UNIVERSITA' DEGLI STUDI DI PADOVA

DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI
"M. FANNO"

CORSO DI LAUREA MAGISTRALE IN
ENTREPRENEURSHIP AND INNOVATION

TESI DI LAUREA

"Measuring and mapping the European space economy"

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MATRICOLA N. 2080419

ANNO ACCADEMICO 2023 – 2024

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Abstract

This thesis analyzes the European space economy, focusing on industry dimensions and supportive national and supranational policies. It begins by examining the European aerospace scenario, with specific attention to Germany, France, and Italy, highlighting the role of the European Space Agency and the emergence of the New Space economy. The second part explores the upstream and downstream segments of the industry, identifying opportunities and limitations for entrepreneurs seeking entry into these markets.

The final part provides an in-depth analysis of the Italian aerospace industry, emphasizing investments outlined by the NRRP under the agreement between the Italian Space Agency and the European Union. This analysis is crucial in the context of the COVID-19 pandemic, which has significantly impacted industries globally, including aerospace. It reviews Italy's complete space supply chain and the regional districts dedicated to aerospace activities, examining their composition and the products and services they offer.

A key focus is the performance of companies within the AIR (Aerospace Innovation and Research) network. The thesis assesses their Relative Comparative Advantage (RCA) scores to understand how these scores correlate with company performance. Additionally, it examines the skill and task family associated with these companies, highlighting the specialized workforce and the range of tasks essential for maintaining competitiveness. The RCA score helps evaluate the global competitiveness of these companies, revealing how well they have adapted and thrived in the challenging post-pandemic environment.

This comprehensive analysis underscores the resilience and strategic positioning of the Italian aerospace sector within the broader European context, illustrating its capacity to maintain a robust presence in the global aerospace market.

1. The European Space Economy

The Organisation for Economic Cooperation and Development (OECD), in the *OECD Handbook on Measuring the space economy* (1st Edition 2012 - Page 20), defines the Space Economy as "*the full range of activities and the use of resources that create and provide value and benefits to human being in the course of exploring, understanding, managing and utilising space*".

It has not to be circumscribed only to the space dimension, but its applications can be extended to a wide range of fields as agriculture, industry, tourism and others.

The *OECD Handbook on Measuring the space economy* identified the main sectors of application of space activities in order to have a better measurement of the whole industry:

1. **Satellite communications:** Related to send signals to Earth for fixed/mobile telecommunications services (voice, data, multimedia, and Internet) and broadcasting (TV and radio services, video services, Internet content)
2. **Positioning, navigation and timing:** Navigation is used for air, maritime and land transport, or the localization of individuals and vehicles. It also provides a universal referential time and location standard for a number of systems.
3. **Earth Observation:** Use of satellites to measure and monitor Earth and related parameters such as climate, environment and people.
4. **Space transportation:** Related to launching services, government and commercial spaceports and logistics services.
5. **Space exploration:** Meaning exploration of the universe beyond Earth atmosphere (Moon, solar system planets and asteroids). This sector encompasses the activities done by the International Space Station (ISS) and astronauts-related ones.
6. **Science:** A wide range of scientific activities related to numerous areas of interest related to space flight or any phenomena dealing with space, and its planets (e.g. planetary science, astrophysics, space debris tracking) and space-relate earth science.
7. **Space technologies:** Encompassing every space system technologies used during space mission, such as space nuclear system, solar electric propulsion, etc.
8. **Generic technologies or components that may enable space capabilities:** Those technologies whose primary application is directly related to an application in space sector but may be used in developing new space products or services.

In the global space economy, satellite services represent the largest sector (over one-third of the whole industry) as stated in the report *The future of the European space sector* by the European Investment Bank (2019 – Page 7). Earth Observation still represent the biggest user of the satellite manufacturing and launch services.

Both space hardware and applications have been employed outside the boundaries of the same area of interest, especially with the continuous fall of satellite manufacturing and launch vehicles costs.

The spillover effect between industry sectors has been an omnidirectional innovation driver for multiple segments and relative sub-segments. Advancements in science and technologies led to disruptive innovations, creating a market with different value proposition.

Space became an innovation enabler for various industry, as shown in Figure 1, where different space projects such as Copernicus and Galileo have found employment for diverse space-related applications as GPS and agriculture.

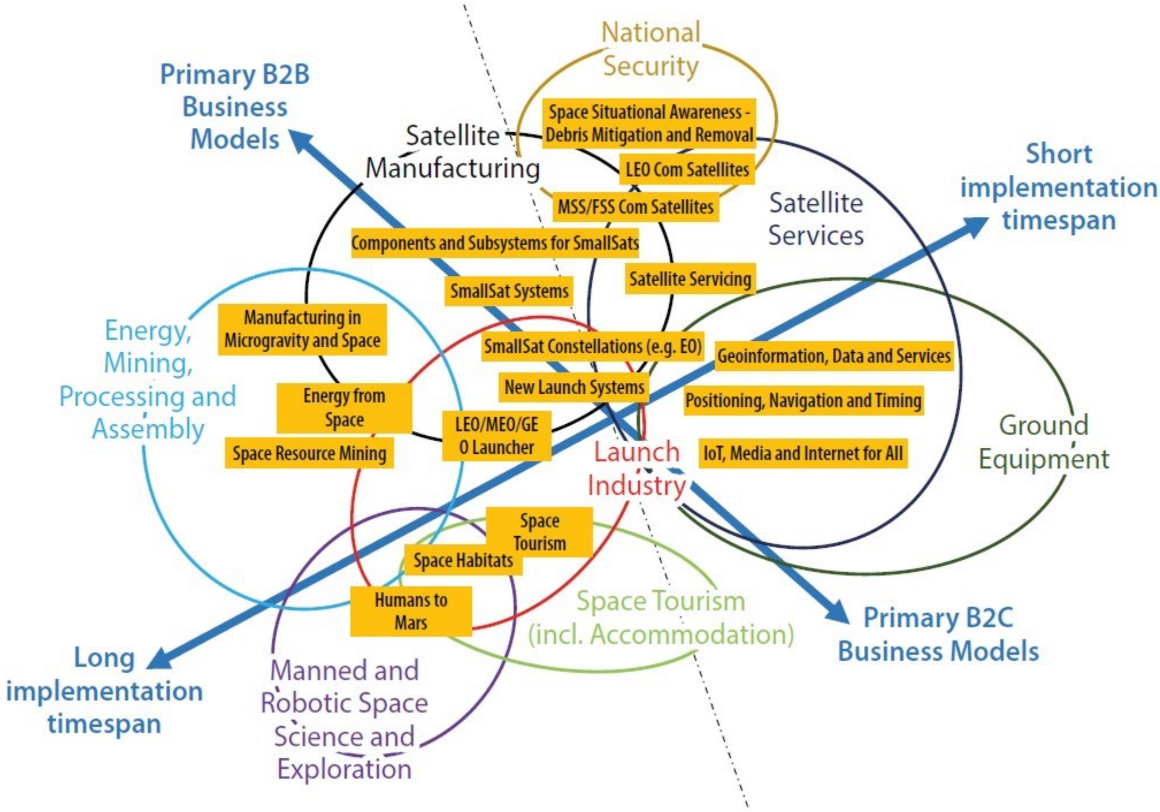


Figure 1: Interlinkages of industry sectors, The Future of European sector – 2019 (Page 8 - Alessandro de Concini, Jaroslav Toth)

In the last 15 years, "*New space*" enterprises have introduced groundbreaking new services in space launch, manufacturing and operations, as well as in specialized areas such as Earth observation and satellite communications. This has been accomplished through significant strides in data processing and computing; consequently, reducing the cost of accessing space and broadening the scope of space applications led to a scenario where new entrants are able to come in filled with interest for the region. In this respect, there has been a great reduction on the cost of getting into space while expanding its range or reach due to advancements made related to data processing and computing. As a result, it has allowed many other players to join in as well as it generated more interest for what happens within that atmosphere.

The term “new space” first appeared in the early 2000s to distinguish between the contemporary breed of commercial activities and entities that were emerging from those already established in the industry. *Old space* was often linked with defense firms or aerospace firms that had long term relationships with government agencies on major projects whereby they relied on government procurement but also received great R&D support.

Within the area of the European Union, there are the three main leading economies: Germany, France and Italy which contribute in financial and research terms to empower the European Space Agency. The latter is considered as the gateway to space, its aims lie on the support and development of EU member states’ space capabilities and consequently on maintaining the competitiveness of the European industry.

The ESA programmes, those falling into the mandatory category, are financed by all member states proportionally to their Gross National Product (GNP).

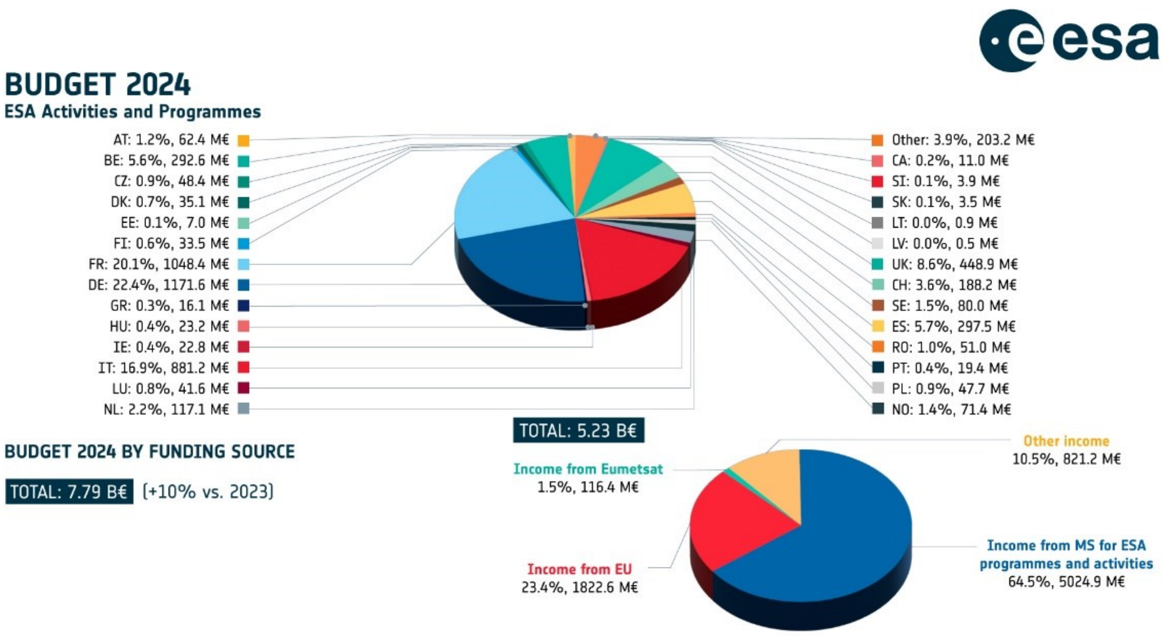


Figure 2: European Space Agency, Budget chart - 2024

As showed in the Figure 2, Germany is the leading contributor to the ESA programmes with 1.17 billion of Euros followed by France (1.04B€) and Italy (881.2 M€). The three aforementioned countries finance almost the 60% (rounded) of ESA total annual budget, translated in numerical terms 3.101,2 billion of euros.

National governments play a pivotal role in industry segments such as space manufacturing and launch, as funders and procurers of R&D, products and services. In some OECD countries, sales to government customers account for a large share of revenues

However, private actors and venture capitalists have started to play a bigger role in recent years.

The *Annual Eurospace Report* by Eurospace (2022 – Page 23) *provides* the main segments of the European Space industry showing how the *Institutional Europe* segment generates twice the level of sales as the *Commercial and Exports* segment, as shown in Figure 3.

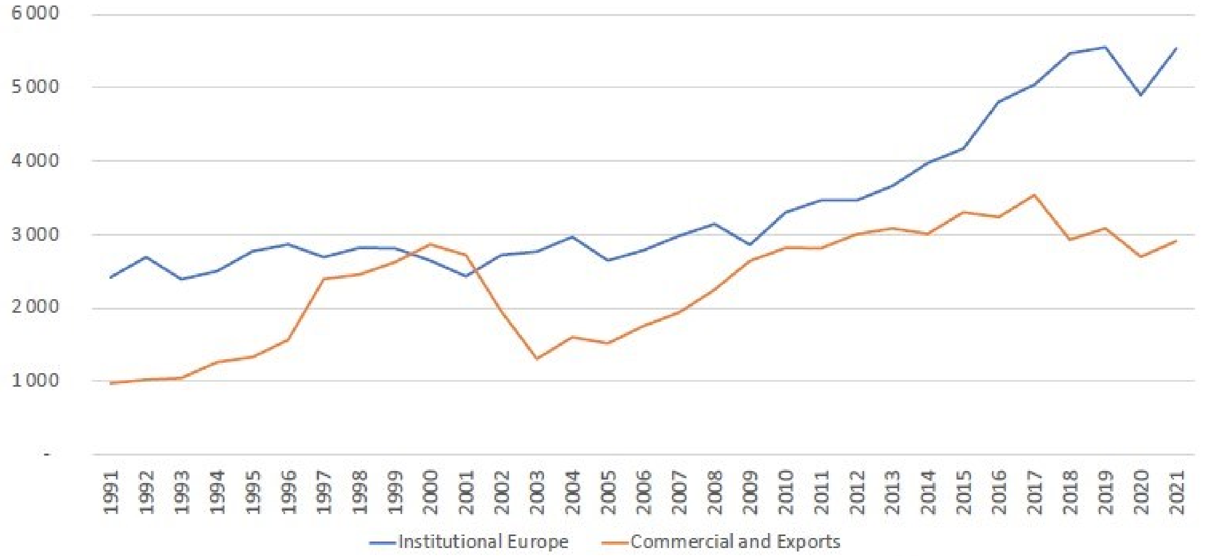


Figure 3: European space industry sales by main customer segment, Eurospace Annual Release (2022)

Herein, it shows how the COVID-19 pandemic constrained the European space industry growth in terms of sales. In the next figure (4) the same happened for the allocation of the national space budget where, in the period 2015-2022, analysed in the OECD countries in *The Space Economy in figures* (2023), a similar trend is represented, a comparison against the dollar currency (here for logistics reason, only charts regarding Germany, France and Italy are displayed).

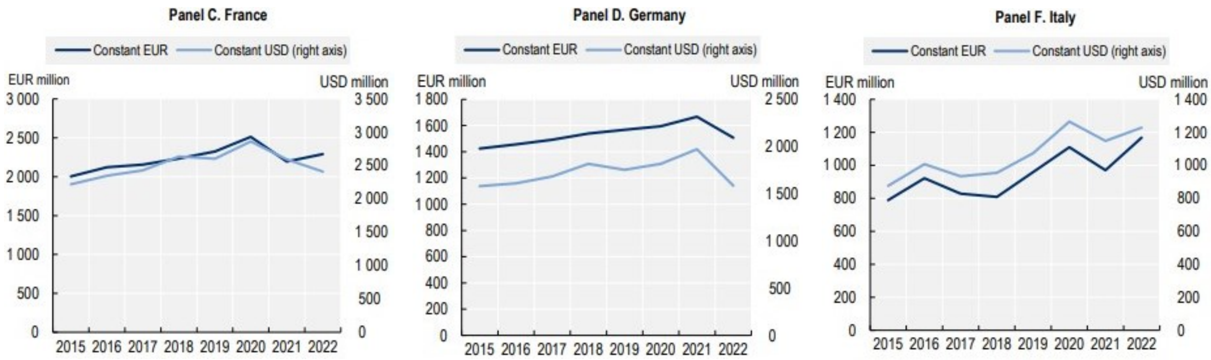


Figure 4: Evolution in selected government space budgets, OECD (2023)

If from one side, the whole space sector suffered the impact of the pandemic event in economic terms, on the other side *"During the COVID-19 crisis, space manufacturers and agencies have actively contributed to the response efforts, by producing medical equipment, providing storage and processing capabilities for modelling and other research needs and studying impacts. Space actors have also provided high-speed connectivity to remote locations as well as earth observation imagery for industry intelligence and monitoring of remotely located infrastructure."* as it is stated in the report *The impact of COVID-19 on the space industry* provided by the OECD (2020 – Page 2).

This assessment illustrates the essential role of space-based technologies, such as low-Earth orbit satellites, in enabling rapid and effective responses by institutions in situations where such solutions were previously unavailable.

Global challenges, such as war and climate change, whose consequences affect the European Union and the rest of the world periodically, have highlighted the maturity of space systems in terms of performance. In supporting a variety of key infrastructures and activities, space framework is very crucial.

It acts as an important factor in the functioning of energy and finance infrastructural systems by providing reliable communication and data transmission. Other than that, it also ensures public safety through emergency response and disaster management. Moreover, it plays a major role in air traffic management systems which are part of transportation at large. Additionally, within food supply sector, space infrastructure contributes through various applications like weather monitoring and crop management.

Number of countries per designated sector

Sector	Number of countries designating sector as critical	It is supported by space technologies	Includes space activities	Is fully space-related
Transportation	32	√		
ICT	32		√	
Energy	32	√		
Finance	24	√		
Health	24			
Water	23			
Food supply	17	√		
Government	16	√		
Chemical industry	15			
Public safety	15	√		
Dams and flood defence	15			
Law enforcement	10	√		
Nuclear sector	10			
Critical manufacturing	7		√	
Defence industry	7		√	
Space sector[1]	4			√
Other	19			

Table 1: Number of countries per designated sector, OECD (2022)

Furthermore, the report *A new landscape for space applications: Illustrations from Russia's war of aggression against Ukraine* conducted by Marit Undseth and Claire Jolly among the OECD countries (on the behalf of the organization itself) highlights the criticality of the space sector under certain kind of circumstances, even when its involvements and applications may not be so explicit to the community.

The convergence of countries in defining the space sector as critical surely stems from the fact that many activities falling under the so-called space activities (which at first might seem to fall outside this sector) have been defined by the organization itself as *critical*.

The OECD is incrementally ascribing the terminology "critical infrastructure" to an increasing number of space activities; this is happening thanks to the *Recommendation on Digital Security of Critical Activities* adopted by the OECD council in 2019, which defines (Page - 6) *critical activities* as:

"*Economic and social activities the interruption or disruption of which would have serious consequences on:*

9. *The health, safety, and security of citizens;*
10. *The effective functioning of services essential to the economy and society, and of the government;*
11. *Economic and social prosperity more broadly*

Critical activities are identified on the basis of a national risk assessment."

The most important countries within the OECD that have defined the space sector as "critical" are Belgium, France, Spain and United Kingdom. Even more countries are including space activities in other industry sectors (e.g. satellite telecommunications included in the *Information and Communication Technology* or space manufacturing in critical manufacturing and defence industry.

The deliver of this *Recommendation* (2019 – Page 4) is aligned with what is mentioned above related to the impact space activities and space-based had during the pandemic years. Indeed, the document provided by the OECD council states:

"*The COVID-19 crisis highlighted our dependence on certain critical activities, as well as the growing digitalization of their operators, which increases their exposure to digital security risk. For instance, many hospitals have been the target of digital security attacks such as Distributed Denial-of-Service (DDoS) or ransomware. In fact, the pandemic has been a stress test for the digital security risk management practices of many of our critical infrastructures. This Recommendation provides governments with timely guidance on strengthening the digital security of such critical activities, without undermining the benefits of digital transformation*."

In light of the recent global events, especially the ongoing Russia-Ukraine conflict, the space sector is once more confronted with a very complex geopolitical landscape. In other words, this conflict has demonstrated that there are many sovereign interests and security concerns in the space field thus affecting trade flows.

The global space supply chain is deeply integrated into Russo-Ukrainian conflict because both countries play an important role in this industry. They are notable commercial and manufacturing partners for U.S.A and European Union (EU) members.

For example, Atlas V and Antares which are American launchers widely relied on Russian engines while their first stage rockets are made by Ukraine showing how tightly they are linked to the given political issues.

Moreover, European space also became a victim of this war where Ukrainian engines were incorporated into Vega upper part. Also, since 2011 when it started launching satellites for Copernicus and Galileo programs, European Space Agency depends on Russian Soyuz launcher as well indicating far reaching consequences of Russia-Ukraine crisis on global space.

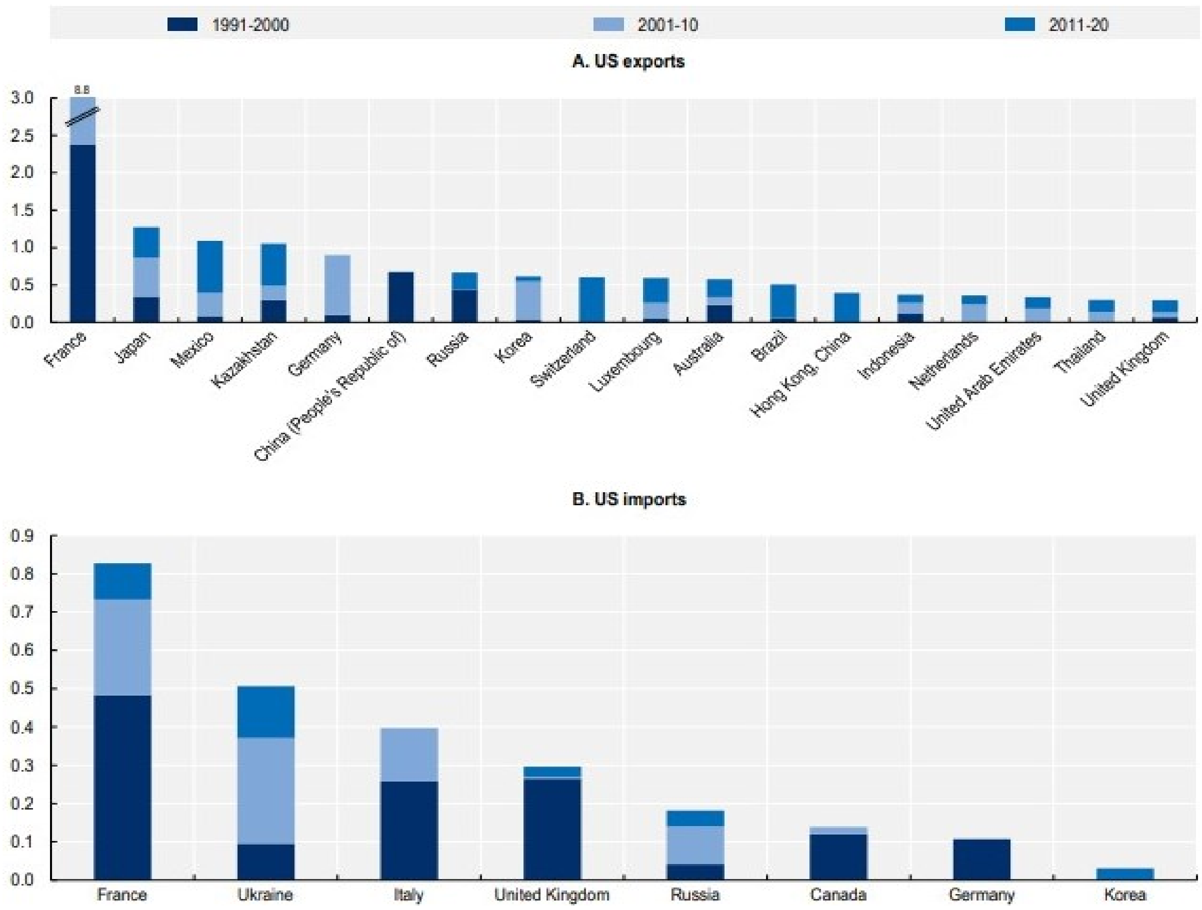


Figure 5: Actual trade in space manufacturing (components and subsystems excluded), "Harmonised System 1988", International Trade by Commodity Statistics (database) **2022**

Additionally, the Russian-operated Baikonur spaceport in Kazakhstan is frequently used for international commercial launches and was the only gateway to space for OECD partners of the International Space Station (Canada, European Space Agency, Japan and the United States).

According to the data collected (in USD billion) in the report *A new landscape for space applications* by OECD in 2022, Ukraine and Russia (and Kazakhstan) have been important trade partners of the United States and other OECD countries for spacecraft, satellites and launch vehicles over the last three decades.

The launch date of the first-ever European Mars rover Rosalind Franklin, which was initially planned to be carried out by a Russian rocket from Baikonur in September 2022, is currently uncertain. Additionally, ESA has decided to terminate its collaboration with Russia on planned robotic moon missions. The European Space Agency (ESA) is currently seeking additional funding from its member states for an upcoming launch, as well as for the replacement of the Russian landing platform. The next potential launch date has been proposed as 2028.

Other events such as the COVID-19 pandemic has also revealed significant vulnerabilities for smaller and younger firms in handling long-term economic shocks.
As many companies in the space sector appear to be managing well, there are increasing concerns about the potential long-term impacts of the crisis on government budgets and customers demand, such as inflation and scarcity of human resources.

In Europe, associations representing space manufacturing industries (Eurospace) and remote sensing companies (European Association of Remote Sensing Companies – EARSC) track

Class	No. Employees
OMC	1
Micro1	2-5
Micro2	6-10
Small	11-50
Medium	51-250
Large	>250

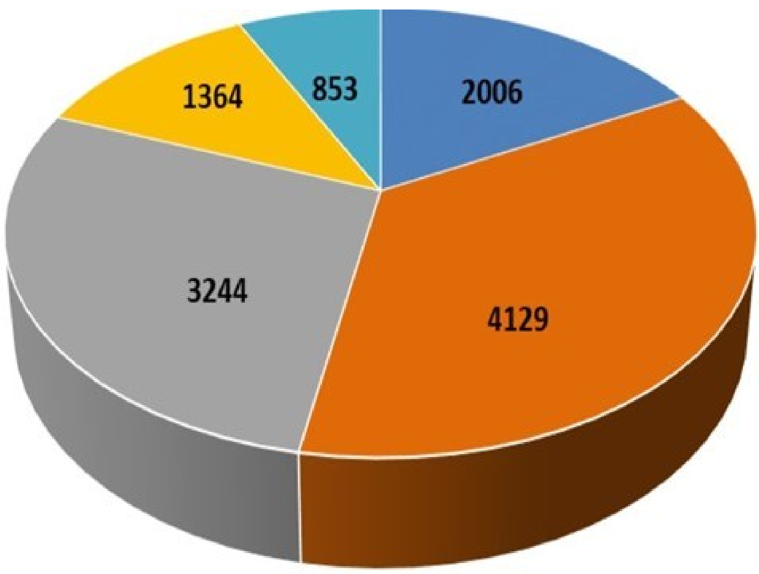


Figure 6: Breakdown of Employees per Company Class, EARSC (2021)

SMEs among their respective members. EARSC found through an industry survey that in 2020 some 96-97% of European earth observation companies had less than 250 employees.

Some industry experts anticipate potential funding reductions in future institutional programs. Given the high barriers to entry in the sector, there is a risk that the ongoing series of economic crises could result in the reduction of smaller and younger firms that are important sources of innovation, employment, and economic growth.

The ESA objective is to strengthen the European industry and R&D initiatives in order to make countries quicker in their ability to respond to future needs with the full exploitation of space resources.

Such strengthening of the space exploitation employs numerous initiatives boasted by the European space Agency (ESA) and the European Union Agency for the Space Programme (EUSPA) in order to support European and (occasionally) international companies.

European Union holds to be true Space as a key priority which would allow a strategic independence for the European countries in an ever-changing world destabilized by war and oscillations of the markets, first of all the power market.

The enablers such as ESA and EUSPA aim to obtain a shortening in the development cycle of space-based technologies, which, according to the report *The Future of European space sector* written by the Innovation Finance Advisory in collaboration with the European Investment Advisory Hub (part of European Investment Bank), are way longer than the general tech one.

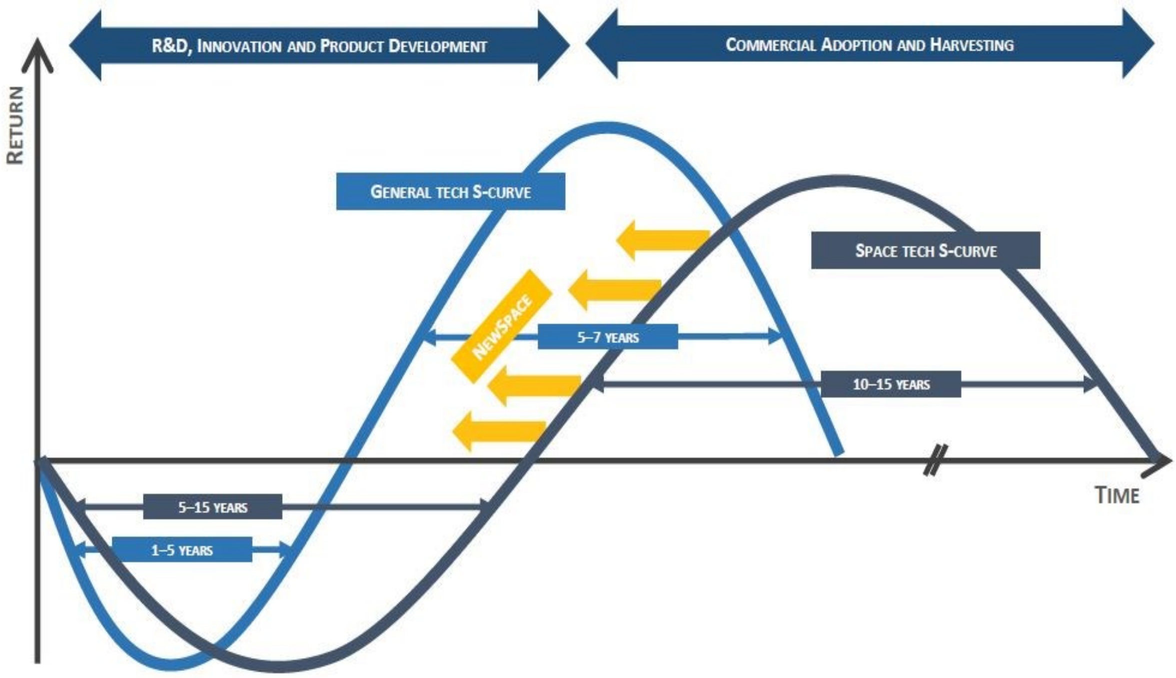


Figure 7: Comparison of Development cycles, Innovation Finance Advisory (2019)

As shown in Figure 7, there is a meaningful gap in the two development cycles. Herein is taken as example the ICT sector where the development time span for B2B and B2C software startups is 1-5 years, then when the curve gets upwards slope, meaning return starts being positive, the time interval ranges from 5 up to 7 years (commercialization phase).

Whereas the curve of the space technologies development cycle shows that the research and development phase get a time interval of at least 5 years, with extreme case where it may last up to 15 years. In this timeframe (so-called *valley of death*), the associated risks may hinder startups in the way they should reinvent themselves, in chasing market trends, or face incumbent firms or new startups. Additionally, the subsequent commercialisation and harvesting phase encounters difficulties in adopting the innovative technology. The time interval span from 10 years up to 15 years, ultimately results in a minimum of 30 years for the entire process.

The phenomenon of NewSpace startups is trying to disrupt the development processes in the *traditional* space economy. Early-stage NewSpace startups may create a left-shift of the curve, in shortening the time interval of R&D and Commercialisation phases, this may happen in selling to larger NewSpace companies which differ from long-time established companies. The latter belong to a slower and traditional way of acquiring, while the new synergies creating between this new category of firms may create a win-win situation for the Space sector, where NewSpace startups sell quicker their services or products or may found investors easily; example of this synergy is the cooperation between OneWeb and Airbus who created a joint venture in the satellite manufacturing process (Figure 8).

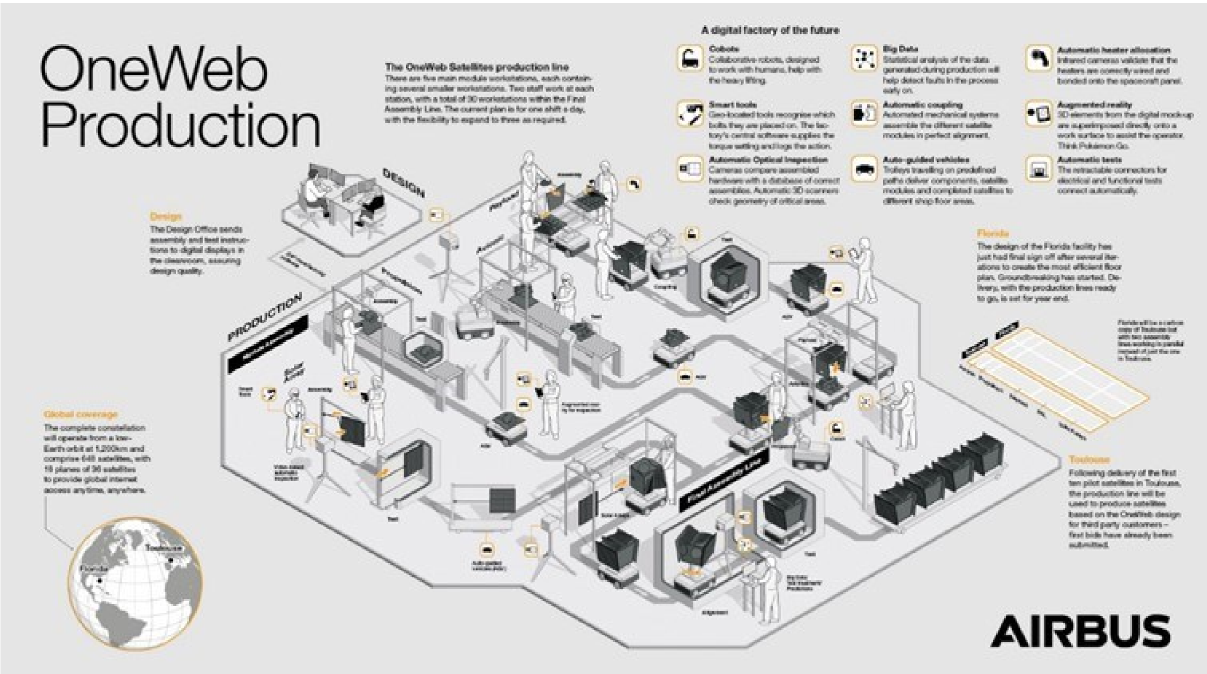


Figure 8: OneWeb and Airbus manufacturing process

In summary, the national governments should increase grants, loans, and tax breaks, as well as access to finance and know-how for small businesses. SMEs are key drivers of innovation and economic growth in European economy. Moreover, such firms are usually the backbone of this sector, size notwithstanding, creating innovative technologies and highly skilled jobs.

Nevertheless, they are also very sensitive to global events such as war and epidemics that can disrupt supply chains, reduce demand, and threat their economic development. Governments can assist in realizing their full potential through investing in these firms, thereby benefiting the whole European economy in the future.

The upcoming paragraphs offer two distinct perspectives on the space economy in Germany and France. The first will delve into a detailed examination of the structural elements of the German aerospace industry, including insights into internationalization processes and potential challenges. The second approach will provide a comprehensive overview of the French industry, with a specific focus on the two primary space hubs in the country, as well as the government's support for this sector through a unique taxation regime for innovative firms operating within the industry.

1.1 Germany’s space industry framework

Germany is the main actor in the EU space sector, its dominant position is due to the strong synergies existing in the country, between public and private actors. The country hosts the European Organisation for the Exploitation of Meteorological Satellites and the European Southern Observatory, as well as the European Space Agency’s Space Operations Centre.

In the report *The Space Economy in Figures: Responding to Global Challenges* by OECD (2023), there is a section containing data (with contributions to ESA and Eumetsat) about Germany’s space sector.

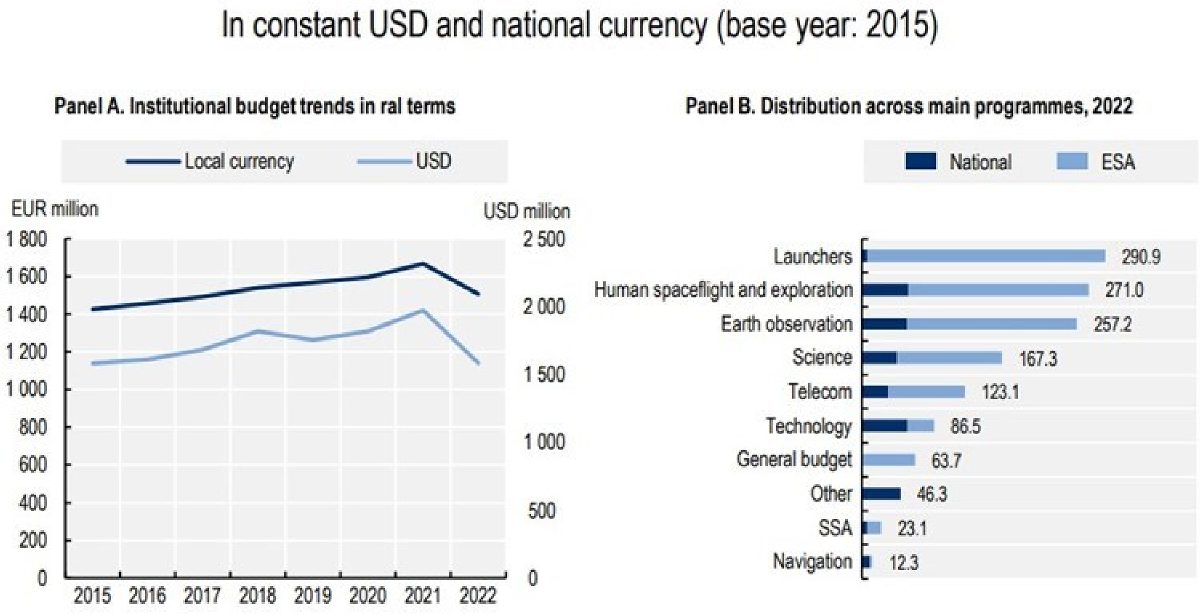


Figure 9: Germany: Space budget trends, OECD (2023)

The latest data available own by the OECD states the following considerations:

1. In 2022, Germany allocated a total of EUR 1,749.2 million for the space sector, with a steady annual growth of 0.8% since 2015
2. Approximately the 58% of the institutional space budget has been addressed to the European space agency to support its activities, with an additional 5% dedicated to Eumetsat
3. The remaining budget was allocated for national space initiatives and smaller international programs
4. The institutional space budget accounted for 0.045% of the German gross domestic product in 2022, remarking its weight in the national economy

More data are provided by the *German Aerospace Industry Association* (BDLI) thanks to its publication *German Aerospace Industry Figures 2022*, where it is declared how the employment level in the space segment decreased from 9300 units (2021) down to 9000 units, but on the other hand sales had a small increase during the year from to €2.6 billion from the €2.4

billion in 2021. The changes have been attributed to the upcoming transition from Ariane 5 to the new Ariane 6 launch vehicle.

Additionally, in the publication (Page 2) is reported the following statement:

"[..] *space travel is regarded as a key critical infrastructure as well. Following the successful ministerial-level ESA council meeting at the end of 2022, the task now is to implement the planned European satellite constellation IRIS and ensure Europe's autonomous access to space on a permanent basis. Germany must be able to retain its role as an attractive partner in European and international programs. This requires increasing the space travel budget in the National Program for Space and Innovation to an initial €500 million per year, to continue enabling technical program developments in the field."*

The above assessment confirms the necessity in investing money in space programs, in its crucial role in making possible a faster developments and advancements in the German aerospace industry, implying a concrete and future-oriented strategy for the space segment.

In occurrence to this, the German Federal Government already published its space strategy in a report *Making Germany's space sector fit for the future* back in 2010, were the primary focus of future actions regarding the space sector dealt with the following macro-areas with pursuing numerous objectives:

1. **Expanding strategic space expertise:**
    - Germany will further expand its already first-rate capabilities in Earth observation, supporting future technologies
    - In satellite communication, Germany will extend its systems capability with regard to the building of geostationary communication satellites and will drive forward strategic satellite technologies.
    - In satellite navigation, Germany will maintain its lead role in Europe's Galileo navigation system and develop the necessary innovative navigation applications and procedures aimed at ensuring that the highest security requirements can be met
    - Particular attention must be paid to establishing a competitive industry in downstream growth markets.
2. **Establishing a unified legal framework:**
    - The Federal Government will provide a comprehensive and dependable legal framework for private and commercial space activities

- Germany will seek to persuade the EU and its European partners to introduce similar rules at EU level and in other space faring EU partner countries in order to ensure a level competitive playing field.

3. **Sustainably reinforcing Germany's strong position in space research:**
   - Germany aims to reinforce and expand the strong position it has established at the European and international level in the fields of space exploration, the use of space for scientific purposes, and the study of the Earth system.
4. **Tapping new markets:**
   - Satellite-based services constitute a rapidly developing, dynamic field of business. Entirely new markets will be created in satellite-based Earth observation and navigation as well as through their links with integrated applications. This in turn creates the necessary conditions for the build-up of know-how and intellectual property
5. **Exploiting space for civil and military security purposes:**
   - Germany will make greater use of the potential for synergy between civil and military space research in the development of security-related technologies in the Earth observation and telecommunications sectors
6. **Shaping the distribution of roles in the European space sector:**
   - The Federal Government will call for a clear demarcation of roles based on the principles of subsidiarity and complementarity, avoiding duplicate activities and structures, and establishing the necessary funding and contract procedures to meet the specific requirements of the space sector.
   - Germany will continue to press for a strengthening of ESA as an independent intergovernmental organization
   - The Federal Government will continue to support measures to optimize the proportion of German representatives within all European bodies
7. **Defining the roles of Germany and Europe in exploration:**
   - A comprehensive assessment of ISS operations will be conducted in order to provide the basis for a decision on a possible follow-up system or on other options. This is due to the peaceful symbolism of the International Space Station in terms of international cooperation.
   - The development of autonomous systems, in particular robotic exploration within the Solar System, represents a priority for Germany. This is in line with the proven capabilities of its industry in the context of the European Union.

8. **Securing technological independence and access to space:**
    - Germany aims to ensure the most cost-effective possible access to space transportation systems, to maintain the international competitiveness of Ariane 5 and, in so doing, to ensure a high level of national added value.
    - Germany supports intensified efforts to develop critical hardware and components in Europe in order to avoid dependency on any single source

In 2023, The German Federal Government released its new *Space Strategy* where the first paragraph of the report (Page 5) states:

"*Since the publication of the Federal Government's last Space Strategy, in 2010, human perspectives on climate and space have changed profoundly. In the process, the importance of space programmes has grown enormously, and the requirements for such programmes have become much more ambitious. Space infrastructures now play key roles in many different areas, including the economy, climate action, research, innovation, transport, telecommunications, security and our daily lives*. […] *and the spectrum of space-based applications we now rely on is extremely diverse*."

The role Germany had in the European Space Cooperation with the European Institutions (ESA and EUMETSAT) and EU countries, above all, with the Ariane 5 program the arrival of the Ariane 6 and Vega C launch vehicles will guarantee autonomous and independent launch capabilities for the whole continent.

Since 2010, there has been a big increase in the amount of money that the Federal Government allocates to civil space programs, with budgetary funding rising by almost two-thirds. The German Aerospace Center (DLR) is critical in executing and utilizing this boost in funding.

In fact, some of the German Länder (states) have also begun to participate actively in space activities within the country, which shows an increasing involvement beyond the federal level. Other than a few large companies, over 400 Small and Medium Enterprises (SMEs) have actively participated within the German space sector thereby exhibiting a varied and vibrant environment.

In order for Germany's industry and researchers to develop vital technologies and abilities upon which competitiveness can be based both nationally as well as internationally in space markets' context, the National Programme for Space and Innovation played a significant role. By so doing, this program aims at supporting Germany's knowledge base for boosting its global status of being a leading player in space industry.

The Federal Government has identified nine key areas of activity that can enable it to turn these challenges into successes for German and European space activities.

1. **European and international cooperation** → The Federal Government will support joint projects, enhance participation in European space programs, and engage in international partnerships for space exploration and research
2. **Space as a growth market – high-tech and NewSpace** → Measures include promoting research and development in high-tech space technologies, supporting entrepreneurship in the space sector, and encouraging the growth of NewSpace ventures
3. **Climate change, resource protection and environmental protection** → The government will utilize satellite data for climate monitoring, resource management, and environmental protection efforts, contributing to sustainable development and disaster response
4. **Digitalization, data and downstream activities** → The Federal Government will promote the use of satellite data for various applications such as navigation, communication, agriculture, and urban planning, fostering partnerships with downstream sector companies
5. **Security, strategic options and global stability** → Strategies will be developed for safeguarding space assets, ensuring cybersecurity in space operations, and collaborating with defense and security entities to address emerging threats
6. **Sustainable, safe use of space** → The government will advocate for international agreements on space debris mitigation, traffic management, and celestial body exploration, supporting the development of a global geodetic reference frame for precise navigation
7. **Space research** → Support will be provided for space research missions, international collaborations for space science, and investment in research and development of critical space technologies. This support may involve funding for mission planning, spacecraft development, and data analysis to ensure the success of research efforts.
8. **International space exploration** → The Federal Government will support robotic and human space exploration missions, collaborate with international partners on space exploration projects, and advance space science research for exploration purposes

9. **Space activities in the context of recruiting and attracting talent** → Efforts will be made to strengthen strategic partnerships to attract talent, invest in education and training programs for space-related fields, and promote opportunities for career development in the space industry. The government will allocate resources to develop and support education and training programs tailored to space-related disciplines.

The aims for the various areas of activity within the Space Strategy will be achieved via measures and resources of the ministries involved with space activities.

For implementation of this Space Strategy, it will be necessary to expand coordination between the Federal Government and the Länder; between the Federal Government's various departments and between public and private entities within the policy area of space.

In the present strategy, these areas of activity are used as a basis for identifying and defining the strategic, political, socioeconomic and scientific goals of the Federal Government's space policy, for a target horizon of 2030.

The analysis will go through a top-bottom approach (from institutional side to industry small players), so starting from the public ones, among the government agencies (some of them already mentioned above), there are:

- DLR (Deutsches Zentrum für Luft- und Raumfahrt) – German Aerospace Center
- Federal Ministry of Education and Research (BMBF)
- German Aerospace Industry Association (BDLI)
- Federal Ministry for Economic Affairs and Climate Action (BMWK),
- Federal Foreign Office (AA),
- Federal Ministry of Defence (BMVg),
- Federal Ministry for Digital and Transport (BMDV),
- Federal Ministry of the Interior and Community (BMI)
- Federal Ministry of Education and Research (BMBF)

The private sector is made up of great space companies:

- Airbus Defence and Space
- OHB SE
- MT Aerospace AG
- IABG mbH

- Large group of small and medium- sized enterprises

In a study conducted by the *Supply Chain Excellence Initiative* (SCE) on behalf of the Federal Ministry for Economic Affairs and Energy, it has shown that Germany presents a detailed supply chain all over its area. The study engages the close cooperation between German aerospace associations, clusters, Federal government, the Lander and industry which results to be a crucial keystone for the German aerospace supplier landscape.

Idealized Tier-Structure using the structural engeneering example

Categorization of companies according to ideal requirements		Indicators
OEM	• Development and integration system aircraft	Type approval
TIER 1	• Development and production of technically complex (QSF-C) • Responsability for the complete system under aviation law • Delivery to OEM	QSF-B and C EASA 21J and G ISO 9100
TIER 2	• Production of assemblies/components (QSF-B) including process chain • Responsability for the production process under aviation law • Delivery to Tier 1	QSF-B EASA 21J or G ISO 9100
TIER 3	• Production of parts (QSF-A) • Little to no aviation responsability (extended workbench) • Delivery to Tier 2	QSF-A ISO 9001/9100
MULTI-TIER	• Materials, standard parts • Operating resources • Personnel service provider	

Table 2: German Supply chain structure, Supply Chain Excellence Initiative

The coverage of this joint project implies the industry supply chain breakdown in many sub-segments. Starting from the aircraft construction area (Structural components, engines, cabins and systems) to the ones regarding the production and development (testing, research, mechanical and plant engineering); concluding with the areas of maintenance, repair and overhaul.

Table 2 shows the pyramidal structure of the supply chain landscape, where the Original Equipment Manufacturer (OEM) represent the peak of the relationships between the suppliers.

The OEM is supplied by a Tier 1 supplier who deals with system manufacturing and in a cascading effect the Tier 2 suppliers deliver system components to Tier 1 and so, Tier 3 suppliers.

The legend of this scheme follows as:

- **OEM:** Companies entitled to manufacture a particular aircraft type.
- **Tier 1:** System manufacturers which develop and manufacture technically complex systems.
- **Tier 2:** Component manufacturers produce units to be installed by OEM or Tier 1 suppliers. They deal mainly with manufacturing processes, but they can deal with component development.
- **Tier 3:** Parts manufacturers produce items according to component manufactures' specifications and they are usually certified to aviation standards.
- **Multi-Tier:** They supply materials, norm parts or equipment along the entire supply chain as well as personnel services.

There is a widespread presence of suppliers, almost 2300 companies, throughout Germany, mainly in Northern German, Central and Eastern Germany, where are located metropolitan areas as Hamburg, Bremen, Hannover, Berlin and Dresden.

At the light of this data, the aerospace industry plays a meaningful role in the German industrial landscape.

The German aerospace supply chain is mainly small-medium enterprise oriented, the total amount of people involved in this sector counts 108,000 individuals with a revenue overall of €37.5 billion.

The feature of the SMEs' strong presence is justified by the fact that more than the half of the aerospace industry's companies generate a reported annual revenue of less than €10 million and they have less than 250 employees. The supply chain is marked by a very high specialisation among the Tier 1 and many small-medium enterprises.

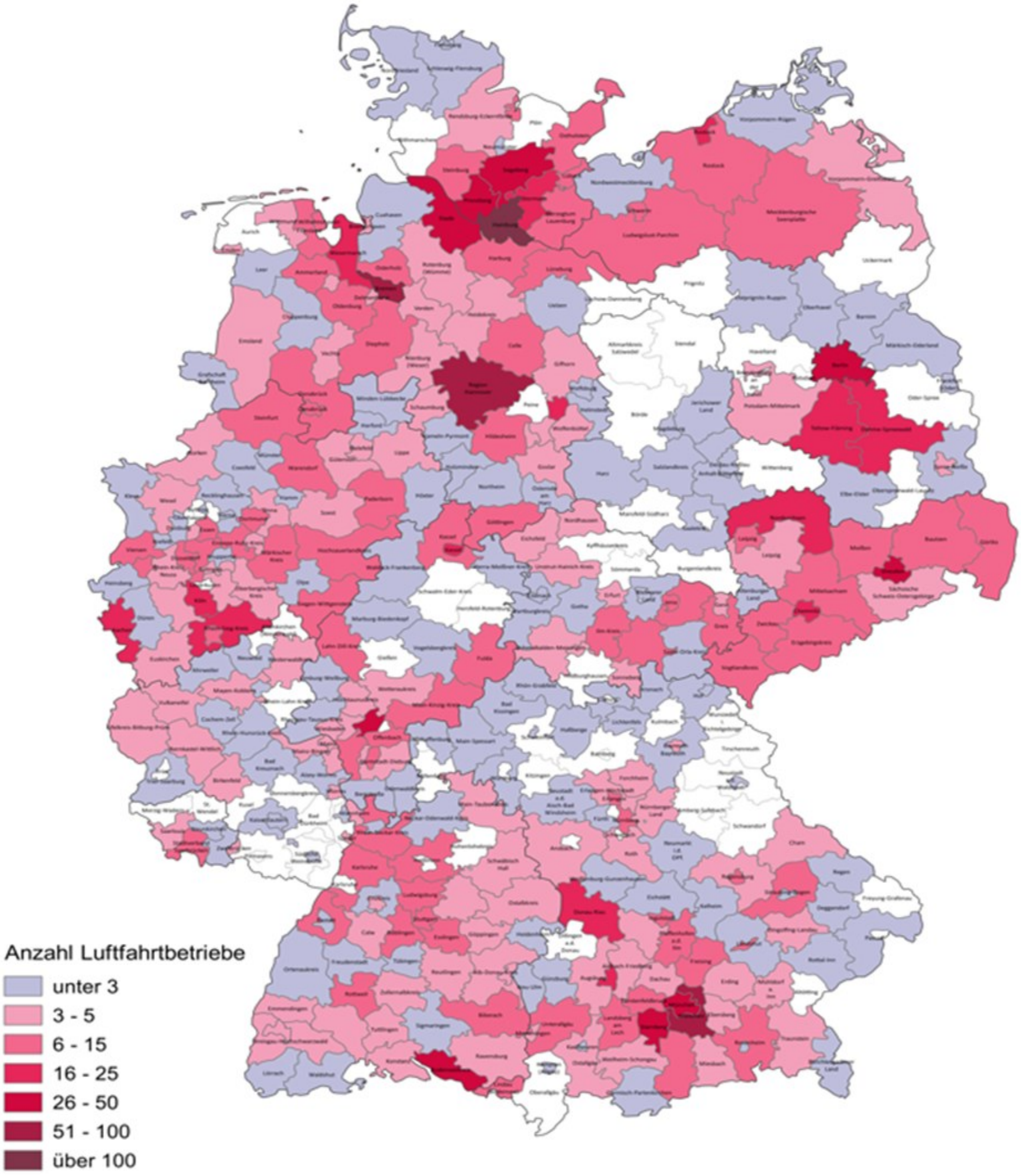


Figure 10: Distribution of suppliers in Germany, SCEI

The German suppliers are highly qualified in manufacturing, where the value chain spans from development to assembly capabilities, and on materials processing techniques. Materials and services competencies are part of the wide spectrum of capabilities lying in the German aerospace supplier industry.

Along the entire value chain, what has gained importance, for aerospace companies, in the last years are the areas related to certification and licensing in order to get a great position in the market. The absence of these factors can jeopardise the growth and stability of aerospace companies in the value chain. There is a plethora of certifications to which companies can apply to in order to acquire competitiveness in the market.

The structure itself of the value chain in the aerospace industry is not composed mainly of OEM or suppliers from Tier 1 level but rather by companies belonging to components and parts suppliers (Tier 2 and Tier 3), where the majority consists of SMEs.

The German aerospace industry, represented by the suppliers as a whole, has strong ties to Airbus, which is the most important customer for German suppliers, even if the trend is aiming to an internationalisation process. Recently, a lot of business activities are involving several manufacturers located outside the European Union (such as Boeing, Embraer and COMAC).

An additional element which features the aerospace sector is the cross-industry spillover in terms of innovation and technology, it spans from the civil aviation to the automotive industry. The German aerospace industry leads the market as one of the main drivers of technology.

Furthermore, the existing networks with other industries, which exploits the benefits of being linked to aerospace industry, enable the SMEs to develop a proper independence and robustness, and consequently avoid being dragged into economic downswings.

German suppliers' international opening is starting within the European borders, favouring Germany's position as the main sales market for many suppliers in this industry. The process is still in an embryonal phase because the internationalisation remains challenging for the most of the German suppliers' base, due to the huge efforts employed to be competitive and maintain a stable positioning in the markets.

The potential within internationalising the aerospace industry results to be paramount for the suppliers' growth. The latter has been threatened by the so-called best-cost-countries due to the challenges addressed to the traditional supply.

The leading position is kept thank to Germany's technological competitiveness, but the existing suppliers, in order to survive and scale up to a higher level, must be able to manage comprehensive projects together with the OEMs.

A factor affecting German companies' positioning in the international market is their widespread SME-structure. This can be mitigated by undertaking cooperation initiatives between the suppliers along the whole value chain.

The challenges that the German aerospace industry is facing require diverse actions on a large scale in order to adapt to the new competitors coming from the Asian countries, to resist to the pressure coming from the internationalisation process required to survive and to gain a position in the global market for the numerous SMEs present at the Tier 2 and Tier 3 of the German suppliers' value chain.

1.2 France's aerospace industry framework

The French aerospace industry represents the second European space economy.

Within this vast sector, the space economy holds a pivotal position, driving advancements in satellite technology, space exploration, and satellite-based services.

The main actors of the value chain, Airbus and Thales, are based in the "Aerospace Valley" in the Occitanie and the Nouvelle Aquitanie regions, in the southwest area of France, but in the recent years the Auvergne-Rhône-Alpes hub is arising in terms of importance for the entire industry.

In order to have a more comprehensive and clearer overview of the French space industry, a proper map of such sector is required.

Starting from the nation's leading space industry hub, the *Aerospace Valley* encompasses the Occitanie and Novuelle-Aquitanie in the southwest France. It is mainly located around the two major cities of the area, Toulouse and Bourdeaux, and boasts a complete ecosystem for aerospace endeavours.

Specifically, Toulouse is considered one of the most valuable centre of the European aerospace industry, due to the presence of the headquarters of some of the most significant actors such as Airbus, S.P.O.T. satellite system, ATR on the industrial side.

On the research field the city hosts the Toulouse Space Centre, a research and development centre of CNES (The National Centre of Space Studies), which is the largest national space in Europe.

The *Aerospace Valley*'s industrial leaders list includes:

- **Airbus Defence and Space**: a division of the bigger European powerhouse of Airbus Group which deals with satellite manufacturing, satellite services and space technologies along with its exploration. It has a wide technological portfolio encompassing telecommunications satellites, Earth observation systems, and space exploration missions.

- **Safran**: a major player in space propulsion technologies, specifically components for satellite propulsion systems and equipment.
- **Thales Alenia Space:** a joint venture between Thales Group (FRA) and Leonardo (ITA). It is a giant player in this industry, specialized in satellite manufacturing, telecommunication satellites, and scientific missions.

Additionally, the presence of the French National Centre for Space Studies' major facilities, in Toulouse, makes the hub a crucial player in conducting research, development, and industrial activities. All these elements continuously fuel innovation by providing a highly qualified workforce and groundbreaking technologies.

The French hub can rely on a strong and comprehensive a value chain, it can be staged as it follows:

- **Research & Development:** The widespread presence of such institutions stands as the forefront of the Aerospace Valley. The major centres located in the French southwest area are the CNES (Centre National d'Études Spatiales) and ONERA (Office National d'Études et de Recherches Aérospatiales). They lead the charge in fundamental research, technological innovation, and knowledge dissemination, providing a solid foundation for the region's aerospace sector.
- **Satellite Manufacturers:** The Defence and Space division of the Airbus group and the joint venture Thales Alenia Space fall within the category of companies which lead the French satellite manufacturing industry. Both the companies act as global leader in this field, their activities spectrum spans from the design and integration of complex aircraft to the test of telecommunication and earth observation system. Their strength is based on the expertise of numerous suppliers for specialized components and subsystem.
- **Suppliers:** These play a pivotal role along the entire value chain in the provision of specialized components, the most notable companies are:
  - **Safran:** A multinational aerospace and defence company known for its propulsion systems, avionics, and aerospace components is Safran. As one of the suppliers of propulsion system to satellite within the Aerospace Valley, Safran fills a vital role. Conversely, they enhance the reliability in terms of performance on platforms for satellites in Aerospace Valley because they deal with materials like composites as well as precision engineered parts among others**. (**https://www.safran-group.com/)

- **RUAG Space:** Top provider of aerospace components like structural elements, payload fairings and launch vehicle structures. For instance, RUAG Space has made crucial contributions in the area of satellite integration as well as launch operations within Aerospace Valley. As an example, their structure parts which include payload adapters and satellite bus structures are what facilitate the assembly and integration of satellites. These structures protect satellites during launch and ascent into orbit until they are safely deployed by RUAG Space’s payload fairings. Another instance is when RUAG Space’s competence in rocket fairings or interstage adapters improves the dependability as well as functionality of launch vehicles used by Aerospace Valley’s launch services providers. (https://www.ruag.com/en)
- **OHB system:** A European aerospace company which deals in satellite systems and payloads. OHB System is one of the suppliers of satellite platforms, components and subsystems for the satellite manufacturing in Aerospace Valley. The satellite platforms they have include small to medium-sized satellite buses that serve as building blocks for satellite missions across applications such as telecommunications, Earth observation, and scientific research. OHB System's components and subsystems provision, includes attitude control systems, power systems and thermal control solutions. Furthermore, the company's expertise on satellite payloads like imaging instruments or scientific payloads increases the capabilities of area-manufactured satellites. (https://www.ohb-system.fr/)

These suppliers in their provision of high qualified know-how and advanced technologies in the Aerospace Valley that enables the region to maintain its standing as a hub for aerospace excellence and innovation.

The second most important French hub is the ARA (Auvergne-Rhône-Alpes) hub, which it is considered to be within the next 5 years known as France’s second Aerospace Valley, thanks to the commitment of the local government and in creating the skilled workforce needed by the increasing demand in the industry.

The reason behind such statement is related to its importance for the French economy, considering that the Rhône-Alpes region generates €240 billion which makes it the second richest region in the country. It is considered one of the most important industrial districts in Europe for what concerns research, design and innovation. The region hosts a large number of suppliers belonging to Tier 1 (OEM) and Tier 2 level, as well as numerous Small-Medium enterprises, this is due to the recent agreement established with the aforementioned Dassault in the 2017.

As stated, in the *Global Business Report - Auvergne-Rhône-Alpes Aerospace* (2018 – Page 10), by the Vice President of Enterprise and Economic Development of the Region Auvergne-Rhône-Alpes, Annabel André-Laurent - "*The aeronautics sector has a strong presence in Auvergne-Rhône-Alpes with nearly 700 companies, including 350 specialist companies (equipment manufacturers and suppliers) bringing together nearly 30,000 direct jobs and representing €3.3 billion in sales*." and she adds: "*The presence of a rich technological and industrial landscape within the Auvergne-Rhône-Alpes Region enables us to compete as a global player and this is a hallmark which differentiates us from other French Regions. We have a unique capacity of regional industry manufacturers to supply all aeronautical materials and structural components*."

Considering the shorter lifespan compared to the Aerospace Valley hub's one, the ARA cluster encompasses a smaller but still well-defined value chain.

Figure 11: Map of the Auvergne-Rhône-Alpes, Global Business Report (2018)

The industrial leaders, nestled in the southeastern hub, remain the same: the joint venture of Thales Alenia Space (in Valence office) and the division of Airbus - Space and Defense.

Thanks to the report published by *Global Business Reports*, we can profile a value chain within the Auvergne-Rhône-Alpes hub, where are analysed the companies who are involved in the hub, in what they are specialized and what are their capabilities used along the value chain in the southern region.

Within the ARA's value chain, in the electronic parts production, there are some major players:

- **Michelin Aircraft Tires**: A leading global supplier of airplane tires, supplying these materials for multiple sectors such as Transportation Applications: Commercial and Regional Airlines, Military Aviation and General Aviation. (https://aircraft.michelin.com/)
- **Thales Alenia Space** (https://www.thalesaleniaspace.com/)
- **Secaero:** An aerospace company based in France, specializing in the design and manufacturing of structural components and systems for the aerospace industry. The company provides a range of products and services including precision machining, assembly, and integration of aerospace structures. Secaero's expertise encompasses a variety of materials, including metals and composites, and its solutions are utilized in various aerospace applications, including aircraft, satellites, and launch vehicles. As a key player in the aerospace supply chain, Secaero contributes to the advancement of aerospace technology and the success of aerospace projects worldwide.
- **Crouzet Aerospace:** Specialized in advanced engineering electromechanical components and systems focused on the aerospace market as well as military applications. Different types of items manufactured by Crouzet Aerospace include electrical actuator parts, solenoids, sensors, control units etc. It includes multiple areas such as fixed wing aircrafts (including combat aircraft), helicopters (civilian or military purpose), drones (used for defense purposes only) as well as space segment. (https://www.crouzet.com/)
- **SKF Aerospace**: An aerospace company that operates internationally in many countries. The organization is dedicated to supplying high-performance solutions for aerospace applications, especially bearings, seals, and lubrication systems. These products are applied in various aerospace applications including propulsion systems, moving planes and flight command systems. (https://www.skf.com/)

In the Design and Manufacturing activity, a division regarding sectors can be made between Landing systems area:

- **Teledyne**: A major player in the aerospace and defense sector, in the ARA hub, it deals with the building of landing systems. The company is specialized in subsystems and systems for aerospace and defense applications. Solutions provided by Teledyne are applied for a wide range of aerospace platforms, including commercial and military aircraft, satellites and space exploration missions. (https://www.teledyne.com/)

- **Zodiac Aerospace:** Engaged in the provision of systems and equipment for aerospace manufacturing companies which include a broad range of offerings aimed at different types of civilian aircraft like business, commercial and military planes. The company's product line consists of such things as cabin interiors, seating systems, galleys, lavatories and various airplane systems including oxygen systems, evacuation slides, and lighting systems.
- **Constellium:** Its major facility is the Issoire plant. The company's principal objective is the manufacture of high-performance aluminum alloys for a range of components across the aerospace and defence (ARA) value chain. The utilization of their products is directed towards the construction of fuselage and wing structures. (https://www.constellium.com/)
- **Safran landing systems:** Located in the Villeurbanne site, where are specialized in the aerospace wheels and brakes construction with the use of carbon-carbon composite.

In the field of servitization, many OEMs are adopting more digital and hyperconnected technologies into their manufacturing processes, globally dubbed 'Industry 4.0'. The use of digital technology in aircraft manufacturing is not new, at least when it comes to OEMs. Airbus' utilization of the complex Dassault Systems' 3D Experience software platform for the manufacturing of the A350 XWB series demonstrated the transformative potential that Industry 4.0 has for aircraft manufacturing, creating a single platform for design, simulation and manufacturing, where employees and suppliers can instantaneously collaborate with one another on digital simulations of the manufacturing process. Airbus' utilization of this software represented not only an adoption of Industry 4.0, but also one of its major pushes towards a consolidation of the aerospace supply chain.

One of the principal aims was to remedy a lack of communication that had previously plagued the aerospace supply chain that extended design time, included errors that drove up costs. This collaborative approach demonstrably provided positive results.

- **INOPROD:** An engineering consultant based in Auvergne-Rhône-Alpes that helps industrial companies to optimize their manufacturing processes and supply chain management (creating new manufacturing plants and/or optimizing existing plants). Thanks to this expertise they are able to create digital twins of manufacturing plants and calculate the interaction between all of the processes and resources within it. It contributes by helping small and medium companies in aerospace significantly increase their production capacity. (https://www.inoprod.com/)

The blossoming of aerospace clusters in France can be attributed, at least in part, to the Research Tax Credit Scheme (CIR - Crédit d'Impôt Recherche). The latter paved the way to spur innovations in all industrial areas (in this case, the aerospace one), indeed this measure grants a tax credit that businesses can offset against corporation taxes.

The Research Tax Credit Scheme includes several research expenditures:

- Depreciation of fixed assets: created or acquired new and used immediately for scientific and technical research operations.
- Personnel expenditure for researchers and research technicians: who are directly and exclusively involved in these operations.

The tax credit rate for**:**

- R&D expenditure is 30% of outlays up to €100 million per year, and 5% over this limit.
- Innovation expenditure is 20% of the eligible outlays up to a maximum of €400,000 per year.

The CIR available for companies of all sizes operating in France, across all sectors, and aerospace companies within the Auvergne-Rhône-Alpes region is investing heavily in research spending supported by the Research Tax Credit Scheme.

In particular, SMEs have found the scheme to be profitable and far more accessible than other sources of funding. Furthermore, it covers the education and training of a skilled workforce, as evidenced by the numerous companies in the region reporting a desire to take on more staff in the coming years as they expand their operations in the region. This creates a pressing need to create a workforce to meet this demand.

2. The rise of *astropreneurs*

Traditionally, entrepreneurs were individuals who possess a keen understanding of business who would raise capital, push expansion and sales, and oversee the day-to-day operations of a company.

A whole new category of people has been made possible by the Internet, digital communications, and lightning-fast technical advancements: those who employ innovation through entrepreneurship.

In the last two decades, the rise of the New Space economy paved the way for the phenomenon of a new entrepreneurial figure, the astropreneurs.

One of the most important citations of this term has been stated by Marion Blakey[1], during the hearing on the Commercial Space Transportation: Beyond the X Price, saying: "*There is a bold new group of people, astropreneurs, and their aim is to bring space flight into everyone's grasp*."

Through the affordances and platforms made possible by space technology, a new breed of space entrepreneurs known as astropreneurs is being given the chance to co-create the ecosystem.

The opportunities for astropreneurs varied according on whether the space technology application is meant for usage in space, on Earth, or as a "spin-off" to a different market. Furthermore, depending on the linked affordances, astropreneur groups' co-creation and the technology's malleability across markets shift.

By examining the ways in which the various spatial contexts and the technological affordances that go along with them provide new forms of co-creation and fluidity among the entrepreneurial community, astropreneurs are fundamentally reshaping the landscape of space exploration and innovation.

In the OECD in the report *Space and Innovation* (2016 – Page 10) is described the extremely innovative nature of the space sector as follows: "*When exploring technological trends and the potential of space innovation for the next decades, the space sector seems to be on the verge of starting a new cycle in its development. This cycle could be characterized by the ever-growing uses of satellite infrastructure outputs (signals, data) to meet societal challenges, like helping bridge the digital divide and contributing to mitigate climate change with global satellite monitoring*."

The *OECD Handbook on Measuring the Space Economy* defines three space segments setting up the perimeters of space activities (reported same definitions to avoid misleading interpretations), products and services as follows:

1. The Upstream segment includes:

- Fundamental and applied research activities conducted at higher education institutions, public research organizations, and private and non-profit research organizations
- Ancillary services such as finance, insurance and legal services and consultancies

[1] Marion Blakey - Administrator, Federal Aviation Administration (2002-2007).

- Scientific and engineering support including the provision of research and development services, engineering services such as design and testing and similar activities
- Supply of materials and components for space and ground systems, including both passive parts (cables, connectors, relays, etc.) and active parts (e.g. diodes, transistors, semiconductors)
- Design and manufacture of space equipment and subsystems such as electronic and mechanic equipment and software for space and ground systems, as well as systems for spacecraft guidance, propulsion, power, communications, etc.
- Integration and supply of full systems including complete satellites/orbital systems and launch vehicles as well as terrestrial systems such as control centres and telemetry, tracking and command stations

2. The Downstream segment includes:

- Space and ground systems operations: Satellite operations provide lease or sale of satellite capacity mainly for communications but also increasingly for earth observation. Ground systems constitute the link between satellites and terrestrial infrastructures with networks of ground stations at strategic positions (often polar or mid-latitude). Satellite operations firms may be active across the entire value chain, own their own satellites and ground stations for instance, and also provide products and services directly to customers.
- Data distribution services: A growing number of companies provide cloud computing powered platforms or services simplifying the access, use and distribution of (mainly geospatial (GIS)) products.
- Supply of devices and equipment supporting the consumer markets: Activities in this category include devices manufacturing (chipsets, terminals, global navigation satellite services (GNSS) equipment and other devices) and the development of software.
- Supply of services supporting the consumer markets: Direct-to-home (DTH) provision (television, radio, broadband); positioning, navigation and timing services provision; provision of electro-optical imagery (telemetry, tracking and command services). Current applications include cartography and mapping; logistics and distribution; sales and marketing; surveillance and security; timing and precision work; and communications.

- Supply of data added-value services: The processing of products and services from one or multiple data sources (satellite imagery/signals and in-situ observations, other sources of information) and transforming them into readily usable information. The same company may provide both raw and processed products and services. Many actors in this category do not consider themselves as space sector companies although their products depend on space signals or data

3. The space-related segment finally includes space applications, products and services from spin-offs or technology transfer from the space sector, which use satellite technology but do not depend on it (low incorporated quantities of "space" components).

A simplified visual explanation is still provided by the *OECD Handbook on Measuring the Space Economy*, with the following figure the division of Scope and Activities is reported in order to have a better understanding on how the Space Industry is measured and defined according to the current taxonomy.

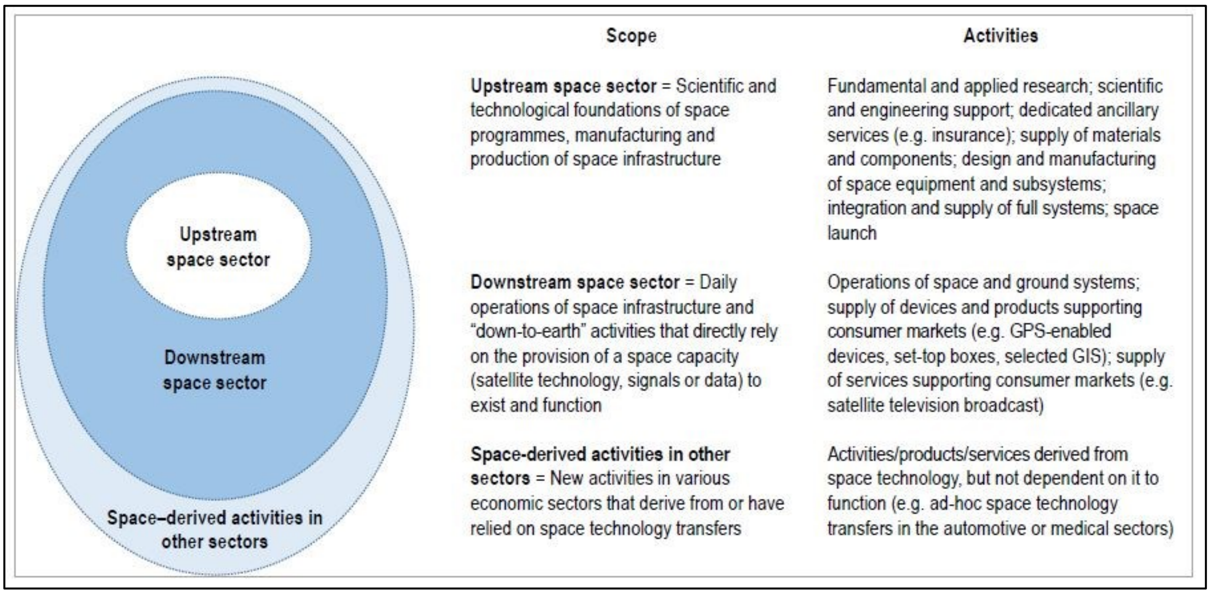


Figure 12: Space Industry structure, OECD Handbook on Measuring the Space Economy (2021)

These definitions of the industry only describe the perimeters of activities circumscribing the field of applications, but the so-called *rules of the game* differ for each segment mentioned.

The market landscapes, where it is meant the elements interaction (actors, policies, structures, market share, etc.) encompassing the whole sector, regarding the upstream segment and the downstream one display two different maneuver margins for entrepreneurs working in the space industry.

Upstream activities are conducted by the government sector, space business enterprises and the scientific community at large and they are essential enablers for downstream activities.

The participants of the upstream sector are manufacturers firms of space hardware and providers of technologies that launch system into space. What is delivered to the space market are launch vehicles and services, ground control station and space payloads such as satellites (of every size), manned spacecraft and, space stations.

The supply chain consists of prime companies and system integrators who rely on product of subsystem and component minor firms. Whereas in the downstream segment regards a series of product and services which involves the massive use of space assets.

In this precise area of the space industry, there is a consistent spillover effect providing enhancing opportunities to several industry sectors such as health, telecommunication, transportation, education, banking and natural resource management.

On one side of the coin, the upstream industry is characterized by the strong presence of major players (Airbus, Thales Alenia Space, Leonardo, etc.) which constrains the entrepreneurial opportunities due to the extended monopoly of companies managing key resources to which they have easier access. The innovative aspect seems to be a business matter only for the dominant player.

It can be assessed how this segment results to be closed, highly regulated and hierarchically constituted with almost no room for smaller entrepreneurs or established small-medium enterprises (SMEs).

What supports this statement is the fact that even the institutional side plays a significant role in shaping the value chain of the upstream segment.

For instance, the European Space law in a return on investments perspective binds primers to work with suppliers located in countries which invested money in the European Space Agency (ESA), but this has a downside effect when it comes to face the competition with companies from United States on bigger projects.

This statement is supported by the report written by Eurostat in the report *Developing a space economy thematic account for Europe*, it follows as:

"*Member States are not obliged to coordinate space programmes with the EU, meaning that they can often implement their own space programmes according to their national space strategy. This space strategy can be adopted in parallel with the strategy at EU level, provided that they compile with the principle of loyal cooperation, i.e. the legal principle that binds the EU and its Member States to assist each other in fulfilling the tasks and objectives outlined by the EU (Article 4(3) of the Treaty of the European Union)*." and "*the EU has launched the EU*

Space Programme with the intent of ensuring strategic autonomy in satellite navigation and earth observation. […] Dependence on non-EU resources or technology sources often implies vulnerabilities and increased exposure to supply chain shocks and shortages, which could result in detrimental economical and employment effects along with negative impacts on the well-being and security of EU citizens."

One of the elements driving the segment is the application of innovations coming from the upstream sector, in addition to the different policies and entrepreneurial logics.

Furthermore, allocation of key resources finds a more equal distribution among the enterprises working in it, even if the institutional rules result to be less defined and clear.

It is important to note that astropreneurs, as a category of entrepreneurs, encompass a broader industry sector than the space sector alone.

They seek to leverage opportunities within the space sector and across other sectors belonging to other industries. The Italian case of Zoppas Industries is a notable example of this phenomenon.

In 1970, the company expanded its product lines from solely producing household items to manufacturing electric coils for the industrial market. Subsequently, the Vittorio Veneto plant, RICA, began collaborating with the European Space Agency in 1992, providing electric heaters for satellites.

The path, that a technology innovative solution can undertake, can go through different industry sectors over its first-meant one, it can be overstepped the boundaries given by the "dual use" definition provided by the European Commission as follows "*Dual-use items are goods, software and technology that can be used for both civilian and military applications*."

Because as of today, most of the technologies developed are not strictly related to the military field or they are not related at all, these could have a multiple and diversified functions in a civilian application perspective, in other terms for earth-based markets.

Following these considerations, a clearer overview on how investments, in this case within the European Union, are allocated in the two-space industry sector mentioned above.

Starting from the Upstream space segment, according to data from Dealroom, European Upstream sector has reached a peak of over $2.5 billion investments in 2021 as it is shown in Figure 13.

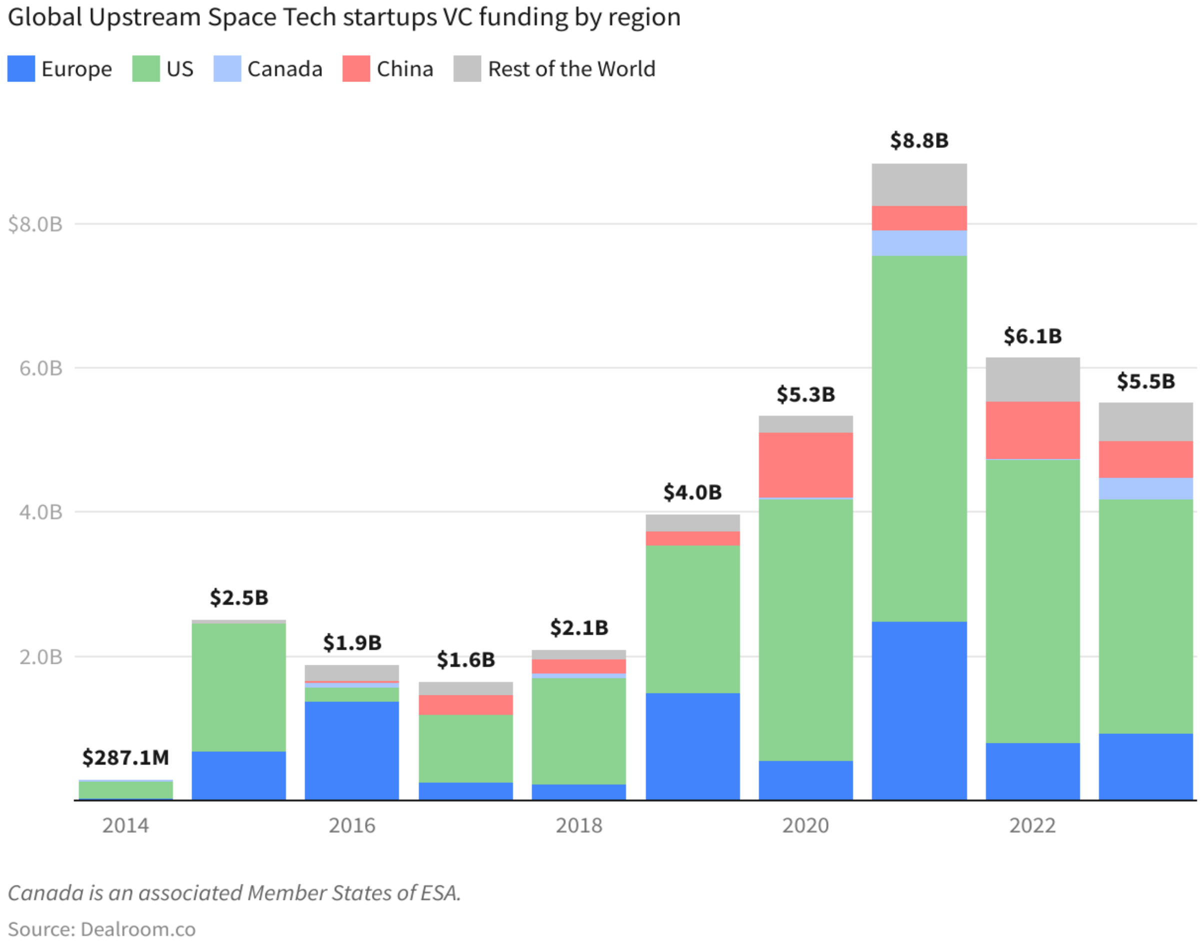


Figure 13: Global Upstream Space Tech startups VC funding by region, Dealroom (2023)

In particular, as it can be seen in Figure 13, after the COVID-19 pandemic investments in this sector started growing rapidly reaching and overcoming the threshold of four billion dollars at global level, registering a bursting rise of the space economy, here data are more significant because it is dealing with money invested in this sector.

Reasons behind a development of such importance related to space economy may be:

- The ever-growing reliance of space-based technologies in daily life
- The Geopolitical competition between countries at global level
- Quick Technological Advancements and spread Commercialization

Specifically, money invested in the global upstream industry during the last year amounts to $932.1 million, less than half of what peaked in 2021. In the same year (2023), Space transportation has been the most funded segment in the industry ($430 million), as shown it Figure 14.

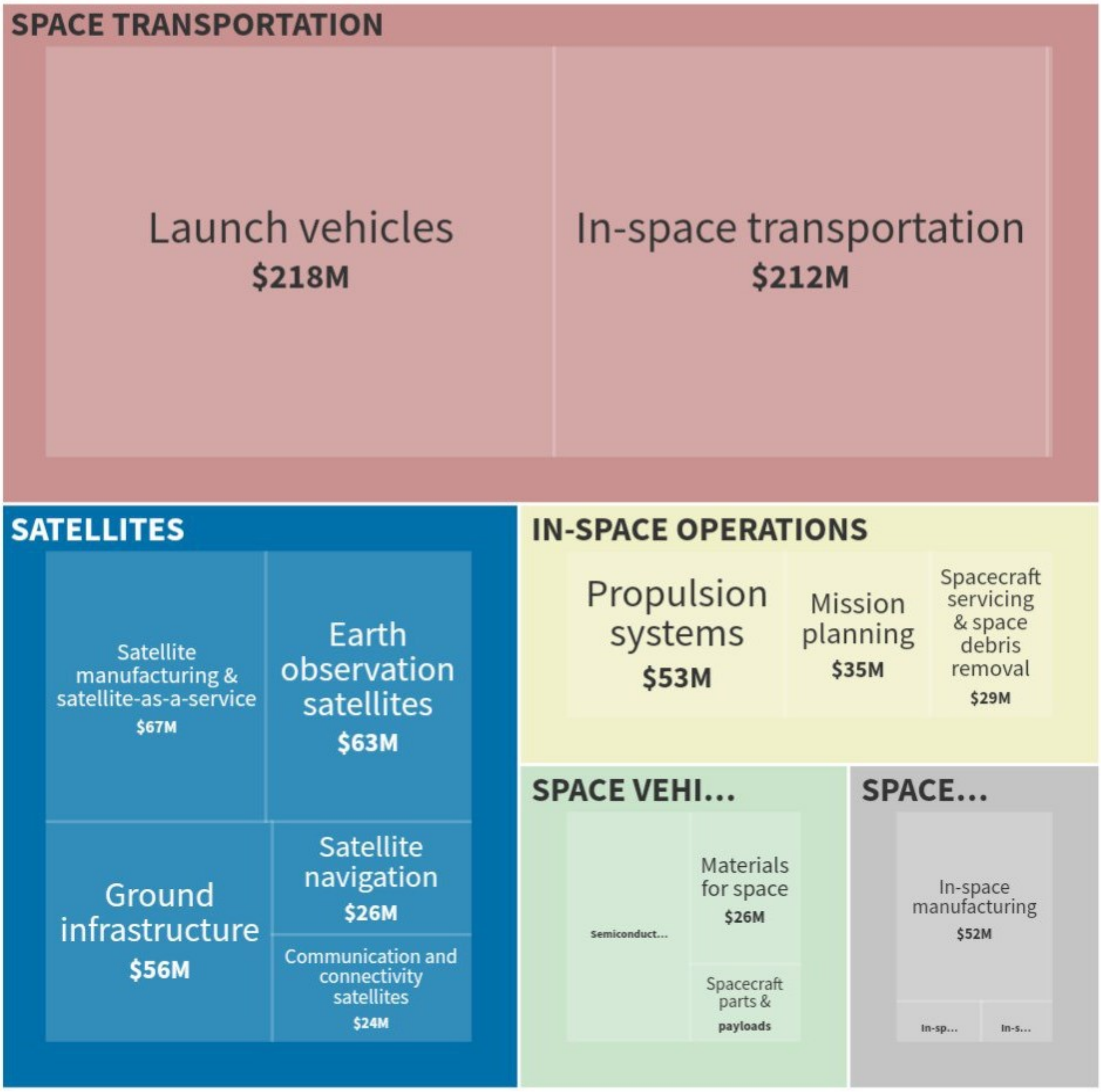


Figure 14: Allocation of investment for Upstream sub-segments, Dealroom (2023)

The sub-division of the space transportation macro areas encompasses: Launch vehicles and In-space transportation. The former has been the most funded sub-segment in 2023 around $218 million (a total of $660 million since 2016) in the European Union.

The second most founded sub-segment belonging to the Satellites macro area is the Earth observation (EO) satellites in the period analyzed (from 2016 to 2023) by Dealroom with a total amount of $568 million.

According to what is stated in the *Space Tech report* of Dealroom (2023), Space economy's major enablers are launch vehicles. At the very beginning, the state of art of these sub-segments was labeled as difficult to sustain and develop in economic and financial terms due to construction costs and high level of qualification of workforce, in other terms unstainable along the entire value chain.

As of today, it is reported to be around 5,000 satellites operating in space, with a projection of 100,000 units by 2030. Forecasts of this type rely on the ever-increasing number of industry sectors arising for earth-based markets such as in-space manufacturing and resources extraction made possible by the constant development of this segment.

As shown in the next chart, it can be seen how the cost related to launch sub-segment decreased drastically in the last 30 years, making possible the arrival of new startups in this sector (recalling how the upstream sector is ruled by major players as Airbus or Thales Alenia Space).

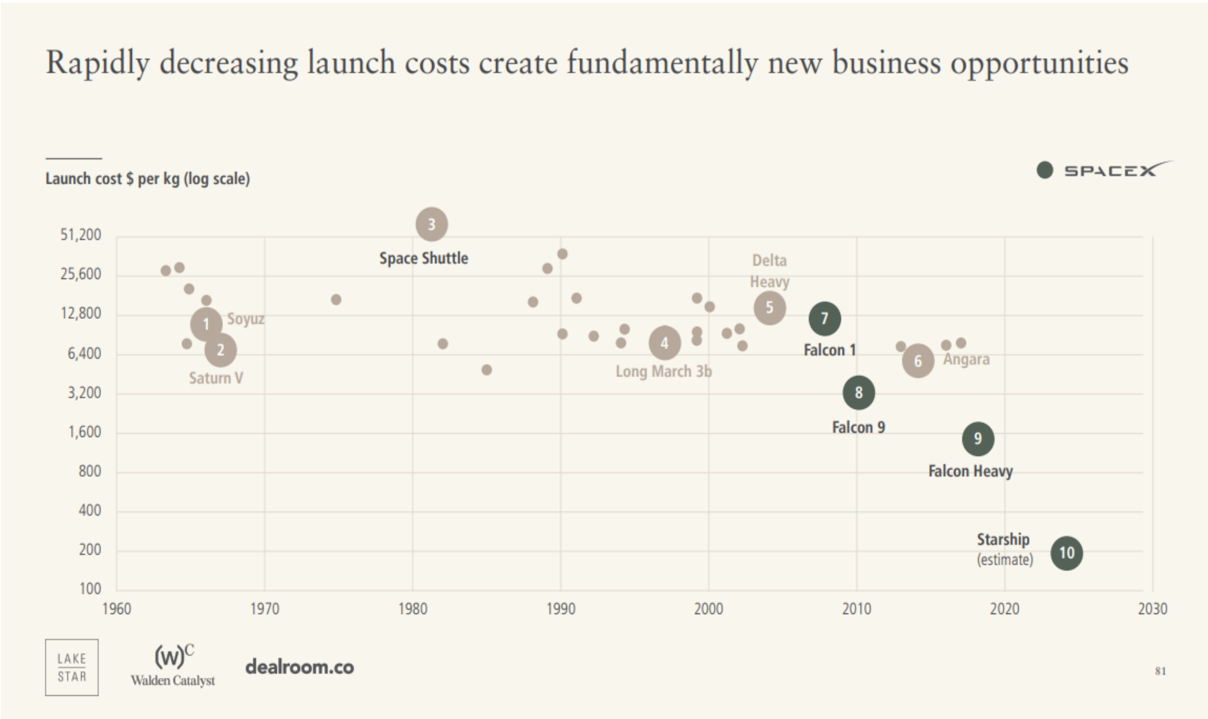


Figure 15: Cost reduction of satellites manufacturing, SpaceX (2023)

The importance of such segment is due to the political and economic consequences it gives to countries who approach this critical type of business; indeed, United States is the first country in terms of strong presence, thanks to SpaceX, of own satellites in orbit, followed by China as second player in this field.

The spread presence of national satellite is marked by the concept of geopolitical sovereignty for what concerns influence related to the exploitation of the outer space. This can be translated as strengthens a nation's position in accordance with Article I of the *Outer Space Treaty*, which emphasizes the benefits of space exploration for all of humanity while acknowledging the inherent national security implications of spacefaring capabilities.

In the European context, space organizations represent crucial sources of initial funding for advancements in public research and development processes and at the same time, they are fundamental customer regarding all space industry product lines and type of services offered.

Furthermore, Europe accounts for a solid 21%, in the period observed by Dealroom (2018-2023) of the entire investments attracted in relation to the Global Upstream sector; where just in the last year, the amount of money invested in the European upstream segment startups was about $1B.

Figure 16: European Upstream Space Tech startups VC funding, Dealroom (2023)

Dealroom provides information regarding those countries who lead the race in the *Space Upstream funding* where:

Country	% last 12 months growth	% last 24 months	2023	2022	2021	2020
Germany	257%	195%	$296M	$83M	$100M	$85M
UK	34%	41%	$197M	$147M	$140M	$123M
Italy	1914%	684%	$144M	$7M	$18M	$16M
Switzerland	41%	501%	$88M	$62M	$15M	$27M
France	−57%	63%	$82M	$188M	$50M	$148M
Finland	−75%	−40%	$34M	$139M	$58M	$109M
Spain	−8%	−65%	$24M	$26M	$70M	$13M
Netherlands	14%	0%	$20M	$18M	$0	$15M

Table 3: Leading European countries for Space Upstream funding, Dealroom (2023)

As it is shown in the Table 3, Germany led the race with $296M funded with United Kingdom and Italy following with $197M and $144M respectively.

The Downstream segment, where it is meant space—derived technologies applied on Earth-based market, encompasses a plethora of products/services/activities which employs and exploits space assets. The latter find application in many other industries as already mentioned before.

Here the landscape seems to be more fruitful for small-medium entrepreneurs who cannot managed to find room in the upstream sector due to the elements discussed above. The venture capital investment numbers, in the downstream sector, with the data estimated by Dealroom, are in line with the ones invested in the upstream industry segment, as shown in Figure 16.

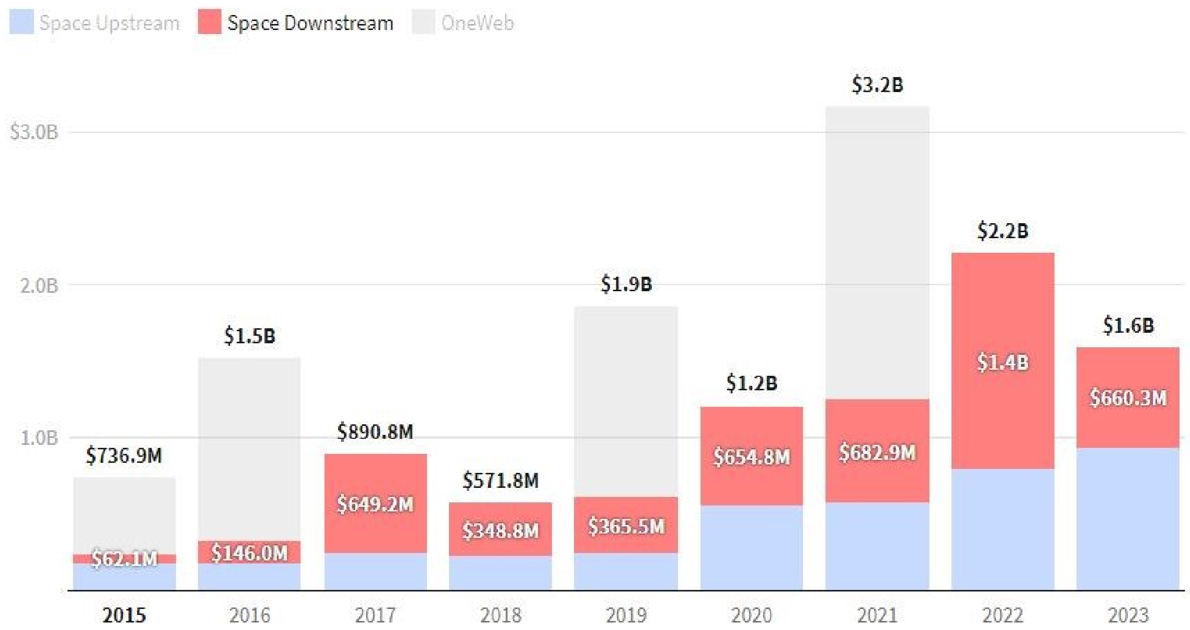


Figure 17: European Downstream Space Tech startups VC funding, Dealroom (2023)

In the European Space Segment, major companies such as Airbus Defense and Space and Thales Alenia Space, are committed in delivering spacecraft systems for governmental and commercial users; supply chain is characterized by numerous synergies with small-medium enterprise in the design and assembly processes.

Spacecraft systems encompass several purposes such as communication, Earth observation, meteorology, navigation, planetary exploration and transportation of humans and cargo.

As of today, the communication and connectivity satellite segment are dominated by SpaceX (Starlink), OneWeb (Eutselat), Astranis and Kaficic. The latter are planning and producing constellations of small satellites, in low Earth orbit (LEO), in order to provide high-speed internet coverage all over the world.

The European Union moved in the same way with the IRIS project, countries are expected to deploy a constellation of satellite with will have a complementary role in completing the geostationary orbit for communication purpose, deployment will be effective by 2027.

In parallel, another sub-segment which developed rapidly in the last decades is the Earth Observation sector, it is explained by the increasing unit number of satellites in orbit (11 unit in 2006 to 500+ in 2022).

In the last three years, Startups operating in this segment received more than the double of money obtained in the previous four years, as shown in the next Figure 18.

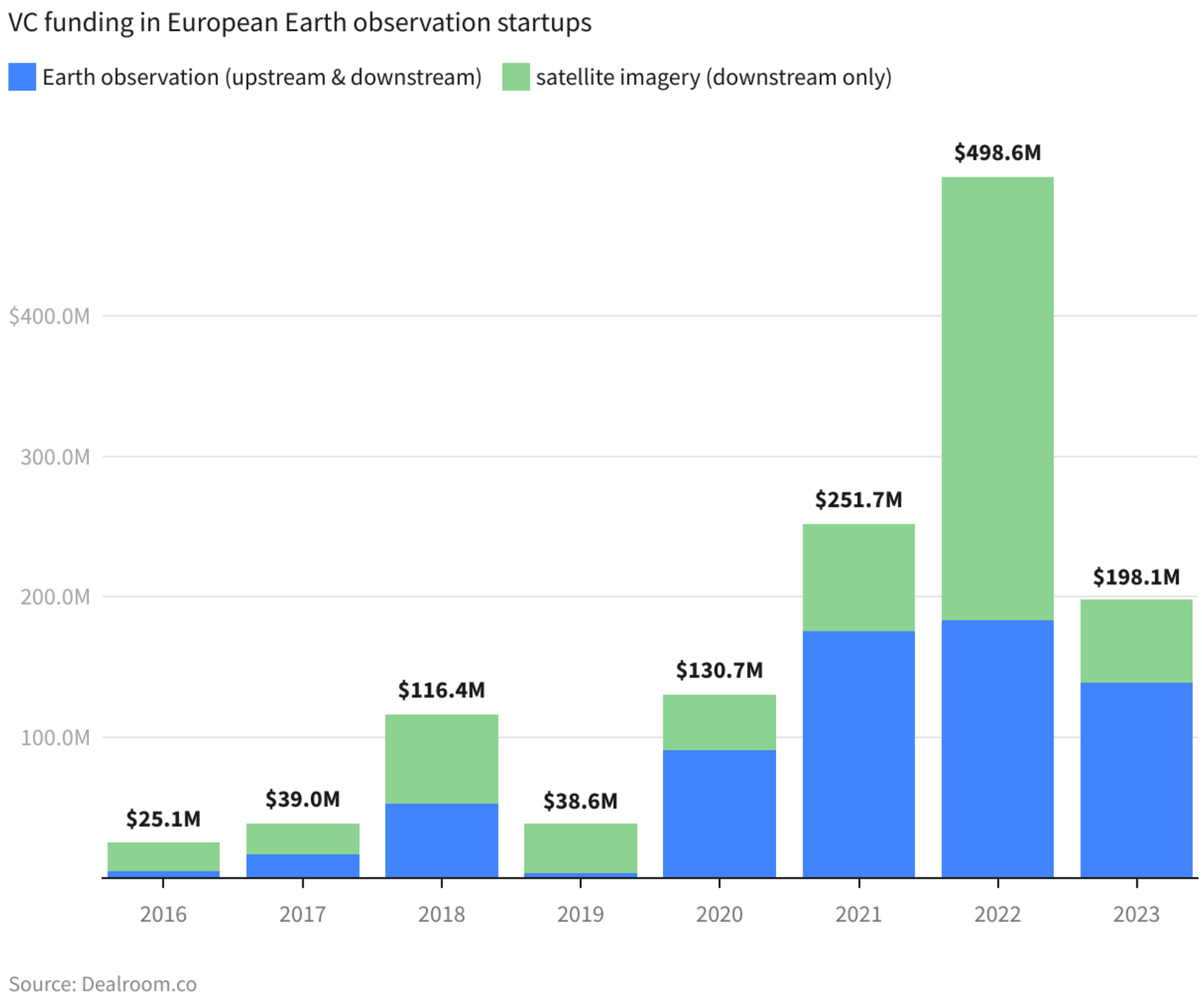


Figure 18: VC funding in European Earth Observation startups, Dealroom (2023)

All these considerations show a track on how the European Union is moving to a specific direction in order to not increase the gap, in geopolitical and technological terms, with countries such as United States and China, investing in innovative startups which generate new wealth.

This follows the principle of an independent European space economy, which can rely on its own self-sufficient supply chain based on the cooperation of the member states and the suppliers working in these, through the mechanism supported by the European Space Agency.

Mapping the startups which are part of the top 100 most funded in the European Union (for this analysis UK will be kept out) in the two space industries mentioned above (Germany and France) and in Italy (which will be analyzed later), there are:

GERMANY:

1. Reflex Aerospace (Berlin) → Satellite Manufacturing
2. OKAPI: Orbits (Braunschweig) → Logistics Services

3. Vyoma (Darmstadt) → Operational decision-making Services
4. Alcan Systems (Darmstadt) → Smart antennas Manufacturing
5. Constellr (Freiburg) → Earth Observation
6. Isar Aerospace (Ottobrunn) → Launch Service provider.
7. OCELL (Munich) → Earth Observation
8. OroraTech (Munich) → Earth Observation
9. AIRMO (Munich) → Pollution Monitoring
10. Celus (Munich) → Component Design
11. Klarx (Munich) → Logistics Services
12. The Exploration Company (Planegg) → Human Resources
13. Mynaric (Gilching) → Laser Manufacturing

FRANCE:

1. Latitude (Reims) → Launch vehicles
2. Sequans Communications (Colombes) → Semiconductors for space
3. Dark (Paris) → Spacecraft Servicing & Space Debris Removal
4. InterstellarLab (Paris) → Mission Planning
5. Exotrail (Massy) → In-space Transportation
6. Geoflex (Massy) → Earth Observation
7. CAILabs (Rennes) → Laser Manufacturing
8. Unseenlabs (Rennes) → Communication and Connectivity satellites
9. Secure-IC (Cesson-Sévigné) → Space Cybersecurity
10. NAWA Technologies (Voiron) → Materials Manufacturing
11. Kalray (Montbonnot-Saint-Martin) → Semiconductor Manufacturing
12. PROMETHEE (Aix-en-Provence) → Hardware & Software Developer
13. Kineis (Ramonville-Saint-Agne) → Satellite manufacturing & satellite-as-a-service
14. Agenium Space (Toulouse) → Earth Observation

15. U-space (Toulouse) → Satellite Manufacturing

16. Look Up Space (Toulouse) → Spacecraft Servicing and Debris Removal

17. E-Space (Toulouse) → Communication and Connectivity Satellites

ITALY:

1. D-Orbit (Fino Mornasco) → Logistics services and In-space transportation

2. Leaf Space (Lomazzo) → Ground infrastructure

3. Apogeo Space (Brescia) → Communication and Connectivity Satellites

4. GreenBone (Faenza) → Biotechnologies research

5. Sidereus Space Dynamics (Naples) → Spacecraft Parts and Payloads

From a geographic distribution perspective, the diverse startups listed above show how: highly specialized in the Earth Observation segment Munich represents one of the most enabling innovation hubs for the German space industry indeed this statement is supported in the *German Startup Monitor 2022* by PwC showing how the Bavaria region was the third area for concentration of startup (13.6%) after the North Rhine-Westphalia region (19.8%) followed by the Berlin area (19.1%).

Regarding the French space sector, Toulouse represents the hottest innovative hub (mentioning the Aerospace Valley), in this case mainly linked to the upstream sector, to boost the startup environment, in March 2018, the NewSpace Factory has founded in the region, with the aim of offering a complete, flexible and easily accessible portfolio of solutions geared towards international markets.

Whereas Italy does not show a precise area where there is a rising and enabling hub for space startups, even if it must be considered how the D-Orbit is considered one of the most innovative and valuable startups across all the European Union member states.

3. The Italian Space Economy: an overview

As previously written, Italy ranks among the top three space economies in the European Union and is the third largest contributor to the European Space Agency's annual budget.

However, the place that Italy has earned within the European and global space industry landscape is no coincidence; there is a vast sequence of elements and skills that have contributed to the position and reputation the country holds today.

Italy was one of the first countries to have a fully owned satellite, San Marco 1 in 1964, which was part of the larger San Marco Project (which included a constellation of four other satellites). After the Soviet Union in 1957, the United States in 1958, the United Kingdom and Canada in 1962, Italy was the fifth country to launch a proprietary satellite into orbit. San Marco 1 was also the first in-flight satellite built entirely by a European country.

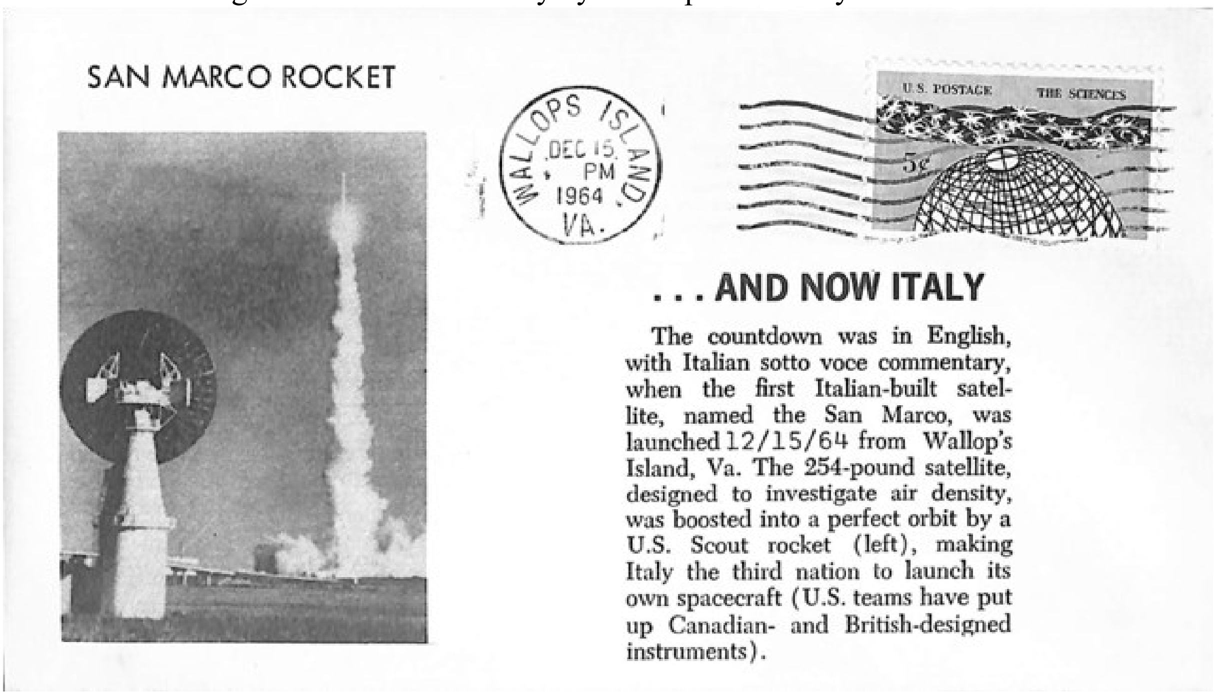


Figure 19: Commemorative launch postcard, MEDIA INAF

In October 1961, the San Marco Project was officially approved by the government headed by Amintore Fanfani, in close cooperation with the United States, with an allocated budget of 4.5 billion lire. The project envisaged: a series of satellites of Italian design and construction, but also of American interest, for technical/scientific activities; the training of Italian personnel in all phases of orbit (preparation for launch, launch, orbit launch and orbital control); On 15 December 1964, the San Marco 1 satellite was launched from Launch Area 3 at the US base on Wallops Island and placed in orbit. The uniqueness of this project was that the launch of San Marco 1 was entirely managed by Italian personnel, thanks above all to the collaboration established with NASA in the 1960s, which provided for the training of engineers from Italy for future space missions to be carried out independently, as was the case with the launch of San Marco 1.

As of today, Italy's space economy ranks among the top ten global economies and top five European economies; proving to be one of the leading industries at national as well as international level, both in Europe and worldwide. According to the article *Space Economy, il grande business da un trilione di dollari* by IlSole24ore, Italy is among the nine countries that have a space agency with a budget exceeding USD 1 billion annually.

It is also ranked as the 6th or 7th highest spender in the world in terms of space expenditure relative to its GDP, thanks to the PNRR (National Recovery and Resilience Plan).

This last statement is supported and confirmed by Euroconsult in its 23rd Annual *Government Space Program*, which reports that space budgets allocated by governments globally exceeded the $117 billion threshold, claiming a growth of more than 15% over the previous year, and for the first time there was an increase in defence investment over civil programmes.

As stated in the above-mentioned report, Italy ranks as the 7th largest space economy in terms of expenditure for about USD 2,111 billion (Figure 20).

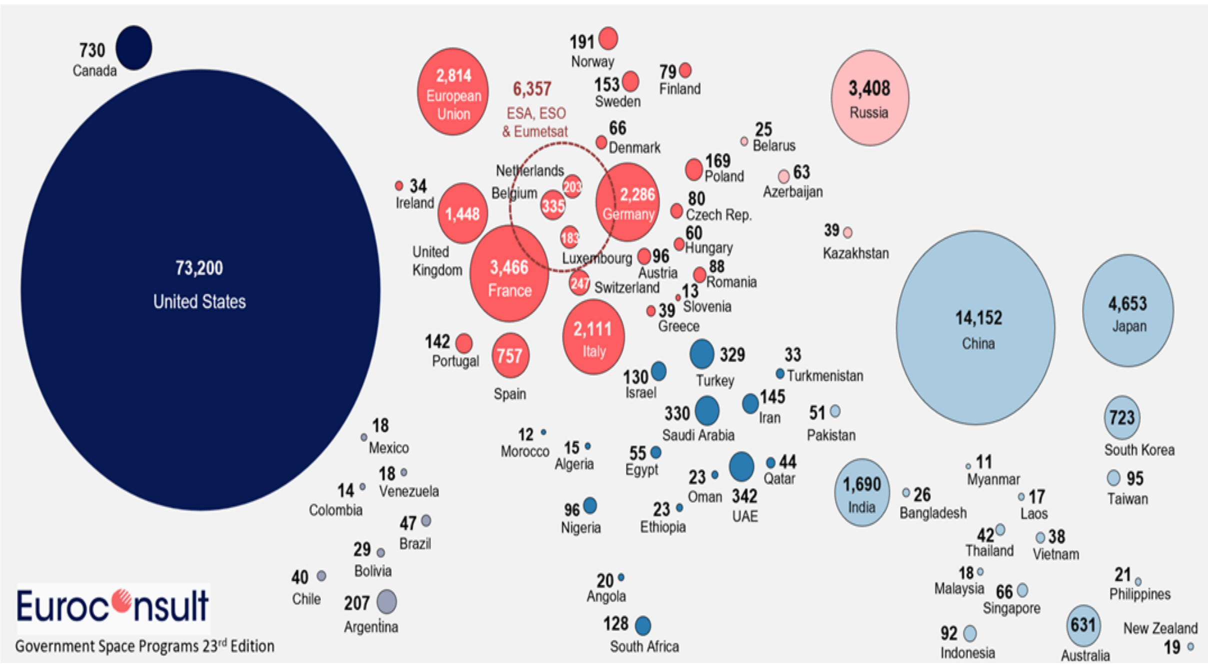


Figure 20: World government expenditures for space programs, Euroconsult (2023)

Switching to the governance of the entire industry, according to the *Three-Year Plan of Activities 2022- 2024* (Piano Triennale delle Attività 2022-2024) by the Italian Space Agency (ASI), a key element is the National Recovery and Resilience Plan (NRP). Indeed, the NRP plan submitted by Italy to the EU also offers a paramount opportunity for the national space industry.

In order to implement space-based activities according to the National and Resilience Plan (NRP), a joint collaboration is forecasted between:

- The European Space Agency (ESA) for several Earth Observations (EO) and Space Transport activities
- The Italian Space Agency for activities such as Satellite Communications, Earth Observation, Space Factory and In-Orbit Economy (including In-Orbit Servicing and Space Surveillance and Tracking activities)

The overall framework of institutional relations of the ASI and its stakeholders is very articulated and rich of interactions, and includes among its major interlocutors

- National institutions such as policy, control and supervisory bodies (Presidency of the Council of Ministers, COMINT, MUR, MEF, MAECI, ANVUR, ANAC and Corte dei Conti) as well as Ministries, Local Authorities Civil Protection, ICE, Regions, Aerospace Districts, CTNA, Italian Embassies around the world, etc.
- the research and training sector (Public Research Institutions, Universities, Foundations and research centres, CRUI, primary and secondary schools, teachers and students)
- National trade associations and companies
- International institutions (multilateral inter-governmental and inter-agency institutions, national agencies embassies of foreign countries)
- The 'media' (news media, journalists, production companies, publishing houses, bloggers, press agencies press agencies)
- Internal stakeholders including employees, Board of Directors Technical and Scientific Committee, Trade Unions.

As of today, the Italian space sector includes the following categories of players:

- 200 companies;
- 1 government agency – Italian Space Agency (ASI) founded in 1988
- 3 National Industrial Associations:
    - AIAD: The Italian Industries Federation of Aerospace, Defence and Security (AIAD) was funded in 1947. It includes almost all the national enterprises that operate with advanced technology in the design, production, research and services activities for the civil and military aerospace, military navy and army sectors. AIAD is a founding member of the National Technology Cluster for Aerospace.

- AIPAS: The Association of Italian Space Companies (AIPAS) is a not-for-profit Association born in 1998 aiming at protecting the interests of Italian Space Small and Medium Enterprises. AIPAS Members are active both in the upstream and the downstream covering all the space value chain. They have competences in the principal technology domains and consolidated experience both in ESA e EU programmes, being Prime Contractor of complex activities, subcontractors or coordinators of consortia with several partners.
- ASAS: The Association for Space-based Applications & Services was established in 2004 by the most significant Space industries whose mission is to develop and enhance applications and services based on space, to bring technologies and capacity "from Space to Earth". ASAS promotes space applications and technologies as a powerful tool to develop knowledge and innovation, support wellness and quality of life and contrast natural disaster and critical emergencies. It is a member of the AIAD.

- 13 Technology Districts located in the Italian regions;
- 1 National Technology Cluster for Aerospace (CTNA): born in 2012 from the aggregation of the main regional technological districts, industrial and research players in the aeronautical and space sectors, the Italian Space Agency and AIAD - Italian Aerospace Defence and Security Federation, with the aim of implementing a strategy based on research and innovation for the competitiveness of the Italian aerospace sector
- A vast and articulated research system, represented by about 60 realities, including Universities/Departments and Research Centres with recognized peaks of excellence.

According to the PTA figures from ASI, the average annual budget for space programmes over the past three years has been around EUR 1.5 billion and the workforce around 7000 units.

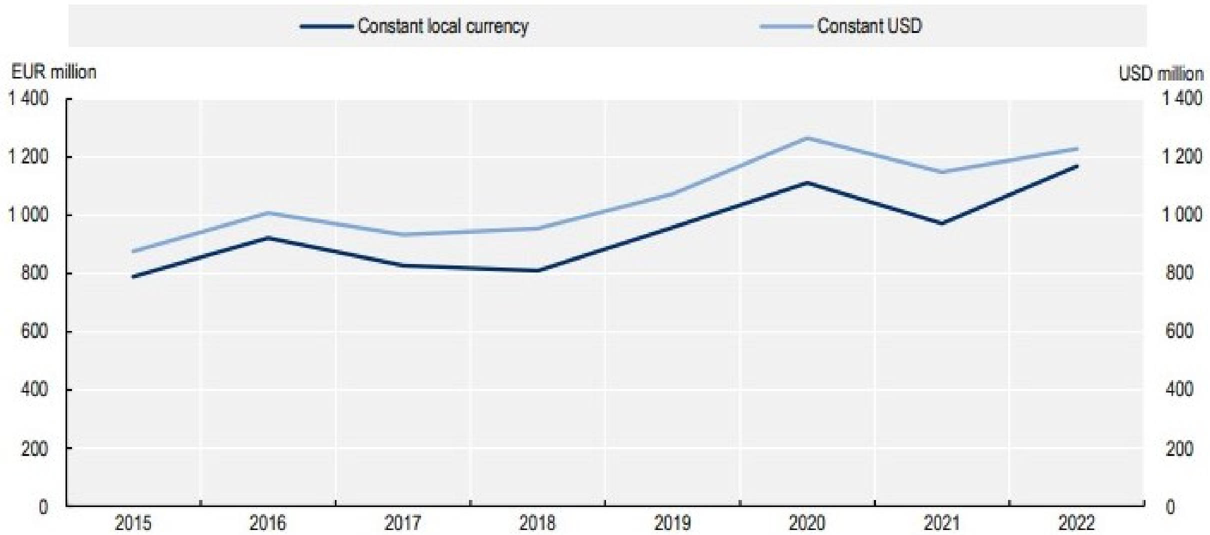


Figure 21: Italy: Space budget trends, The Space Economy in Figures (OECD – 2023)

These figures match those in the section dedicated to the country Italy (Figure 21 - base year 2015 up to 2022) in the more extensive report *The Space Economy in Figures* by OECD (2023).

The figures in the graph do include the contributions for ESA, which amount to 51% of the budget, and for EUMESTAT, which amount to 5% of the budget, but do not include the funds from the NRRP. However, as shown in the Figure 21, it is evident that the trend of the line is steadily increasing. A side indicator of how considerably Italy continues to invest in this area is related to the number of scientific outputs had in the country (meaning the number of scientific publications), which according to the indicators for scientific production adopted by the OECD.

Scientific journal categories (Scopus)	Aerospace engineering		Astronomy		Atmospheric science		Space and planetary science	
	Italy	OECD	**Italy**	OECD	**Italy**	OECD	**Italy**	OECD
Percentage of scientific publications among the world's 10% top-cited publications	**13.5**	12.8	**13.8**	12.7	**17.0**	9.8	**13.2**	12.7
Percentage of scientific publications involving international collaboration	**26.2**	18.0	**58.9**	60.9	**50.6**	42.3	**61.7**	56.1
Publications per 100 000 inhabitants	**0.6**	0.4	**1.0**	0.5	**0.3**	0.4	**0.8**	0.5

Table 4: Space-related scientific output and excellence indicators in 2021, The Space Economy in figures

According to the analysis carried out, these exceed the average of the countries belonging to the organization itself (with the exception of the "Percentage of scientific publications involving international collaboration").

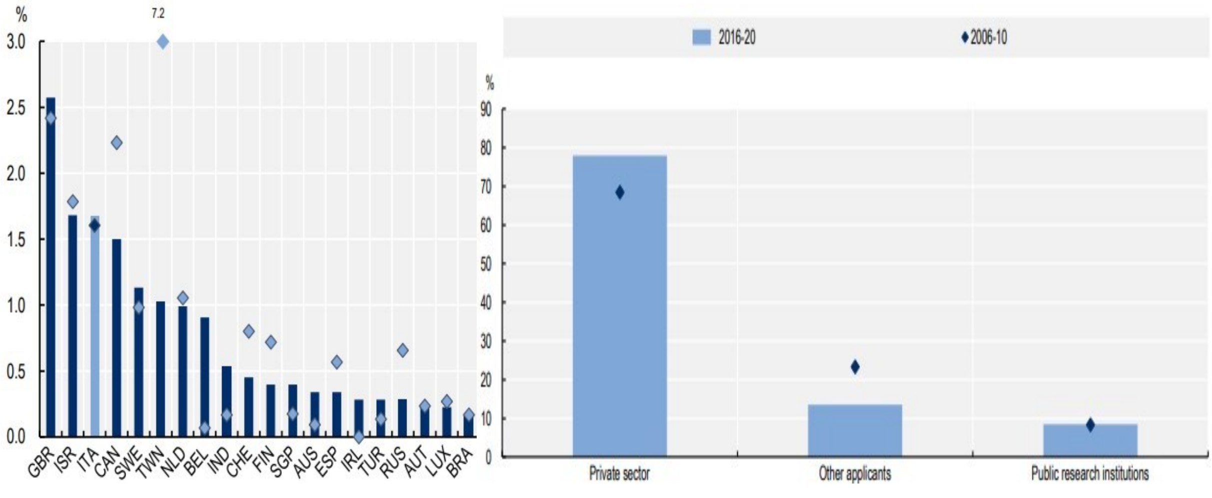


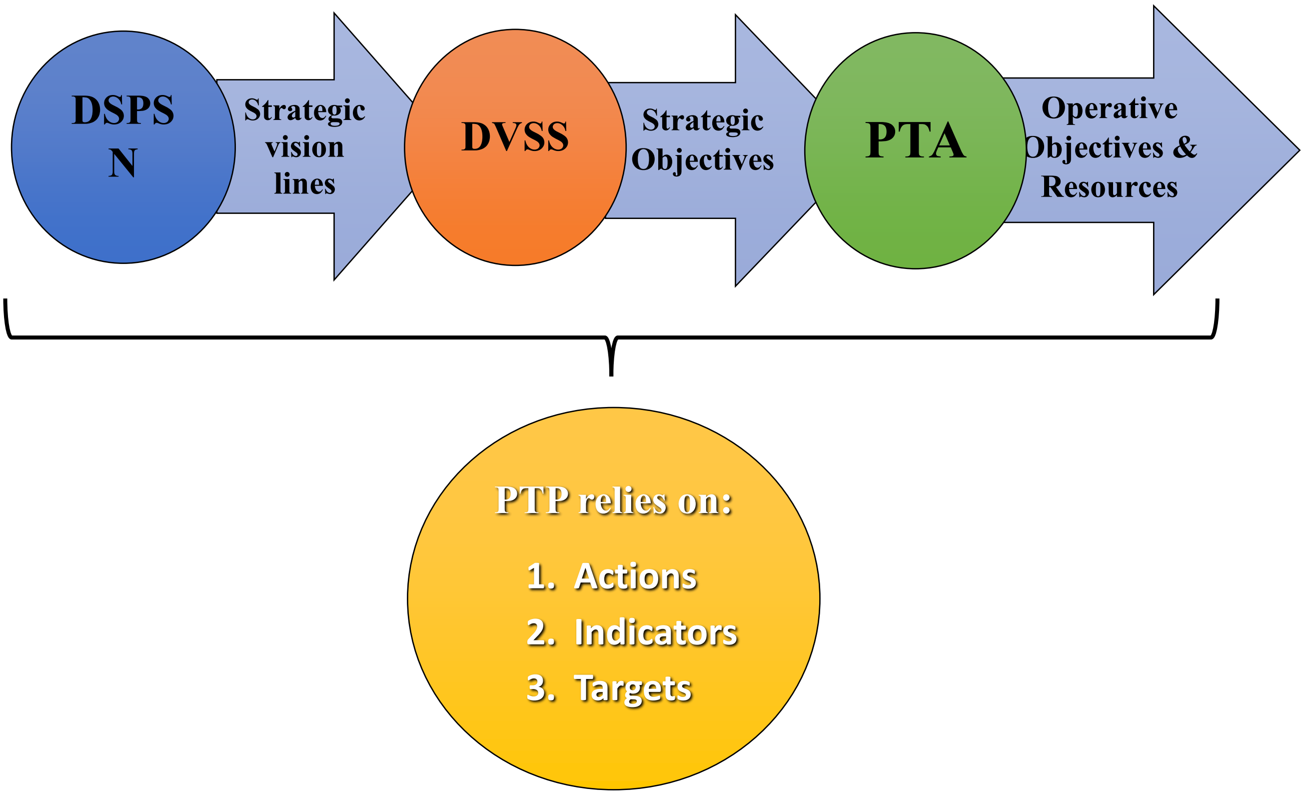
Figure 22: Space-related patent applications, The Space Economy in figures (OECD - 2023)

Moreover, as mentioned in the above-mentioned report by OECD: "*Italy was among the top ten patent applicants in space-related technologies worldwide in the 2016-20 period,* […] *accounting for some 1.7% of applications. Private firms filed a majority of applications (77%). The share of private sector applicants increased between 2006-10 and 2016-20.*" Confirming the excellent output of any genre (publication or patent) in the Italian space sector.

3.1. The NRRP impact and ASI role

According to what is stated in the *Three-Year Plan of Activities 2022- 2024* by the ASI, the latter has developed a funding plan considering several strategic and operational factors, taking into account global trends in the space sector, national priorities, and opportunities for international collaboration.

As affirmed in the document "*The governance of the Italian Space sector, as redefined by Law 11 January 2018 no. 7, has defined the hierarchy of relations and fulfilments, as well as the institutional planning documents that derive from it, which are summarized in the figure below: starting from the Government Addresses, the strategic vision lines for the Country are identified in the Documento Stategico di Politica Spaziale Nazionale (DSPSN), which the ASI, for the part of its own competence, makes its own and implements through the Documento di Visione Strategica per lo Spazio (DVSS 2020-2029) in force, up to the current Three-Year Plan of Activities 2022-24 (Piano Triennale delle Attività - PTA) and the Piano della Performance (PTP).*"



Chapter 7 of the PTA by ASI describes the planned incoming and outgoing financial resources of the organization, consistent with the realization of all the objectives described in the Three-Year Plan.

The technical-programmatic activities will be carried out to a large extent thanks to the funds:

1. Allocated through the ASI-PCM agreement signed in December 2021 (1632 M€); in order to achieve the overall objectives, further funding is expected from the PCM (224.5 M€);
2. Allocated for the initiatives to be carried out with the space funds identified under the PNRR (880 M€), for which a specific DPCM has already been signed and registered and the specific agreement between ASI and PCM is being finalized.
3. About 300 M€ (170 from MISE and 130 included in the last stability law) for initiatives related to the Artemis program;
4. Research activities financed by the MUR under the National Research Plan (PNR) are also included;
5. New space-based activities are identified for which the necessary financial coverage must be found;

The table (5) below shows the detailed allocation of funds for the implementation of the activities defined according to the current Strategic Vision Document for Space (DVSS 2020-2029). The figures are divided according to the two periods shown, the first from 2022 to 2024 and the second 2022-2026 for the completion of the activities.

Funding Sources	2022-2024 (€)	2022-2026 (€)
PCM-ASI agreement for PTA 21-23 (#1)	**1.321.972.243,21**	**1.632.036.347,64**
ARTEMIS funds	**220.000.000,00**	**300.000.000,00**
New activities	**202.643.373,56**	**306.978.873,56**
additional PCM funds for PTA 21-23 (#4)	**198.862.281,29**	**202.963.652,35**
NRRP Space activities for ASI	**268.000.000,00**	**570.000.000,00**
Complementary fund to the NRRP	**174.130.000,00**	**310.000.000,00**
PNR funds	**17.332.258,00**	**20.982.258,00**
MUR funds	**35.000.000,00**	**55.000.000,00**
PCM funds of the PTA 2021-23 (#3 sub-orbital)	**22.500.000,00**	**22.500.000,00**
Total Amount	**2.460.440.156,05**	**3.420.461.131,54**

Table 5: Funding sources, PTA - ASI (2022)

In the "*Relazione alle Camere contenente l'illustrazione delle attività e dei risultati degli investimenti nel settore spaziale e aerospaziale, ai sensi dell'art. 2, comma 6, lettera q), legge 11 gennaio 2018, n.7*" is reported how the funds to finance the actions and programs related to the Italian space industry and how initiatives such as the NRRP and the Complementary Fund impact and will impact on this industry segment highlighting the crucial role of these factors.

The Council of the European Union with the drafting of the *'Council Implementing Decision'* (CID) in 2021 initiated the National Recovery and Resilience Plan (NRRP) initiative.

In the latter, investments for the space sector were defined with "*Mission 1 - Component 2 - Investment 4 - M1C2.I4: Satellite technologies and space economy*" with underlying sub-investments' together with the funds belonging to the National Fund for Complementary Investments.

The funds earmarked by the NRRP for the aforementioned mission M1C2.I4 provide for a total amount of resources of EUR 1.487 billion. In addition to these, there are the resources from the Supplementary Fund to the NRRP, established by Law No. 101/2021, which amount to a total volume of EUR 800 million for the objectives set by the end of 2026.

Below is an initial table (Table 6) from the same document mentioned above with the division of resources of these initiatives.

Initiatives resources of NRRP and National Complementary Fund	
NRRP ('Mission 1 - Component 2 - Investment 4 - M1C2.I4)	1.487
National Complementary Fund (space sector)	800
Total amount (M€)	**2.287**

Table 6: Resources allocated under the PNRR and National Complementary Fund, PCM (2023)

For the implementation of the space activities of the PNRR, its resources have been divided for four sub-investments areas:

1. Satellite telecommunications (M1C2.I4.1);
2. Earth Observation (M1C2.I4.2);
3. Space Factory (M1C2.I4.3);
4. In-Orbit Economy (M1C2.I4.4).

In order to implement action lines, several entities have been identified: the ASI, the ESA and, in addition, another implementing body, *Cassa Depositi e Prestiti Venture Capital Sgr S.p.A.*, which aims to develop instruments to support innovative companies in the aerospace industry (the so-called "incubator"), to which part of the resources provided by the National Complementary Fund have been allocated in the "Space Factory" program area.

A strategic allocation of roles has been created between the European Space Agency (ESA) and the Italian Space Agency (ASI), so as to carry out these initiatives. Distinct responsibilities are outlined for each agency in this collaborative framework and it compliments their specialties and ensures effective implementation. In addition, a differential allocation of means has been adopted that is precisely customized to suit particular investment areas. This strategic allotment guarantees that the best promising ventures receive financial support enough to thrive.

The following table (Table 7) shows a more detailed overview of the data for the periods set within the institutional agreements with the ESA and ASI duties.

	Body	**NRRP**	**CF**	**Total**
M1C2I4.1 – SATCOM		**210**	**110**	**320**
	ASI	210	110	320
M1C2I4.2 – Earth Observation		**797**	**430**	**1.137**
OT Constellation	ESA	797	273	1.070
Matera labs and 2nd upgrade	ASI	-	62	62
Space Innovation/downstream	ASI	-	5	5
Incubator	CDP – Venture Capital Sgr SpA	-	90	90
M1C2I4.3 – Space Factory		**180**	**100**	**370**
Access to Space – Space Transportation System	ESA	64	36	100
Access to Space - High Thrust Liquid Propulsion Engine Development	ESA	56	64	120
Space Factory 4.0	ASI	60	-	60
M1C2I4.4 – In Orbit Economy		**300**	**160**	**460**
In-Orbit Service	ASI	230	120	350
SST – Fly Eye	ASI	70	40	110
Total amount (M€)		**1.487**	**800**	**2.287**

Table 7: Multi-year investments from NRP and CF funding, PCM (2023)

The document "*Convenzione per la realizzazione delle misure relative alla Missione 1 - Componente 2 - Investimento 4 (M1C2.I4)*" shows how the investments deriving from the PNNR and the Complementary Fund (CF) are spread over the period 2022 to 2026, in accordance with the milestones set, Table 8 shows the funds ASI will use with the different funding sources mentioned before.

Fund	Sub-investment	Project	2020	2023	2024	2025	2026	Total Amount
NRRP	**M1C2.I4.1 – SatCom**	*Satellite Communications*	-	25	60	25	-	**110**
CF		*Satellite Communications*	22	38	60	59	31	**210**
CF	**M1C2.I4.2 – Earth Observation**	*Laboratori di Matera*	-	13	13	14	-	**40**
NRRP	**M1C2.I4.3 – Space Factory**	*Space Factory 4.0*	7	15	15	23	-	**60**
NRRP	**M1C2.I4.4 – In-Orbit Economy**	*In-Orbit services*	9	30	40	50	101	**230**
Cf		*SST - Fly Eye*	7	10	15	28	10	**70**
		In-Orbit services	-	19,07	31,06	35,56	34,31	**120**
		SST - Fly Eye	-	3	10	27	-	**40**
Total Amount (M€)			**45**	**153,07**	**244,06**	**261,56**	**176,31**	**880**

Table 8: Allocation of NRRP and CF for M1C2.I4, PCM (2022)

The sub-investments of Mission 1 -Component 2 - Investment 4 (M1C2I4) provide funding for the implementation of the projects listed here:

1. **Sub-investment M1C2.I4.1 – SatCom**: A total amount of 320M € has been earmarked for the implementation of the *SICRAL 3* (Italian System for secure communications and Alerts) program for satellite telecommunications to support missions on Italian and foreign soil, with the agreement signed in 2022 between the Ministry of Defence and the Italian Space Agency. This program envisages the involvement of the companies Thales

Alenia Space and Telespazio, which in the past had already been involved in the construction of the first two generations of SICRAL satellites, for the construction of the SICRAL 3 secure satellite communications system (specifically SICRAL 3A and SICRAL 3B) for the Ministry of Defence

2. **Sub-investment M1C2.I4.2 – Earth Observation:** A total amount of EUR 40 million from the Complementary Fund was injected for the strengthening of the '*Laboratori di Matera* ' in the broader project of the *Space Centre* (in Matera). To realize this sub-investment a list of sub-projects has to be implemented:
   2.1 ***In Orbit Lab*****:** Project involving the construction of an infrastructure by Planetek Italia, D-Orbit and AIKO within the Matera Space Center using NRRP funds, with the ultimate goal of providing tools and services for Earth observation research and experimental development of new technologies. This project is unique in that it is the first ASI multi-purpose system that can be reconfigured during its operational life. The project will enable the efficient use of data from space missions.
   2.2 ***Matera Space Center Lab:*** The Matera Space Center Lab works as a hub for people who work together using satellite data and other advanced technologies to address local issues. The laboratory is oriented on tackling environmental challenges, enhancing territorial management and dealing with security questions by promoting innovations among universities, research institutions, private companies, startups, and representatives from civil society. By encouraging this kind of innovative collaboration among universities, research institutions, private companies, startups and representatives from civil society the lab can serve as a nexus for confronting environmental problems of the region.
   2.3 ***MapItaly data provision system:*** In accordance with the 'Multimission Platform' initiative, there is a project called COSMO-SkyMed's MAPITALY which is now in progress to put up data archive. This will generate and deliver huge amounts of data very quickly. The *Multimission Access Data System* (MADS) project aims to create a national platform that will support ground segment missions and provide access to current and future ASI mission data. Additionally, the platform will be fully integrated into MapItaly, have centralized user management, multi-mission helpdesk system and cloud-based infrastructure.
3. **Sub-investment M1C2.I4.3 –** ***Space Factory*****:** With a total amount of 60M €, The program *Space Factory 4.0* aims to establish a network of interconnected satellite factories across Italy to produce small satellites (M-AIT project), leveraging innovative technologies to enhance production efficiency and meet the demands of the space economy. A

consortium led by Thales Alenia Space Italia, together with Argotec, Sitael e CIRA, will focus on digitalization, robotics, virtual and augmented reality, and artificial intelligence in satellite production.

4. **Sub-investment M1C2.I4.4 – *In-Orbit Economy*:** A total amount of 460M € will be invested in the *In Orbit Services* e *Space Surveillance and Tracking (SST) – FlyEye* programs to manage space traffic and orbital debris. Specifically, these programs envisage:

   4.1 M1C2.I4.4.1 – *In-Orbit Services:*

   4.1.1 ***Multi-purpose green engine:*** Avio is set to design the 'Multi-Purpose Green Engine', which will be a liquid propellant engine for future In-Orbit Servicing and Space Logistics applications. Additionally, it will serve as propulsion for next generation space systems, such as the Vega-class launcher stage engine. The project seeks to enhance national capabilities on space logistics, Space Situational Awareness (SSA) and Space Traffic Management (STM).

   4.1.2 ***Design, development and ground qualification of an In-Orbit Servicing demonstration mission:*** The dedicated In Orbit Servicing (IOS) mission will be developed by Thales Alenia Space, Leonardo, Telespazio, Avio and D-ORBIT. This mission to be launched in 2026 is aimed at testing some technologies that can repair, refuel and replace the satellites in Low Earth Orbit (LEO), move them to new orbits or bring them back into earth's atmosphere. For this mission, Leonardo is developing a robotic arm through collaboration with such organizations as SAB Aerospace, INFN and IIT for robotic operations on satellites already in orbit. Telespazio and Altec will handle ground segment development design and validation. For the orbital stages' propulsion system constructor are Avio designing and developing Orbital Support Module. Activities associated with the target satellite platform will be managed by D-Orbit through its ION platform and refueling system.

   4.2 M1C2.I4.4.2 – *SST/FlyEye:*

   4.2.1 ***Strengthening of Space Surveillance and Space Debris Tracking (SST):*** For the purpose of safety, ASI has recently signed an agreement with OHB Italia for the supply of four Flyeye telescopes dedicated to Space Surveillance & Tracking (SST). Developed using Italian technology, these telescopes will work as sentinels in space that will help track space junk and consequently reduce risks. One telescope is financed under ASI *Three-Year Plan* (PTA) whereas others are backed up by PNRR funds. These Flyeye telescopes have wider coverage area and can monitor diverse orbits where space debris is located, thereby enhancing efforts to prevent collisions.

4.2.2 ***Development of Dual Cloud infrastructure at the ASI Space Geodesia Center in Matera, and development of dedicated software for future Space Traffic Management (STM) activities:*** Telespazio S.p.A will implement the Infrastructure Hardware and Software (IHS) project, through collaboration with other industrial entities, small and medium-sized enterprises (SMEs), academic institutions and university spin-offs in order to coordinate space traffic management activities. The Matera ASI Center has a central role in this 36-month long project. To avoid collisions, IHS project also offers services for monitoring orbital fragmentation, tracking reentry into the earth's atmosphere; as well as assisting on-orbit satellite servicing operations and collision avoidance maneuvers that are pertinent to both civilian and defense satellite operators.

The resources allocated by the NRRP were designated to cover a specific portion of the investments outlined for these particular areas of intervention. In addition to these resources, the National Complementary Fund (CF), in its own right, contributed some money towards achievement of targeted objectives by 2026 when this project ends. The scope and coordination of space activities span across continents and Europe, making it a natural platform for investment. In Mission 1 of NRRP, there are financial resources earmarked for space activities. This component aims at assisting in enhancing the competitiveness of the production system by supporting digitization, technological innovation as well as internationalization through various complementary measures. This is because space has become a widely acknowledged place for economic development given its potential to drive technology and address the challenges of "transition" including climate change impacts through satellite observation. With this component, attention is paid to sectors with high technological content that are aligned with central European initiatives with a view to fostering the acquisition of specific skills. Finally, certain targeted initiatives will be created which also focus on specific sectors that are relevant for European Union priorities such as "Satellite Technologies and Space Economy" under Investment 4. These M1C2.I4 sub-investments are covered by the mentioned EUR 880 million for the period 2022-2026.

The PTA outlines how the funds are allocated to support a wide range of activities and programmes, divided into specific macro investment areas (DVVS sectors).

Sector (S#)	2022-2024 (€)	2022-2026 (€)	Description
S1 -Telecommunications, Earth Observation, and Navigation	**844.655.419,33**	**1.058.997.640,00**	Enhance satellite telecommunications, environmental monitoring, and navigation systems.
S2 - Study of the Universe	**225.125.000,00**	**344.750.000,00**	Support astrophysical research, cosmic phenomena observation, and development of innovative technologies for universe study.
S3 - Space Access	**411.330.000,00**	**781.500.000,00**	Facilitate space access through the development of launch and re-entry technologies and innovative propulsion systems.
S4 - Sub-orbital Flight and Stratospheric Platforms	**22.500.000,00**	**22.500.000,00**	Develop technologies for sub-orbital flight and use of stratospheric platforms for various scientific and commercial applications.
S5 - In-Orbit Servicing	**11.000.000,00**	**17.000.000,00**	Support maintenance and repair of satellites in orbit, extending their operational life.
S6 - Robotic Exploration	**209.712.257,39**	**283.729.259,59**	Develop technologies for robotic exploration of other celestial bodies.
S7 - Human Space Exploration	**51.041.203,33**	**61.729.764,07**	Prepare human-crewed missions for deep space exploration.
S8 - Space Situational Awareness (SSA/SST)	**75.464.765,14**	**142.300.000,00**	Monitor and mitigate risks from space debris and other orbiting objects.
S9 – International Relations and Cooperation	**1.940.000,00**	**3.300.000,00**	Strengthen international cooperation in the space sector.
S10 - Engineering, Innovation, and Technological Valorization	**448.739.999,99**	**491.969.999,99**	Promote technological innovation and valorization of engineering skills.
S11 - Space Economy, Finance, and Corporate Participations	**2.175.165,68**	**2.365.000,00**	Support the development of the Space Economy and corporate participation in strategic projects.
S12 - Development and Enhancement of Space Research and Knowledge	**43.685.631,56**	**57.385.631,56**	Support scientific research and dissemination of knowledge in the space sector.
S13 - Technical Support and Infrastructure	**113.070.713,63**	**152.933.836,33**	Improve technical infrastructure and provide operational support for space activities.
Total amount	**2.460.440.156,05**	**3.420.461.131,54**	

Table 9: Sector budget allocation, PTA - ASI (2022)

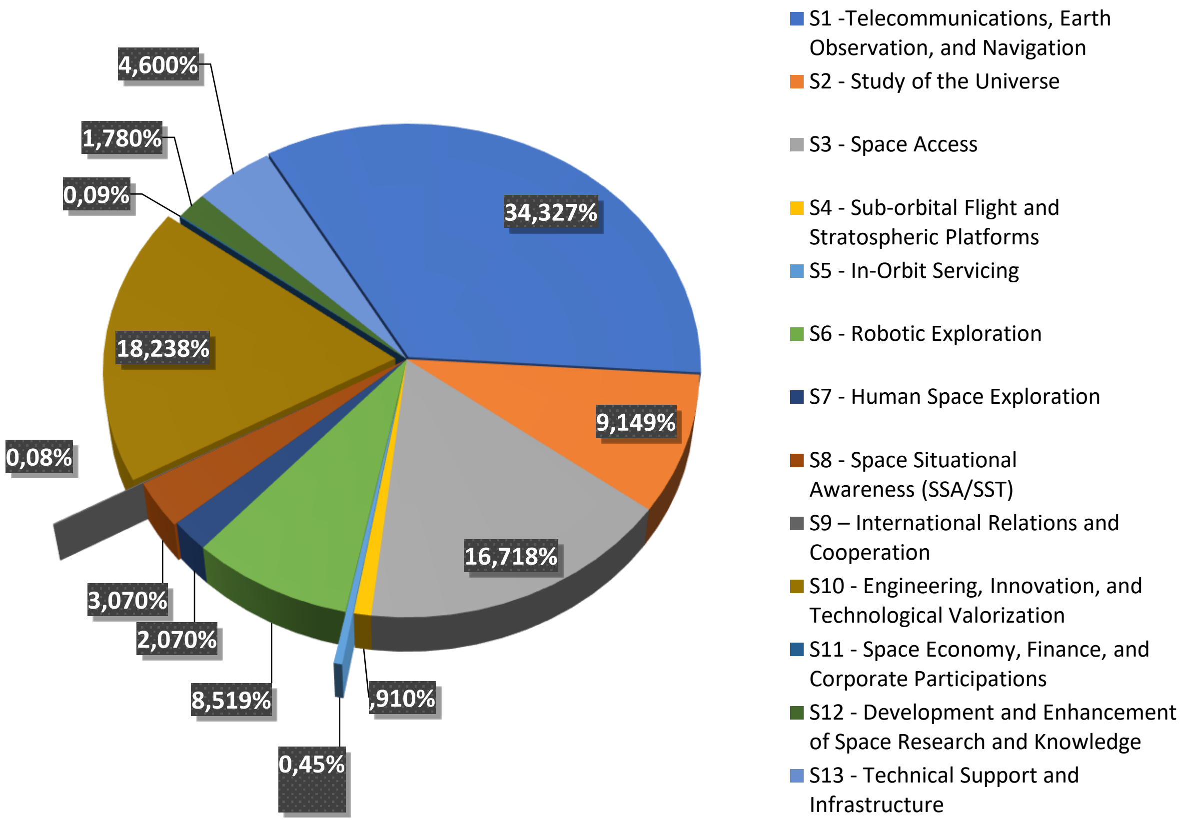


Figure 23: Chart of sector budget allocation for 2022-2024, PTA - ASI (2022)

The research-related areas defined by the Strategic Vision Document for Space (DVSS), such as the *S2 - Study of the Universe* and the *S12- Development and Enhancement of Space Research and Knowledge* amount to approximately 10% of the allocated budget for the next three years.

On one hand, this figure shows how research in the Italian space industry is inserted into the different key activities defined at institutional level; on the other hand, it reinforces the data reported above on the scientific output in Italy in this sector, with results that are above the average of OECD member countries.

On the other hand, it must be mentioned how the majority of investment regarding the action's lines according to the Three-Year Plan of the Italian Space Agency convey to the development of the downstream space sub-segment (recalling the definitions of downstream technologies as space-based technologies which have or will have an application for the earth-based market).

All sub-investment activities falling under Mission 1 Component 2 Investment 4 must be finalized by the second quarter of 2026, in strict accordance with the terms set by agreements.

Estimates for the space economy sector point to significant growth in the coming decades. According to forecasts derived from data collected by various institutions, the growth margins appear to be impressive.

Euroconsult, in its annual *Space Economy Report 2023*, estimates the global value of this sector at USD 462 billion for the current year and forecasts an estimated valuation of USD 640 billion in 2030 (+25.75%).

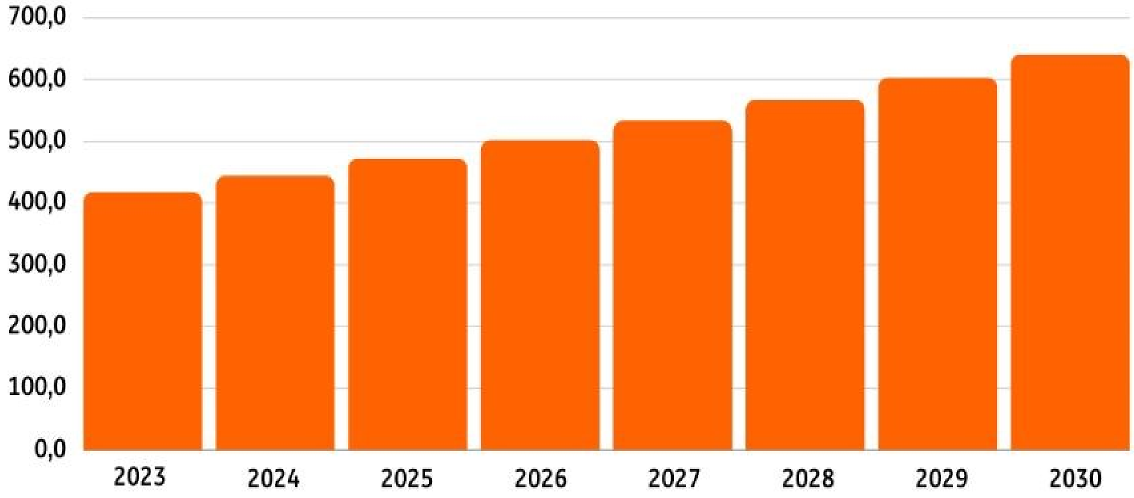


Figure 24: Space Economy growth 2023-2030, Space Economy Report 2023 - Euroconsult (2023)

There are those, on the other hand, such as PWC Italy, Bank of America and United Launch Alliance, who foresee an even more promising growth by the end of this decade, with the sector's valuation rising to $1 trillion. More downwards are the estimates of UBS and Morgan Stanley, which forecast the $1 trillion mark by 2040.

As far as the country Italy is concerned, according to the report 'THE NUMBERS OF THE ITALIAN AEROSPACE INDUSTRY' by Cribis (2024), the Italian aerospace sector, one of the most important at European and world level, contributes significantly to the Italian economy, with an annual turnover of around 13 billion euros.

Currently, the industrial stratum is mostly composed of small and medium-sized enterprises and a smaller group of large companies scattered throughout the country. This large number of small and medium-sized enterprises constitutes practically the majority of the industrial population with 76.4% of SMEs in Italy, more specifically 40.5% are micro-enterprises and 35.8% are SMEs.

As of today, the aerospace industry in Italy is spread over 1 national technology cluster and 13 scattered regional clusters.

3.2. Italian regional aerospace districts

Figure 25: Distribution of Regional Aerospace Clusters, Personal elaboration on CTNA data (2024)

The National Aerospace Technology Cluster (CTNA) is a nonprofit association that brings together the main players in the Italian aerospace supply chain. Together with the 13 regional districts, the CTNA represents the backbone of the aerospace supply chain in Italy.

These industrial clusters arise (or are retroactively recognized) under provisions of Law No. 103 of 2017, especially in support of economic growth in southern Italian regions, where is stated:

"*Art. 3-bis. (National Technology Clusters for the acceleration and qualification of programming in the field of research and innovation in favor of the areas of Southern Italy). - The National Technology Clusters (NTCs), as support and efficiency structures for the coordination of industrial research policies at national and local levels, as well as linking the measures promoted at central and regional levels and, with reference to the regions of the Mezzogiorno, also as facilitating tools for the implementation and deployment of interventions in the territory, established following the notices issued by the Ministry of Education, University and Research, traceable to the innovation clusters referred to in Regulation (EU) No 651/2014* [...].

2. Each CTN shall draw up a three-year action plan, updated annually, in which it describes the activities it plans to carry out, including from a strategic perspective, to achieve the goals, objectives, expected results, timelines, organizational aspects, necessary resources, and the territorial context of the interventions.

3. [...] the CTNs shall submit the action plan to the Ministry of Education, University and Research for evaluation, to be carried out also with the help of experts, and subsequent approval."

A more detailed analysis of the actors involved in the supply chain of these technology districts, starting from the north and ending in the south of Italy. A fact sheet of each cluster is reported, containing the most important general information, main objectives and its industrial tissue of component companies.

The main three regional clusters for each Italy's geographical section (North, Centre, South) are:

1. **Piedmont Aerospace Cluster (DAP)**

Description: The Piedmont Aerospace Cluster is a non-profit association established in 2019 with the objective of ensuring the continuity of the previous Committee. Since 2005, the Cluster has involved all relevant stakeholders with the aim of enhancing the competitiveness of Piedmont's aerospace industry, guaranteeing coordination and long-term vision for public and private investment in technological innovation. The Cluster was one of the founding members of the National Aerospace Technology Cluster (CTNA), which brings together Italy's leading aerospace hubs and all the key players in the national aerospace system. The Piedmont Aerospace Cluster was established with the aim to support and strengthen the excellence of the regional aerospace sector through the creation of a network of large companies, SMEs, research system and institutional subjects. At Thales Alenia Space's Torino site, in collaboration with Piemonte's uniquely skilled supply chain of innovative SME's, over 50% of the habitable modules for the International Space Station have been manufactured. As of today, it counts almost 22.000 employees. In 2023, the cluster generated about 7 billion euros in revenue.

Composition:

- 6 Public institution
- 7 Research and training institutions
- 5 Large key players (Leonardo, AVIO, Thales Alenia Space, Mecaer and Microtecnica)
- 2 Trade associations
- 81 Small-Medium Enterprises (SMEs)

Production and services:

- Aerostructures, components, system
- Propulsion systems and components
- Interior equipment and furnishing
- Landing systems
- Electrical / electronic components
- Avionics
- Machinery, tools and mechatronics
- Special processes and materials
- Testing and certification
- Space System
- Platform
- Payload
- Ground systems and equipment
- UAV/UAS/OPV
- MRO

Areas of action/Objectives:

- Strengthening the Aerospace Supply Chain

- Responding to the aerospace industry's need for training and new skills
- Drive for innovation and enhancement of the Network
- Research funding opportunities and communication activities
- Promotion and internationalization

2. Lazio Aerospace Technology District (DTA)

Description: The Aerospace Technology District (DTA) in Lazio holds strategic importance due to its role as a central hub for aerospace activities within the region. Established in 2004, the DTA integrates a diverse range of stakeholders including large corporations, SMEs, research centers, and universities. This collaborative ecosystem supports various sectors such as space transport, satellite design, and data utilization services, fostering innovation and research. Lazio's aerospace sector is a cornerstone of the region's economic development strategy, recognized for its comprehensive supply chain and international collaboration efforts. The Cluster was one of the founding members of the National Aerospace Technology Cluster (CTNA), it is anchored by significant infrastructure and institutions. It hosts key players like the European Space Agency (ESA) and the Italian Space Agency (ASI), along with 253 companies engaged in activities ranging from satellite manufacturing to space exploration technologies. As of today, across all the enterprises there are approximately 23,500 employees. The district has a yearly turnover of almost 5 billion euros.

Composition:

- 10 Public institutions,
- 5 Research and training institutions (as “Sapienza” University of Rome and University of Rome Tor Vergata)
- 23 Large Key Players (Leonardo, AVIO, Thales Alenia Space, Telespazio, E-Geos, etc.)
- 3 Trade associations
- 230 Small-Medium Enterprises (SMEs)

Production and services:

- Launchers (Vega, solid rocket motor for Ariane)
- EO, NAV & TLC SATs manufacturing and services
- Manned and Unmanned Space Exploration (incl. ISS)

- Ground Segment Control Centers
- Air Traffic Management
- Aeronautical & stratospheric systems, interior design manufact
- RPAS - UAV
- Sub systems and components:
- Homeland/Cyber Security/Safety
- Key enabling technologies (Micro & Nano-electronics, Photonics, Advanced Materials)

Areas of action/Objectives:

- Consistent development of Space Transport Systems and Launch Services
- Expand capabilities in satellite design, production, and operation.
- Focus on industrial applications as telecommunications or environmental monitoring
- Pioneer technologies for in-orbit servicing
- Foster collaboration between public/private actors to drive innovation
- Focus on developing environmentally sustainable aircraft and propulsion systems.

3. Campania Aerospace Technological District (DAC)

Description: The Campania Aerospace Technological District – DAC S.c.a.r.l. – was established in May 2012 within the frame of the National Operational Program "Research and Competitiveness", the Aerospace District of Campania (DAC) is a network that brings together the protagonists of the aerospace sector present in the region. It includes the main industrial and scientific players in the sector which in Campania plays a leading role in terms of technological content, scientific skills, know-how, industrial tradition and turnover, as well as for export capacity and number of employees. The priority mission is to foster synergies amongst the technological and production excellences of the network in the perspective of an enlarged supply chain and a compact industrial ecosystem to promote greater commercial penetration capacity. The total value of exports 2021 of the Campania region in the aerospace sector amounts to about 1 billion 326 million Euros.

Composition:

- 14 Public institutions,

- 5 Research and training institutions
- 27 Large Key Players (Leonardo, MA Group, DEMA, GEVEN, Atitech, Telespazio)
- 150 Small-Medium Enterprises (SMEs)

Production and services:

- Development of enabling methodologies and technologies to design and build aircraft
- Manufacturing and assembly techniques of light aircraft in the B&G Aviation
- Design and development of space platforms (e.g. micro-satellites and dual technologies)
- Development of methods of maintenance and transformation useful for the new technologies and methodologies planned within the district

Areas of action/Objectives:

- Foster synergies amongst the technological and production excellences of the network
- Enlarge the supply chain and strength a compact industrial ecosystem
- Promote greater commercial penetration capacity
- Support associated SMEs in their renovation path
- Develop collaborative processes and exchange of experiences and best practices

This chapter described the national scene by illustrating what constitutes the overall industry composition and policies of the national government. It analyzed how the Italian Space Agency will employ European Union (EU) funds that are and will available through the *National Recovery and Resilience Plan* (NRRP) and *Complementary Fund* (FC) initiated by the government to help grow aerospace industry and several other industry sectors.

The European Union (EU) has laid down project milestones for Italy as described in Year Three Plan by Italian Space Agency. These correspond to Mission 1 Component 2 Investment 4 (M1C2I4), including its sub-investments in various areas of interest within a wider spectrum of space-based technologies. To conclude, the Italian space industry is typified by strong regional clusters which each have their own special contributions and promote innovation. The Italian aerospace ecosystem remains dynamic but not static with emerging regions such as Veneto playing an important role alongside well-established clusters.

In the upcoming chapter, a deep analysis will be conducted regarding the rising Veneto aerospace cluster, examining its potential, strengths, and strategic importance. This cluster's development will be explored in terms of industry composition, how the enterprises perform according to financial indicators and economic measurements.

The final elaboration that will come from the analysis that will be carried out on the *Co.Si.Mo. consortium* in the Veneto region will try to explain how, in a cluster at a still embryonic state, there is already the presence of a semi-complete supply chain that sees how the presence of so many small and medium-sized (SMEs) enterprises is essential for the growth of the cluster itself and the regional economy.

3.3. The Raising Veneto Aerospace district – AIR

In February 2020, Veneto Innovazione (a regional company in charge of promoting regional development, particularly industrial development, by directly supporting small and medium-sized enterprises) provided all the documentation, to the regional offices, for the recognition of the new regional innovative network named "Aerospace Innovation and Research - AIR" at the request of Stefano Debei, Director of the "Centro di Ateneo di Studi e Attività Spaziali "Giuseppe Colombo" - CISAS".

The AIR innovative network adopts a vision centered on the transversality at the skill level of the aerospace industrial sector, conceived as a hub that will enhance the multiple spheres of the Veneto regional economy thanks to the strong thrust arising from the combination of different expertise and innovative technologies.

This regional district has as its main mission to be pursued the transfer of innovative technologies between the aerospace industrial sector and the area's industrial supply chain.

The peculiar aspect of this new regional innovative network is its multisectoral nature, the latter of which allows the AIR regional district to fall within the so-called *Regional Smart Specializations*.

The latter is a tool that European Union member states, and consequently the regions, adopt to maximize investment in the region with the ultimate aim of creating new synergies between industrial and academic players, such as universities and research centres, present in the region. These collaborations are characterized by their objectives of sustainable development and digitalization in the new solutions and approaches adopted.

The network "*Aerospace Innovation and Research - AIR*" given its cross-sectoral configuration, falls under the already mentioned regional smart specializations (RIS 3 - Veneto), which are:

- *Smart Agrifood* → In the context of New Space Economy, specifically for the use of space technologies aimed at improving the agriculture sector with the potential exploitation of infrastructure, for the realization of services, such as satellite monitoring and control of crops and technology transfer for the realization of agricultural machineries for the efficiency of work processes in this sector and process automation.
- *Smart Manufacturing* → Enhancement of production activities through the development of new machinery aimed at energy saving and more appropriate use of resources, in line with the implementation of innovative production methods and the production of better materials, both metallic and non-metallic.
- *Sustainable living* → Purpose of space activities impacts on development of innovative solutions addressed to daily living such as advanced home automation technologies, switching to home design solutions, spread of energy autonomous building (decreasing energy wasting/city pollution) and all those technologies which made up the new concept of smart city.

The specific objectives outlined for the aerospace sector aim, firstly, to improve the living conditions of astronauts for long duration missions in space, through the specific design of habitats developed to make human presence suitable through the implementation of advanced automation solutions and the development of energy self-sufficient facilities.

Secondly, the development of efficient monitoring and control systems based on environmental parameters in the astronauts' living areas to ensure safer conditions for humans.

Furthermore, the design of technologies suitable for measuring astronauts' stress factors without invasive methodologies, so as not to negatively affect the psychological and physiological well-being of the people involved in the space mission.

As of today, the structure of the regional innovation network *Aerospace Innovation and Research - AIR* consists of several partnerships involving Research organizations such as:

- CISAS - G. Colombo
- T2I - Technology Transfer and Innovation
- University of Venice - Ca' Foscari
- University of Verona
- University of Venice – IUAV
- UNIVENETO Foundation
- Institute of Photonics and Nanotechnologies - CNR – IFN

- CONFINDUSTRIA Veneto SIAV

Together with multiple member companies spread across the Veneto region among its provinces (mainly in the province of Padova, Treviso, Venezia, Verona and Vicenza), with some companies with registered offices in other regions of Italy but with their operational headquarters in the region.

The next figure (26) shows the concentration of private companies in the aerospace sector in the Triveneto area (which includes the province of Pordenone among the others) based on data in the ORBIS database, giving a preview of what will be explained in the Methodologies and Data chapter.

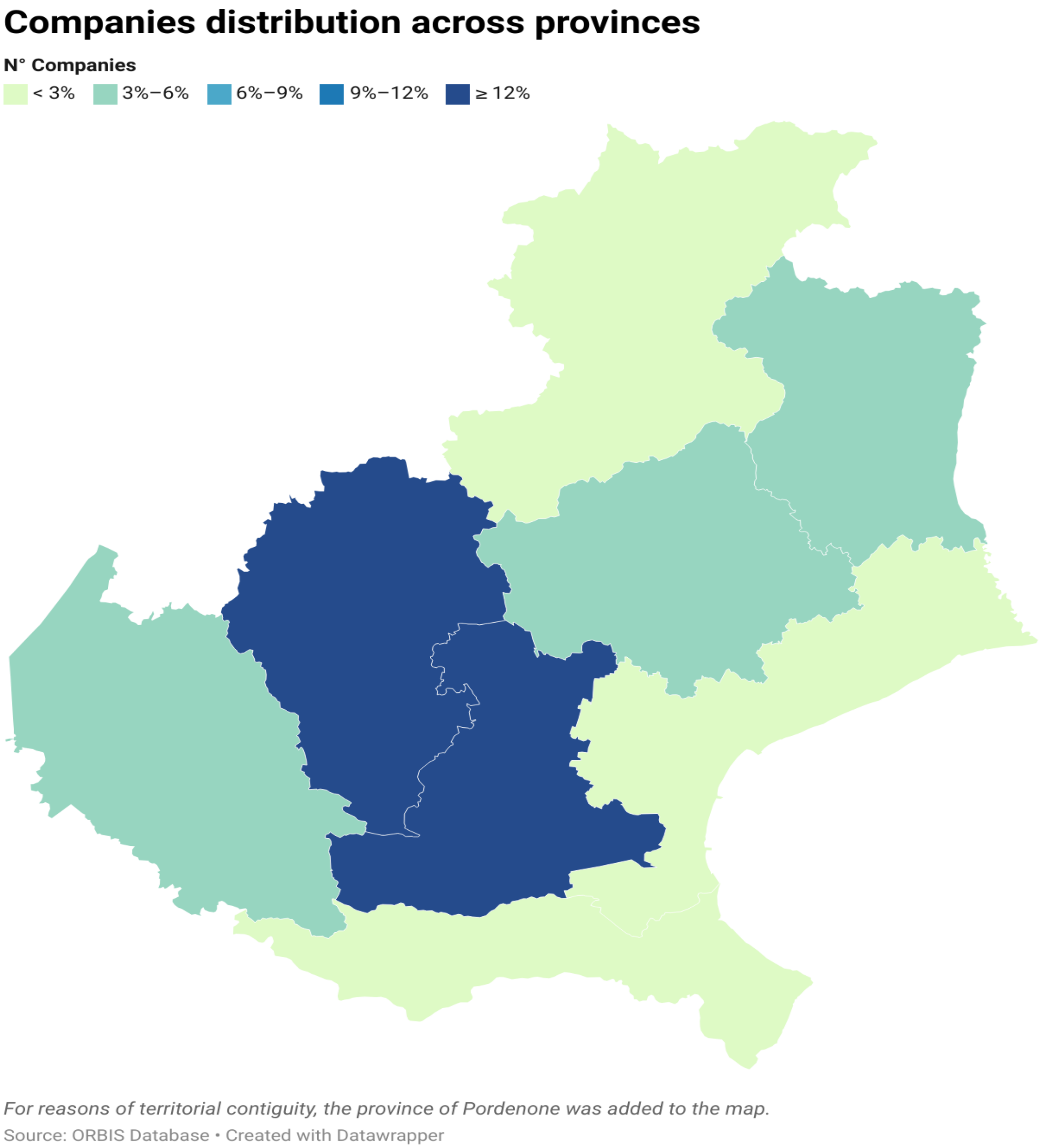


Figure 26: Companies distribution across Provinces, Personal elaboration on Orbis data

For the sake of clarity, the provinces analyzed are: Belluno, Padua, Rovigo, Treviso, Venice, Verona and Vicenza (with the addition of the province of Pordenone, which, however, is in the Friuli-Venezia Giulia region).

Associated with the AIR regional innovation network is the Aerospace and Cosmonautics Consortium - *Co.Si.Mo.*. The role of the latter is to manage and represent Aerospace Innovation and Research network in relations with the Veneto region and other public administrations.

It consists of a number of entities such as the UNIVENETO Foundation and I.R.C.A. S.P.A., with tasks such as strategic planning, coordination and implementation of initiatives on aerospace (such as the Space Meetings that had their first edition in 2023 and the second in May 2024).

The significance of this Consortium concerns the management of national and international collaborations, as well as the promotion of technological advancements and the strengthening of the region's industrial capabilities within the aerospace sector.

In February 2024, at the 18th edition of the A&T (Automation & Testing) Fair in Turin organized by the National Aerospace Technology Cluster (CTNA), Federico Zoppas, the current director of the Co.Si.Mo. Consortium, explained the path of the regional district in the Veneto region, explaining its distinguishing features, such as its close relationship with local industrial realities and its wide network of collaborations with many research institutes.

Capitalizing on the industrial fabric of the Veneto region has enabled the creation of events such as the Space Meetings, which aim to promote the reputation of the regional district and attract funding, including from abroad, to increase the competitiveness of the region's aerospace sector. In recent years, the consortium has grown quite rapidly.

The Veneto district's strategy involves leveraging local industrial synergies and research collaborations to strengthen its position in the aerospace industry amidst evolving global demands and technological advancements.

The ultimate goal is to acquire large shares in the markets of the upstream and downstream segments, especially in the latter in order to streamline the Veneto's agricultural sector, which already counts on several world-renowned excellences such as the wine and dairy sector, which includes many products that fall under the DOC and DOCG labels.

4. Empirical analysis

4.1. Descriptive analysis of Economic and Financial performance

This section provides an overview of the topic explored in the last part of the previous chapter in the economic and financial perspective of the industry within the newest regional district adherent to the AIR network. Considering the innovative nature of the aerospace sector and its relative 'youthfulness' compared to other industries, an analysis of the performance and health of companies in economic and financial terms is of interest, especially with the ever-increasing expansion of earth-based markets, which are part of the downstream sub-segment of the entire space economy, offering more business opportunities for entrepreneurs and emerging companies.

It is very interesting how the Veneto region's innovation network - "Aerospace Innovation and Research - AIR" - has performed in the five-years period from 2018 to 2022, especially considering how the COVID-19 crisis has affected the economy globally in between, despite being the newest regional aerospace district in the Italian space industry landscape and also in the roster of districts that are part of the broader “National Aerospace Technology Cluster – CTNA”.;

The target of the research is to understand how the private companies which adhere to the Aerospace Innovation and Research – AIR network, performed through the five-year time interval and to see according to the stratification variables how the different financial indices used differ.

4.1.1. Database

This chapter deepens into the empirical analysis, focusing on data sourced from the Orbis database by the Bureau Van Dijk (BvD), a subsidiary of the major company Moody’s Analytics.

Orbis is the most powerful comparable data resource on private companies—and it covers listed companies too, the database empowers the simplification of the decision-making processes through the usage of a wide variety of data which is treated and standardized in order to be easier to get integrated. Thanks to the agreement between the Department of Economics and Management "Marco Fanno" and the Bureau Van Dijk, allowing the collection of comprehensive data on companies operating in the Italian industry and worldwide.

The selected sample is made up of 45 private companies belonging to the Veneto region's "Aerospace Innovation and Research - AIR" network, only for those companies adhering to it. This sample is characterized by an auto-selection bias, this feature causes a non-total representation of the whole aerospace industry in Veneto, also considering the given voluntary nature of the adherence to the AIR network.

From the entire list of the associated partners of AIR Network, public and research organizations have been removed from the sample, as well as those companies which are outside the Tri Veneto area perimeter.

For this research, 2 sets of key variables have been selected:

1. The stratification variables set includes:

    I. **Company size:** Small Company (n° Employees < 15), Medium-Sized Company (n° Employees >= 15), Large Company (n° Employees >= 150), and Very Large Company (n° Employees >= 1000). (Qualitative ordinal variable)

    II. **Province:** Pordenone, Padua, Treviso, Venice, Verona, and Vicenza. (Qualitative non ordinal variable)

    III. **NACE code:** Manufacturing (from 14 to 33) and Services (from 43 to 95). (Qualitative non ordinal variable)

2. The economic variables set includes:

    I. *Total employees* → This variable measures the number of people employed by the company at a given point in time. It is an important indicator of the company's size and its ability to produce goods and services.

    II. *Total production value* → This variable measures the total value of the goods and services produced by the company. It is an important indicator of the company's size and its contribution to the economy.

    III. *Value added* → This variable measures the difference between the value of the company's output and the cost of its inputs. It is an important indicator of the company's productivity and its contribution to the economy.

    IV. *Revenue from sales and performances* → This variable measures the income generated by the company from the sale of its goods and services. It is an important indicator of the company's sales performance and its ability to generate revenue.

    V. *Profit/loss before taxes* [Net Profit] → This variable measures the company's profit or loss before taxes are paid. It is an important indicator of the company's profitability.

VI. *Profit/loss for the financial year* [Net Profit] → This variable measures the company's profit or loss for the financial year. It is an important indicator of the company's overall financial performance.

Additionally, we examine three financial indices, who are our main targets in relation to the 3 mentioned stratification variable:

- *Return on Capital Employed* (ROCE) → This variable measures a company's profitability that shows how much profit it generates relative to the amount of capital it has employed. It is calculated by dividing the company's EBIT (Earnings Before Interest and Taxes) by the capital employed (as the difference between Total assets minus Current liabilities).
- *Return on Assets* (ROA) → This variable measures a company's profitability that shows how much profit it generates relative to its total assets. It is calculated by dividing the company's net income by its average total assets.
- *Return on Equity* (ROE) → This variable measures a company's profitability that shows how much profit it generates relative to the amount of equity it has invested. It is calculated by dividing the company's net income by its average shareholders' equity.

The data for the variables Total employees, Value added, Total production value, Revenues from sales and services, Profit/loss before taxes, Profit/loss for the financial year will be used in their value per employee form.

For the financial indices (ROCE, ROE, ROA) the median values for the same three levels already mentioned have been taken into account, for a better output due to the more robustness of median values to the outliers' values than the average ones.

All the variables and the indices provide a comprehensive view of the companies' performance, allowing us to measure both economic output and financial health.

It is important to highlight that this analysis is an interpretation of data extracted from Orbis database on private companies belonging to the AIR network in the Veneto region and province of Pordenone.

The unrolling of this research will begin with comments on the descriptive analyses with absolute values on the economic variables along the time interval under consideration (2018-2022).

Secondly, there will be a second part with the analyses considering the stratification and economic variables (with value per employee), and finally, the final analyses of the financial ratios given for all three stratification variables along the time interval.

4.1.2. Results

4.1.2.1. Descriptive analyses

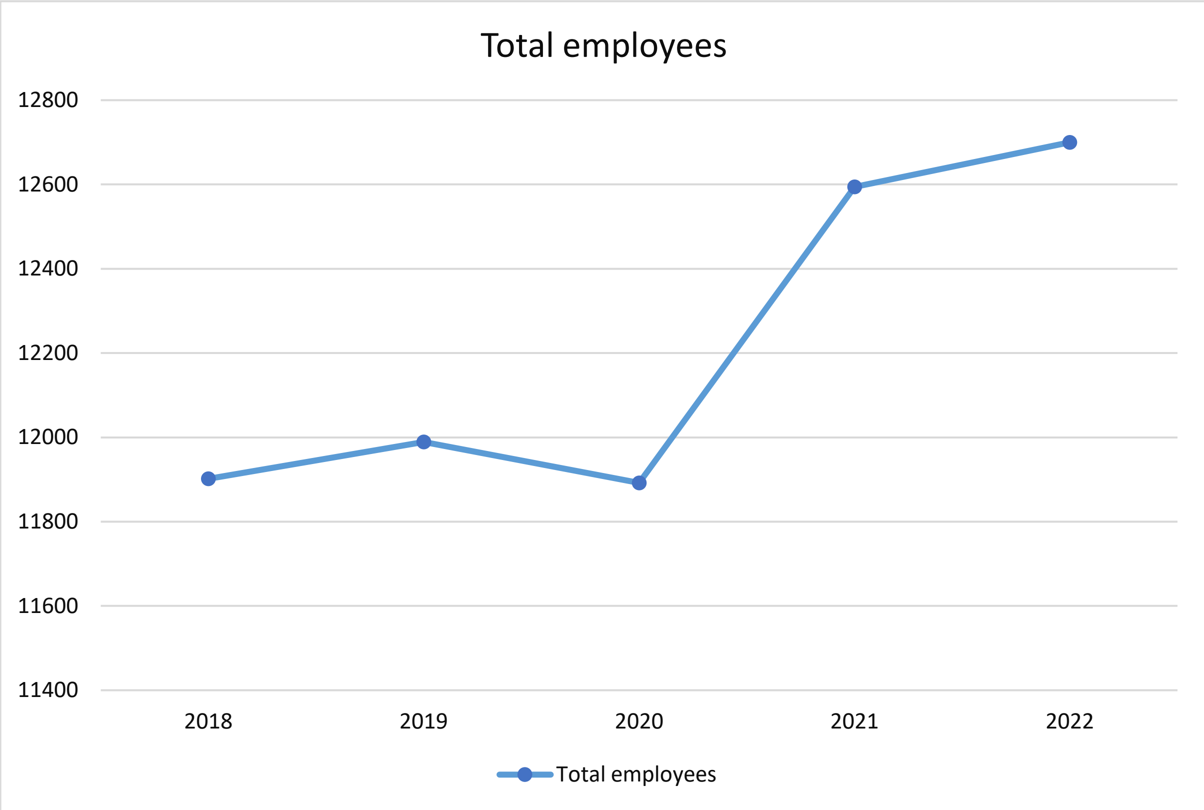


Figure 27: Total number of employees changes, Personal elaboration on Orbis data

From Figure 27, it can be seen that the total number of employees despite a slight increase in units between 2018 and 2019, in the year of the COVID19 pandemic crisis there was a decrease of nearly 100 total employees (from 11989 units down to 11892 units), a loss of 2 employees per company. While in the two-year period between 2020 and 2022, the total number of employees had an increase of more than 800 units, the AIR network had a great rebound in terms of employment.

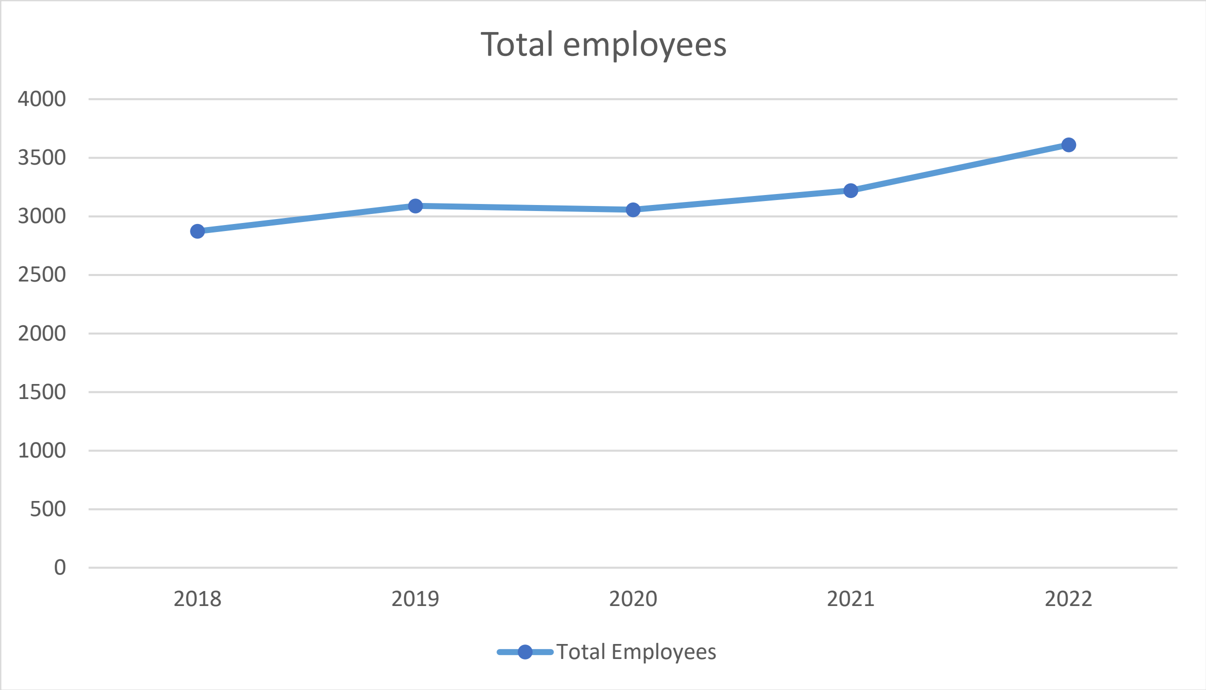


Figure 27.1: Total number of employees changes (IRCA excluded), Personal elaboration on Orbis data

Figure 27.1 shows the sample with the exclusion of "I.R.C.A. S.P.A. INDUSTRIA RESISTENZE CORAZZATE E AFFINI", which can influence the trend of the data over the time interval considered, since its units amount to 72% of the entire number of employees. It can be stated that the trend of this graph shows the same pattern of the whole sample.

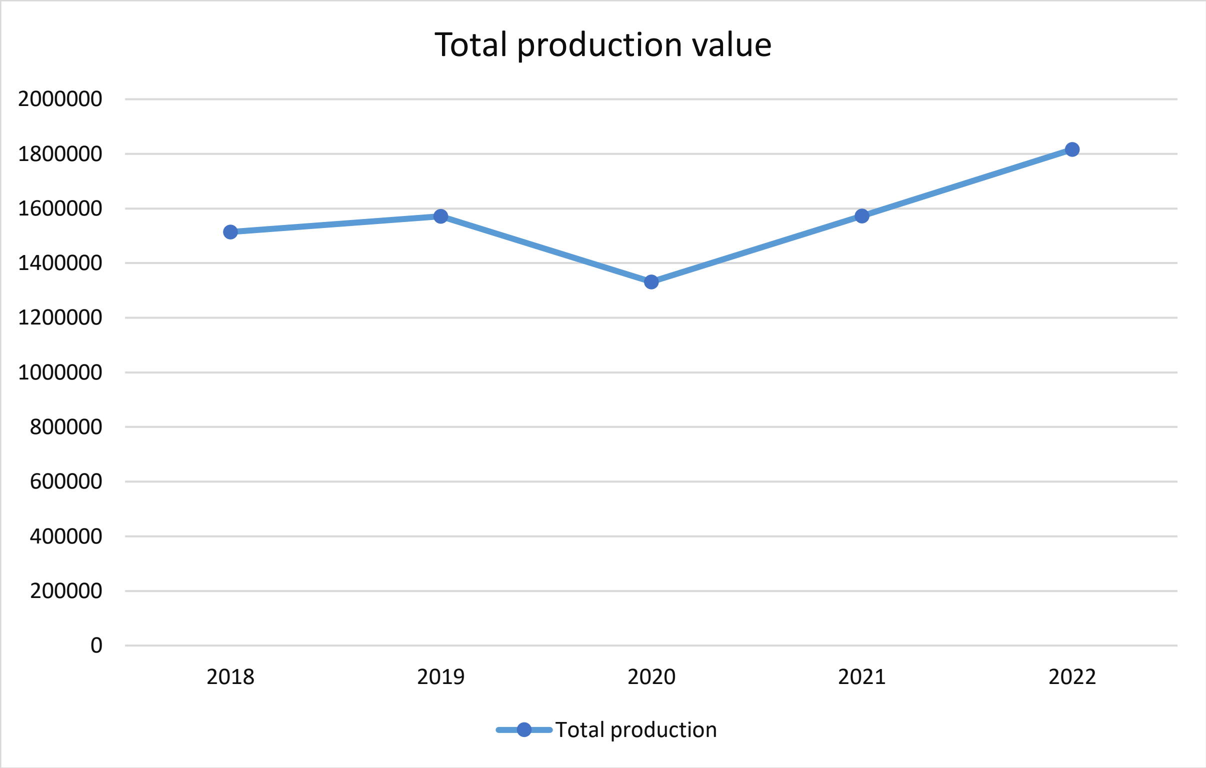


Figure 28: Total production value changes, Personal elaboration on Orbis data

In figure 28 appears the same trend as in the figure 27 regarding the number of employees. The AIR regional district has experienced a contraction in the total value of production of its member companies, the negative trend seems to be always contingent on the global pandemic crisis. In 2020, the total value of production fell below the 1.4 million euros threshold, only to rise again above a total value of 1.8 million euros in 2022, with a growth of the same amount for the previous two years.

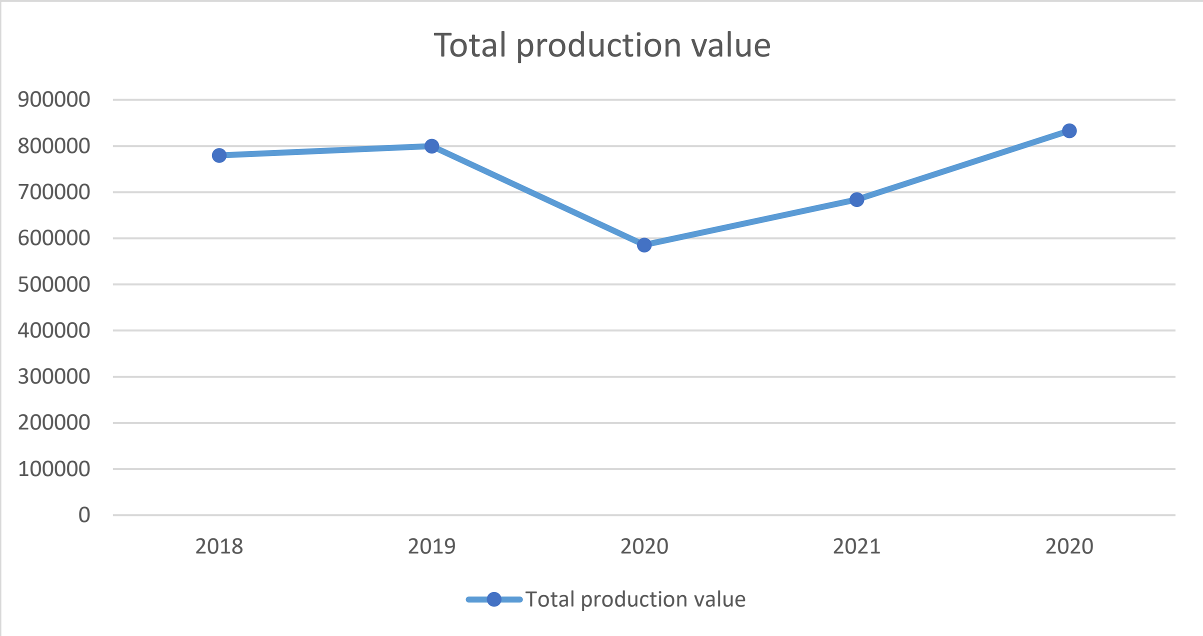


Figure 28.1:Total production value changes (IRCA excluded), Personal elaboration on Orbis data

Figure 28.1 shows the sample with the exclusion of "I.R.C.A. S.P.A. INDUSTRIA RESISTENZE CORAZZATE E AFFINI", which can influence the trend of the data over the time interval considered, since its units amount to 50% of the AIR production value.

It can be stated that the trend of this graph shows the same pattern of the whole sample, with less stepped variations.

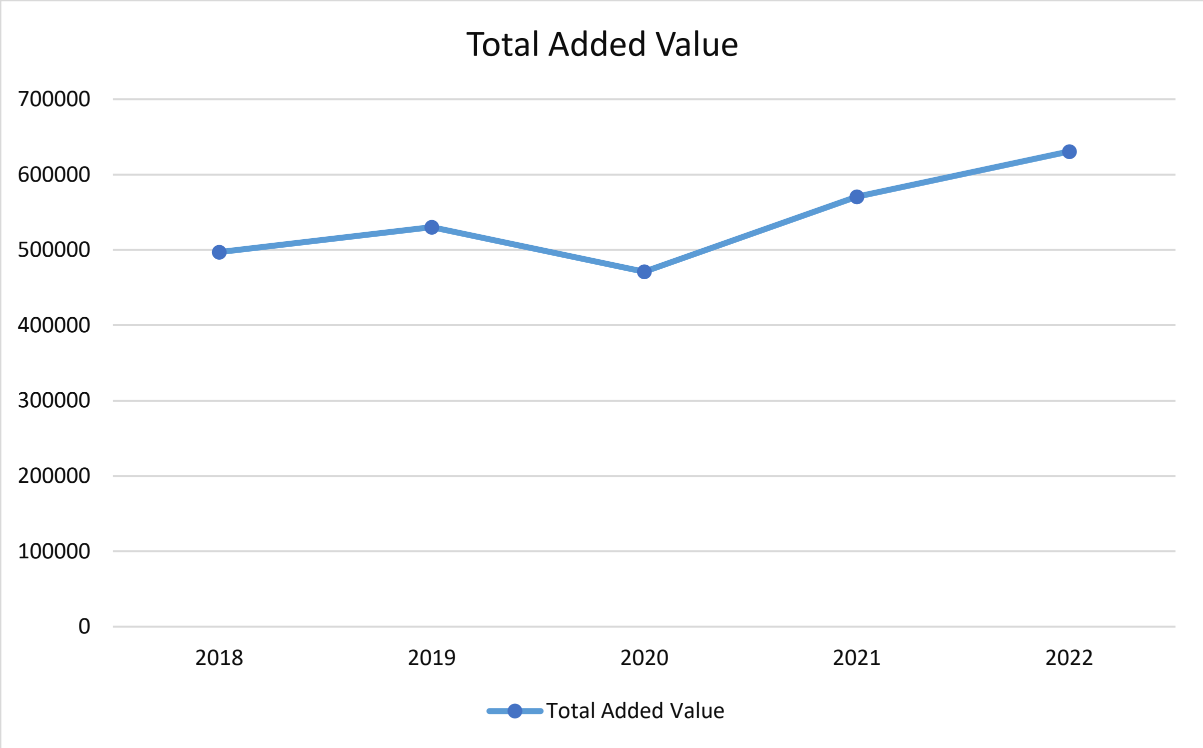


Figure 29: Total added value changes, Personal elaboration on Orbis data

The Added Value variable in the time interval considered follows the same path as the two variables already mentioned. Despite the fact that the companies have been productive from the very beginning (in this case 2018), the figure shows that here too the COVID19 pandemic crisis caused a slight drop in value added. Here, the rebound effect in the following two years shows an increase of almost 1/3 of the total value added compared to 2020 levels.

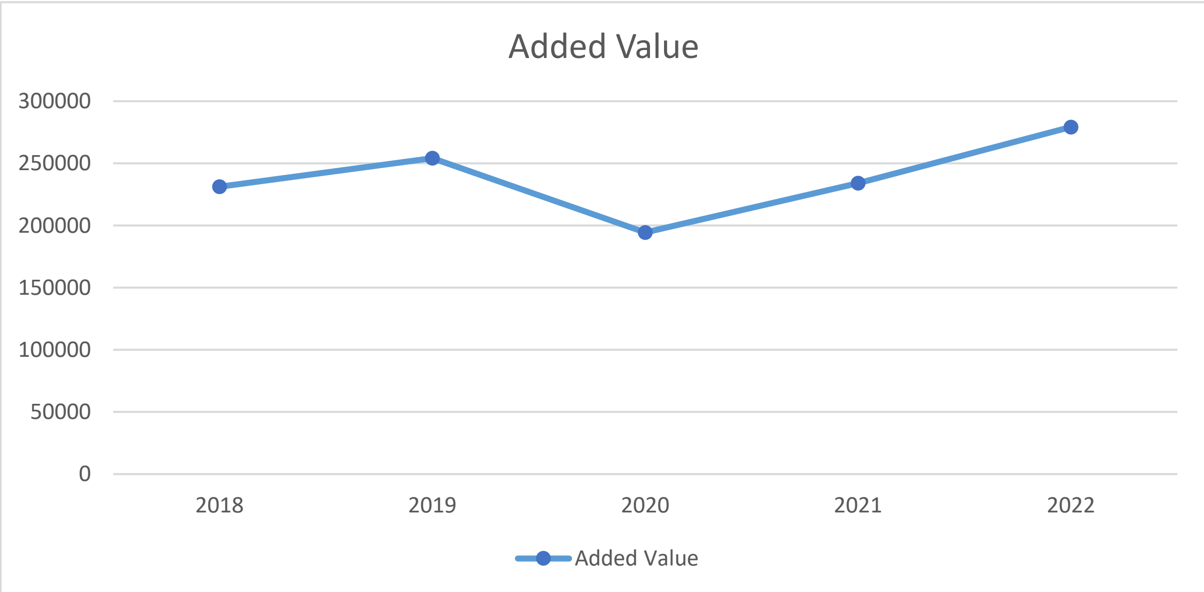


Figure 29.1: Total added value changes (IRCA excluded), Personal elaboration on Orbis data

Here, Figure 29.1 shows how the trend followed is the same, even if I.R.C.A. S.P.A. is excluded from the sample considered (it accounts about the 50% of the Added value computed from the whole sample).

4.1.2.2. Descriptive analysis by Company size

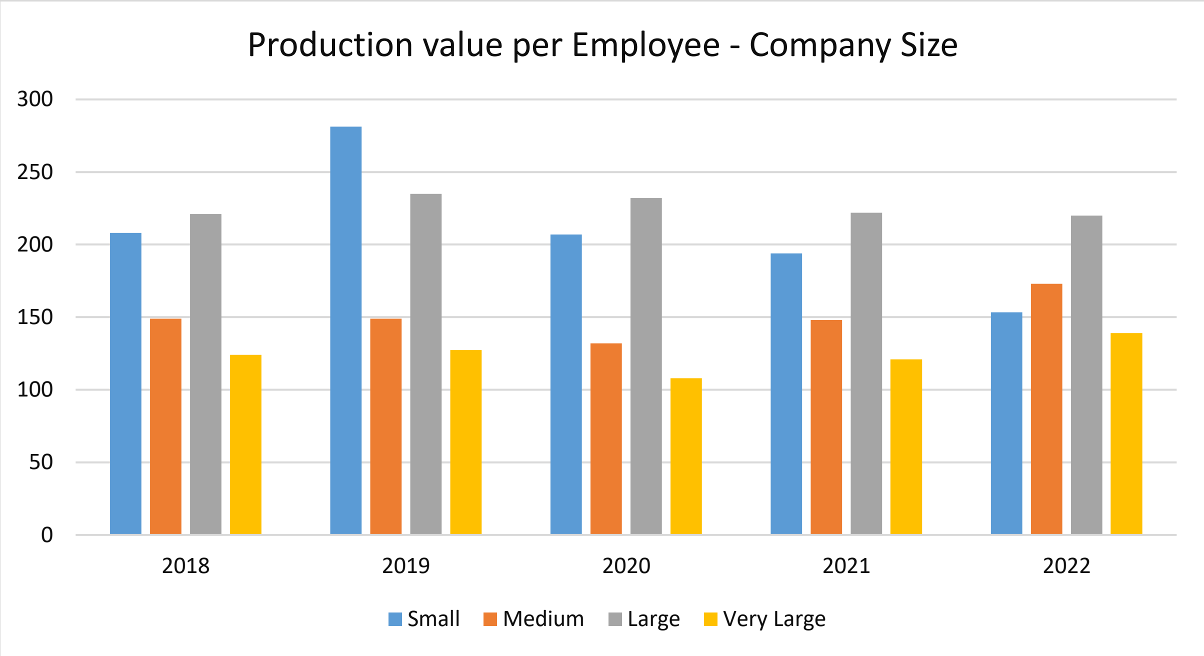


Figure 30: Production value per Employee in time interval by company size, Personal elaboration on Orbis data

In Figure 30, it can be noticed how small and large companies shown the same trend pattern with an increase in the production value for the 2019 year but a decreasing trend in the following years (2020-2022). At the same time, medium and very large companies performed in the same way in the increase from the 2018 to 2019 and a contraction in the following year and then an increase in the production value in the next two years.

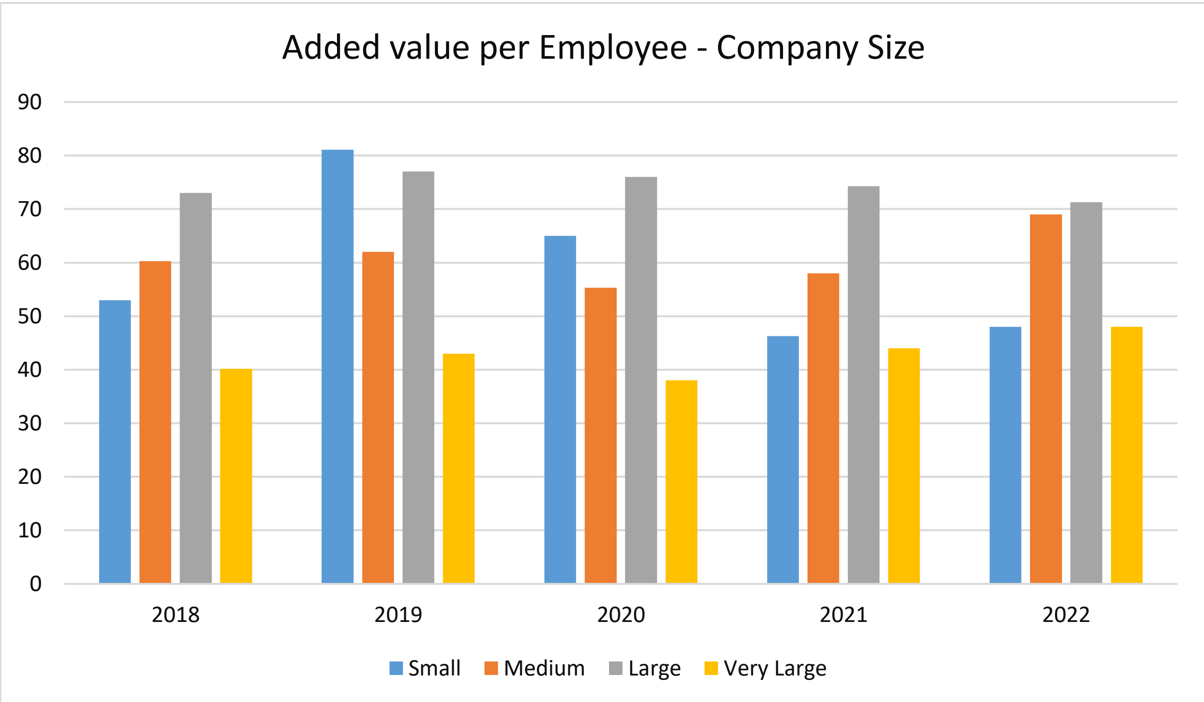


Figure 31: Production value per Employee in time interval by company size, Personal elaboration on Orbis data

Figure 31 explains the added value per employee by company size from 2018 to 2022. Small companies show significant changes with a peak in 2019 and subsequent decline. Medium and large companies display gradual increases, while very large companies show consistent values with slight growth in 2022.

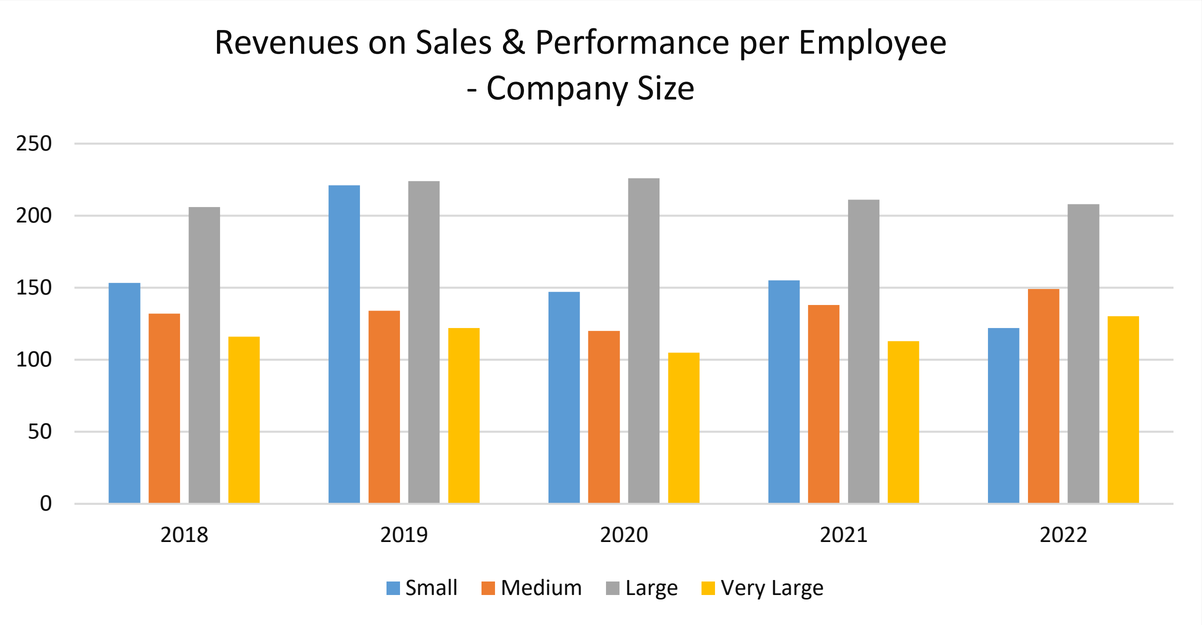


Figure 32: Revenues on sales & performance per Employee in time interval by company size, Personal elaboration on Orbis data

Figure 32 shows revenues on sales and performance per employee by company size from 2018 to 2022. Small companies show large variations, while medium and large companies are more stable with slight growth. Very large companies, although lower in values, show consistent performance indicating a balance between size and efficiency.

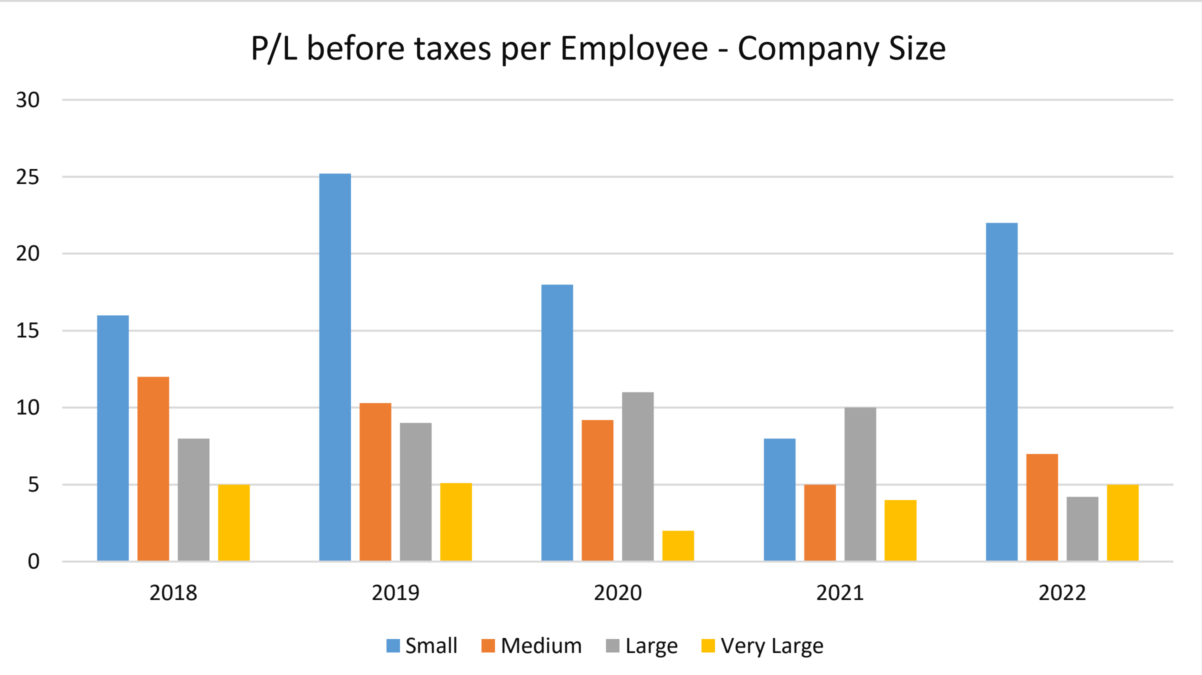


Figure 33: P/L before taxes per Employee in time interval by company size, Personal elaboration on Orbis data

Small companies show considerable variability, peaking at 25.2 in 2019 and dropping to 8 in 2021 before rising again. Medium and large companies have more moderate fluctuations, while very large companies show relative stability with minor changes.

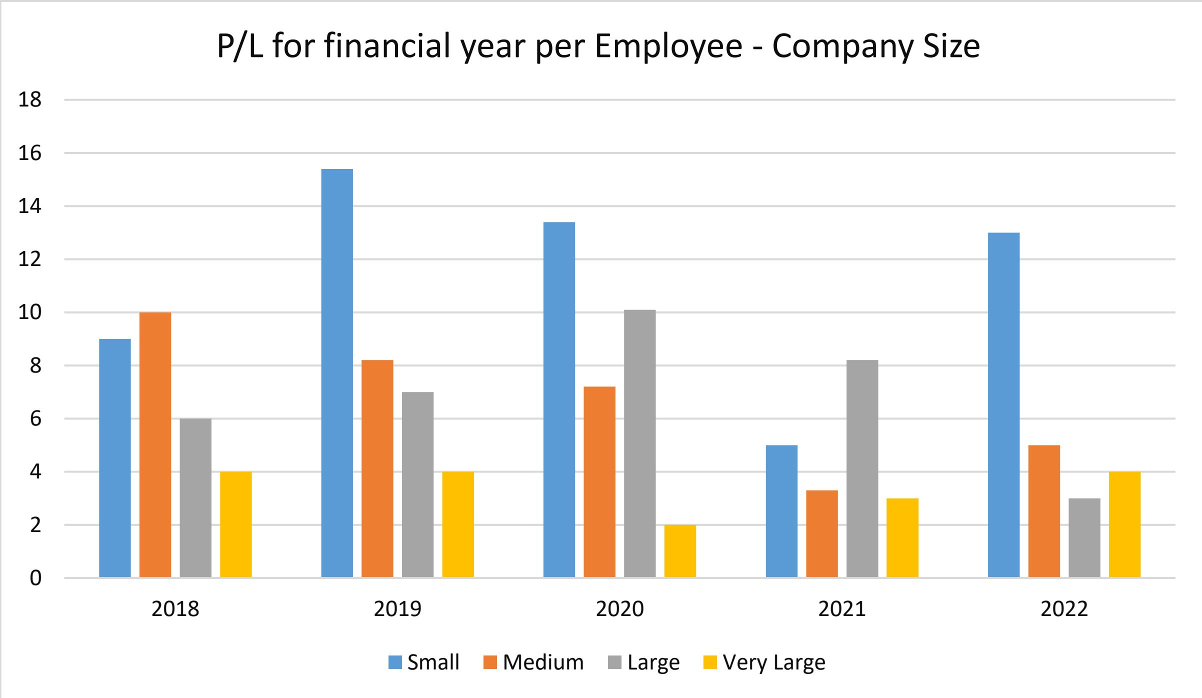


Figure 34: P/L for financial year per Employee in time interval by company size, Personal elaboration on Orbis data

Small companies again show significant variation, peaking in 2019 and declining in 2020 before recovering. Medium, large, and very large companies display more gradual changes, indicating different financial resilience and management strategies.

4.1.2.3. Descriptive analysis by Province

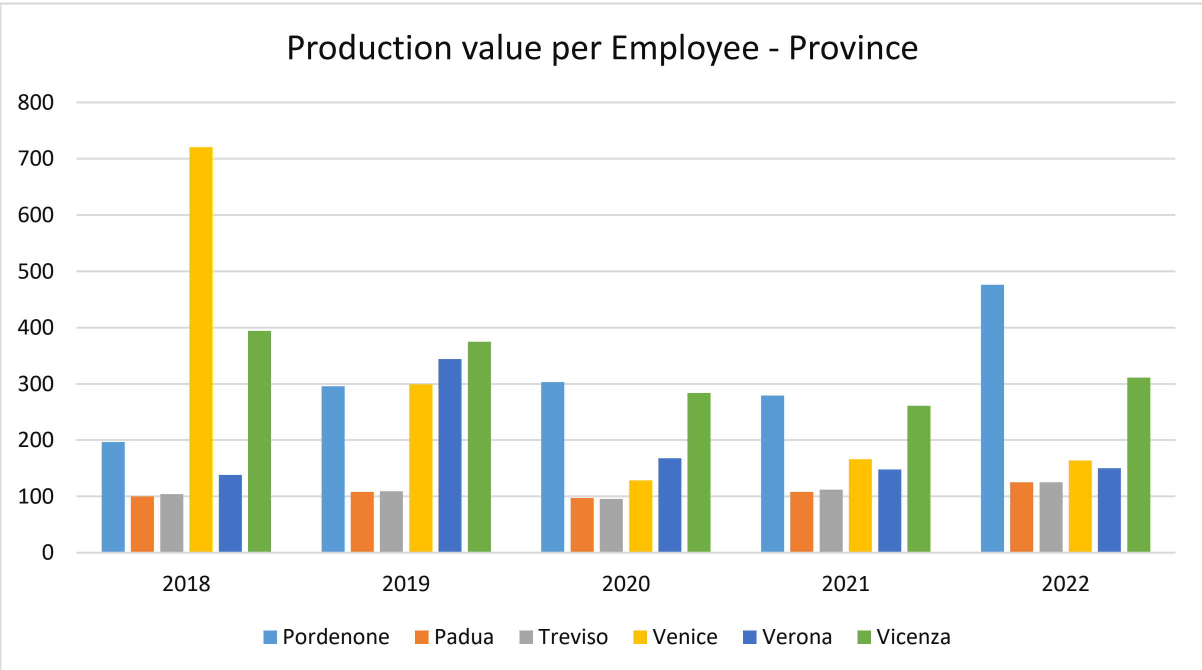


Figure 35: Production value per Employee in time interval by province, Personal elaboration on Orbis data

This graph displays the production value per employee by province from 2018 to 2022. Pordenone shows a dramatic increase, especially in 2022. Venice also shows significant peaks, while other provinces show more gradual changes, reflecting differing regional dynamics.

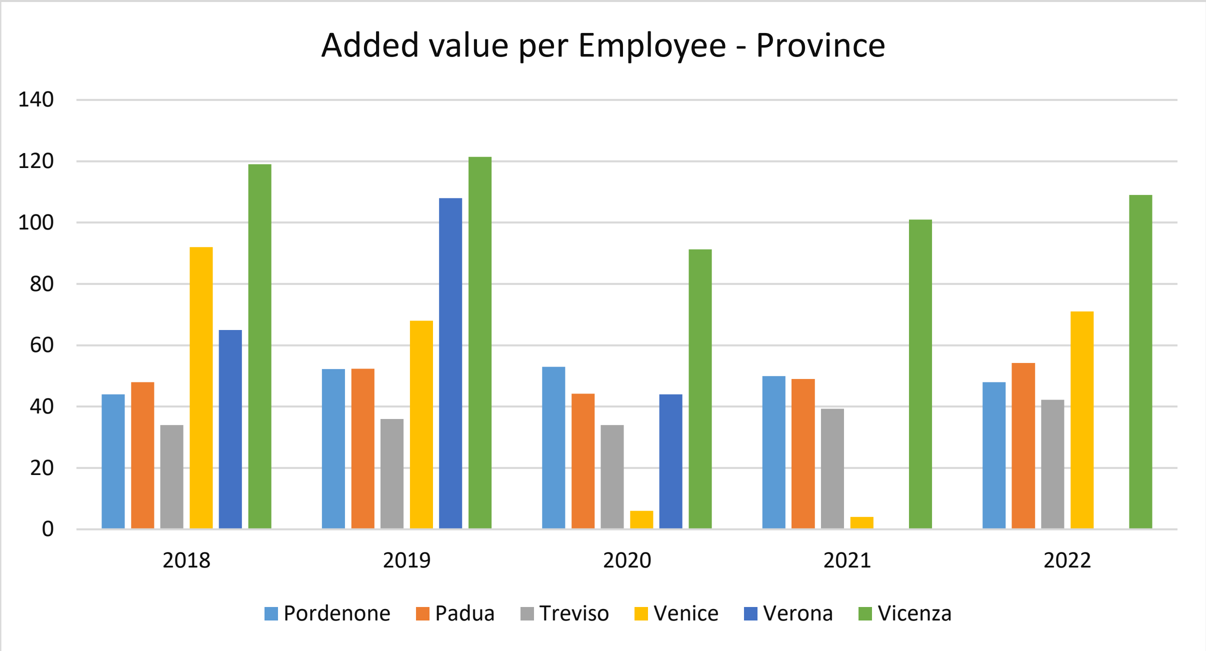


Figure 36: Added value per Employee in time interval by province, Personal elaboration on Orbis data

Significant variation exists among provinces, with Vicenza and Venice showing high values and considerable changes over the years. Other provinces show more stable trends, with moderate increases or decreases.

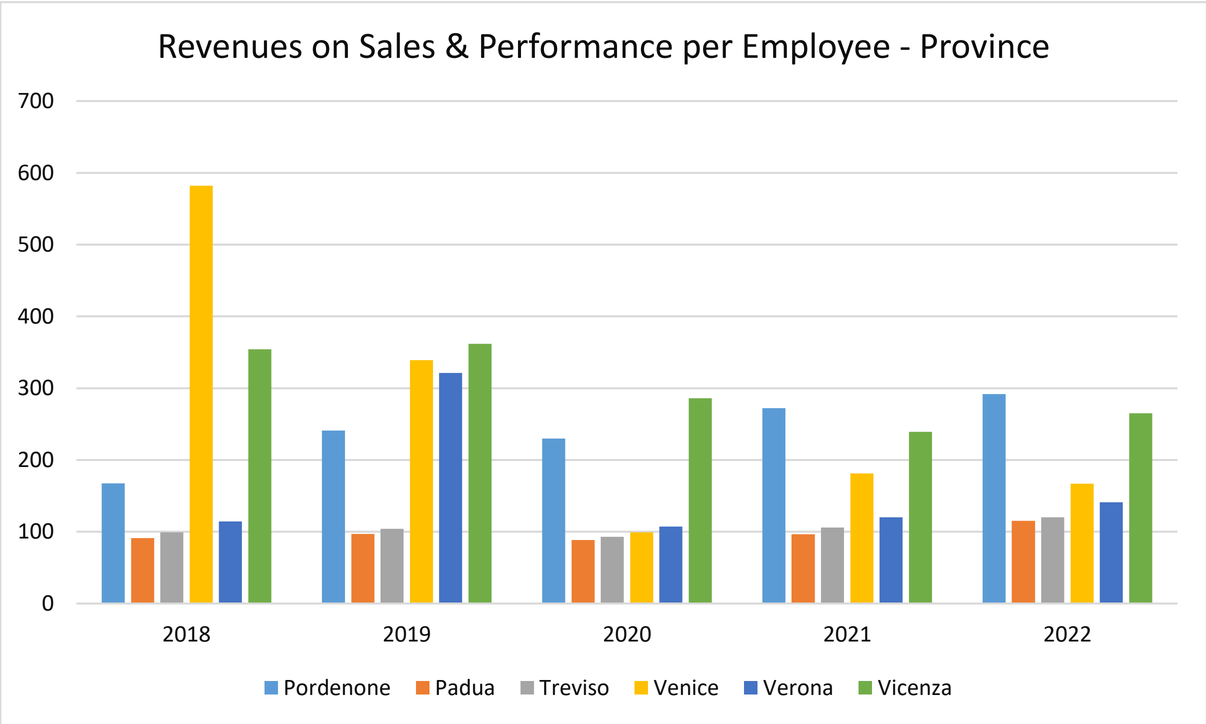


Figure 37: Revenues on sales & performance per Employee in time interval by province, Personal elaboration on Orbis data

Wide variations are observed, with Venice showing large fluctuations possibly due to tourism and service sector dynamics. Pordenone and Vicenza also show notable increases, while other provinces have more stable trends. These variations highlight regional economic diversity and the differential impact of external factors.

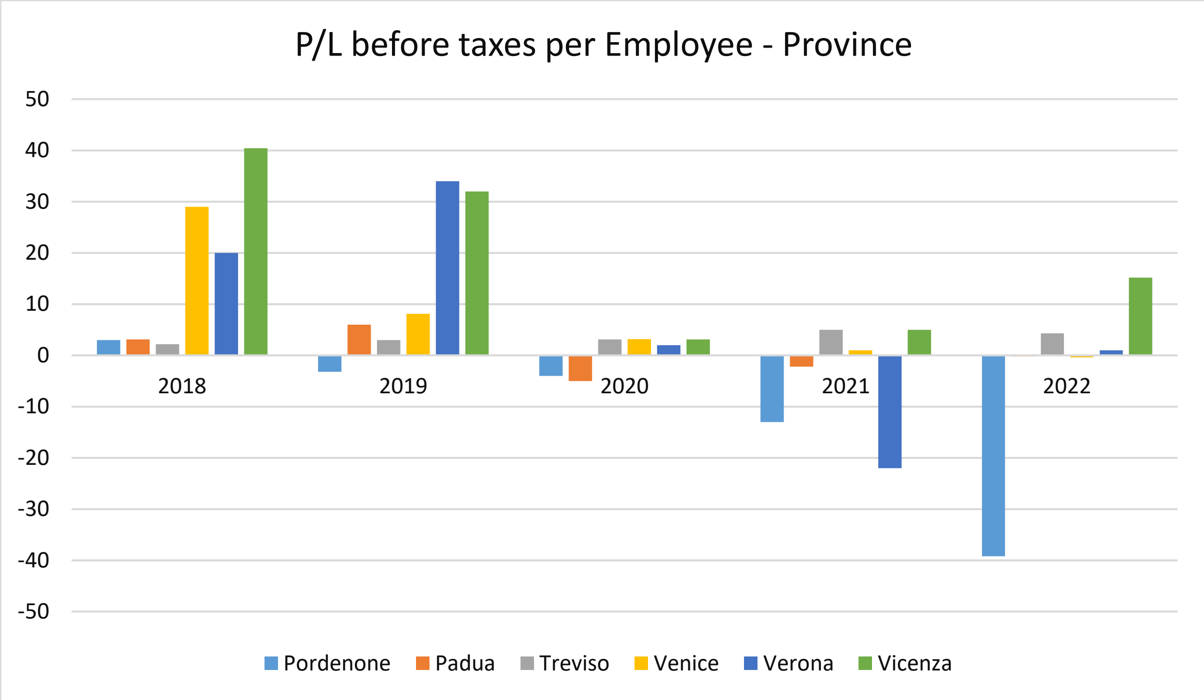


Figure 38: P/L before taxes per Employee in time interval by province, Personal elaboration on Orbis data

Provinces like Verona and Vicenza show higher values in some years, indicating better financial performance before tax. Pordenone experiences significant negative values, reflecting fiscal challenges. These variations highlight regional disparities in financial health and the effectiveness of local industry strategies.

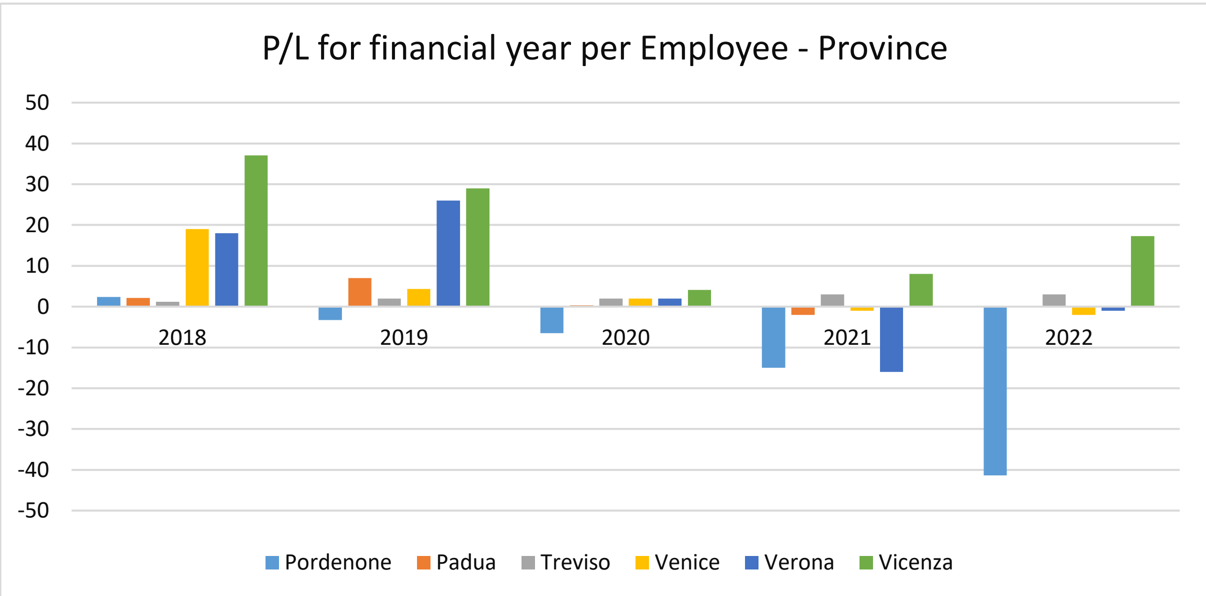


Figure 39: P/L for financial year per Employee in time interval by province, Personal elaboration on Orbis data

Significant variability exists among provinces, with negative values in some years for Pordenone, indicating financial challenges in certain periods. Other provinces show peaks and troughs, reflecting diverse financial performances influenced by local economic conditions and company-specific factors. The overall trend suggests regional differences in financial stability and profitability.

4.1.2.4. Descriptive analysis by NACE

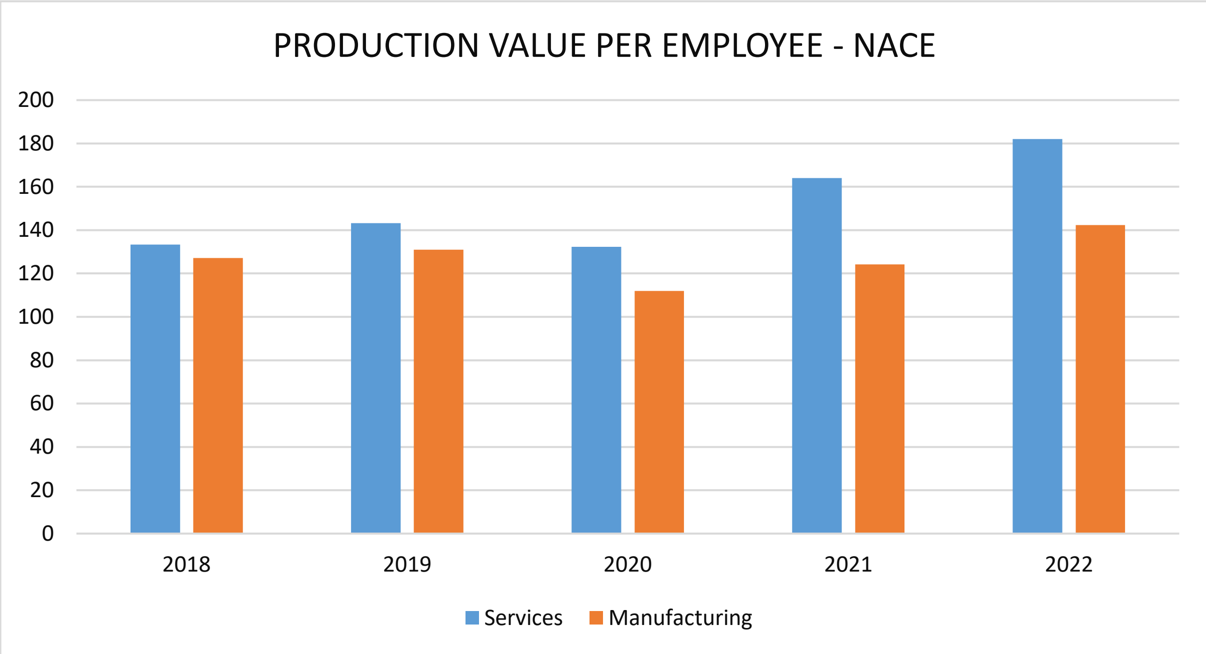


Figure 40: Production value per Employee in time interval by NACE code, Personal elaboration on Orbis data

The services sector shows significant growth in production value per employee, increasing from 133.4 in 2018 to 182 in 2022, driven by increased demand for aerospace services and technological advancements. The manufacturing sector also shows an upward trend from 127.1 in 2018 to 142.3 in 2022, despite a notable dip in 2020 due to pandemic-related disruptions. The recovery in subsequent years reflects the sector's ability to adapt to new market conditions and operational challenges.

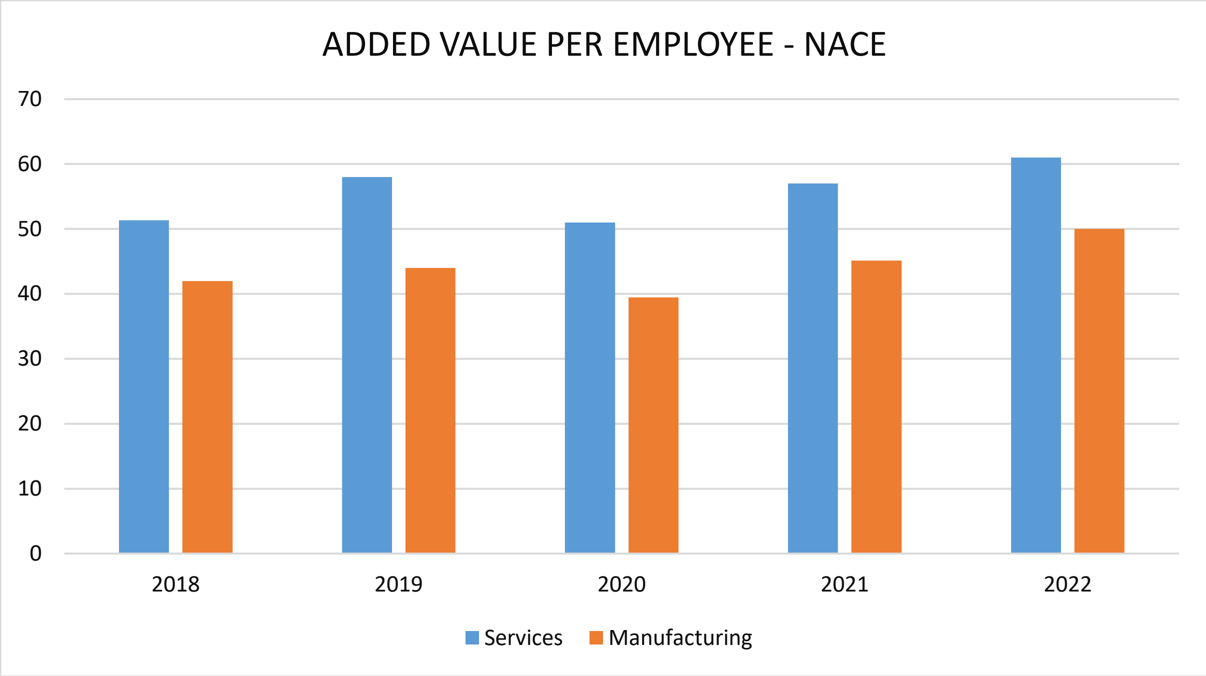


Figure 41: Added value per Employee in time interval by NACE code, Personal elaboration on Orbis data

The services sector shows a steady increase in added value per employee, rising from 51.33 in 2018 to 61 in 2022. This trend reflects ongoing improvements in productivity and efficiency within the aerospace services industry. The manufacturing sector also exhibits growth, from 42 in 2018 to 50 in 2022, despite a slight decrease in 2020 likely caused by the COVID-19 pandemic, which disrupted supply chains and reduced manufacturing output globally. The recovery in 2021 and 2022 indicates the sector's resilience and adaptation to new operational challenges and increased demand for aerospace products.

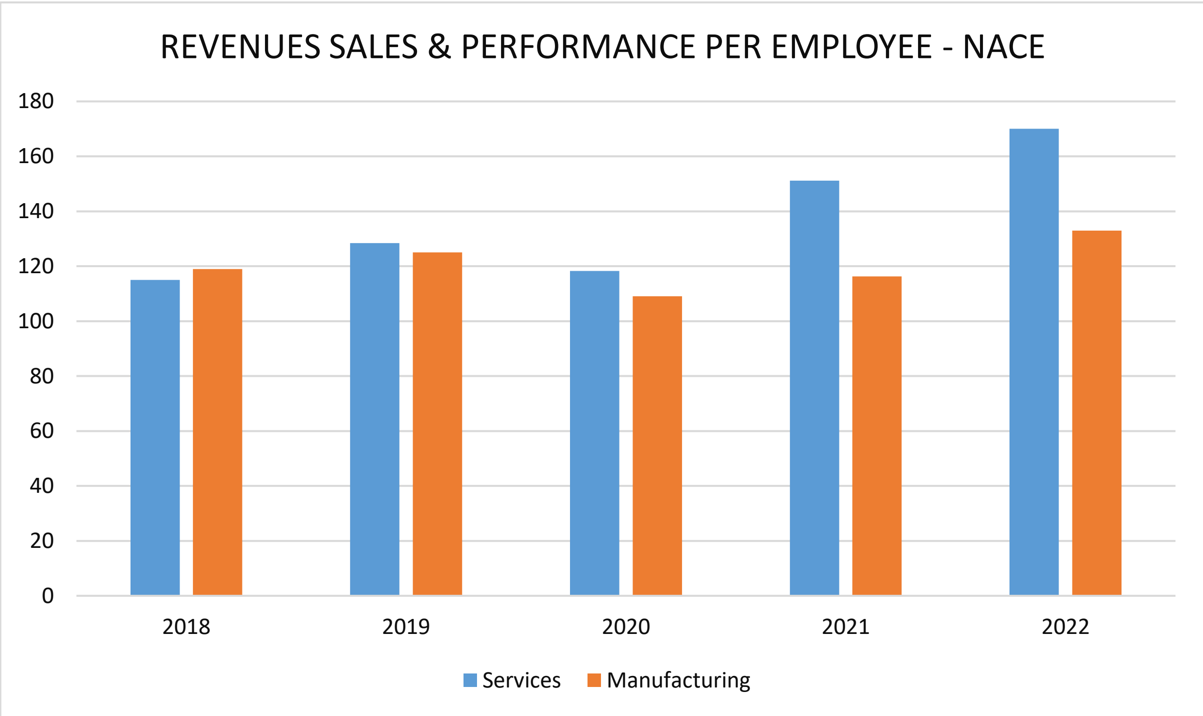


Figure 42: Revenues sales & performance per Employee in time interval by NACE code, Personal elaboration on Orbis data

Revenues per employee in the services sector increase significantly from 115 in 2018 to 170 in 2022, reflecting growing market demand and successful adaptation to digital and remote service delivery models during the pandemic. The manufacturing sector also shows revenue growth from 119 to 133, despite a dip in 2020 corresponding to the widespread impact of the pandemic on manufacturing operations and global supply chains. The subsequent recovery illustrates the sector's resilience and strategic adaptations.

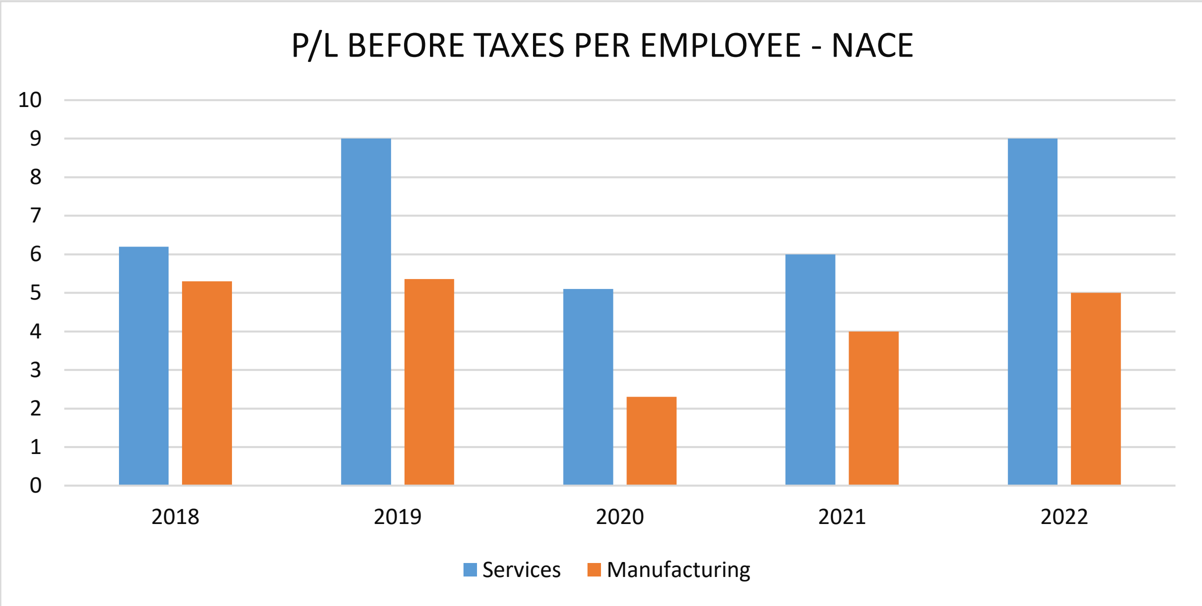


Figure 43: P/L before taxes per Employee in time interval by NACE code, Personal elaboration on Orbis data

Both sectors experience fluctuations, with the services sector ranging from 6.2 in 2018 to 9 in 2022 and manufacturing showing variability from 5.3 in 2018 to 5 in 2022. The significant drop in 2020 aligns with the peak economic impact of the COVID-19 pandemic, which caused widespread financial strain. The gradual recovery indicates the sectors' resilience and ability to restore profitability as economic conditions improved.

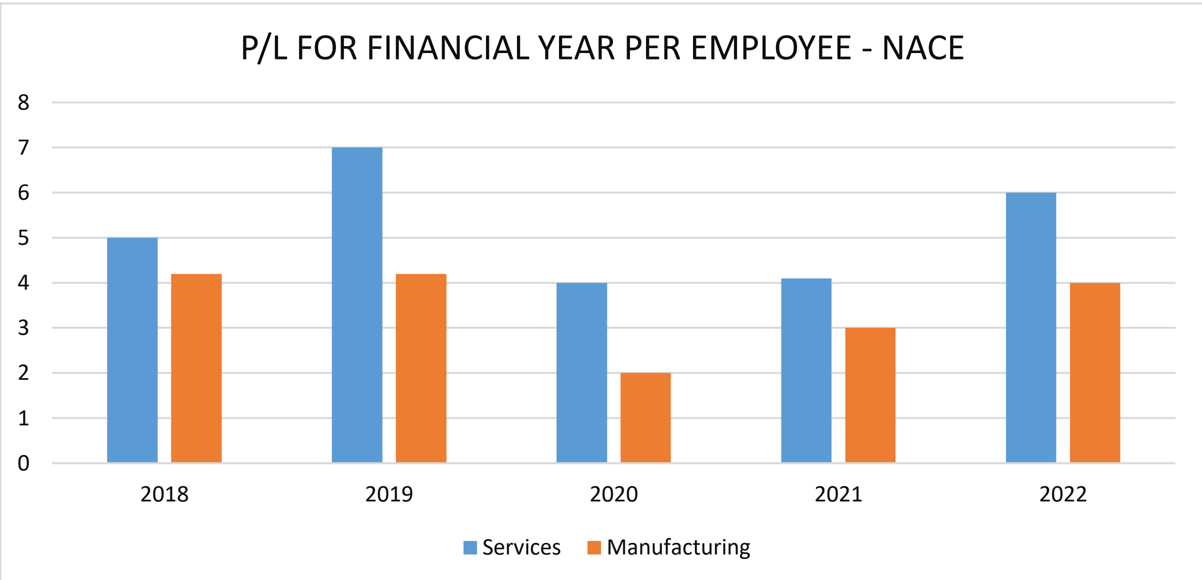


Figure 44: P/L for financial year per Employee in time interval by NACE code, Personal elaboration on Orbis data

Both sectors show a recovery post-2020, with services increasing from 5 in 2018 to 6 in 2022 and manufacturing from 4.2 to 4. The stability in the services sector suggests effective financial management and strategic adaptations, while the manufacturing sector's more gradual recovery highlights the lingering challenges in production and supply chain logistics.

4.1.2.5. Financial analysis – ROCE index

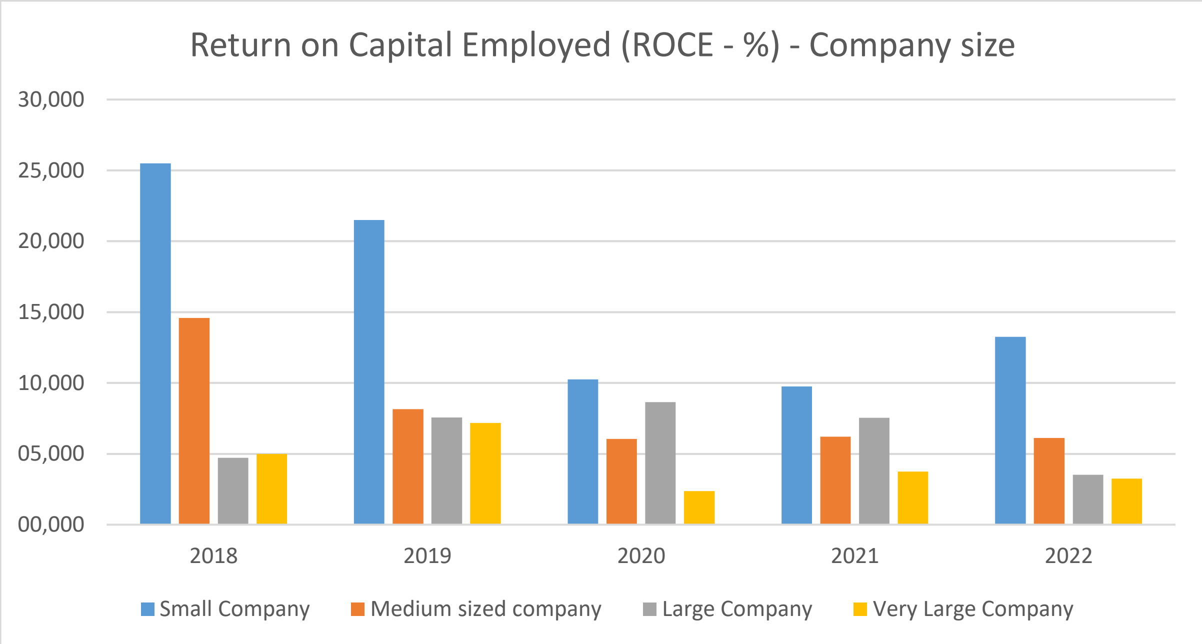


Figure 45: ROCE in time interval by Company size, Personal elaboration on Orbis data

Smaller companies exhibit more volatility in ROCE, reflecting their sensitivity to market changes and operational challenges. Medium, large, and very large companies demonstrate more stability, with gradual improvements over time, indicating better capital management and financial stability. The recovery post-2020 highlights the resilience of larger companies in managing capital efficiently.

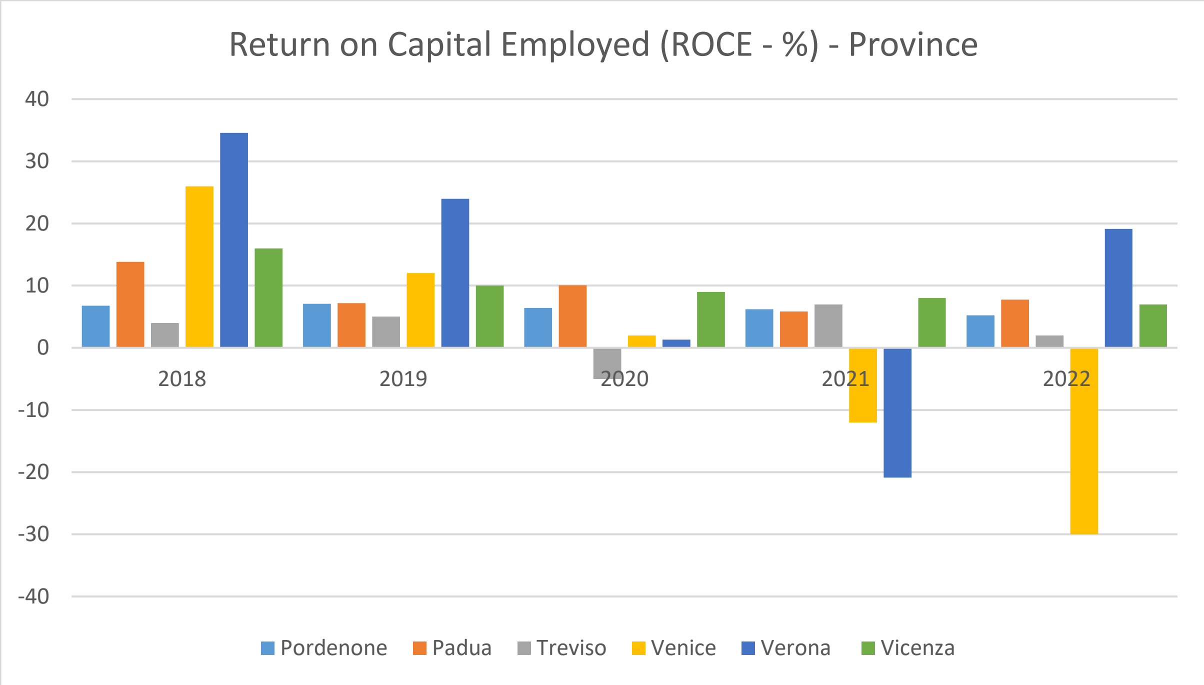


Figure 46: ROCE in time interval by Province, Personal elaboration on Orbis data

Variability exists among provinces, with some like Verona and Vicenza showing higher ROCE, indicating efficient use of capital. Other provinces like Pordenone exhibit lower ROCE, reflecting less efficient capital utilization.

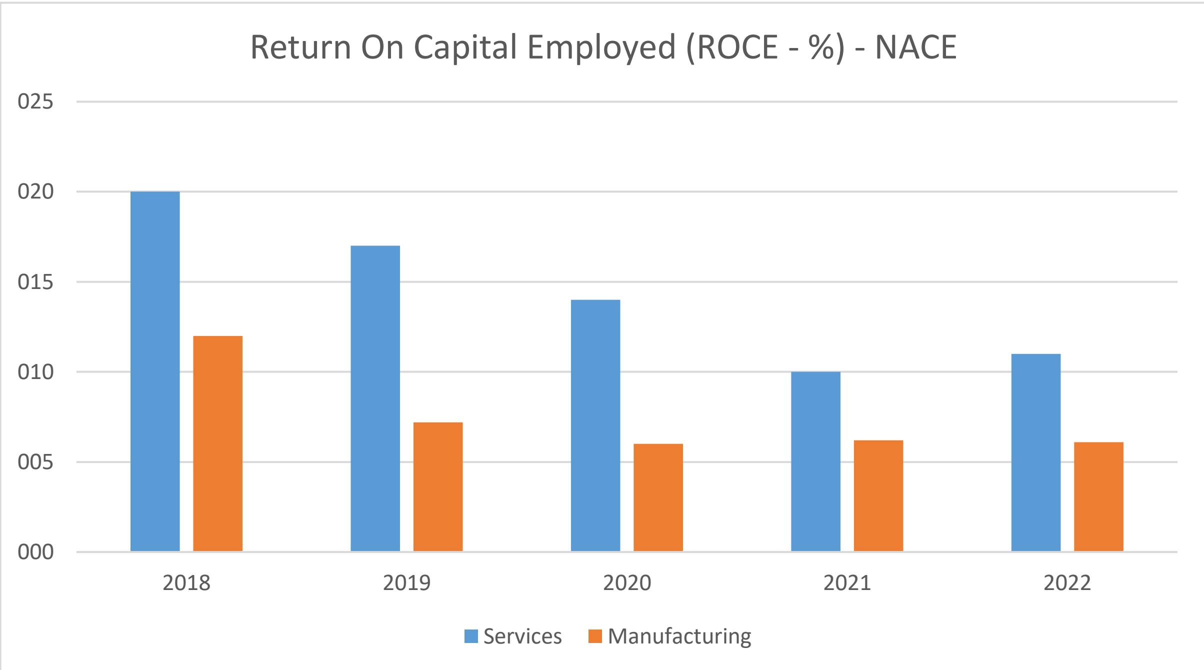


Figure 47: ROCE in time interval by NACE code, Personal elaboration on Orbis data

The ROCE shows fluctuations, with a notable dip in 2020 due to the pandemic's impact. The subsequent recovery in 2021 and 2022, particularly in the services sector, reflects improved capital efficiency and profitability. Manufacturing shows a more gradual recovery, indicating ongoing efforts to enhance capital utilization and financial performance.

4.1.2.6. Financial analysis – ROA index

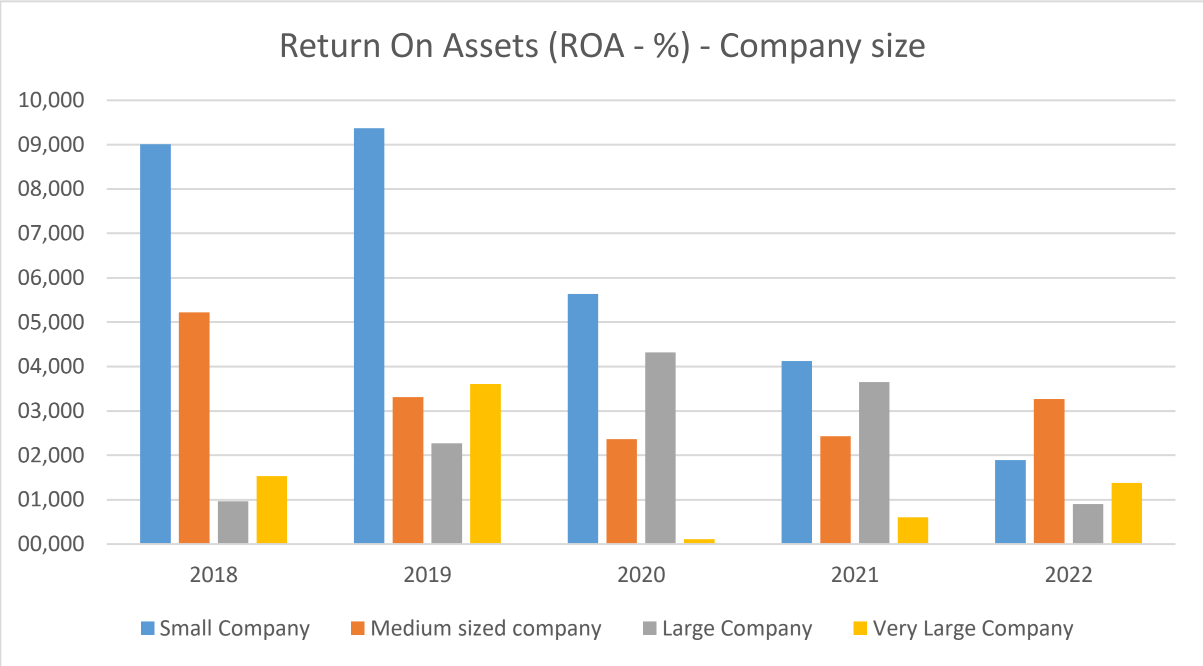


Figure 48: ROA in time interval by Company size, Personal elaboration on Orbis data

Similar to ROCE, smaller companies show significant fluctuations in ROA, indicating operational volatility. Medium and large companies exhibit more stable and gradual improvements, suggesting better asset utilization and operational efficiency. Very large companies maintain consistent ROA values, reflecting strong asset management practices and stability in financial performance.

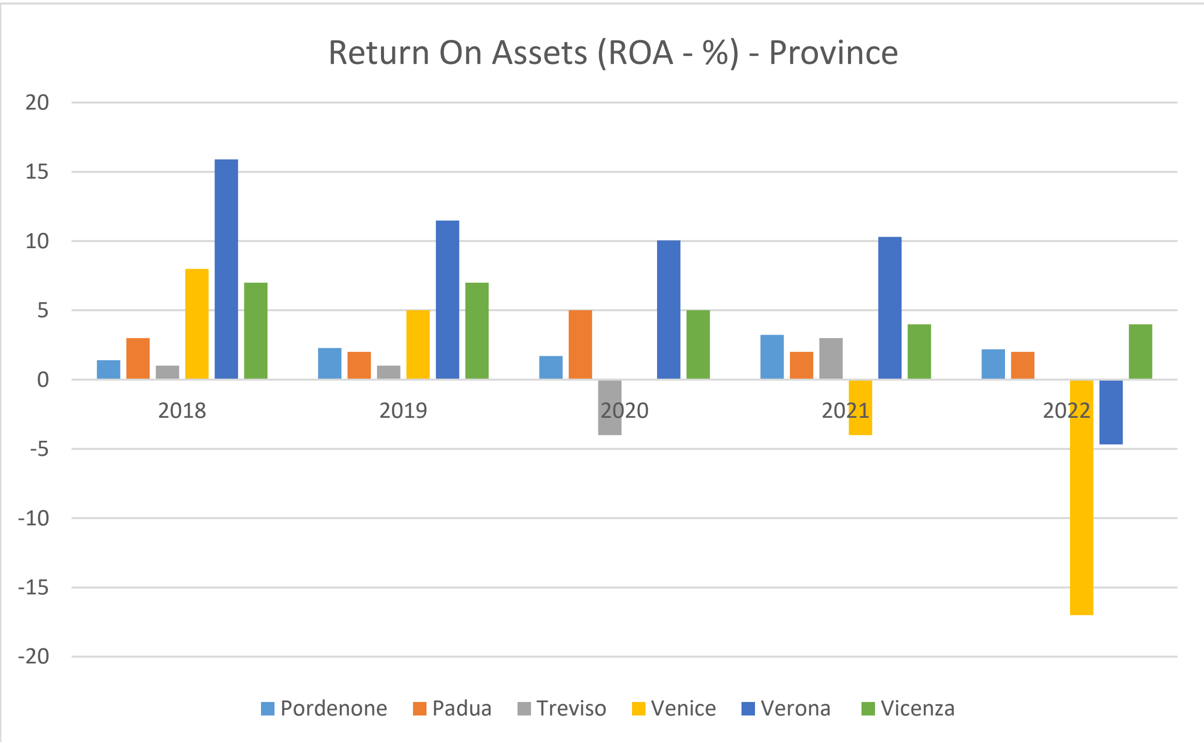


Figure 49: ROA in time interval by Province, Personal elaboration on Orbis data

Provinces like Verona and Vicenza display higher ROA on average through time interval, suggesting efficient use of assets. In contrast, other provinces show lower ROA, indicating varying levels of asset utilization efficiency across regions.

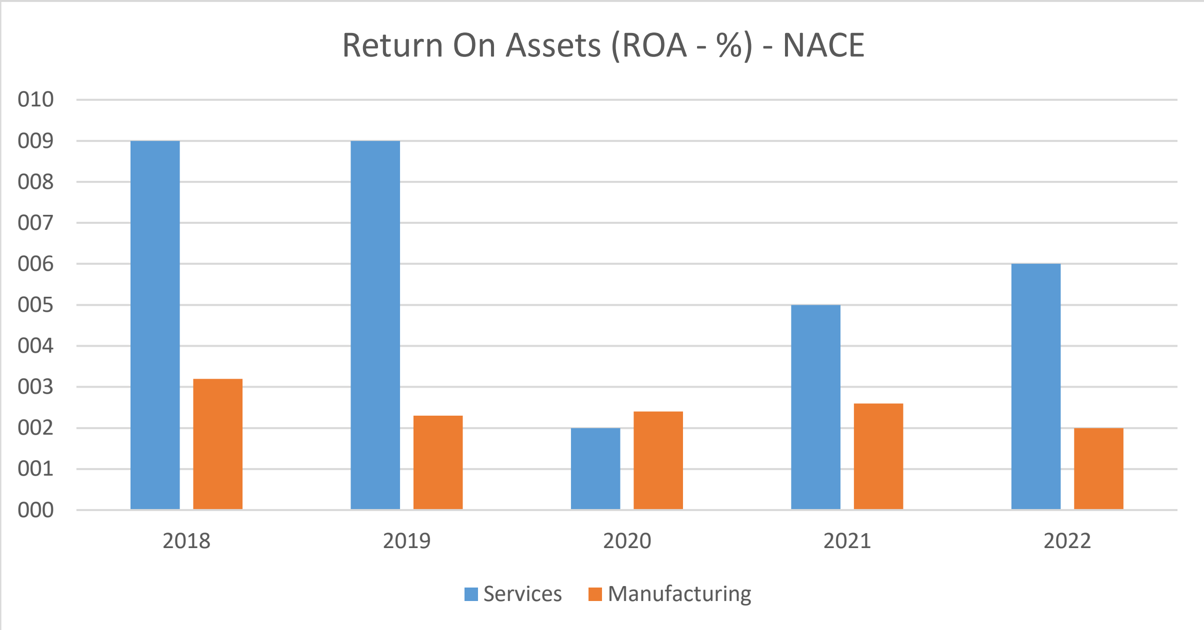


Figure 50: ROA in time interval by NACE code, Personal elaboration on Orbis data

The manufacturing sector shows a quicker recovery in ROA compared to the services sector. This trend indicates that manufacturing companies were able to improve their asset utilization and operational efficiency more effectively post-pandemic. The services sector, however, faced ongoing challenges in restoring asset productivity, reflecting the slower recovery of service activities and changing market conditions.

4.1.2.7. Financial analysis – ROE index

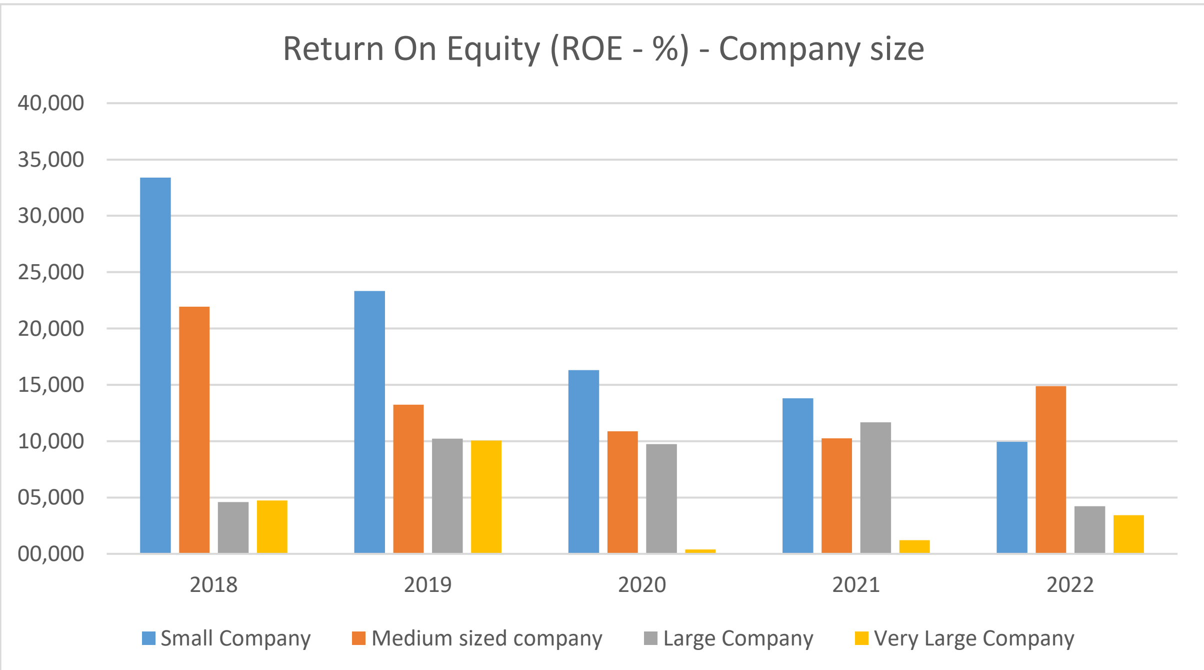


Figure 51: ROE in time interval by Company size, Personal elaboration on Orbis data

The ROE shows a significant decline in 2020 across all company sizes due to the financial strain caused by the pandemic. Smaller companies (Small and Medium) experience more pronounced declines, reflecting their higher vulnerability to financial disruptions. The recovery in 2021 and 2022 is more evident in larger companies, which benefitted from better access to capital and more robust financial management practices.

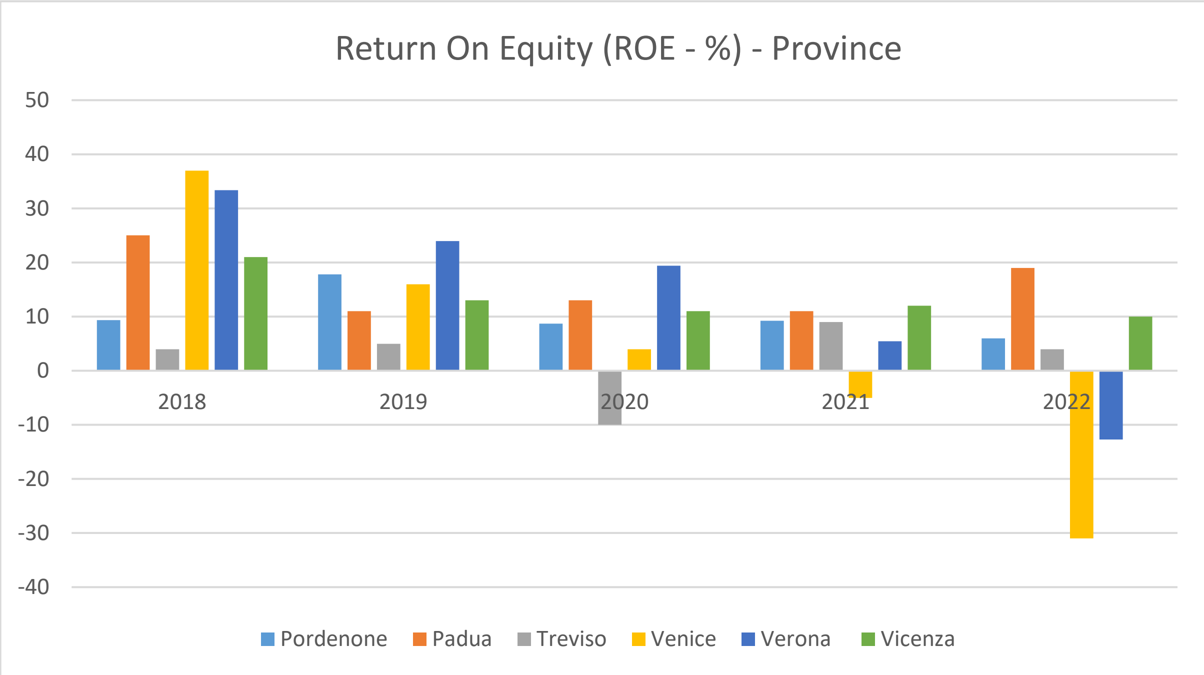


Figure 52: ROE in time interval by Province, Personal elaboration on Orbis data

Companies in provinces with a strong industrial base, such as Treviso and Vicenza, show a quicker recovery in ROE, reflecting their ability to restore profitability and improve financial performance post-pandemic. Provinces like Pordenone and Padova, while also recovering, indicate more significant initial impacts on equity returns, reflecting regional economic challenges and differences in industrial composition.

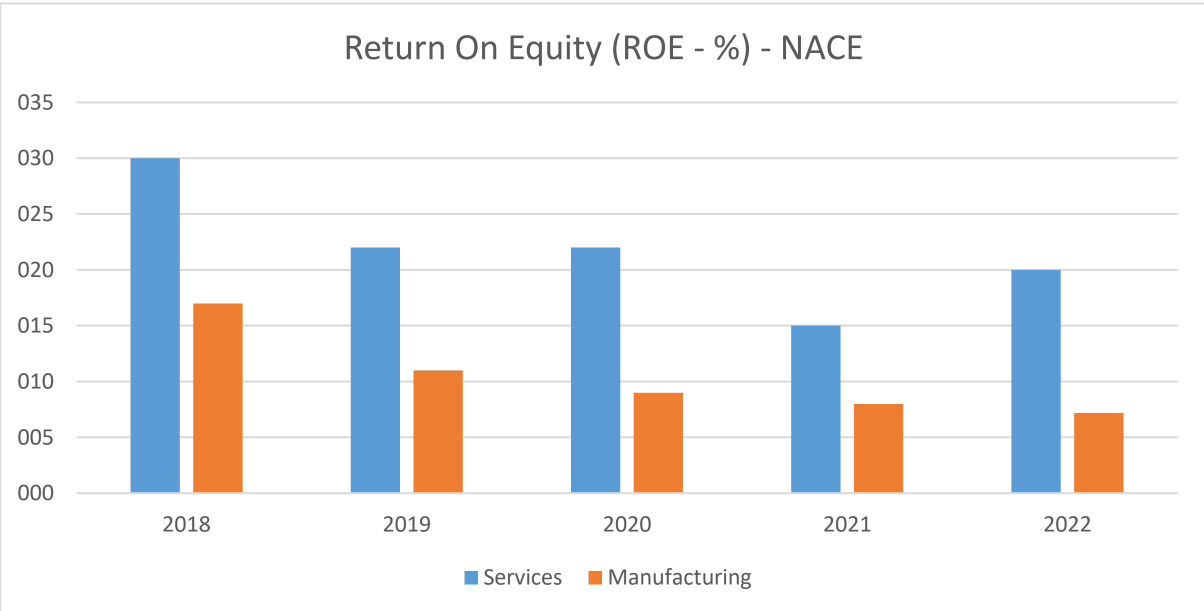


Figure 53: ROE in time interval by NACE code, Personal elaboration on Orbis data

The manufacturing sector demonstrates a stronger recovery in ROE compared to the services sector. This trend highlights the manufacturing companies' ability to quickly adapt to new market demands, restore profitability, and enhance financial performance. The services sector, however, faced more prolonged financial challenges, reflecting the slower recovery of service-related activities and ongoing adjustments to changing market conditions.

These data provide a comprehensive understanding of the trends observed in ROCE, ROA, and ROE for aerospace companies belonging to the AIR network, segmented by company size, province, and NACE code from 2018 to 2022. They highlight the significant impact of the COVID-19 pandemic on financial performance and the varying recovery dynamics across different segments of the industry.

4.2. Employment Database

The Sistema Informativo Lavoro Veneto (SILV) serves as a crucial information system for monitoring labor market dynamics within the Veneto region, thanks to SILV a wide spectrum of workers information can be reached such as the occupational title (up to the fifth identification number), gender, nationality and level of education, which will be used in this research (Table 10). This empirical analysis draws on a sample of 35 aerospace companies registered in SILV belonging to the AIR network (sample information are present in both database – Orbis and SILV), spanning from 2008 to 2020, the sample is divided in categories as follows:

- 19 Manufacturing companies
- 16 Services companies (14 KIBS and 2 traditional services)

	Manufacturing	Services	KIBS
Gender	%	%	%
Male	78.12	80.00	74.59
Female	21.88	20.00	25.41
Nationality			
Italian	93.96	90.00	96.13
Foreigner	6.04	10.00	3.87
Education			
Basic	37.86	45.00	13.82
Secondary school	43.94	42.50	20.99
Tertiary degree	18.19	12.50	65.19
Emp (2590)	91.47 (2369)	1.54 (40)	6.99 (181)

Table 10: Distribution of employees by gender, citizenship, education - total and by macro-sector, year 2020, SILV data

The database, which is both aggregated and anonymized, provides a robust basis for examining the distribution of skills and competencies among personnel in these companies. Within this context, KIBS (Knowledge-Intensive Business Services) refers to sectors covering activities such as publishing, software, IT consulting, R&D, architecture, and engineering, specifically categorized under ATECO codes 58-74. The ATECO classification codes 14 to 33 correspond to the manufacturing sector, while codes 43 to 95, excluding KIBS, pertain to the services sector.

From Table 10, a series of information can be extrapolated:

- Analysis of 35 companies sample gave a total number of 2590 occupational title code, where the 91,47% (2369) belongs to the Manufacturing macro-sector.
- Macro-sector of services as an aggregate percentage of 8,53% (221), sub-divided in traditional services 1,54% (40) and Knowledge-Intensive Business Services – KIBS – 6,99% (181).
- Majority of both sectors, according to the *Gender* class, is made up of male employees (ranging between 74% up to 80%).
- Regarding all the sector, over the 90% of the employees has the Italian *Nationality*, in particular these data are highlighted in the Manufacturing and KIBS sectors (respectively 93,96% and 96,13%).
- - In the *Education* class, the figure for employees with a tertiary degree in the KIBS sector is particularly significant (65.19%). In this class, this is the only result that exceeds half of the overall KIBS sample. The level of *Education* for the Manufacturing and Service sector is distributed between basic and secondary education with similar percentages, in the same thresholds the KIBS sector shows the lowest percentages. As will be seen in the following pages, the KIBS sector invests heavily in the employment of human capital, requiring high levels of education.

1-digit code	Occupational Title
Code - 1	Legislators, senior officials and managers
Code - 2	Professionals
Code - 3	Technicians and associate professionals
Code - 4	Clerks
Code - 5	Service workers and shop market sales workers
Code - 6	Skilled agricultural, fishery workers, craft and related trade workers

Code - 7	Plant and machine operators and assemblers
Code - 8	Armed Forces

Table 11: ISCO-88 International Standard Classification of Occupations

Starting from Table 11, the following analysis will deal with the distribution of the occupational title (Manufacturing and KIBS), keeping out the traditional services companies given the small number of companies in the sample.

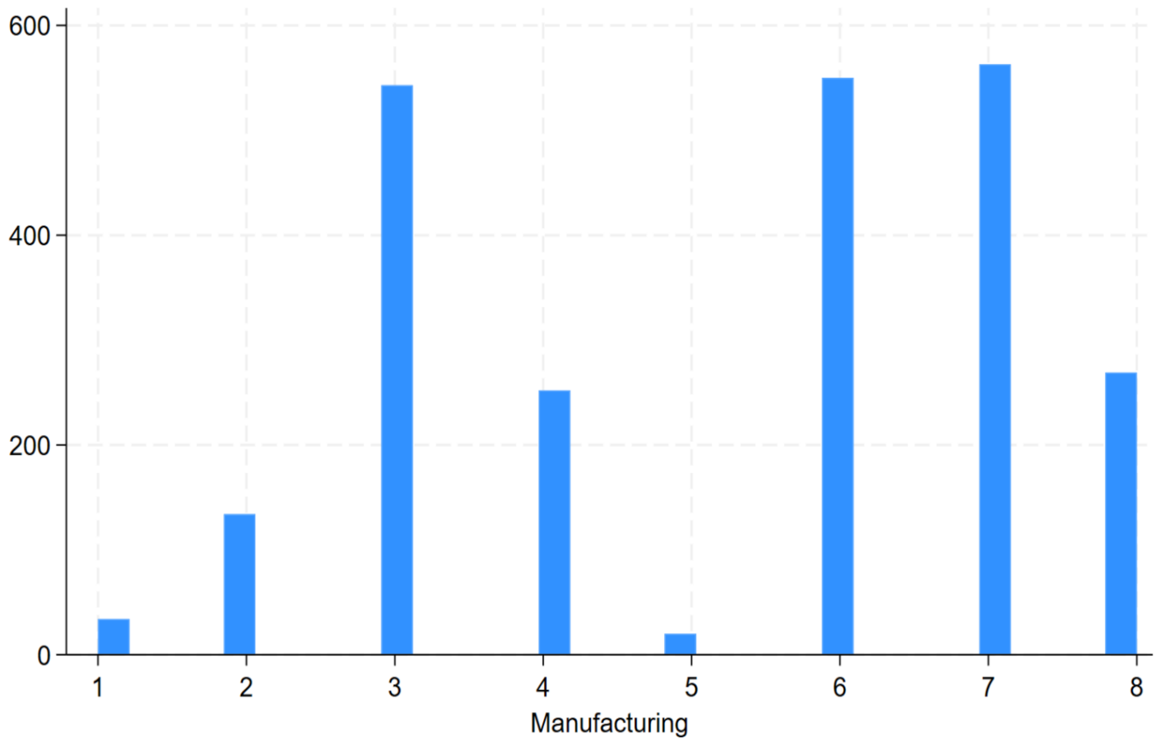


Figure 54: Distribution of 1-digit occupational title by KIBS macro-sector, SILV database

Figure 54 displays high concentrations of employees working in the manufacturing sector belonging to the 1-digit occupational title (according to the ISCO table) of: Technicians and associate professionals (code – 3), Skilled agricultural, fishery workers, craft and related trade workers (code – 6) and Plant and machine operators and assemblers (code – 7).

Employees falling within these 1-digit code are characterized respectively by: 1) technical-disciplinary knowledge, 2) use of working experiences and application of technical and practical knowledge of materials, tools and processes, 3) drive and control of industrial machines.

Code – 3 occupational title is characterized by a employees' education from secondary, post-secondary or university level I education.

Both Code – 6 and Code – 7 are featured by a basic knowledge of employees acquired by completing compulsory schooling or through the experience acquired while exectuting manual labour.

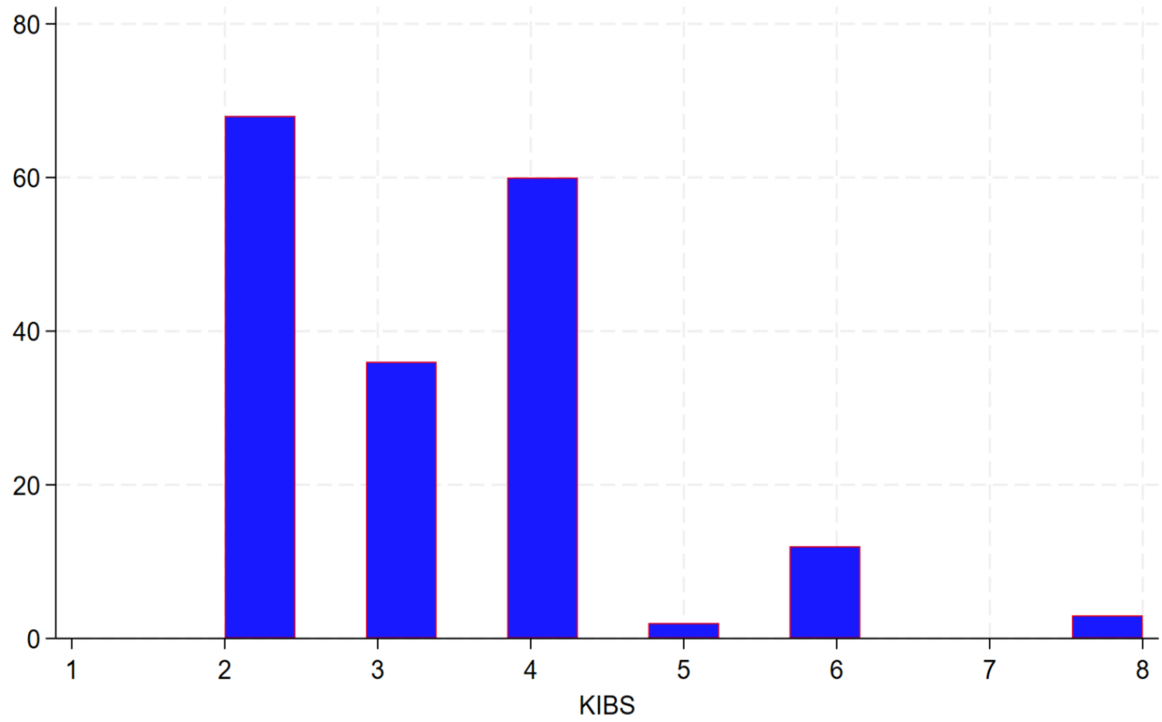


Figure 55: Distribution of 1-digit occupational title by KIBS sector, SILV database

Employees in the KIBS sector are distributed between these 1-digit occupational title: Professionals (code – 2) and Clerks (code – 4).

Employees falling within these 1-digit code are characterized respectively by: 1) a high level of theoretical knowledge in order to analyse problems/complex situation and solve them, 2) performance of office work without requiring managerial capacity.

Code – 2 occupational title has a general level of knowledge acquired through the completion of Level II university or postgraduate education.

Code – 4 occupational title is marked by knowledge similar to that acquired by completing compulsory schooling or a short course of upper secondary education, or a professional qualification or work experience.

4.2.1. Occupation title analysis

In this section, data from SILV is integrated with data from ICP 2013 (*Indagine Campionaria delle Professioni*), a survey inspired by the US O*Net (Occupational Information Network), according to which the occupation is a multidimensional concept that can be described by referring to several areas of information on work attitudes, knowledge, skills, and tasks.

Promoted by INAPP and ISTAT (https://www.inapp.gov.it/rilevazioni/rilevazioni-periodiche/indagine-campionaria-sulle-professioni-icp), the ICP investigates the characteristics of the occupations, with particular reference to the skills and knowledge required for their development, the requirements for their performance and the characteristics of the work contexts in which the various professions are carried out. Table 12 and Table 13 provide the full list and description of 41 available tasks (namely, *generalized work activities*) and 35 skills (namely, *knowledge necessary to perform the profession*) used in the following analysis. Tasks and skills are further grouped into *families* using the INAPP-ISTAT methodology, which follows the O*NET classifications.

The ICP 2013 provides task and skill information for all the five-digit occupational titles. Therefore, using the occupational title (i.e, the *Codice Professionale* 2011) as a key variable, it is possible to merge the ICP 2013 with the SILV, the applied methodology follows the one used in Antonietti et al. (2022), obtaining an employer-employee-task/skill dataset: for each of the 35 available companies, we have information on all the employees (by five-digit occupational title), and, for every single employee, we have information on the tasks performed on the job and on the skills necessary to accomplish tasks. More specifically, each task and skill is associated with two scores ranging from 0 to 100: one score (a) measures how *important* the individual task or skill is in the performance of the job; the other (b) measures how *necessary* the individual task/skill is for the performance of the job.

Given these scores, the analysis proceeds as follows. First, an average is computed within each company for each task and skill. In this way, it is possible to compute the average score of task/skill *j* in each company, in the year 2020, which depends on the distribution of occupations within each company. Second, we pool tasks and skills into families, respectively 7 and 6, by averaging the (average) scores previously obtained across the groups described in Tables 12 and 13.

Task title	Task Description	Task family
Gather information (- g1)	Observe, receive or obtain in any way, information from relevant sources	Information input
Identify objects, actions, and events (- g2)	Identify information cataloguing, evaluating and recognizing the differences and similarities	Information input
Control processes, materials, or surroundings (- g3)	Check and reviewing information from materials, events, or the environment to detect or assess problems	Information input
Inspect equipment, structures or materials (- g4)	Inspect equipment, structures, or materials to identify the causes of errors or other problems or defects	Information input
Estimate the quantifiable characteristics of products, events, or information (- g5)	Estimating sizes, distances, and quantities, or determining time, costs, resources, or materials needed to perform a specific work.	Information input
Assess the quality of items, services, or persons (- g6)	Estimate the value, importance, or quality of things or people	Analytical
Evaluating information to determine compliance with the standard (- g7)	Use relevant information and individual opinions to determine whether events or processes comply with international standards, laws and regulations	Analytical
Process information (- g8)	Compile, code, categorize, calculate, tabulate, review or verify information or data	Analytical
Analyzing data or information (- g9)	Identify the relationships, the reasons underlying facts or information to disaggregate information or data into separate parts	Analytical
Make decisions and solve problems (- g10)	Analyse information and evaluate results to choose the best solution and solve problems	Analytical
Think creatively (- g11)	Developing, designing, or creating new applications, ideas, relationships, and new systems and products (including artistic contributions)	Analytical
Update and use knowledge relevant (- g12)	Stay informed about technical changes and apply new knowledge	Analytical
Develop goals and strategies (- g13)	Establish long-term goals, and specify the strategies and actions to achieve them	Analytical
Plan the work and activities (- g14)	Schedule events, plans and activities or the work of other people	Analytical
Organize, plan, and prioritize work (- g15)	Develop specific objectives and work program setting priorities	Analytical
General physical activities (- g16)	Perform physical activities that require you to move the entire body or a considerable use of the arms and legs, such as climbing, climbing stairs, standing balance, walking, bending and manipulating materials	Manual (non-routine)
Handle and move objects (- g17)	Use hands and arms to handle, install, position, and moving materials, or to manipulate objects	Manual (Routine)

Managing machines and processes (- g18)	Use both the control mechanisms that direct physical activity to operate machines or processes (not including computers and vehicles)	Manual (non-routine)
Working with computers (- g19)	Using computers and computer systems (hardware and software) to program, write software, set functions, enter data, or process information	Other cognitive (non-routine)
Manoeuvre vehicles, mechanical or equipment (- g20)	Operate, operate, drive or drive vehicles or mechanical equipment such as forklift trucks, transport vehicles, aircraft or boats	Manual (non-routine)
Write drafts, notes and draw technical specifications for components or equipment (- g21)	Produce documentation, detailed instructions, drawings, or specifications to explain how they are manufactured, assembled, modified, maintained, or used devices, components, equipment or facilities	Other cognitive (non-routine)
Repair and maintenance of mechanical equipment (- g22)	Do maintenance, repair, adjust and test machines, devices, moving parts and mechanical equipment (non-electronic)	Other cognitive (routine)
Repair and maintenance of electronic equipment to (- g23)	Do maintenance, repair, adjust, calibrate, or try to develop machines, computer peripherals and electronic (not mechanical)	Other cognitive (routine)
Document, record information (- g24)	Enter, transcribe, record, store, or maintain information in written, electronic or magnetic	Other cognitive (routine)
Interpret the meaning of information (- g25)	Interpret or explain the meaning of information and their possible use	Interactive
Communicate with superiors, colleagues, and subordinates (- g26)	Provide information to superiors, colleagues and subordinates by telephone, in writing, by e-mail or in person	Interactive
Communicating with people outside the organization (- g27)	Communicating with people outside the organization, representing the same to customers, the public, government, and other external entities, personally, in writing, by telephone or by e-mail.	Interactive
Establishing and maintaining interpersonal relationships (- g28)	Create constructive and cooperative working relationships and maintain them over time.	Interactive
Assist and take care of other (-g29)	Providing personal assistance, medical attention, emotional support, or other personal care to others (colleagues, clients, patients)	Interactive
Sell goods or affect other (- g30)	Convince others to buy goods or goods or make them change their minds or behaviour	Interactive
Resolve disputes and negotiate with other people (- g31)	Handle complaints, negotiate, soothe disputes and resolve conflicts	Interactive
Working in direct contact with the public or perform (- g32)	Perform for the public or deal directly with the public. Includes serving customers in public establishments or shops and receiving clients or guests	Interactive

Coordinate the work and activities of other (- g33)	Far so that the components of a group work together to perform the tasks assigned	Interactive
Grow and enable working groups (- g34)	Encourage and nurture mutual trust, respect, and cooperation among members of a group.	Interactive
Train and teach (- g35)	Identify the training needs of other people, to develop programs or formal education or training, and teaching or instructing others	Interactive
Guide, direct, and motivate subordinates (- g36)	Guide and direct subordinates defining the standards in performance and control of these	Interactive
Train and develop others (- g37)	Identify growth needs of other people and train, take the lead or help others to improve their knowledge and skills	Interactive
Provision of advice and tips to other people (- g38)	Provide guidelines and suggestions qualified to management or other groups on technical matters or relating to systems or processes	Interactive
Perform administrative tasks (- g39)	Daily administrative tasks, such as managing files and attend practices	Interactive
Recruit staff (- g40)	Recruit, interview, select, hire and promote employees in an organization	Interactive
Monitor and control resources (- g41)	Monitoring and controlling resources and overseeing the spending activities	Interactive

Table 12: Classification of tasks, INAPP-ISTAT 2013

Tables 12.1 and 12.2 show the average scores (type a and b, respectively) of each task family for manufacturing, KIBS, and the whole sample of firms.

Task family A	Manufacturing	KIBS	Tot
Information input	46.44	**50.48**	48.17
Analytical	46.70	**59.85**	52.41
Manual non-routine	**21.71**	7.555	15.50
Manual routine	**36.32**	16.48	27.62
Cognitive non-routine	41.31	**56.95**	47.84
Cognitive routine	26.61	**27.33**	26.67
Interactive	35.06	**43.87**	38.92

Table 12.1: Average score of Task family A to assess each importance degree, SILV 2020

This table presents the average scores of different task families, assessing the importance degree within manufacturing and KIBS sectors. From the table it can be seen that 5 out of 7 task families see higher scores in the KIBS sector than both the average scores in the manufacturing sector and the Veneto regional average.

Of these 5 task families, the Information input, Analytical and Cognitive non-routine task families exceed the 50% threshold of scores in the KIBS sector, also demonstrating their high degree of importance and the complexity of the work activities related to this sector.

On the manufacturing front, on the other hand, we see higher scores than both the KIBS sector and the regional average in the Manual non-routine and Manual routine task families, demonstrating the great importance of physical activities, including those related to the use of machinery.

Task family B	Manufacturing	KIBS	Tot
Information input	41.43	**46.23**	43.51
Analytical	42.57	**54.87**	47.91
Manual non-routine	**19.80**	7.968	14.65
Manual routine	**34.96**	19.15	27.96
Cognitive non-routine	36.04	**47.10**	40.60
Cognitive routine	25.08	**25.10**	24.88
Interactive	32.40	**40.92**	36.14

Table 12.2: Average score of Task family B to assess each necessity degree, SILV 2020

In Table 12.2, you can see how the pattern is similar to the previous table. Task families such as Analytical, Information input and Cognitive non-routine demonstrate a high degree of necessity of these activities within this sector.

On the other hand, the manufacturing sector also presents the same task families as a degree of necessity in its purely labour-related activities (as shown in table 12.1).

Overall, tasks that involve analytical, cognitive non-routine, and interactive activities are more important in KIBS sectors like consulting, IT services, and financial services require more data processing, problem-solving, and customer interaction, whereas manual routine tasks are more important in manufacturing while for KIBS are less relevant, because of their reliance on intellectual and service-oriented tasks rather than physical labor.

The analysis conducted so far has focused on the tasks performed within the individual companies in the AIR sample. Now, instead, we try to compare how necessary is a task for the AIR occupational profiles with the rest of the occupational profiles available in the Veneto region as of 2020. To do so, we proceed by computing the revealed comparative advantage (RCA) for each task family and for each available company.

The RCA is computed as follows:

$$RCA_{iT} = \frac{X_{iT}/\sum_T X_{iT}}{\sum_i X_{iT}/\sum_{iT} X_{iT}}$$

where:

X= Score of enterprise i in task T in 2020. The numerator corresponds to the importance of task *T* in AIR company *i* as compared to all the other tasks performed in the same company. The denominator, instead, measures the importance of task *T* in all the AIR companies with respect to all the companies recorded in the SILV. In this way, the RCA index measures whether a company has a revealed comparative advantage in the use of task *T*. If RCA>1 then the company has a score task *T* that is higher than the average of Veneto region, which means that it is employing a number of workers for which that task is necessary that is larger than the Veneto average.

Once having computed the RCA for each task of every occupational title, we assign a value of 1 if the RCA is larger than 1 and 0 otherwise. In this way, we obtain, for each occupational title, a vector of 0s and 1s which identifies whether a worker has a comparative advantage in task *T*. Then, we proceed by summing the number of 1s in each company to have the number of occupational titles for which a company has a comparative advantage. Then, we proceed by averaging this number across the seven task families. Finally, we divide this number by the total number of FTE employees, and we obtain the share of employees (or occupational titles) for which a company has a comparative advantage in each of the seven task families.

Table 12.3 shows the distribution of the RCA for each task family in the manufacturing, KIBS, and for the total sample of AIR companies. We observe that the AIR sample has the highest share of employees with an RCA for two important task families, which are the cognitive non-routine and routine. Interestingly, the comparative advantage in cognitive non-routine tasks is particularly frequent in KIBS companies, whereas the one in cognitive routine is more frequent in manufacturing. If we look at the task families for which the shares are higher than 50%, we find four in AIR manufacturing companies (information input, manual routine and non-routine, and cognitive routine), and two in KIBS (analytical and cognitive non-routine). From this scenario, we conclude that both manufacturing and knowledge-intensive service activities involved in Veneto's aerospace industry involve the accomplishment of more complex tasks than the average.

RCA - task	Manufacturing %	KIBS %	Tot %
Information input	**50.67**	43.10	47.72
Analytical	41.72	**62.32**	50.66
Manual non-routine	**53.22**	9.508	34.55
Manual routine	**56.68**	18.37	39.99
Cognitive non-routine	72.26	**84.62**	77.17
Cognitive routine	**57.97**	48.40	53.38
Interactive	36.55	**49.05**	42.03

Table 12.3: Share of RCA based on Task family, SILV 2020

The same analysis is repeated for skills. Table 13 reports the list and description of the 35 skills available, and the corresponding six skill families as identified by INAPP and ISTAT.

Skill title	**Description**	**Skill family**
Understand written texts (- c1)	Understanding written sentences and paragraphs in work-related documents	Basic
Listen actively (- c2)	Making full attention to what other people are saying, pausing to understand the main points by asking questions at the appropriate time, and avoiding inappropriate interruptions	Basic
Write (- c3)	Communicating effectively in writing as appropriate to the needs of recipients.	Basic
Talk (- c4)	Talking to others to convey information effectively	Basic
Mathematics (- c5)	Use mathematics to solve problems.	Basic
Sciences (- c6)	Apply scientific rules and methods to solve problems.	Basic
Critical Thinking (- c7)	Using logic and reasoning to identify the strengths and weaknesses of solutions, conclusions or alternative approaches to problems.	Basic
Active Learning (- c8)	Understand the implications of new information for problem solving present, future and for decision-making	Basic
Learning strategies (- c9)	Select and use appropriate methods and procedures training to learn or teach to learn	Basic
Monitor (- c10)	Monitor and evaluate personal work performance, other persons or organizations to improve or correct	Basic
Social perception (- c11)	Understand the reactions of others and react in certain ways because	Social
Coordinate with other (- c12)	Coordinate their actions with those of other	Social
Persuade (- c13)	Persuading others to change their attitudes or behaviour	Social

Negotiate (- c14)	Discuss and negotiate with each other to reach an agreement and try to reconcile different views	Social
Instruct (- c15)	Teach others how to do certain things	Social
Service orientation (- c16)	Actively seek solutions to meet the needs of the other	Social
Solve complex problems (- c17)	Identifying complex problems and gather information to evaluate possible options and solutions	Complex Problem Solving
Analysis of the operational phases (- c18)	Analyze the characteristics and requirements of tools, services or products necessary for the implementation of a project	Technical
Technological design (- c19)	Producing or adapting equipment and technology to meet the needs of users	Technical
Select tools (- c20)	Identify the tools necessary for the performance of a job.	Technical
Install (- c21)	Install equipment, machines, wiring, or programs applying the technical specifications	Technical
Program (- c22)	Write computer programs for various purposes	Technical
Quality Control (- c23)	Conduct tests and inspections of products, services, or processes to evaluate quality or performance	Technical
Monitor machines (- c24)	Check liquid level measurement, dials, or other indicators to ensure the correct operation of a machine	Technical
Operate and monitor (- c25)	Check the operations and activities of equipment and systems	Technical
Maintenance (- c26)	Perform routine maintenance on equipment and determine when and what kind of maintenance is needed	Technical
Solve problems (- c27)	Determine causes of operating errors and deciding what to do about them	Technical
Repair (- c28)	Repairing machines or systems using the appropriate equipment	Technical
Analyze systems (- c29)	Determine how it should work a "system" (i.e., machines, factories, organizations, environments) and how environmental changes, or operational situation will affect his performance	Systemic
Evaluate systems (- c30)	Identifying measures or indicators of system performance (i.e., machines, factories, organizations, environments) and the actions needed to improve or correct in relation to the objectives of the system	Technical

Evaluate and decide (- c31)	Assess the costs and benefits of potential actions to choose the most appropriate	Technical
Manage time (- c32)	Manage your time and that of others	Resource management
Manage financial resources (- c33)	Determine how much money you need to spend to do a job and account for expenses	Resource management
Manage material resources (- c34)	Obtain and handle the appropriate use of equipment, tools and materials needed to perform a job	Resource management
Managing human resources (- c35)	Motivate, develop and direct the staff and to identify the most appropriate staff to work	Resource management

Table 13: Classification of skills, INAPP-ISTAT 2013

Tables 13.1 and 13.2 report the average scores (again, type a and b respectively) for each skill family in manufacturing, KIBS, and the total sample of AIR firms.

Skill family A	Manufacturing	KIBS	Tot
Basic	52.21	**65.71**	58.69
Social	45.85	**54.47**	50.13
Complex problem solving	55.03	**69.13**	61.89
Technical	**37.75**	35.83	36.36
Systemic	29.56	**33.25**	31.30
Resource Management	42.64	**48.24**	45.32

Table 13.1: Average score of Skill family A to assess each importance degree, SILV 2020

Skill family B	Manufacturing	KIBS	Tot
Basic	46.33	**59.75**	52.70
Social	41.96	**51.94**	46.76
Complex problem solving	48.67	**62.10**	55.00
Technical	**34.77**	34.73	34.25
Systemic	28.48	**32.98**	30.46
Resource Management	38.31	**45.69**	41.72

Table 13.2: Average score of Skill family B to assess each importance degree, SILV 2020

Within the skill families both in degree of importance and necessity of these. The pattern that occurs is similar, here the KIBS sector reports high scores in 5 out of 6 skill families, with skill families such as Basic, Social and Complex problem solving exceeding the 50 percent threshold, together with Systemic and Resource management skill families that however as scores exceed both the manufacturing sector and the Veneto regional average, explaining how these are very important in KIBS for effective communication, strategic planning and efficient resource allocation.

The only skill family in which manufacturing companies score higher than KIBS and regional average is the Technical skill family, which is essential for operating machinery and managing production processes.

Finally, Table 13.3 shows the shares of employees with an RCA in the six skill families.

RCA - skill	Manufacturing %	KIBS %	Tot %
Basic	37.77	**55.37**	45.39
Social	28.51	**41.34**	33.63
Complex problem solving	45.85	**71.17**	56.59
Technical	**63.18**	44.14	54.91
Systemic	55.82	**63.00**	58.95
Resource Management	32.06	**36.87**	34.49

Table 13.3: Share of RCA based on Skill family, SILV 2020

Manufacturing shows a higher RCA in technical skills highlighting the sector's dependence on technical proficiency, whereas KIBS shows a higher RCA in basic, social, and complex problem-solving skills reflecting their operational needs and sector strengths.

To sum up, in light of this evidence, KIBS companies place higher relevance on cognitive, analytical, and interactive tasks, as well as on skills related to problem-solving, social interaction, and resource management. Conversely, manufacturing emphasizes manual and technical tasks and skills. The RCA analysis further highlights these sectoral differences in task and skill utilization. Finally, these data consequently explain the better performance in terms of financial ratios such as ROCE, ROA, and ROE, as well as for economic variables such as total value of production and value-added of the service macro-sector compared to manufacturing seen in the previous analysis.

Conclusions

The Italian aerospace industry over the years has embarked on a path that seems to be leading it to confirm its position among the nations confirming their strong investments in this sector.

With the advent of the New Space economy, several companies including many startups have become part of this industrial segment, especially through the sub-segment of the downstream markets, also thanks to the lowering of the strong barriers that these markets had until the beginning of the 21st century (including the initial investments needed to build even small-to-medium sized satellites).

As of today, the Italian institutional and industrial landscape, see the Italian Space Agency playing a role with great scope, thanks to the funds delivered by the National Recovery and Resilience Plan (NRRP) initiative, for the fulfillment of several projects that see the space sector, a pivotal industry that can bring a spillover effect in other industries with which synergies are generated in terms of co-creations of innovative technological solutions.

On the industrial front, Italy has some 13 regional aerospace districts distributed along the territory along with the National Aerospace Technology Cluster (CTNA), which is the backbone of this network in terms of coordination and resource management.

The purpose of this thesis in its final part was to analyze the regional innovation network "Aerospace Innovation and Research - AIR," considering its being the most recently established cluster in the Italian space industry both in terms of economic and financial performance and composition at the level of labor codes within companies with a special focus on tasks and skills, in terms of their importance and necessity in the type of task of the labor figures considered according to the ISCO table classification.

In the first part of the economic and financial analysis, the clear positive performance of medium-sized and large companies during the five-year period taken into consideration from 2018 to 2022 was noted, even with an observation regarding the downturn period that occurred with the global crisis caused by COVID19. The latter event but also showed the increasing importance of this industry sector and its permeation through the various space-based technologies that contribute to the development of innovative solutions for other industries. In the analysis conducted, key financial indicators and economic measurements were utilized to assess the health and performance of these companies, highlighting a robust expansion in earth-based markets, particularly in the downstream segment of the space economy.

Provinces, which internally have about half of the total sample of 45 companies analyzed, such as Padua and Vicenza showed strong resilience to the pandemic event, with a downturn in the two-year period of the crisis but with a subsequent rebound effect on both the total value of production and value added of these areas as they moved toward the end of the 5 years considered.

Regarding the second part of the analysis carried out on the composition of the corporate workforce of the sample derived from the AIR network's member subjects, it was seen that most of the ATECO codes, obtained from the SILV administrative database, belong to the manufacturing macro-sector (2369 out of 2590).

The dominant gender in the workforce of this sample (35 companies found out of 45 total) is male, and the education level of the manufacturing sector sees more than 80 percent of the job codes distributed between basic and second-degree education, while the education level of the KIBS sector sees 65% of the employees with a Tertiary degree. Furthermore, regarding the analysis on task and skill families, it is seen that task families such as Information input and Cognitive non-routine task family belong to the KIBS sector, on the other hand Task family such as Manual non-routine and Manual routine belong to the manufacturing sector, both in terms of importance and necessity. On the skill family front, it has been seen that except for technical skill which belongs to the manufacturing sector, the other skills such as basic, Social, Complex Problem Solving and Systemic and Resource management belong both in importance and necessity to the KIBS sector.

The concluding part of the research on occupational titles, with a particular focus on Shares of RCA, shows how the workforce employed in KIBS has far higher values than the Veneto regional average, in task families such as Analytical task, Cognitive non-routine task and Interactive task, explaining how the investment at the human capital level in the KIBS sector is highly regarded, a fact that is well matched in important performance at the production level (in terms of services) and Added value generated. The same pattern is reflected in the Share of RCA related to skill families, which sees those employed in the KIBS sector having scores that far exceed the figures for the regional worker average (the highest score for Complex problem solving exceeds the regional average by almost 15 percentage points). The only data that concerns the technical skill family, which also shows a very high figure here compared to the regional average of +10 percent. The data collected describe a so-called industrial population that has high job qualifications, demonstrate a workforce that is highly skilled and faces challenges that require all the skills that the RCA scores show.

The complexity of tasks and skills, defined as generalized work activities and knowledge necessary to perform the profession, respectively, especially in the KIBS sector is well reflected on both economic and financial performance indices, which sees a large gap with the manufacturing sector, at least as far as the AIR network is concerned.

Certainly, the pandemic event has shown how even a high-growth sector such as aerospace has been affected by the period of contraction on a global scale, but the high level of specialization and qualification of the workforce employed in the aerospace sector accompanied by both the growing trend in terms of investment and national government policies aimed at stimulating this industrial sector will allow this sector to have exponential growth in the years to come.

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