005
	United Kingdom	United Kingdom Space Agency (UKSA)	Member state since 1978	Harwell – Since 2011
	Belgium	-	Member state since 1978	Redu – Since 2012
	Portugal	-	Member state since 2000	Coimbra – Since 2014
	Sweden	Rymdstyrelsen	Member state since 1976	Luleå – Since 2015
	Switzerland	Swiss Space Office (SSO)	Member state since 1976	Zurich – Since 2016
	Ireland	-	Member state since 1980	Cork – Since 2016
	Austria	Agentur für Luft- und Raumfahrt (ALR)	Member state since 1986	Graz – Since 2016
☑	**Czechia**	-	Member state since 2008	Prague – Since 2016
	Finland	-	Member state since 1995	Espoo – Since 2017
	Norway	Norwegian Space Agency (NOSA)	Member state since 1986	Kjeller – Since 2018
☑	**Estonia**	Eesti Kosmosebüroo	Member state since 2015	Talinn – Since 2017

[11] European Space Agency, "ESA Business Incubation Centres", https://www.esa.int/Applications/Telecommunications_Integrated_Applications/Business_Incubation/ESA_Business_Incubation_Centres , retrieved 16 April 2021

CEE	Country	National Space Agency	ESA relation	ESA BIC?
✓	**Hungary**	Magyar Űrkutatási Iroda	Member state since 2015	Budapest – Since 2018
	Denmark	Institut for Rumforskning og Rumteknologi	Member state since 1997	Copenhagen – Since 2020
✓	**Greece**	Hellenic Space Centre	Member state since 2005	Athens – Since 2021
✓	**Poland**	Polska Agencja Kosmiczna (POLSA)	Member state since 2012	(Planned)
	Luxembourg	Luxembourg Space Agency	Member state since 2005	-
✓	**Romania**	Romanian Space Agency (ROSA)	Member state since 2011	(Planned)
✓	**Slovenia**	-	Associate member since 2016	-
✓	**Latvia**	-	Associate member since 2020	(Planned)
✓	**Lithuania**	-	Associate member since 2021	-
✓	**Bulgaria**	-	Cooperation agreement with ESA	-
✓	**Croatia**	-	Cooperation agreement with ESA	-
	Cyprus	-	Cooperation agreement with ESA	-
	Malta	-	Cooperation agreement with ESA	-
✓	**Slovakia**	-	Cooperation agreement with ESA	-

In the lightest shade, Luxembourg, Romania and Poland are full ESA member states but possess no BIC as of the time of the writing of this report. Luxembourg instead relies on its successful start-up support programme Fit 4 Start which has a dedicated focus on ICT and space. The 500,000-inhabitant country has indeed very favourably space (entrepreneurship) policies and attractive standards of living but is also ideally located between the Belgian, Dutch and Northwestern German space ecosystems.

With grey background are Slovenia, Lithuania and Latvia, who are not yet formally ESA member states, but rather “Associate members”.

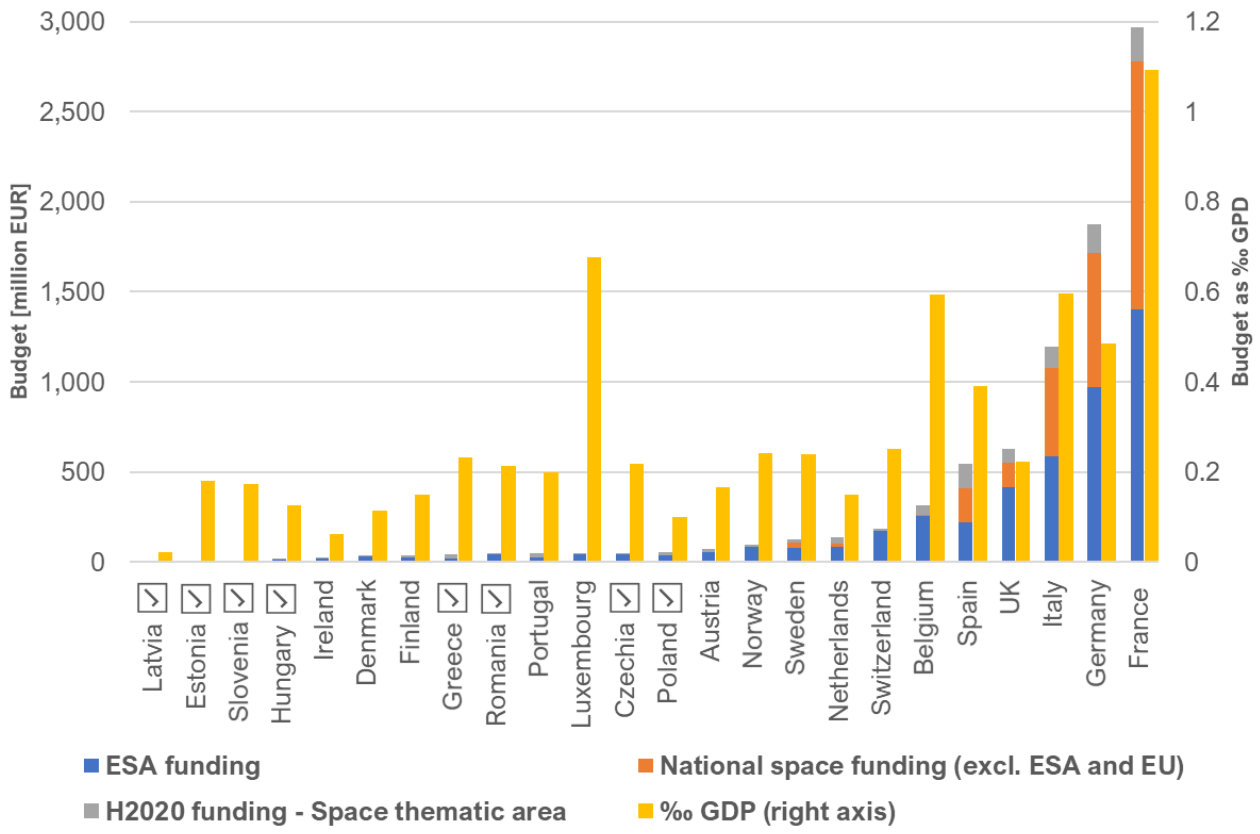
Lastly, in white, Bulgaria, Croatia, and Slovakia (as well as Cyprus and Malta, outside of CEE/SEE) have no national space agency and are not an ESA member state.

1.2.1 CEE/SEE's space budgets are below the European average

The BIC-chronological ranking established above bears some correlation with present-day institutional funding. In Figure 9, we attempt at estimating the total space budgets in a selection of countries in Europe, taking into account their contribution to ESA, and the amount of money spent on domestic activities. It is a rather difficult exercise due to the interplay between EU, ESA, and national space agencies, but double-counting was avoided in a best-effort manner.

Without almost 3 billion EUR spent on space activities annually, including almost half of it as its ESA contribution, France is leading the way in Europe. Its strong national space industry provided the groundwork on which European programmes such as the Ariane launchers could depend on. Germany, Italy, the UK, and Spain follow with 1.8, 1.2, 0.6 and 0.5 billion EUR spent on space, respectively.

Figure 9: Space budget estimation of ESA member states. CEE/SEE countries highlighted with a tick mark (source: ESA, European Commission, National Space agencies + STP analysis)



In terms of absolute budget, a rather clear picture emerges for CEE/SEE countries. **Their budgets are one to two orders of magnitude lower than in the West.** This mechanically prevents these nations from pursuing space ventures at the same pace as in the West. Apart from boosting space budgets, the issue might be overcome in two ways. First, in the agile and software-heavy era of New Space, not developing heavy space components does not necessarily mean a strong space industry cannot grow, as start-ups could be encouraged to focus on downstream applications. Second, space hardware capabilities are well-developed in the West, and there is indeed little sense in duplicating an Ariane or ATV programme; CEE/SEE nations may thus rely on them in a well-integrated Europe.

An important driver of these large spreads between Eastern and Western European countries is their GDP. Indeed, when looking at space budgets at a fraction of GDP, the picture is less unfavourable to CEE/SEE. These

countries spend about 0.14 ‰ of their GDP on institutional space activities, which is still significantly lower than the ESA average of 0.44 ‰. However, it is a comparable figure to countries such as the UK, the Netherlands, and Austria.

While the wild differences that exist between CEE/SEE countries and Western Europe can in part be attributed to GDP, there is still room for improvement, and increases of space-related spending at constant GDP would still go a long way.

1.2.2 Dissimilar sets of space and entrepreneurship policies

Generally speaking, the medium-term policy objective of many Central Eastern European countries, such as, e.g. Slovenia, Poland and Romania, is **to deepen their relationship with ESA**. The way contracts are distributed between European Space Agency member state follows a proportionality rule with regards to the amount these countries pledge on ESA. This policy is known as **georeturn** and ensures that the contracts do not overwhelmingly favour a few countries with outstanding space industry. **This mechanism is crucial for Central and Eastern Europe, as it ensures they can be involved in projects of worldwide relevance** in a way that is proportional to their chosen investment into ESA. For this virtuous circle to kick in, however, more space funding is required upfront on the part of the member states.

Furthermore, many CEE countries such as Bulgaria, Croatia or Slovakia have signed a cooperation agreement with ESA, thus paving the way for future associate membership, and eventually full membership. For example, Lithuania has become an associate member of ESA in 2021, building on a cooperation agreement from 2015. Despite these individual actions, the general impression of the CEE countries is that they do not have a ambitious plans for the space sector. **This prevents the embedding of these countries into the greater European landscape**, hence usually limiting their space activities to purely academic research on space science.

Unfortunately, some countries do not have a coherent national space strategy and as of now, see little value in significantly increasing their involvement in space activities. Mechanically, this prevents the embedding of these countries into the greater European landscape. Space activities in these countries are thus usually limited to purely academic research on space science.

The space strategy of most countries with a smaller space industry is to focus on niche areas where these countries may have an edge. For instance, the Polish Space Agency's specific goal to be "fully competitive on a global scale in selected areas" and to support local space-oriented companies[12].

More generally, **entrepreneurship and start-up creation can be seriously hampered by inadequate regulation**. The situation can be even more critical for space startups, given the generally intense governmental oversight on space activities. Starting a company comes with costs, and contributions that must be paid to public authorities can be high. Additionally, high contribution taxes raise the costs of running a company, especially for newly established ones. This is one reason why start-ups delay incorporating the company until they get revenue. Others, such as Estonia, have fully embraced the digital revolution, as attested, for instance, by their E-residency scheme and overall technology regulatory framework[13]. Estonia is however not a big player within the European space sector, neither on the public or private front, highlighting that good startup ecosystems alone do not automatically lead to a thriving space sector.

[12] Polish Sace Agency, "About POLSA", https://polsa.gov.pl/en/about-polsa/about-polsa, retrieved 21 April 2021.

[13] Ministry of Economic Affairs, Republic of Estonia, "Why You Should Launch Your Startup Business in Estonia", https://incorporate.ee/learning-centre/startup-business-in-estonia, retrieved 19 April 2021.

2 Deep dives in local ecosystems

In this section, we present in-depth analyses for four countries: Croatia, Greece, Romania, and Slovenia. Particular importance is given to the first three, as they will hosting the pilot projects of the InnORBIT innovation programme. The intelligence gathered in these "deep dives" will be further consolidated and addressed in the participatory design activities of InnORBIT, applying the notion of co-creation[14] for the design of the project's capacity building and business support programmes. InnORBIT's Co-Creation Workshop will introduce selected stakeholders from local innovation intermediaries and ecosystems (both space and non-space) as well as from relevant EU initiatives, financial support mechanisms and members of the project's Advisory Board into the initial designs and findings at the time, engaging them into a series of co-creative exercises.

These deep dives attempt at giving **a comprehensive picture of the space start-up ecosystem** in the considered country. Investigated factors include the availability of VC funding and their attitude towards space, the quality of the support structures for fledging businesses, the strength of academic institutions, the regulatory context and national space strategy, the existence or experience of governmental space agencies, and how all these aspects relate to each other. The detailed methodology can be accessed in Section 5.

Figure 10: Geographical location and key facts about the four countries studied in the deep dives

Croatia

Population	4,058,165
GPD	56 billion EUR
Unemployement	8.3%
Mean gross salary	1,241 €
R&D spending	1,11% of GDP

Greece

Population	10,709,739
GPD	189 billion EUR
Unemployement	15.8%
Mean gross salary	1,459 €
R&D spending	1.27% of GDP

Romania

Population	19,317,984
GPD	289 billion EUR
Unemployement	5.3%
Mean gross salary	1,213 €
R&D spending	0.48% of GDP

Slovenia

Population	2,095,861
GPD	52 billion EUR
Unemployement	4.7%
Mean gross salary	1,995 €
R&D spending	2.04% of GDP

[14] A user-centred, collaborative approach according to which users and stakeholders are involved in the design process of a product or service.

2.1 Croatia – Albeit fragmented, a start-up ecosystem showing a lot of potential for the space sector

Even though **space is an unexplored domain in Croatia**, there is a high potential for the development of a space-related part within the ecosystem. Initiatives have been scarce and usually private, but not as much targeted to space start-ups and SMEs. Given the **strong ecosystem support for generic start-up development**, various ecosystem players are open to getting involved in space entrepreneurship initiatives or programs. However, there is a need for more active communication on the topic and on the benefits of getting involved.

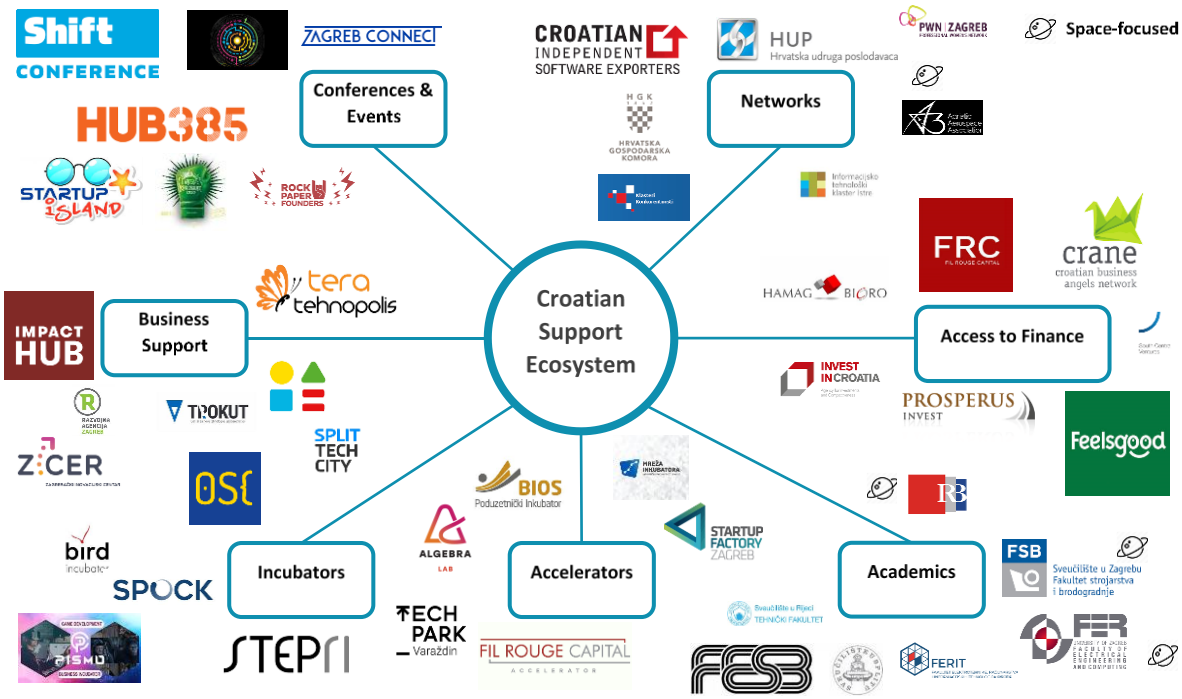
KEY TAKEAWAYS	
Summary of Best Practices	▪ Strong ecosystem support for generic start-up development ▪ **A high number of incubators**, accelerators, and other business support organisations active throughout the country (from the biggest cities to the smallest ones)
Areas for improvement	▪ Better funding support for early-stage start-up development (pre-traction period) ▪ Stronger cohesive factor among different stakeholders to benefit networking ▪ Private/public tension: with private institutions focusing on offering the best possible services for start-ups (on which their financial success depends), and with **public institutions dedicated to securing funding** and consequently, offering services to start-ups ▪ Centralization and sustainability of events, conferences and networks
Gap identification	▪ Space-focused initiatives are scarce, primarily focused on academic research, with very few and largely unknown SME initiatives ▪ **Lack of cooperation** or openness to cooperation between certain stakeholders, such as **start-up - industry** collaboration ▪ Difficulty in transferring technology from research stage to market

Croatia signed a cooperation agreement with the European Space Agency in 2018. Reasons for such a late arrival are many and can be debated, but the consequences are clear: even at this very moment, **Croatia does not have a national space programme or any kind of national space strategy** or vision for the development of space technologies and space entrepreneurship included. Moreover, there is no awareness of the potential of space programmes for the overall economic development, and consequently not even the basic understanding of what space entrepreneurship is. If there is any kind of government support for space-related initiatives, they are, like the decision by the Ministry of Science from August 2019, **strictly concerned with the additional support of conference attendance for researchers** participating in already approved Horizon 2020 space-related projects. At the same time, there is tremendous enthusiasm in astronomical pre-graduate education and research, primarily fuelled by the work of Visnjan Observatory (which is amongst the top five observatories in the world in collecting more near-Earth object measurements).

At the moment, **there is one space actor that strives to play a structural role in the national space ecosystem, the Adriatic Aerospace Association (A3)**. It is an association of research institutions and high technology firms, whose vision starts from the premise that commercialisation of space is, on the global level, still at an early stage of development and that Croatia has a chance to join in and participate. As its main assignments, A3 sees research and development, inter-mediation and education and counselling. The most pertinent section here concerns inter-mediation. A3 sees itself as a mediator between scientific research institutions and economic entities oriented to develop new technologies for the aerospace sector, as well as a

focal point for the international aerospace agencies, creating an environment where all stakeholders (industry, academy, public sector) are involved, thus enabling the growth in this sector. They organised Adria Space Conference in 2019 and 2020 to raise awareness of their work. Most members of the A3 are academic institutions. This pushes the work of the association more towards R&D and less towards space entrepreneurship. Their major challenge is the non-existence of any kind of coherent funding: all members take part in the activities on a voluntary basis, which heavily impedes their resonance and impact factor.

Figure 11: Ecosystem chart for Croatia.



The general entrepreneurship climate and **ease of doing business can be overburdened by regulation and policy**. Starting a company comes with costs, and contributions that must be paid to public authorities can be high. Additionally, high contribution taxes raise the costs of running a company, especially for newly established ones. This is one reason why start-ups delay incorporating the company until they get revenue. Both starting a company and liquidating it are difficult processes due to regulations, which can often be uncertain and change frequently. One exception to this rule is founding what is termed "a simple limited company". Moreover, there is **no general recognition of a failure culture**, and companies who fail cannot exit easily without administrative burden. Entrepreneurs do not generally feel supported by the government when it comes to regulations and policies. There is no overarching policy or strategy to support start-ups to go forward and make Croatia a more attractive ecosystem. In terms of education regulations, VC funds cannot invest in student-led projects, as students would lose their student status when they become employed by their start-ups.

There are neither an overarching strategy nor policies for space nor any national space innovation programs. Croatia has signed a Cooperation Agreement with the ESA in 2018, allowing for the creation of a framework for more concrete cooperation related to ESA programmes and activities. The creation of the framework never took place, and consequently neither did subsequent activities.

However, when it comes to space entrepreneurship, in the Croatian start-up communities, there is a lack of awareness of the potential and ability to network and partner up with relevant stakeholders. Even though there are few private initiatives related to space, this domain remains unexplored in Croatia. At the moment, the space sector is not seen as strategic by public authorities.

As for business and support, and access to finance, there are various support instruments for new and existing businesses, **however, there is a lack of support for early-stage start-ups and there is a limit in what they can receive in later stages** (not more than EUR 5 million). VC funds invest from a Seed stage up to Series A, while later stages fundraising opportunities (Series B and beyond) are only available abroad. The current amount of grants and investment money present in Croatia, in comparison to other Western Balkan countries, is much higher, primarily thanks to one VC fund which operates a programme funded by the EIF.

When it comes to public funding, the biggest share consists of EU funds; the agency managing and distributing most public financial support programs is Hamag-Bicro. Different grants are available to start-ups in the IT and tech sectors. There are a few proof-of-concept grants and other support programmes helping teams in their beginnings. For instance, the City of Zagreb is giving out grants for proof-of-concept of up to EUR 14 000, to IT as well as other sectors. But, by the rule of thumb, neither the local nor the national government consider investment in start-ups as something important for overall development. There is a **limited number of VC funds**; the most notable being South-Central Ventures, Fil Rouge Capital and Feelsgood Capital. **VC funds can invest up to EUR 3 million; there are no ticket sizes above that, which is normal for an ecosystem of Croatia's size**. As for other private investment opportunities, business angels are not very active in the Croatian ecosystem. They are organized in an association called CRANE (Croatian Angels Network), but many operate independently, as well. There have been some private angel investment initiatives, but these usually lasted for a limited time. There is a need to raise awareness about business angel investments in the ecosystem, to show the availability of various financing instruments and give start-ups the option to choose.

In terms of incubators and accelerators, Croatia has a high number of such programs, with different ecosystem players have launched their own. For instance, the City of Zagreb has their incubator (ZICER), with their own program, Start-up Factory, accepting 15-20 start-ups a year, where teams can get funding up to EUR 20 000. Fil Rouge Capital has its accelerator, and they also provide funding opportunities at an idea stage. Many universities have their incubation programs, like Algebra and within the University of Zagreb, the Faculty of Electrical Engineering. There is, however, a small number of incubators/accelerators offering a soft component, for instance in terms of networks of mentors (i.e. Algebra, Bird, ZICER). The business support ecosystem is heavily fragmented between brick-and-mortar incubators (local incubators offering housing for start-ups and no mentor or any other support) and incubators with educational and mentor programmes. Hamag-Bicro received around EUR 1 million in funding from the EU to create a national business organisations network. The project aimed to standardise counselling and mentoring services for start-ups. The network so far encompasses over 90 different incubators. Unfortunately, even though the project started in July 2017 and ended in September 2019, with the exception of a few new tools for starting a business, there are no concrete networking effects achieved. Most funds are industry-agnostic and there are **no grants or funding specifically targeted at the space sector**. There is, however, interest in getting involved in space entrepreneurship initiatives or programs, as long as there is a market reasoning behind it. Particularly, VC funds would be interested in supporting entrepreneurs active in the space sector, with B2B business models. Ecosystem players reckon that if space opportunities would be better and more actively communicated, start-ups and other actors would be more motivated to participate in such initiatives.

As for academics, there are several important players active in the Croatian ecosystem. Notably, Institute Ruđer Bošković, and universities like Faculty of Electrical Engineering within the University of Zagreb, Rijeka University, Faculty of Economics in Split. Private universities, like Algebra, are also very active in connecting and engaging stakeholders in the ecosystem. Many academic institutions have their start-up support programs and incubators. **Most universities have their own technology transfer offices, which often lack funding**. In terms of spin-offs, there is often a conflict on who owns the intellectual property and the equity. There are many examples of quality projects and spin-offs coming out of Croatian universities, however, there is a lack of promotion and awareness that many of these exist. Often, the process of spinning out is rather heavy, due to the difficulty of decision making from the higher end within universities. In terms of space, there are no courses in this domain yet, however, there is space-related research.

When it comes to talent attraction, **brain drain is a recurring issue, and because of taxation policies, entrepreneurs tend to prefer working as freelancers**. Croatia has a digital nomad visa program, allowing to live and work in Croatia, without paying taxes, for one year. However, there is no start-up visa program yet. On attracting international talent, a success story would be Rimac Automobili, with more than 50% international staff. Often, local developers choose a secure job in local or foreign agencies, rather than the less secure entrepreneurial career path. A solution could be to build strong VC funds to invest in local talent as early as possible.

When comparing local and international talent, **there is a lack of business, marketing and sales skills and knowledge locally, despite the excellent tech talent**. Additionally, scaling a company and thinking beyond the local and regional markets are also lacking skills – many start-ups do not believe they could make a successful growth story, or when they believe they could, they lack clear ideas on how to achieve that. However, this might change given recent success stories, like Croatia's first unicorn, Infobip, and the second unicorn-in-waiting, Rimac Automobili. There is a need to make the ecosystem more attractive for both local and international talent. Another issue around attracting international talent lies within the education system and **traditional state universities not being open to international students**. At the same time, private universities offer their programmes fully in English and compatible with the highest quality standards. Thus, hiring professors with international experience, as well as international staff and establishing programs in English could attract more international talent in Croatia.

Previously, cities would each have their own start-up conferences and events, however, most of them ended up being one-time events. The three most notable events that have been organized recurringly, are: Rock Paper Start-ups by Netokracija, Shift conference organized in Split, and Business Café organised in Zagreb. However, there are not many events focusing exclusively on start-ups and founders, an area that could be improved in the future. There are many tech conferences where different ecosystem players can network, such as Idea Knockout by Bug Magazine, DEBUG by Bug Magazine, or start-up competitions by the Good Game community. **There is a limited number of start-up competitions connecting more experienced founders with new ones.** An example is Algebra's "Investors Conference" and Fil Rouge Capital's accelerator sessions. Conferences and events in Croatia usually focus on tech and fintech (i.e. Shift Money), and they tend to either not have a specific focus or be very niche. **When it comes to the space sector specifically, there are no meetups, conferences or events specialized in space with a high profile.** There is only an annual conference organised by the Adriatic Aerospace Association (A3), since 2019.

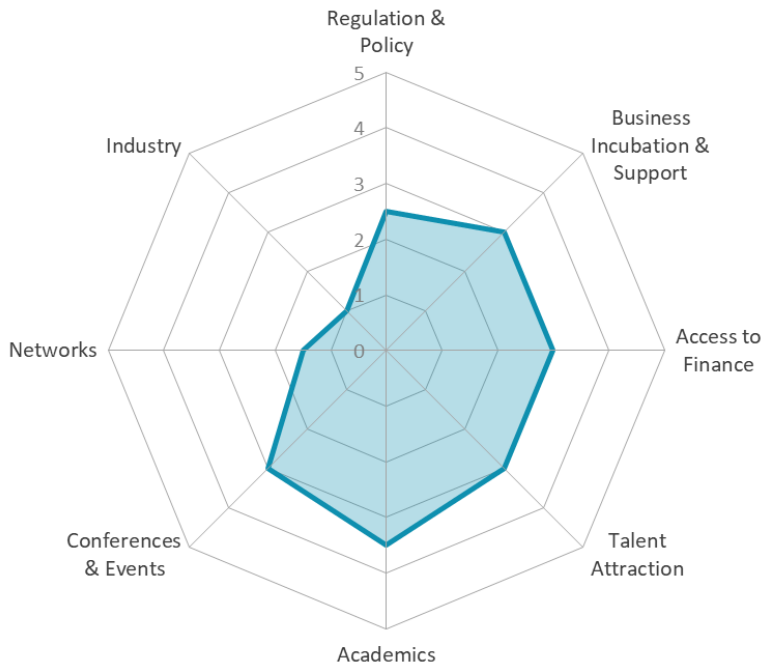
One issue is the centralization of events, most of them being held in Zagreb, even though there are success stories from other parts of the country (i.e. Shift Conference in Split, Start-up Island in Hvar). There is a need for more conferences and events held in other local start-up communities in Croatia. Moreover, there is a lack of sponsors funding events and conferences in Croatia, compared to more advanced ecosystems (i.e. USA, France); a situation that could discourage the organization of more events in the future.

As for networks, there is a general misunderstanding of what networking is, in the Croatian ecosystem. Usually, when it comes to networking and getting to know one's own connections in the ecosystem, there is a lack of knowledge in how to network proactively. Moreover, the small size of the ecosystem comes with opportunities of getting to know founders much more easily, which is not sufficiently used by ecosystem players. There are no high-profile clusters, except for groups such as CISEX (an association gathering Croatian IT companies). A network working to bridge the gap with the space sector is the Adriatic Aerospace Association (A3). Otherwise, space initiatives are scarce and academic research focused.

When it comes to industry, and specifically start-up-industry cooperation, there is little to no link with industry players and corporates – which often do not have the initiative to invest in start-ups, as they do not see the potential benefits in terms of both talent and technology, and rather deem it as a risk. **Many industries, especially traditional ones, do not see the added value of cooperating with start-ups.** The additional challenge stems from the fact that most big industry players and corporations are foreign-owned – meaning, their strategic decision-making on technological and business development does not reside in Croatia. Sectors

that do work with start-ups include banking (e.g. Erste Bank), telecom (e.g. Croatian telecom), and oil (e.g Mol Group have their own incubator in cleantech). A way to improve this cooperation could be for corporates and big companies to employ entrepreneurs, who could spearhead the connection and work inside the company politics. Another way to improve the connection is to organize thematic events for corporates around technology relevant to their industry, where start-ups could take part.

Figure 12: Spider chart – assessment of space business location in Croatia (Maturity Level by Key Drivers, 0-5 Scale)



When it comes to synergies, **some ecosystem players such as VC funds are usually cooperating with the academic sector**, in terms of educating through workshops, lectures. However, when it comes to industry-academia synergies, the difficulty stands in transferring solutions from the research stage to the market. Networks and universities are also in cooperation, trying to connect academia with different stakeholders depending on their domains. Many times, however, collaboration with universities and research institutes is rather rigid, due to difficulties in getting the research on the market, and often academia is not characterized by an entrepreneurial mindset. Another lack of cooperation was observed between start-ups and corporates, who do not see the potential added value in start-ups and consider investing in start-ups high risk.

Several gaps have been identified in each of the above-mentioned domains, such as the scarcity of space-focused initiatives for start-ups and SMEs, less access to finance for early sage start-ups, lack of entrepreneurial soft skills, lack of synergies between different stakeholders. Some recommendations are related to looking for existing success stories and solutions. Besides having access to more funding, particularly for early-stage start-ups, mentorship, and education, being in closer contact to peers and the industry via events and networks, local initiatives and success stories from local players, like Algebra and Adriatic Aerospace Association (A3), working to match the right players in the field. **Promoting success stories from neighbouring countries and from the region**, that could apply to Croatia is also a solution (i.e. Serbia's local events outside the capital, both big companies and local tech players sponsoring events and conferences, as seen in Romania). Especially from a networking perspective, the community is rather small, and the right stakeholders could be easily reachable, which can be an advantage for the Croatian ecosystem over bigger start-up communities abroad.

2.2 Greece – Home to a comparatively advanced space entrepreneurial ecosystem

The Greek space sector is **an emerging industry covering a wide range of upstream, midstream and downstream technologies for space**, such as Earth observation, navigation, satellite communications, operations, microelectronics, robotics, materials and structures, etc. The Greek ecosystem comprises promising start-ups with a considerable output of innovative products and services, collaborations with prominent space actors at an international level and an active presence in ESA and EU funded research and innovation programmes. An increasing number of business initiatives are in place to offer incubation and acceleration programmes, some of which are focusing on the space domain and are promoting the advancement of the space ecosystem.

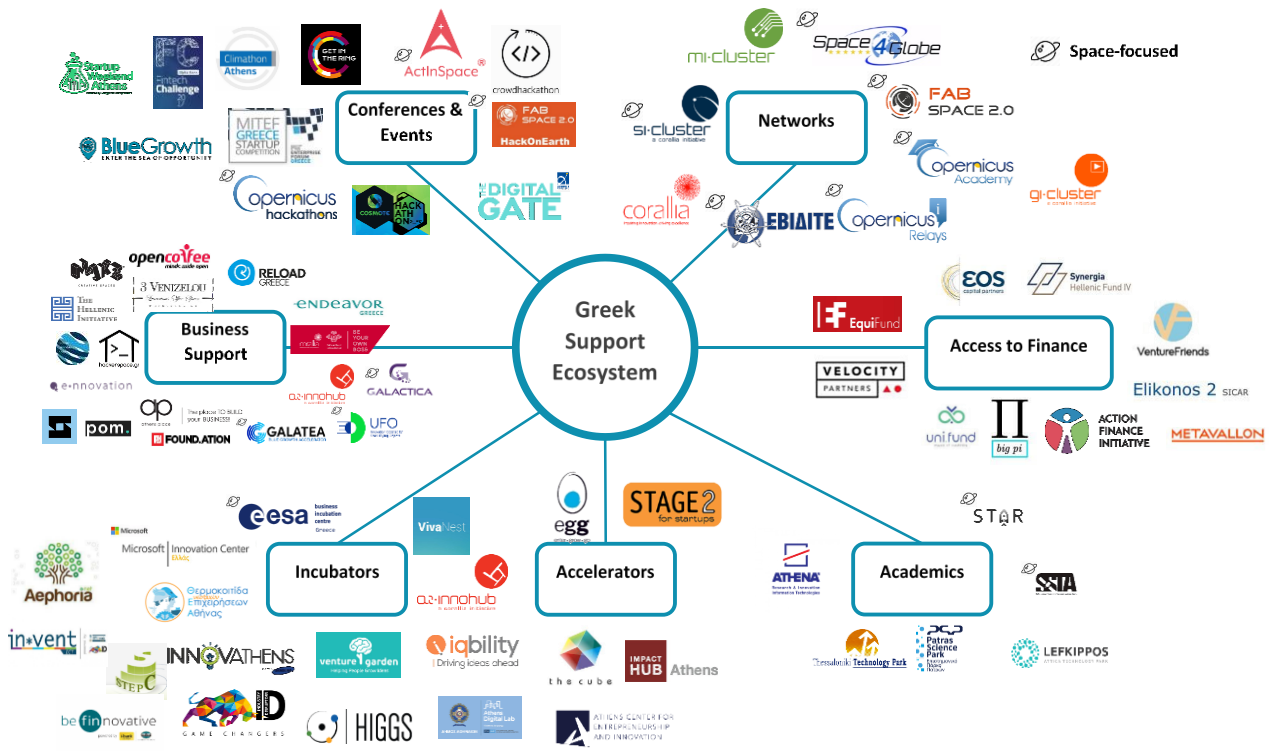
KEY TAKEAWAYS	
Summary of Best Practices	▪ **An active industry** with strong technical expertise, producing innovative products and services, forming strong international collaborations ▪ Supportive networks and clusters for the advancement of the Greek space sector ▪ Strong mentality of cross-sectorial and international collaborations ▪ Business incubation and acceleration programmes for start-ups and SMEs in space and non-space sectors. Launch of the ESA BIC Greece
Areas for improvement	▪ More favourable labour market/**work conditions to attract highly skilled workers** to Greece ▪ Academic institutions need to introduce activities and programmes to invest in developing workplace and entrepreneurship skills of students ▪ Funding instruments need to include space-focused start-ups and SMEs ▪ Organisation of more events, conferences and bootcamps to enhance networking opportunities and visibility of the Greek space ecosystem
Gap identification	▪ Lack of branding strategies to promote the Greek space sector internationally ▪ **Lack of coordinated public support for space** and of a clear and coherent legal framework for entrepreneurship and business ▪ University studies are quite decoupled from any entrepreneurship activities ▪ Not many space-tech related studies are available ▪ Lack of high-scale space infrastructure

Established in 2009 through the conducive efforts of the Hellenic Association of Space Industry (HASI) and the Corallia Clusters Initiative, the si-Cluster (Hellenic Space Technologies and Applications Cluster) is an industry-led and user-driven innovation cluster that brings together private and public actors in the field of space technologies and applications in Greece. The si-Cluster currently consists of over 70 members from the industry, academia and research, and has played a major role in the formation of an organized Greek space innovation ecosystem and the advancement of the international presence of the Greek space sector.

A national space strategy has not been articulated and adopted by the Greek government yet. However, the Hellenic Ministry of Digital Governance in collaboration with the Hellenic Space Center has developed a draft space strategy coupled with a dynamic action plan for its implementation, which is currently under public deliberation with stakeholders in the space domain. The Greek government's commitment to actively participate in the European Space Strategy for the benefit of the national economy as well as to strengthen the Greek space industry is also largely highlighted by the **noteworthy increase of Greece's contribution to ESA budget 2021** and the Greek government's planning and support for the creation of the ESA Business Incubation Centre (BIC) Greece that launched in March 2021 and is being operated by Corallia. Government

policies have become supportive towards start-ups and significant efforts have been made lately to digitise bureaucratic processes resulting in the removal of barriers for business operation and general encouragement for entrepreneurship. Despite progress made, the business environment and market structure are still considered inconducive in Greece and the country performs low on the "ease of starting a business" indicator.[15]

Figure 13: Ecosystem chart for Greece.



Business support instruments are available in Greece mostly through horizontal measures to support businesses, including training for executives, infrastructure building and business acceleration programmes, among others. Several incubators, accelerators and co-working spaces have been established to support general entrepreneurship as well as technology-oriented start-ups and SMEs, such as Corallia, egg, INNOVATHENS, Found.ation, The Start-up Elevator, Technopolis Thessaloniki ICT Business Park, OK!Thess, VentureGarden, and Patras Science Park. **The ESA BIC Greece is a decisive step towards the advancement of Greek space entrepreneurship** as it aims to support 25 start-ups in the next 5 years to grow their business in space technologies and applications, to strengthen the transfer of know-how to and from the space sector, and to create synergies with the industry of other countries participating in ESA programs.

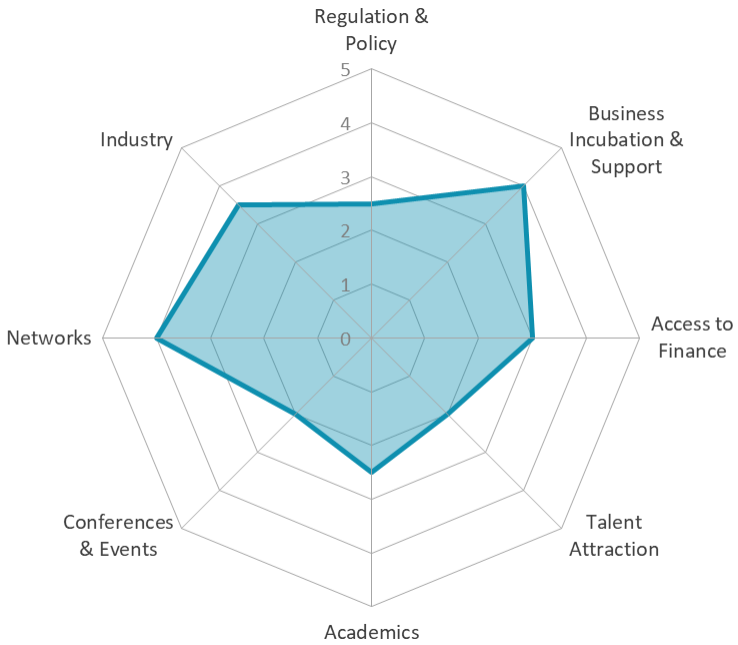
Access to funding for start-ups and entrepreneurs is supported by the government through various public funding schemes, including the Partnership Agreement - National Strategic Reference Framework, the Sectoral Operational Program "Competitiveness, Entrepreneurship & Innovation" and the "Business Financing" Action of the Entrepreneurship Fund. Commercial banks do not appear to be supportive towards start-ups in their early stages and instead opt to finance mostly mature enterprises. **Venture capital (VC) expenditures in Greece have almost doubled in the last 10 years, yet they remain at low levels relative to the European Union**, as documented in the European Innovation Scoreboard 2020. EquiFund is a publicly supported fund-of-funds offering three modules for financing technology-oriented SMEs and researchers, managing a portfolio

[15] European Commission, "European Innovation Scoreboard 2020", https://ec.europa.eu/docsroom/documents/42981/attachments/1/translations/en/renditions/native

of over €300 million. BigPi Ventures, the Metavallon fund, Uni.Fund and Velocity. Partners are oriented towards scale-ups (innovation window funds) while Marathon VC and Venture Friends target start-ups (early-stage window funds). Venture Capital mostly specialises in specific technology domains, e.g., Phaistos fund supports the development and production of 5G-related products and services, whereas there are no reported cases of VCs that target the space sector.

Greece has a large pool of talented and highly educated people, especially in STEM fields, although there is a lack of people possessing expertise in both technology and business. However, the country has been hard-hit by the **brain-drain phenomenon** in the past decade, as a result of the long-lasting economic recession which has worsened work conditions and reduced labour supply significantly. In recent years, the growth of the Greek technology start-up ecosystem and better economic conditions have resulted in an increase of job opportunities in the technology and space sector thus **attracting Greek workers to repatriate to the country** and claim improved working conditions as well as foreign talented employees. Despite this recovery, living standards and wages in Greece remain lower in relative terms compared to the advanced economies of Europe. Cases of talent acquisition programmes exist in Greece, including Regeneration and Code.hub.

Figure 14: Spider chart – assessment of space business location in Greece (Maturity Level by Key Drivers, 0-5 Scale)



In Greece, academia produces the majority of research output in several technological fields and thus is considered as an important link for advancing innovation in the local space ecosystem. Space-focused programmes have been established in Greek universities. Relevant academic departments are the Department of Mechanical Engineering and Aeronautics at the University of Patras and the Department of Aeronautical Science and Technology at the University of Athens. Space-oriented master's programmes include the Space Technologies, Applications and Services programme offered by the University of Patras and the University of Athens, and the Space Science, Technologies and Applications programme organized by the University of Peloponnese and the National Observatory of Athens. **There exist numerous academic research teams with consistent activity in space fields, that participate in EU and ESA funded programmes** and have produced significant results. **However, the academic landscape in Greece is quite fragmented**, as academic research teams are mostly loosely organised, financial support is typically the result of own initiatives, funding is uncertain, while communication for knowledge exchange among teams is scarce. The framework for

commercialization of research inside academia cannot be characterized as supportive, as there is no organized market for patents inside academia to support start-ups, while commercialization of academic research engages arduous bureaucratic procedures for defining intellectual property rights. There exist limited examples of spin-offs that emerged from academic institutions.

Various space-related conferences and events have been organised in Greece. The "2nd International Workshop on Space-Based Lidar Remote Sensing Techniques and Emerging Technologies" hosted in Milos island in 2018, attracted high-profile participants from six government space agencies including NASA and ESA, as well as from several research institutions and industries. Copernicus Hackathons in Athens started in 2018 and involve participants to develop disruptive and breakthrough ideas in response to Copernicus challenges with guidance from experts and mentors. There are also events and competitions targeting high school and university students about designing cubesats. Finally, the 44th Scientific Assembly of COSPAR, a prominent event focusing on space policies, will be held in Athens in 2022. A systematic effort has been exerted during the past years to develop networks of stakeholders within Greek space and space-related industries. The cluster facilitator Corallia and its space-focused cluster, the Hellenic Space Technologies and Applications Cluster (si-Cluster), engage members from the industry, research centres, academic institutions and start-ups active in the fields of space technologies, services and applications. **An increasing number of networking opportunities arise, as more technology and space-related networking events, bootcamps and hackathons are organized in Greece.** However, more efforts are needed to consolidate fragmented networks while traditional institutional stakeholders in the industry need to modernise their processes to foster knowledge exchange through their networks.

The **Greek start-up ecosystem has been on the rise** and Greek start-ups have gradually started to gain noticeable international visibility and presence[16]. Start-ups that recently got funded appear more prepared to scale, the Greek start-up ecosystem now attracts more investments from abroad, and some noteworthy acquisitions have taken place[17]. Some notable cases of indigenous businesses in the space industry have emerged, including but not limited to Adamant Composites Ltd., Hellas Sat, IDE Intracom Defense, Planetek Hellas, and Prisma Electronics SA. **The Greek space industry has also attracted international companies** including OHB Hellas and SITAEL Hellas.

The space sector in Greece is highly institutionalized and thus public institutions and the government closely interconnect with the space ecosystem. However, these linkages are not based on solid foundations since an integrated space policy has not been introduced yet. Research and academic institutions have formed collaborations with the private sector and open channels for communication have been established, though in many cases on an ad-hoc basis and through individual effort. Branding and trademark strategies should be implemented to internationally promote the expertise of Greek stakeholders in disparate space domains. The need for the development of a rigorous legal framework for conducting business in Greece is imperative, as unclear legal provisions and ambiguities may disincentivize investments and entrepreneurship, affecting sectors without a guaranteed market such as space. Current barriers to boosting entrepreneurship include limited access to the right talent, undeveloped collaborative networks, and still a largely unfriendly business environment and market structure[18]. Academic institutions in particular need to establish stronger linkages with the labour market through initiatives that promote entrepreneurship, collaborations with SMEs and large corporations in the space sector, internship programmes and transfer of research output in business environments.

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[16] Enterprise Greece, "The Greek Start-up Scene", https://www.enterprisegreece.gov.gr/files/pdf/startup2019/5-The-Greek-Startup-Scene_2019.pdf

[17] The Foundation, "Startups in Greece 2020-2021", https://thefoundation.gr/innovation-platform/research-publications/startups-in-greece/

[18] The Boston Consulting Group, "Greece's Start-up Ecosystem – A prime opportunity for economic growth", https://image-src.bcg.com/Images/BCG-Greeces-Startup-Ecosystem_tcm9-190625.PDF

2.3 Romania – Leveraging international cooperation to help local players emerge

The space tech ecosystem in Romania is characterised by the **strong presence of local and international stakeholders** that provide the basis for potentially intense development of the space and space-related tech sector. Romania is the 19th full member of the European Space Agency since 2011 and its Romanian Space Agency ROSA is the most prominent stakeholder in the ecosystem at an institutional level. The space ecosystem in Romania is notably inhabited by **international stakeholders that collaborate successfully with the local players**, predominantly in the R&D and scientific fields. Several initiatives support the involvement of youth to bring interest in space and space-related academic and industry activities such as the Romanian Space Initiative (ROSPIN) and Space Generation Advisory Council Romania. Involvement of women in space research, innovation and entrepreneurship is also encouraged and promoted[19].

KEY TAKEAWAYS	
Summary of Best Practices	▪ National **space strategies and government-funded programmes are established to support R&D** and technology transfer relevant to space and space-related industries ▪ Dedicated programmes for youth and women inclusion with an emphasis on the space sector
Areas for improvement	▪ ESA Business Incubation Centre in Romania is yet to be established; however talks with ESA for this establishment are at an advanced stage ▪ Implementation of national strategies and programmes is curtailed by **frequent change of policies and bureaucratic procedures** for an application ▪ The independent entities (business incubators, industry clusters, etc.) that provide support to SMEs in space and space-related tech struggle with limited resources – human and financial ▪ The number of focused events and networking initiatives for space and space-related tech at a national and regional level is yet to be increased
Gap identification	▪ Lack of local initiatives that support space tech start-ups in getting investment ready and that support introduction of Romanian SMEs to the international investment arena ▪ Limited access to directories/databases of entrepreneurs, business angels, VC investor and support service providers (including incubators, accelerators) ▪ **Lack of in-depth awareness on horizontal nature of the space tech** applications in various non-space industries, low cross-sector interaction that hinders industrial cooperation or finding suitable business partnership ▪ A gap in science to technology transfer funding schemes and early-stage start-up support, especially from home-grown capital

Various strategic documents frame the immediate and long-term objectives of the space domain and provide a development framework defined by the means of the Research, Development and Innovation Strategy 2014-2020[20] resulting in policies with effects on both academia and industry encompassing the "3 S's":

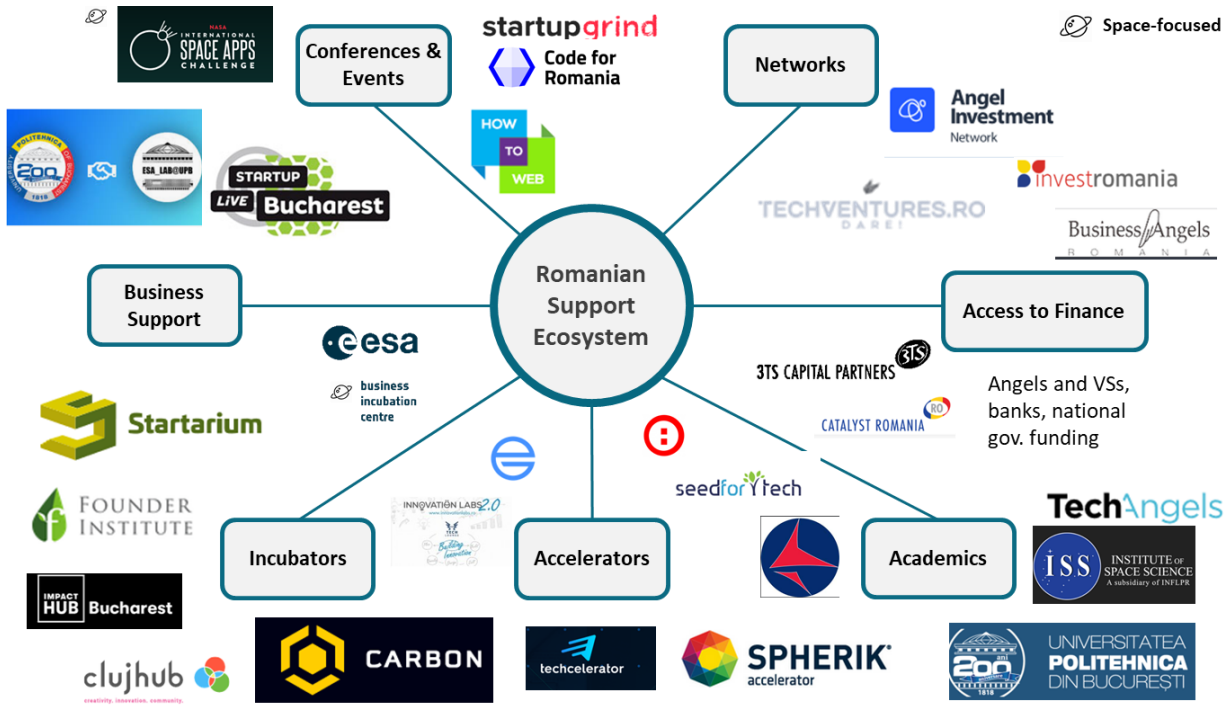
[19] Space Generation Advisory Council, SGAC Romania, https://spacegeneration.org/regions/europe/romania, retrieved April 16, 2021.

[20] Cunoaşterea şi Innovarea Contează, "STRATEGIA DE CERCETARE ŞI INOVARE 2014 – 2020", Versiune tehnică http://www.cdi2020.ro/wp-content/uploads/2014/02/STRATEGIA_Versiunea-tehnica_Februarie-2014.pdf.

1. Science and Technology: driving the most space technology domains and applications for all areas of science, including space exploration.
2. Services: in the scope of the space tech including telecommunications, Earth observation, PNT, and also integrated and cross-cutting applications: precision farming, telemedicine, disaster management, etc.
3. Security: matters such as planetary defence, space weather, space traffic management (SSA, SST), disaster management, prevention and recovery; peacekeeping, arms control, illegal trafficking, de-mining, cybersecurity and monitoring of global issues[21].

As the most influential organisation in the space domain ROSA coordinates national research programmes and space applications and develops and coordinates the implementation of the National Space Program in line with the objectives defined by the national research, development, and innovation strategy. ROSA also supports the development of Romania's national space infrastructure and human resources in order to reach the average European level. The Agency is also authorized to set up research and development centres but there is no ESA Business Incubation Centre (for comparison, there are 23 such centres in Europe today).

Figure 15: Ecosystem chart for Romania



The Romanian Space Agency is the coordinator of Romania's national and international space activities. It is a public institution entirely self-funded, operating under the decisions of the Ministry of Research, Innovation and Digitization (MRID). The Romanian Association for Space Technology and Industry (ROMSPACE) is a non-governmental encouraging participation in national and international programs and projects of national scientific and industrial entities by promoting conditions to optimise their participation.

[21] Marius-Ioan Piso, "Space as Enabler", presentation at the UN Office for Outer Space Affairs, 2019, https://www.unoosa.org/documents/pdf/psa/activities/2019/UNRomania2019/UNRomania_Presentations/2._ROSA_SSS_UN_Cluj_MAY_2019_v1_Short.pdf

The Polytechnic University Bucharest is the most prominent stakeholder in the space domain in Romania at an academic level. Its Faculty of Aerospace Engineering (FAE) is an important part of the national aerospace scientific research system with a mission to advance education and scientific research in generating knowledge and innovation as the main objectives of a knowledge-based society and economy. The Aeronautics and Space Research Centre at the Polytechnic University Bucharest is another important participant in the ecosystem that balances the theoretical and applied research in space technology. The Centre develops a close relationship with major companies in the field, start-ups, research institutes, educational and industrial units for the exploitation of new space technologies, improving the human research potential in the field.

The ecosystem in Romania can be further characterised by **strong ties with international institutions and organisations** (the ESA, UN-SPIDER, EURISY, EREA, Copernicus – to name a few) **that provide various access to knowledge and technical exchange, as well as space missions** and programmes which, on their side, support development of local projects and initiatives. The Romanian space ecosystem also includes scientific, research and academic centres that specialise in space technology and attract or breed talent in the domain, the most prominent of which are the Polytechnic University of Bucharest with its Faculty of Aerospace Engineering and Research Centre for Aeronautics and Space; INCAS – National Institute for Aerospace Research "Elie Carafoli" (under the aegis of The Romanian Academy), the Institute of Space Science (ISS) and CRUTA - Romanian Centre for Remote Sensing Use in Agriculture. The ROSA Research Centre (RRC) is a step forward with venture agreements concluded with CRUTA[22]. A joint venture agreement was also concluded with the Institute of Space Science in Bucharest. RRC is involved in various projects in space dynamics, in particular small satellites and tethered systems, magnetic fluids and magneto-fluidic composites; earth observation (remote sensing) satellite data retrieval, processing, algorithms and software development, applications development; spatial information systems integration, Global Navigation Satellite Systems and space technology for risk management and security.

On investment in the space sector side, InvestRomania is a governmental leading body in promoting and facilitating foreign investment in Romania with aerospace being one of the priority sectors[23]. **Airbus is a large corporate investor that also invests in R&D and human capital**[24]. Home-grown investors are also gaining weight and picking up[25] (Impact Capital, GapMinder Ventures, Sparking Capital). Regional development centres acting also like TTOs and intermediaries are also present (Tehimpuls – The Regional Innovation and Technology Transfer Centre – West Region in Timisoara and CENTI - Technology Transfer Centre Cluj-Napoca, the Science and Technology Park for Micro and Nanotechnologies MINATECH-RO acting also as an incubator). Providers of investment readiness services and organisers of regular events are only a few and are with more generalist orientation (Impact HUB Romania, the Polytechnic University of Bucharest together with the ESA have also launched the ESA_Lab@UPB event[26]; NASA Space Apps Challenge[27]; Aerospace Meetings Romania – a matchmaking platform between international buyers and regional suppliers). The Romanian Space Agency has a role in informing about international events and application calls related to space research and industry, information coming predominantly from the channels of its membership in ESA. One step forward for the space

[22] Romanian Space Agency, "ROSA Research Centre", http://www2.rosa.ro/index.php/en/research, retrieved 16 April 2021.

[23] Invest Romania, "Aerospace", http://investromania.gov.ro/web/doing-business/aerospace/, retrieved 16 April 2021.

[24] Airbus Defence and Space, "Airbus in Romania", https://www.airbus.com/company/worldwide-presence/romania.html, retrieved 16 April 2021.

[25] Mike Butcher for TechCrunch, "8 investors tell us the story behind the romanian startup boom", https://techcrunch.com/2021/01/23/8-investors-tell-us-the-story-behind-the-romanian-startup-boom/.

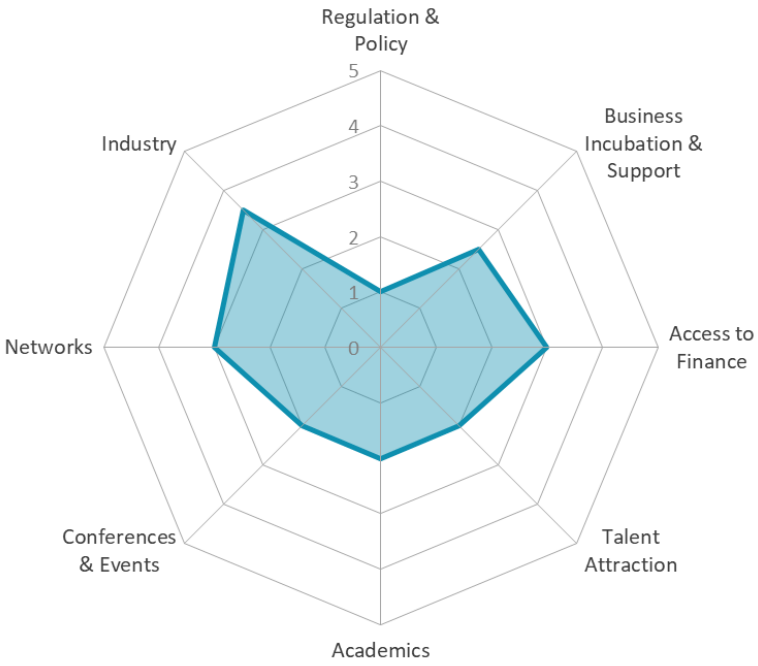
[26] Europea Space Agency, "Invitație: Eveniment de lansare ESA_Lab@UPB", https://www.esa.int/Space_in_Member_States/Romania/Invita_ie_Eveniment_de_lansare_ESA_Lab_UPB, retrieved 16 April 2021.

[27] NASA International Space Apps Challenge – Romania Bucharest, https://2020.spaceappschallenge.org/locations/bucharest/event?fbclid=IwAR02mQPBoMw0METBGu4Qpjab7pozxbu0YLOaS_3LAcU59bZXXKIon8KH3fA, retrieved 16 April 2021.

ecosystem in Romania will be to support specialised incubators and accelerators in providing relevant services to the start-ups, including events and business support programmes.

Even though the legislative and strategic frameworks for the development of the space sector are set and some major stakeholders are present in Romania, there are few areas that need special attention and improvement for the start-ups and companies to develop and grow. **The local independent initiatives that support space tech start-ups in getting investment ready** and that introduce the Romanian SMEs to the international investment arena **are sporadic and struggle with financing**. They are often one-off, project-driven and diminish after a couple of rounds or with the end of the governmental or EU project financial support. The access for companies to directories/databases of entrepreneurs, business angels, VC investor and support service providers (TTOs, incubators, accelerators) can be improved partly by adopting a more unified approach. Currently, such information is scattered in numerous local or external foreign sources and is difficult, to sum up, which hinders the connection and interaction between potential investors to companies and vice versa. There is more to improve in the direction of providing in-depth awareness on the horizontal nature of the space tech applications in various non-space industries. Local initiatives that bring together stakeholders from diverse sectors whose services and products are applicable to or can benefit from the space industry will intensify cross-sector interaction and will boost industrial cooperation or business partnerships.

Figure 16: Spider chart – assessment of space business location in Romania (Maturity Level by Key Drivers, 0-5 Scale)



There are almost no Technology Transfer Offices in Romania that serve space R&D, and the existing ones provide a narrow set of very basic promotional activities. The relation academia – business requires a more practical approach in science to technology transfer funding schemes and early-stage start-up support, especially from home-grown capital. The national initiatives, apart from attracting large international investment capital, should also foster the inclusion of local capital.

2.4 Slovenia – A strong academic sector drives space ventures forward

Slovenia can be seen as an exemplary country within CEE. **Its spending on research and development as a percentage of GDP is the highest in the bloc** and was able to **kickstart a burgeoning space ecosystem from scratch in less than 10 years**. Academic institutions have **strong research programmes of European relevance** through participation in ESA programmes and missions in several fields, such as astrophysics, remote sensing, and cubesat technologies. This includes participation in an M-class mission candidate, the Transient High-Energy Sky and Early Universe Surveyor (THESEUS) mission, in which the University of Maribor is involved. Other structural players are the Jožef Stefan Institute, the University of Ljubjana, and the Slovenian Academy of Science and Arts. When it comes to space, it is most universities that do the work of incubating spin-offs, and as such, form the core of Slovenia's nascent space ecosystems.

KEY TAKEAWAYS	
Summary of Best Practices	▪ Slovenia was able **to grow a relevant space ecosystem in less than 10 years**, initially by strongly partnering with international players and playing on the country's strengths (smallsats) ▪ Important academic sector in the space domain, sizeable scientific contributions to the ESA science programme despite being a small country ▪ Presence of a small but growing domestic industry for both space-related hardware and software ▪ A policy framework that encourages linking old industry with new industries, and tries to promote space to companies that do not have a direct relationship to space
Areas for improvement	▪ Existing accelerators could create branches specifically aimed at space start-ups (like Energy+ is the energy branch of ABC Accelerators) ▪ Several VC companies, **but reluctant to invest in the space sector** due to the high perceived risk ▪ Accelerators are prominent but their number and structural power is yet to be increased
Gap identification	▪ **No space activity from very large aerospace companies**, e.g. Airbus, Thales Alenia, or OHB, in Slovenia ▪ No specific space-related networks ▪ No dedicated space incubator to act as a catalyst for future space entrepreneurs

One such spin-off company is Skylabs d.o.o., a manufacturer of cubesats and subsystems founded in 2010. The company, a spin-off of the University of Maribor, was established at a time when there was no space industry in Slovenia. Through its participation in the European Student Moon Orbiter (ESMO), the University of Maribor was able to send their student to Guilford, UK, for training in the facilities of Surrey Satellite Technology Ltd. Skylabs was established as a "repository" for the gained knowledge, and are now starting to sell internationally. An example of a successful private space firm that did not come from an academic institution is Sinergise Ltd., a company offering GIS services. The downstream company is being described as a sort of role model due to their good profitability.

Overall, **the country is hampered by the fact no major space companies are operating in it**. Established players such as Airbus or Thales Alenia generate local, typically highly-specialised subcontractors, which can then grow larger, pursue other markets and customers.

Regarding start-ups in general, Slovenia's ecosystem really started taking off in the early 2010s, and there exist a few prominent business support structures for would-be entrepreneurs, such as ABC Accelerator, Katapult,

Tovarna Pdojemov, and the various university-related incubators (eg. Ljubjana University Incubator) and technology parks. Most of the Slovenian start-ups are in the field of IT. [28]

One of the weaknesses of the Slovenian space ecosystem is that there are **no formal networks for space start-ups** to attach to. This hinders their ability to learn about best practices, to look for customers, and ultimately, to grow. The main local network for start-ups is Start:up Slovenia, but its scope is very broad and, while it does organise events, it acts more as a repository of start-ups rather than a real support structure. It might be considered that the **Centre of Excellence for Space Science and Technologies is a space-related network** of sorts, but its sights are set on academia and established players, and has yet to support start-ups or connect them.

Figure 17: Ecosystem chart for Slovenia

Concomitant to the lack of space-related networks, there is also a **lack of space-related events** in Slovenia. Space entrepreneurs thus scout large international events, such as ESA conferences or *the Aeronautics & Space Innovative Technology Summit* in Bremen, to find clients. There is a difficulty in bringing companies to meet in Slovenia for business purposes, and thus, current efforts must remain outward-looking.

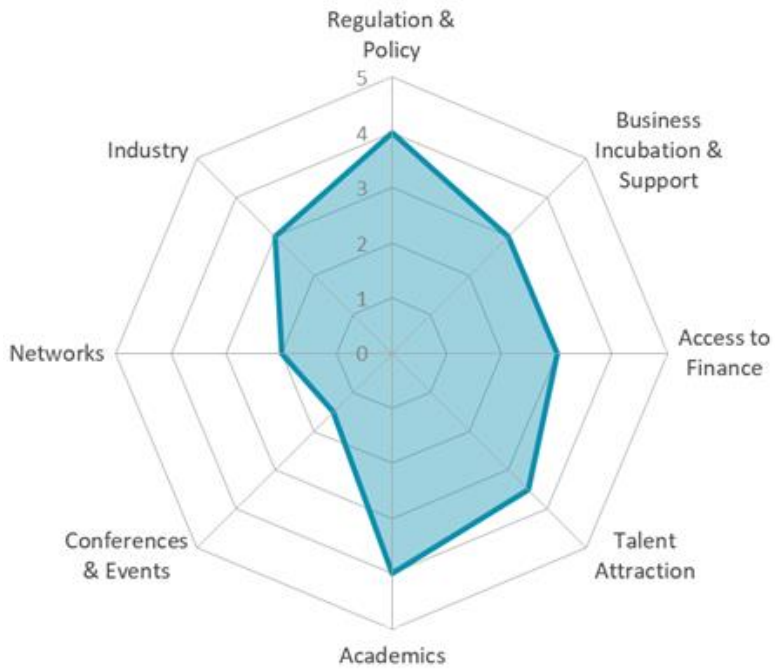
At a governmental level, **the importance of space has been acknowledged** and is understood as an important contributor to growth and high-tech development, and as a way to contribute to the fight against climate change. While Slovenia does not have a national space office, the Ministry of Economics has an active and dedicated team working on space-related issues. Efforts go mostly in the direction of integrating the Slovenian space ecosystem within the European one through scientific collaborations and supporting involvement in ESA projects. Slovenia is an ESA associate member state since 2016. Domains of interest for Slovenia are Earth Observation, human exploration support (e.g. astronaut training facilities) and space technology. Regarding start-up, the focus is on smallsats and downstream applications. Regarding entrepreneurship more generally, the Slovenian government has advantageous procedures for foreign

[28] Startup Europe Central and Eastern Europe Network, Startup Europe Western Balkans Network, "The Ecosystem Portfolio", March 2019.

investors willing to fund local companies and supports the growth of start-ups through competitive awards and by funding networks such as Start:up Slovenia.

On the other hand, **access to finance remains difficult**. About 5% of capital invested into Slovenian start-ups come from Slovenian investors. [29]As everywhere in Europe, large banks are very reluctant to invest in space, and VC funds are sparse. Space entrepreneurs thus need to rely on European institutional money (e.g. ESA or Horizon 2020) for early funding, which is not a very well-suited format for start-ups. However, a stream of recent successful exits is slowly nudging the situation towards more VC availability. Examples of venture capital firms are Poslovni Angeli Slovenije, Fil Rouge Capital, South Central Venture, and Silicon Gardens.

Figure 18: Spider chart – assessment of space business location in Slovenia (Maturity Level by Key Drivers, 0-5 Scale)



Lastly, the situation with respect to talent attraction is ambiguous. There is **brain drain in Slovenia, but less so than elsewhere in Central and Southeastern Europe**. Skylabs d.o.o, for instance, even reports being able to bring back talent from elsewhere in Europe due to the interest their projects generate. This might be the exception rather than the rule, however, as the city of Maribor, where Skylabs operates, is geographically very close to Graz, Austria, one of the technology hotspots Slovenian students often target, making repatriation of talent easier. Some institutions have also not really tried to attract international talent, despite the existence of expat support and networking programmes. The Slovenian government has also introduced a start-up VISA scheme, and support structures exist to help expats integrate within the Slovenian administration.

[29] Startup Europe Central and Eastern Europe Network, Startup Europe Western Balkans Network, "The Ecosystem Portfolio", March 2019.

3 Identified challenges for space entrepreneur ecosystems

Tremendous progress has been done in CEE and SEE in the last ten years. Several countries have joined ESA and have opened space-focused incubators, nascent ecosystems have been created from scratch, several notable space start-ups have emerged.

In Slovenia, the success story of the nascent cube industry is rich in lessons on good practice. The country set itself an ambitious but yet reasonable goal to specialise itself in smallsats and downstream, rather than "emulate Airbus", and starting from a practically nonexistent pre-industrial base, it partnered with large international players to get involved in a small-scale ESA mission, and capitalised on it for the creation of Skylabs. Strong networks have appeared in Greece, which, coupled with a good scientific academic sector, paves the way for a successful space entrepreneurship ecosystem once other factors (such as brain drain) will have improved. While Croatia's space sector has not yet matured, the high-profile success of Rimac, an electric supercar manufacturer, shows that the conditions are there for technology start-ups to emerge.

In parallel to these successes, **a number of challenges common to most CEE and SEE countries were identified**. They are described in the following subsections.

3.1 Lack of space-related networks

Strong networks may be important for any technology field[30], but **the strongly international nature of space exploration** in Europe and to some extent the world makes them particularly central. The large amounts of investment linked to this activity, and the uncertain and long-term payback periods, make it necessary to have established international cooperation and development networks.

The aptly named "network effect" describes how larger networks tend to grow faster than smaller ones. And in this regard indeed, the countries of CEE/SEE are hampered by their small size and the very young age of their space ecosystems. There are often too few players in each country for sizeable and meaningful networks to emerge. Local space-focused incubators, accelerators or co-working spaces can be vital in these situations, as they allow access to a high-quality pan-European network of space expertise and funds. As it stands, **only a third of CEE/SEE countries have a space-focused incubator within their territory**.

3.2 Lack of funding for (space) research

Although pure science funding is not directly related to entrepreneurship, a strong and healthy academic sector does form the bedrock of an innovative society. **Academia is where knowledge is first created** and where the next transformative ideas will arise, and it is also the place where future innovators often have their first contact with technical fields and where they learn their first skills.

With a few exceptions, **spending on research and development in CEE/SEE is still very subpar compared to top innovators** such as South Korea or Israel and is significantly inferior to the EU27 average. While it is true each country is characterised by their standards of living and purchasing power, funding is ultimately the driver of research, and in case it is lacking, what ultimately limits its scope and reach; in order words, countries that spend a larger part of their GDP on research produce more impactful science. Within CEE/SEE, Greece is a bit of an exception to that rule, as the country is able to grab substantial parts of Horizon 2020 grants despite not spending a particularly stellar proportion of their GDP on research. That particularity has its limits though, as Greece's standing on the international scientific scene is still a lot smaller than, Switzerland, a country of similar population, or New Zealand, a country of similar GDP. The case of Slovenia is thus important to underline

[30] Startup Europe Western Balkans Network, "Policy Recommendations", March 2019.

here. It is a CEE/SEE country that invests a significant amount in research and development, and enjoys a strong academic sector that is well-connected internationally.

While all of this applied to science and technology in general, the relevance of *space* research, in particular, will follow the same curve, and governmental funding in CEE/SEE countries is undeniably lower than in Western Europe. For the upstream segment, public funding is even more crucial due to the overall higher time-to-maturity that heavy industry is characterised by.

3.3 Little presence of large aerospace companies

There are three major space companies in Europe, Airbus, Thales-Alenia, and more recently, OHB. Companies of that size are a **golden ticket to grow a space start-up ecosystem** for several reasons. First, these companies have extensive expertise in multiple domains, such as software, spaceworthy hardware, mechanical, thermal, electrical modelling, EMC compatibility, or chemistry, and are thus able to offer technical expertise to start-ups, often through the local space incubators mentioned above. Secondly, their huge **capitalisation allows them to invest considerable amounts without exposing themselves** too much. In that regard, Airbus is ahead of the other two, as attested, for instance, by their joint venture branch "Airbus Ventures". Additionally, the presence of one of these players acts as a fertiliser towards homegrown, specialised subcontractors, which may use their revenues from these big companies to grow and expand abroad. Lastly, companies with very **high visibility such as these act as a magnet for foreign talent**.

Some countries, such as Greece and Romania, enjoy the presence of one of these companies and can confirm the beneficial fall-out. However, their presence in the wide CEE/SEE region is overall limited compared to Western-European countries such as the UK.

3.4 Space is misunderstood

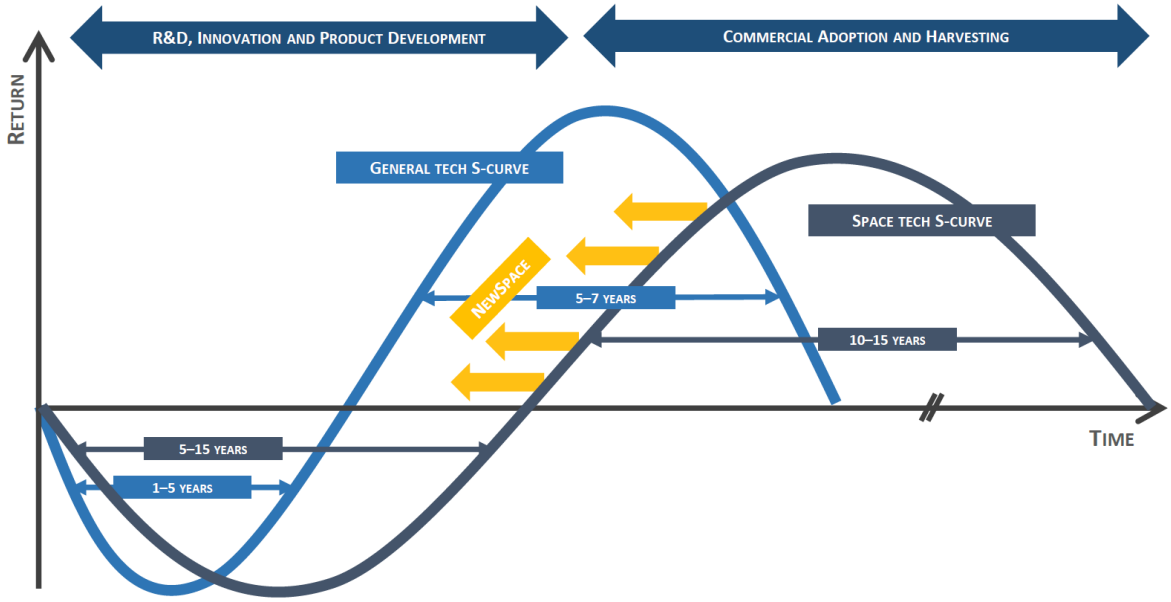
Space is traditionally a "strategic" sector, that is, a sector that is being supported not primarily because of expected return-on-investment, but for reasons pertaining to geopolitical power. As such, space is seen as the turf of larger and more militarised countries, such as the US, Russia, China, or France. People from smaller countries such as those of CEE/SEE, and in turn, the governments of these countries, may thus be under the impression that developing space assets is simply outside of their reach and hence not worth pursuing.

While it is undeniable that space does have such components – the prime example of strategic but non-profitable space activity is the development of launchers – there has been an evolution in the last 10 years towards smaller companies mounting simpler and more profit-oriented space-based ventures. This so-called "NewSpace" revolution offers the perfect opportunity for countries without a strong pre-existing industrial space sector to foster space start-ups. Indeed, a lot of the practical work these "downstream" space companies do is indistinguishable from writing software for any other technical field. **The inherent risk of downstream space start-up is thus not necessarily higher than in any other field**.

The main difference between space-related innovation and the general case is the typically longer development time and commercial adoption delays, as exemplified by the S-curve shown below. The NewSpace approach, however, is precisely to try to apply software development techniques to the space sector, and hence to make the space S-curve more akin to the general tech curve.

Additionally, there isn't yet a clear understanding of the practical advantages of a well-developed space economy. These range from the direct benefits of spatial data in the fields of agriculture, land management, city planning, or logistics and international trade, to the indirect effects spurring technological innovation in various other fields, such as sensors or solar panels technology. Hence, **the added value of the space-based economy is often misunderstood**, and the risk it carries, often miscalculated.

Figure 19: The space technology S-curve[31]



3.5 Private early-stage funding is lacking and large banks do not pick up

The USA model for fostering innovation is characterised by a survival-of-the-fittest mindset and has produced the internet giants that we do not need to name. Above all, this model requires a culture of acceptance of failure, and a high appetite for risk. To make major players emerge, one must take the risk of potentially funding worthless ideas (e.g. Theranos, Juicero). On the other hand, the Chinese model, technically also very successful, is based on massively supporting homegrown players, at the risk of disdaining international rules of trade, and also comes at a high human price.

As it stands, **Europe has not yet found its own model**. While Europe broadly supports the free-market approach, it does not share the failure culture, taste for high-risk-high-reward ideas, around a controversial discussion, the culture of inequality that is part of a survival of the fittest model. At the same time, while Europe tries to fill this gap with public funding, that is not nearly at the scale required to make European champions emerge the way other countries have done.

Thus, **a universal complaint from innovation actors** in CEE/SEE, and to some extent across the whole of Europe, **is that access to early-stage funding is too sparse**, especially when compared to what is available in the United States of America. When available, private investment does not exceed a few million up to series A, and companies are forced to seek money abroad for later rounds, carrying the risk of expatriating. As for large private banks, they may be important lenders in Europe, but their contribution to innovative start-ups remains marginal. While these effects are true for the start-ups' ecosystems of any field in Europe, it is particularly marked for space-related ventures, due to the higher perceived risk they carry. Start-ups have thus had to rely on institutional funding, such as ESA and Horizon 2020 grants, or EU cohesion funds.

[31] European Commission, European Investment Bank, " The future of the European space sector - How to leverage Europe's technological leadership and boost investments for space ventures", written by SpaceTec Partners, https://www.eib.org/attachments/thematic/future_of_european_space_sector_en.pdf

4 Recommendations to tackle the challenges at the CEE & SEE space ecosystem

On the basis of the items identified in the previous section as "challenges" for CEE and SEE, a few possible ways are proposed to meet them. These should be interpreted as suggestions to build upon and to tailor to each ecosystem's specificities. In this report, we have analysed the situation of Central-Eastern and Southeastern Europe with regards to space and space entrepreneurship through multiple angles. We have looked at the macroeconomic picture, at the position of CEE/SEE through various research, innovation, and entrepreneurship metrics and their standing on the European space scene. We have then looked at four countries, Croatia, Greece, Romania, and Slovenia, in much greater detail, by evaluating their specific space ecosystems according to a well-defined typology, and by engaging with the expertise of local innovation stakeholders. On the basis of that research, we have identified five major gaps that are common to most reviewed ecosystems, and have proposed five recommendations to address them.

We have also found the space ecosystems of CEE/SEE show a lot of promise. Encouraging examples have been encountered in the different countries that were more deeply investigated, and we see a lot of potential for the exchange of best practices within CEE/SEE and Europe as a whole.

Overall, these countries do suffer from their smaller GDP per capita to some extent, but they are characterised by fast growth and prosperity is rapidly rising. However, research budgets as a percent of GDP should be increased nonetheless for these countries to fully integrate into the wider European space effort. This is our most important recommendation, because of all the synergies it enables with other recommendations.

4.1 Strengthening space networks at all geographic scales

With the exception of Greece, most space ecosystems are rather small due to the fact interest in space ventures is rather recent. In small ecosystems, efforts must focus on increasing the visibility of existing networks, and embed them in the larger European picture so that any gap (e.g. technical capability) can be filled. In that regard, **local space-focused start-up incubators/accelerators are very powerful catalysts**. They are effectively able to connect local innovators to the wider European pool of experts and funders. For this reason, countries that do not yet have a support mechanism such as the ESA BIC are encouraged to start formal talks for establishing one.

A similar initiative by the European Commission is the establishment of EU space hubs, which aim at strengthening the space start-up ecosystems along all the dimensions mentioned earlier in this report (events, innovation intermediaries, etc.). Moreover, the space entrepreneurship's CASSINI initiative should be kept in the focus. With the aim of supporting European space-based businesses, and covering the full range of start-ups from seed to scale-ups, it is a powerful tool to combine and grasp its suite of activities.

Good networks and high-relevance conferences go hand-in-hand. For this reason, we also propose the establishment of a large space-focused industrial conference that would take place each year in a different capital, taking as a template both the Salon du Bourget and the EU Space Week. If well-utilised, such an event would provide a powerful one-shot boost to the local ecosystems by encouraging networking, exchanges of good practices and client-customer meetings.

4.2 Increase public funding for scientific research and space activities

Throughout this report, we have highlighted the importance of spending on space-related research and development activities, which is typically measured as a percentage of GDP. In that regard, the amounts that CEE/SEE countries can spend are mechanically hobbled by the relatively small GDPs. However, even at constant GDP, we have shown there is room for improvement.

A first objective would be for CEE/SEE countries to reach the **EU-mandated target for countries to spend 3% of their GDP on research and development**, all fields considered[32].

Regarding space specifically, we propose indicative space budgets for CEE/SEE countries in the table ?? below. Two paradigms are followed: the one of a "medium space power", such as Italy or Belgium, which each spend about 0.6‰ of their GDP on space activities, and that of a "great space power", France, which spends 1‰ of its GDP on space activities. These indicative budgets are also compared to the currently estimated budgets. The "medium space power" figure should be considered a very good but attainable target, while the "great space power" figure represents a sort of ideal scenario.

Following the "medium space power" paradigm, four countries would be spending more than EUR 100M a year on space activities, a sum that would doubtlessly allow them to develop their space industry based on their strengths, and would allow them to lead small ESA missions rather than simply contribute to them. Let us remark that the largest economy of CEE, Poland, would be spending half a billion euros a year in space activities under the great space power paradigm, a sum that could be transformative for both its software and heavy industries, and would give it the means to be at the forefront of space exploration in Europe.

Table 2: Current space budgets of CEE/SEE compared to what they would be under a "medium space power" paradigm and a "great space power" paradigm

Country	Current space spending (est.), EUR	Medium space power: spending at 0.6‰ of GDP (eg. Belgium, Italy), EUR	Great space power: Spending at 1‰ of GDP (eg. France), EUR
Bulgaria	8,574,000	36,744,000	61,240,000
Czechia	48,780,000	134,376,000	223,961,000
Estonia	5,070,000	16,867,000	28,112,000
Greece	42,730,000	110,048,000	183,413,000
Croatia	8,820,000	32,546,000	54,244,000
Latvia	700,000	18,278,000	30,463,000
Lithuania	7,840,000	29,278,000	48,797,000
Hungary	18,460,000	87,560,000	145,933,000
Poland	53,700,000	319,442,000	531,403,000
Romania	47,810,000	133,963,000	48,392,000
Slovenia	8,350,000	29 036 000	48,392,000
Slovakia	16,520,000	56,319,000	93,865,000

[32] Eurostat, "R & D Expenditure", https://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure, Retrieved 16 April 2021.

Of course, spending on space activities, and on research and development more generally, does not happen in a vacuum. It needs to serve an ambitious and clearly defined programme, the attributions of the funds must be done in full transparency, and there needs to be an existing scientific and industrial base to make use of these funds and transform it into tangible achievements. Alternatively, increasing one's contribution to ESA and benefiting from the subsequent georeturn is another way to achieve a stronger space ecosystem. In that sense, **the recommendation to increase space R&D funding is highly synergistic with the recommendation to encourage major European space actors to invest in CEE/SEE**, which is the subject of the next subsection.

4.3 Encouraging major European space companies to invest in CEE & SEE

The benefits of having large-cap space companies operate in a given country cannot be overstated. In addition to providing added value, expertise, international talent and opportunities for funding, their presence facilitates the implementation of other recommendations in this report.

The chief mechanism through which these large corporations will invest locally is **to increase space funding and the country's ESA contribution, in order to get the investment back as geo-return**. This recommendation is therefore highly synergistic with recommendation 4.2.

Additionally, CEE/SEE countries have several advantaged they could play on. These countries have a lower cost of labour compared to Western Europe, for both heavy industry (manufacturing) and third-sector activities such as software. In the case of the former, the disruption of the just-in-time supply chain from Brexit could also represent opportunities for CEE/SEE to recapture activity from the UK. Universities in CEE/SEE countries are producing a **highly qualified workforce in the scientific and technical fields**, which often reluctantly leaves the country in search of better opportunities, so attracting space companies with large visibility could also slow brain drain down.

In doing so, CEE/SEE countries should emphasise the **niche fields** in which they excel, such as software, simulation tools, or smallsat systems.

4.4 Space to be a central element in every modern economy

Despite boasting astonishing successes in solar system exploration (e.g. Hyugens, Mars Express, Rosetta), astrophysics (e.g., Herschel, Gaia, Planck), navigation (Galileo) or Earth Observation (Sentinel), **European space activities remain out of the spotlight when it comes to public outreach about space**. In parallel, while human spaceflight is a lot less interesting domain of space in terms of scientific research, it attracts the bulk of the mediatic attention, contributing to the picture amongst many European citizens that the US, Russia, and more recently China, are the sole relevant actors in space. Even in the Viennese Natural History Museum, the totality of the space exhibits is centred on NASA achievements. This skewed perception contributes to the fact space start-ups are viewed with incredulity in many European countries, that the risk they carry is too high, that the right technical capabilities for their maturation are simply not available; in a word, that the development of successful space start-ups can only happen in the US.

A first step to correct this misunderstanding would be to start unapologetically **publicise European space activities in Europe**, in the form of exhibitions at museums, documentaries, and even in mass media, and to highlight the role CEE/SEE countries can play within these endeavours. If the general population has a better understanding of the cutting edge space technology developed in Europe, this sentiment will "trickle up" to entrepreneurs, innovation actors, VC funds managers, and ultimately the government. Along with highlighting the technical prowesses of a given space mission, the message also needs to include **the chain of high-added value SMEs** that contribute to the conception, construction, testing, and operation, and that CEE/SEE too can be part of that, and the tangible benefits space assets bring on Earth.

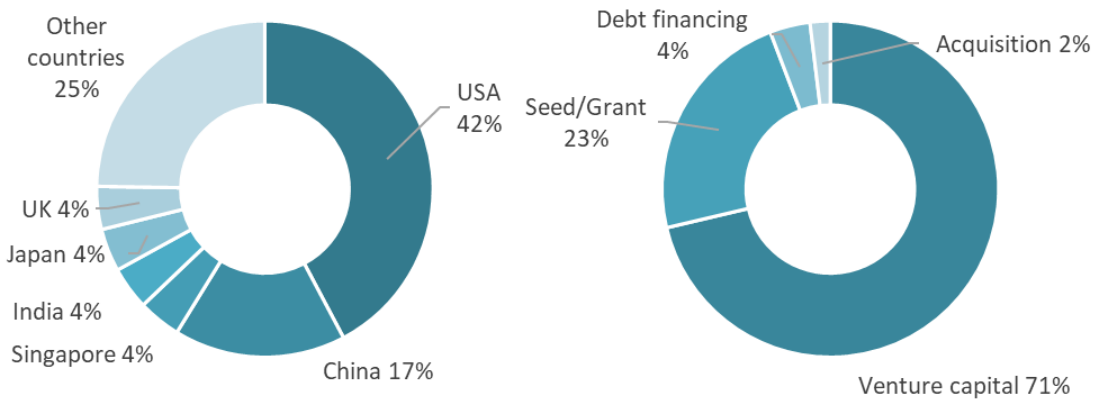
In addition to making the Europan institutional space mission more visible, the successes (e.g. funding rounds, IPOs) of space start-ups must also be better highlighted, contributing to the message that space generates a substantial return on investment. Examples may include wider **European start-ups**, such as France's ThrustMe and Germany's Mynaric, but should focus whenever possible on **local players** such as Slovenia's Synergise.

4.5 Leveraging private funding

Private funding remains vastly favoured over institutional grants as a vehicle for start-up funding. Public funding in the form of grants is considered ill-adapted to space startups, with the main qualm entrepreneurs have with them is the fact applications demand a lot of work.[33]

Private funding has a particular structure within the space sector. In terms of geographical distribution, there is a predominance of American investment, which is growing steadily, to almost USD 5 billion in 2019. The European investment reached 0.5 B EUR in the same year. The number of deals is very limited, standing at approximately 135 in 2019 globally for a total of 5.7 B USD. In regards to the funding structure, it is primarily VC, which has also been multiplying its share in the funding mix recently.

Figure 20: Private investments in space ventures in 2019[34]



Countries should thus incentivise the development of VC capital, through mechanisms such as **special tax regimes** or **risk-sharing**. Mechanisms such as the Belgian Tax Shelter scheme, which allows any tax-payer to make a tax-deductible investment into a start-up or a scale-up could be considered as an example[35]. Risk-sharing might come in the form of co-investing with private actors, or in the form of an "anchor tenant" model, where a public administration becomes the main client of the service offered by the start-up in its early days, to guarantee a certain level of pick-up of the service.

Additionally, they should be encouraged to invest in space start-ups more enthusiastically, a goal that will be achieved synergistically with recommendation 4.3. Institutional actors are invited to support the growth of start-ups in ways other than grants, such as, for instance, covering the cost of the first launch for upstream start-ups. This also ensures these launch contracts do not go to foreign players.

[33] European Commission, European Investment Bank, " The future of the European space sector - How to leverage Europe's technological leadership and boost investments for space ventures" (SpaceTec Partners) https://www.eib.org/attachments/thematic/future_of_european_space_sector_en.pdf

[34] SpaceTec Partners Analysis, Bryce

[35] Sperds SA, "Startup Tax Shelter Belgium", https://startuptaxshelter.be/en/, Retrieved 19 April 2021.

5 Annex: Methodology to assess entrepreneurial ecosystems

In this annex we present the details of the methodology according to which the ecosystems of the countries presented in Section 2 were evaluated.

In addition to the three countries in which InnORBIT pilot projects will take place, Croatia, Greece and Romania, we analysed an additional ecosystem, Slovenia, bringing the total number of mapped ecosystems to 4. To complement and confirm the results of our own analyses, a total of 20 stakeholder interviews were conducted.

5.1 Mapping of the ecosystem

The approach relied on desk research and expert interviews. Experts from a variety of backgrounds were selected and included start-up founders, CEOs of venture capital firms, policy officers, and head of university departments. The panels of each country included stakeholders that were familiar and non-familiar with space matters, in order to probe how space entrepreneurship is viewed in a larger economic context.

5.2 Maturity assessment of local space entrepreneurship

Eight dimensions were probed during these ecosystem assessments, which are described in the typology shown in table 3. From there, the performance of the ecosystem is quantitatively assessed on a 1-5 scale for each dimension. These quantitative evaluations are reported on the "spider charts" of each investigated country. A description of these five levels is given in the level matrix shown in table 4. Note that the dimensions of the level matrix, and hence the spider charts and related discussion, are slightly different from those of the typology so as to have a more natural flow of text in the deep dives.

Table 3: Typology for the assessment of ecosystems

Component	Description	Examples in CEE/SEE
Networks	Committees, clusters, industry association, etc. These can be networks of governments, public agencies, industry or users.	▪ HUP
Access to finance	Venture capital, business angel networks, start-up competitions involving cash prizes, public funding mechanisms that have a space application focus, such as grants, prizes, pre-commercial procurement, PPP, etc. This includes funding guides and informational workshop on access to finance.	▪ Eurobank
Academics	Prominent research centres, university departments, or professors who can influence the research agenda, draw in international talent, and in the case of space, win contracts for major spacecraft instrumentation proposals or data analysis.	▪ National Observatory of Athens
Accelerators	Presence of for-profit companies offering high-paced time-limited support (coworking space, business & legal advice, connection with investors), typically in exchange for equity in the company.	▪ Ok!Thess ▪ Techcelerator
Incubators	Presence of (typically non-profit) well-connected associations which help entrepreneurs define a minimum viable product, provide them with initial guidance, help them make a financial plan, and provide them with opportunities for networking with investors.	▪ ESA BICs

Business support	Organisations disseminating information about opportunities and support programmes for start-ups.	▪ Startarium
Conferences and Events	Physical or virtual events with the main objective to network, share information on own activities (commercial activities, use cases, general outreach of research projects and best practices) and do business development. Typical examples would be trade shows, sales conferences, and other industry-driven events. It could a non-technical side event of a larger conference.	▪ Start-up Island
Industry	Local space hardware or space software company with important European/international activities.	▪ Planetek Hellas

Table 4: Level chart for the assessment of ecosystems

Initiative type	Level 1 Beginner	Level 2 First Traction	Level 3 Active Engagement	Level 4 Advanced Progress	Level 5 Full Swing
Regulation and policy	Burdensome administrative procedures for companies, little or no government support for space-related initiatives.	First proposals for measures or better regulation to support the space ecosystems being formulated at a governmental level. Awareness of the importance of the sector.	Presence of some regulations that aid the formation of new firms and growth of innovation such as competitive grants and subsidies schemes, reduced tax rates for small firms, etc. Space policy or strategy does not exist as such, but strategic measures for the sector are formulated in a relevant regulation.	Simplified business regulations and tax policies for young firms. A specific space strategy is being formulated with attention to space entrepreneurship.	A high ease of doing business. Special advantageous regimes for space companies, high institutional support for space activities overall. A strong space policy or strategy is regularly developed with a clearly linked workplan of actionable measures with a strong focus on space entrepreneurship.
Business incubation and support	Lack of training or support initiatives that support the development of start-ups or SME's.	Pilot initiatives to support start-ups and SMEs. Some incubators/accelerators exist but not yet well-known and well-connected.	Private and public initiatives that offer premises and/or support to entrepreneurs of technology companies. Generic incubation or accelerator programmes.	On top of generic programmes, space-focused accelerators emerge. Growing landscape of space-focused entrepreneurial education programmes.	Several private and public training and educational opportunities with a focus on space and technology that instil entrepreneurship skills; mentoring and coaching programmes to help new entrepreneurs; premises for young companies. Accelerator or/or incubators with space as one of its themes.
Access to finance	Absence of local financing opportunities private or otherwise.	First public or private initiatives to provide access to finance to start-ups.	Access to dedicated private or government financing solutions for technology-related start-ups and SME's.	A growing number of financing opportunities from different actors.	Ample provision of both private and government financing opportunities, including both debt and equity finance for space-related start-ups and SME's.

Talent attraction	Insufficient remunerations and career advancement opportunities, unwelcoming work culture towards newcomers, strong hierarchical structures. Sub-standard quality of life (for OECD standards). The situation of the brain drain.	Strengthening of transparency in job opportunities. Signs of cultural shifts towards more openness. Increasing remunerations. First programmes to help worker relocation and settling.	Easy identification of various job opportunities, financial incentives that attract new workers and businesses and a community that facilitates the transition into a new environment and aids in settling in.	A growing number of companies competing for talent, fostering a healthy environment for international workers.	Excellent remunerations and quality of life can be expected, healthy competition between companies to attract talent. Sophisticated recruiting models and easy job identification. Environments that promote inclusivity and embrace diversity.
Academics	Absence of public institutions with a focus on space research or development or programmes that foster entrepreneurial development.	First space-focused research centres or university departments. First top-level grants being won, but they do not yet play a structuring role locally.	Public institutions that fund local research activities in various branches of science. Institutions that support and coordinate activities to raise awareness for research and educate the public on scientific progress.	Increased interconnectedness between the different emergent space research-intensive clusters. Strengthening of entrepreneurial education programmes.	Several public institutions engaging in space research and development and working with related technologies. Educational programmes for all levels and external training programmes that foster digital competencies and encourage entrepreneurial skill development.
Conferences and events	Generic business events with no dedicated focus on technology, space or related applications	First small-scale events focused on technology and entrepreneurship.	ICT and technology events with high visibility and high-profile speakers, however no dedicated focus on space or related applications	First visible space-focused events, possibly as a side-event to a bigger, high-profile tech conference.	Several dedicated events in the space industry, with high attendance numbers (real and virtual), high profile speakers and firms. Ease of collaboration and networking between attendees.
Networks	General support networks for start-ups and SME's. No particular focus on technology or related applications.	First pilot programmes to build networks for technology-focused start-ups.	Several support networks for start-ups and SME's with a focus on technology and innovation.	First initiatives for dedicated space-related networks.	Several public and private dedicated support networks for start-ups and SME's focused specifically on space-related industries and technologies.
Industry	Presence of some sizeable companies in the technology or manufacturing sector (e.g. software, cryogenics, engineering) but no space-related activity whatsoever.	First important dedicated space company emerges, often as a regional branch of a larger foreign company. Usually a downstream segment company, but not necessarily.	The emergence of at least one prominent indigenous company, which is able to carry out complex space-related activities on behalf of its national space agency, and act as a rally point for the first space start-ups (burgeoning ecosystem).	National champions gain international recognition and first contracts from ESA. The increased recognition activates a virtuous circle bringing in investment and talent.	Presence of a developed ecosystem of dedicated space companies, with one or several large players having an international presence, and specialised space SME's and start-ups. Players active in all three segments (upstream, midstream, downstream)