Space Economy, Open Innovation and Sustainability

Daniele Binci[*], *Andrea Appolloni*[**], *Wenjuan Cheng*[***]

Abstract

Space Economy (SE) is increasingly becoming relevant for business and management with impacts on many industrial segments (i.e. agriculture, transport, assurance and the environment) but also on sustainable practices (i.e. Agenda 2030).

Despite the importance of SE for new business models and value creation processes in the ecosystem, theoretical approaches for the downstream space economy implementation are still quite limited in literature.

Accordingly, this paper aims to understand how open innovation supports the downstream sector through digital platforms. We use a qualitative methodology, by combining a theory-driven approach, based on an in-depth analysis of the main factors that affect the implementation of space value chain models.

Keywords: Space Economy; Digital Platform; Earth Observation; Sustainability; Global Markets

1. Space Economy: A General Overview

The Space sector is currently undergoing a radical transition (Vidmar et al., 2020) in terms of industrial structure, competition forces, innovation management, market demand and public-private relationship (Moranta, 2022), becoming more relevant for business and management.

OECD estimates G20 governments' budgets amounting to 79 billion in 2019, with an annual commercial revenue of 280-300 billion ($). Moreover, the Space Economy (SE) has positive outcomes, including employment, revenues, as well as technological and scientific innovation (OECD, 2020).

[*] Assistant Professor of Management, University of Rome "Tor Vergata" (daniele.binci@uniroma2.it)
[**] Associate Professor of Operations Management, University of Rome "Tor Vergata" (andrea.appolloni@uniroma2.it)
[***] Research Fellow in Management University of Rome "Tor Vergata" (wenjuan.cheng@uniroma2.it)

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Space Economy (SE) is defined as the full range of activities and the use of resources that create value and benefits to human beings in the course of exploring, researching, understanding, managing, and utilizing space (OECD, 2020).

SE impacts on different economic sectors, for instance:

- On monitoring near real-time energy distribution networks, which are often located in remote or inaccessible areas;
- On the risk assessment models improvement and products that are increasingly tailored to actual client risk profile in the assurance companies;
- On the exploitation space data to monitor the traceability and tracking of food
- On the improvement the production on agricultural sector.

However, its relevancy relies not only on the market side. The importance of social and environmental issues for the managerial agenda has been already highlighted in literature (i.e. Brondoni, 2003; Ergene et al., 2021; Brondoni & Ricotti, 2022). Accordingly, the use of space data is instrumental to monitor environmental parameters, included the delivering of economically sustainable and innovative solutions for the green and digital transformation. Examples are:

- industrial sector, that could find benefits to reduce impacts and gas emissions;
- constant monitoring of goods and vehicles in the logistics and transport sector, where to assess the shortest and most profitable routes, and to render loading and unloading more efficient;
- while constantly monitoring and tracing goods, space technologies could be an essential and cost-effective factor.

1.1 Space Economy: The Value Chain

Basically, SE can be divided into three main components (Figure 1):

1. The upstream sector, that corresponds to the economic activities leading to an operational satellite system in orbit;
2. The "midstream" sector, that includes satellite operators and ground-support infrastructure (e.g., network stations, data storage, processing centers) and the full range of actors and activities related to satellite services, including capacity/data markets;
3. The downstream sector, composed by products and services that directly rely satellite data and signals to operate and function. It corresponds with all the subsequent economic activities related to the operation and exploitation of this satellite system for providing space-based products and services to end-users, including user equipment (e.g. satellite TV dishes, navigation devices, satellite phones).

For the aim of this paper we concentrated on the downstream end-user sector.

In particular, according to the research aim, focused on the understanding the digital platform phenomenon in the downstream space sector, we use a qualitative methodology, by combining a theory-driven approach, in which the results of an in-depth analysis of the main factors that affect effective implementation of space value chain models is reported (i.e. Open innovation drivers and Digital Platform business model) together with an empirical approach based on Cleos'case study.

2. Space Economy and EO. Between Sustainability and Innovation

2.1 Space Economy and Sustainability

SE draws upon Earth observation (EO) by relying on advanced technologies such as satellite images, that play an important role in the development of digital and green services across a wide range of sectors (ESA, 2021). Accordingly, SE impacts on sustainability through the satellite data provided by EO, that is relevant as a disruptive driver for the ecosystem. EO is the practice of collecting data (biological, physical, and chemical data) from the Earth, using remote sensing technologies and earth-surveying techniques. EO is a pillar for the sustainability of the planet, as it is tightly coupled with the 2030 Agenda and the Sustainable Development Goals (SDGs), a set of integrated goals to ensure the development of social, economic and environmental sustainability.

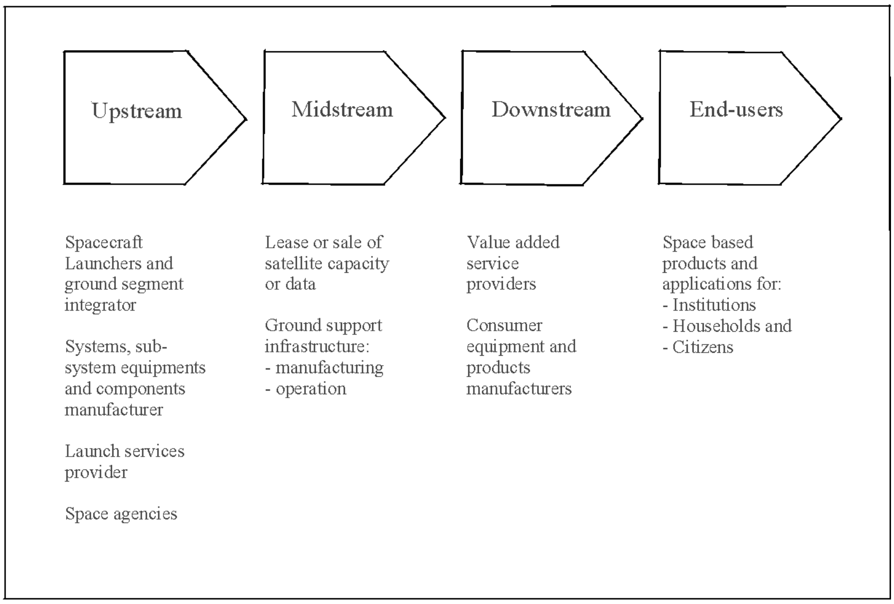
Particularly, EO, with global spatial coverage and high frequency of observations, plays an essential role in monitoring targets and helping stakeholders make informed decisions, by capturing important aspects of sustainable development and in particular the environmental dimension of the Sustainable Development Goals (SDGs), as grand challenges for the planet (Zucchella & Urban, 2020).

Some of the specific applications of EO are forecasting weather, monitoring natural disasters and the health of ecosystems, communities and citizens, EO data informs, locates and provides context for research and policy-making including achieving sustainable societies.

EO is one of the key elements related to the increasing concern about the effects of climate change on a global scale. EO data informs a wide variety of applications including tracking biodiversity and wildlife trends; measuring land use change such as deforestation; mitigating, and managing the impact of natural disasters, including fires, floods, earthquakes, and tsunamis; sustainably managing natural resources, such as energy, freshwater, and agriculture, address emerging diseases and other health risks; and predicting, adapting to, and mitigating climate change (Anderson et al., 2017). It can be used to develop air pollution and various climate indicators, including wildfires, dust storms, urban green space, and urban particulate matter mortality (Anenberg et al., 2020), that gives opportunities to innovative companies, which can develop applications and sell value added services based on EO data.

For instance, the EO services of remote monitoring systems can predict natural disasters using satellite data, informing public authorities when disasters are impending, helping them act reactively and effectively.

Figure 1: The Space Value Chain



Source: our adaptation from Moranta (2022).

2.2 Technology and Innovation on Space Economy

The big amount of data (Big Data) collected via EO impacts on the environmental issues through the innovation triggered by technologies. EO technologies bring new and elaborated solutions on the market that contribute to shaping more tailored services. They enable downstream sector and the ecosystem to create competitive and valuable products to their potential customers through digital technologies (i.e. artificial intelligence and data analytics) that play a key role on EO processes. Machine learning (ML), for instance, a subdomain of artificial intelligence, allows efficiency on complex and repetitive tasks, as retrieval algorithms, bias correction, code acceleration or classification. ML aims to extract information from data automatically by computational and statistical methods with large volumes of data in a variety of formats such as image, video, sensor and health records. For instance, in the space sector, minerals and rocks are classified through ML against mineralogical database's spectral library. ML impacts both on quality and efficiency of the downstream processes and, finally, on the ecosystem.

2.3 Downstream End User Sector: The Open Innovation and the Enabling Role of Digital Platform

Despite the importance of SE on sustainability, innovation and technology, literature about its implementation is just at the beginning (Frischauf et al., 2018). By looking at the value chain of the downstream sector we highlight the importance of spillovers and technology transfer and how it can be basically framed according to the open innovation (OI) paradigm: “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively” (Chesbrough, 2006).

Unlike traditional value chain innovation (Porter, 2001), delineated by close, linear and sequential approach, where vertical integration and defensive strategies are relevant, OI operates through openness and collaboration within the entire ecosystem (Reichstein et al., 2006; Teece, 2006)[1].

Accordingly, OI is similar, despite different, to the “Triple Helix” (Leydesdorff and Ivanova, 2016), a model in which University, Industry, Government and, recently, with the evolution of the concept into the “Quadruple Helix” (Cay and Lattu, 2022), also the Civil Society, are joined in a virtuous cycle for fostering entrepreneurship, innovation and economic growth in a knowledge-based economy, by bridging industrial innovation closer to public R&D (Leydesdorff, 2012).

Similarly, OI assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology and particularly concerns cooperation with firms, universities, clients, end-users; but also the transfer of ideas and technological knowledge from the firm to external ecosystem for obtaining economic benefits; and finally, coupling of these two activity types (COTEC, 2021).

The dominant OI approach is defined “inbound” OI, in which companies use resources that comes from the outside to create value-added offers and accelerate markets entering.

“Companies are more willing and eager to leverage external ideas and resources for their own benefit, but reluctant to share with external entities” (Johannsson et al., 2015).

OI describes a collaboration trend in idea generation and new products and services development. It points to a shift in the innovation ideal from working inside the firm's boundaries to reaching outside them. It has become a mainstream term to define a wide array of distributed and democratized innovation activities.

OI aims to strategically managing the sharing of ideas and resources in the ecosystem to co-create value (Johannsson et al., 2015). The openness among different parties creates tensions between different and sometimes opposite “perspectives, interests, loyalties, histories, prejudices, goals and behaviors” (Van Burg et al., 2017), as the conflict between cooperation and competition: cooperation enables the value creation through collaborative innovation of the stakeholders in the network, while competition is triggered by the value appropriation as a capturing process of the created value (Van Burg et al., 2017).

Digital platforms are at the origin of OI mechanisms: they have favored interaction matching and connection of customer groups, third-party collaborations, and developer communities to enable them to create value and, consequently, to fast develop applications and new business models.

Accordingly, the downstream-end user sector, relying on an OI oriented context, could benefit from the use of platforms, by focusing more on how organizations implement ways of creating and distributing innovation through the open exchange of knowledge within the ecosystem, within a coordinated action among the ecosystems. Digital platforms have the following characteristics:

Open Data based: open data, especially on the downstream sector, have been growing due to falling costs of satellites. Organizations and businesses have access to satellite and open data from satellites. Open data accelerate space research, and also provide spillovers for businesses that have an impact also on not sectors directly related to space.

Users of the platform: the number of users defines the value of the digital platform. The more users animate the platform, the more developers will try to sell their product on it, making the ecosystem unique and difficult to be imitated.

Multi-side-network effect: According to literature (Hagiu and Wright, 2015) digital platforms are "multi-sided" as they create value primarily by enabling direct interactions between two (or more) distinct types of affiliated customers. Usually, multi-side network effect consists of customers that search for a product or a service and of producers that can satisfy customers' needs. The presence of more actors from one side generates value for the other side and vice-versa.

Critical mass: is the threshold at which the growth of the network becomes "self-sustaining". It includes variables, as the type and strength of network effects, customer behaviors and the customer needs. Platforms that do not reach critical mass often unravel.

Open Digital Platforms on Space sector: CLEOS case study[2].

Space data is growing exponentially, enabled by technologies such as Cloud Computing, Artificial Intelligence, Big Data and 5G, accelerating the paradigm shift in the data collection and information delivery towards an OI approach. Accordingly, dedicated Digital Platforms are growing and are increasingly available in the marketplace. Among them, CLEOS is an innovative digital platform officially launched in 2022. It has been founded by e-GEOS, respectively owned by Telespazio (80%) and ASI (20%). According to the OI digital platform, CLEOS is the one-stop-shop for satellite and EO data, by enabling a direct access to a large set of space and non-space data, information products and predefined processing services. Through a unique market place, users can access directly on-line many commercial data to feed customizable workflows already optimized for scalability. CLEOS tools and technology make it possible to obtain information in an accessible way by making these services available immediately, enabled by the big amount of data. CLEOS enables people to easily interact with the geoformation market, through algorithms that provide indicators to recognize and extract data suitable for several markets: from the raw data acquisition from the satellites to the real-time information, services and applications, both for institutional and civilian customers, developed out of the main EO data. The satellites provide data on a global scale to support a variety of applications that include important topics, such as environment, pollution, air quality and traffic, risk management, environmental protection, natural resources exploration, land management, defense, and security. Basically, the large amount of data is aggregated and filtered through specific algorithms and, thanks to advanced technologies, made available in a simpler and more extensive way than in the past. CLEOS allows large, medium and small enterprises, professional users, academies, as well as start-ups, to access the platform offers and particularly applicative platforms, data, third-party EO and other data in a user-friendly mode like an online shop. It identifies and builds a series of vertical services that allow clients to satisfy both institutional and market needs, as the monitoring of the territory, infrastructures, for agriculture and precision farming, services that monitor the marine environment or linked to intelligence. Information therefore begins to become pervasive and, when an open platform is available, it can be filled with content by expanding the base of available information and consequently by growing the market.

CLEOS is a commercial platform that:

a) reach thousands of users all over the world, by allowing them to interact each other, and to make purchases of data and services online on different sectors by having an impact on innovation and on sustainable economy. This means reaching market sectors that were previously difficult to reach;
b) attract private as well as institutional investments in the space sector.

Finally, the paper explores a quite unknown area of the downstream space sector, by highlighting how OI processes support its implementation through the use of digital platform technologies, with benefits also on sustainable practices. Through an in-depth analysis of the main factors that affect the implementation of space value chain models, we shed light on the importance of OI process for enabling the space platform, by highlighting the importance of the multi-side-network effect and the open data, that, in particular, provide spillovers for space no-space transfer technology. Managerial studies in this area are just at the beginning: more literature should be focused on the understanding of how OI processes impact on space digital platforms, by analyzing how social and technical factors should interact for creating and sustaining value.

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Notes

[1] According to COTEC (2021) open innovation emphasizes organizations competitiveness advantages by relying on knowledge transfer process not only from internal knowledge but, increasingly, from several external actors involving managed inflows and outflows of knowledge across organizational boundaries (Chesbrough, 2003).

[2] The case has been developed mainly by collecting public information available on internet, and specifically, at https://www.cleos.earth/