Small and medium enterprises shooting for the stars: what matters, besides size, in outer space economy?

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Abstract. The popular mindset and widespread narrative, at least until not so long ago, was that in outer space affairs the fiefdom belongs, politically and economically, to governments and big businesses. An array of alliances between few states and their privileged partners from the corporate world constituted the highly exclusivist space ecosystem. Little room was supposed to be available to non-full-fledged spacefaring nations and enterprises originated from them, a configuration furthermore jammed by the fact that international agreements – i.e., the “Outer Space Treaty” (1967) an the “Moon Treaty” (1979) – seem to be rather dismissive of extensive exploitation of celestial bodies, adding to the already prohibitive costs of such endeavours if legitimized. Devoted mainly to scientific exploration paired with exploitation only of planetary proximities – viz., the large satellite population orbiting the Earth, with their support and serviced industries, all estimated at half a trillion dollars –, the space economy, in its high-tech dimension, steadily democratized itself, becoming more competitive, and collaborative too, opening up to small and medium enterprises (SMEs), many coming from emerging spacefaring nations. The literature covering SMEs contribution to the development of the space economy is on track of consolidation, as the process itself is unfolding, with data covering only the most powerful space players (e.g., US, EU). Valuable insights are added starting from the common wisdom that institutions (channelling economic information and incentives) are the main drivers in space development, rather than business size, even more in a competitive- collaborative global economy. A case study is dedicated to the Romanian experience (that of a relatively new and little player in European/global space affairs). A conclusion is that in an economy of unbounded creativity and borderless capital, visionary enterprises, big or small, fit even into the space industry value chains, if a pro-market, pro-business climate is secured.

Keywords: small and medium enterprises, space economy, spacefaring nations, technology, value chains.
Introduction

Since Aristotle, passing through Galileo Galilei and reaching towards the clash of the two global superpowers in the Cold War and, more recently, to the private odyssey of Elon Musk, the cosmic space research done in terrestrial laboratories and libraries, as well as in circum-terrestrially orbiting space-stations, or with the help of satellites and space probes, remains eager to explain what lies "beyond". And both natural and social sciences are herein involved. The developments of science(s), in particular the Enlightenment, had the gift of removing myths, superstitions and fantasies from people's minds (partially surviving Flammarion's époque in the sci-fi fuse), bringing more reason to chart(er)ing the space outside planet Earth. Throughout history, the Cosmos has been scanned for astronomical or astrophysical – initially fundamental and then applied – knowledge, though economics cannot stay alien to this as business calculations are always part of the picture (Jora et al., 2019).

It was only with the Cold War that an economic interest in the space outside the Earth spurred and economic science came to the fore at both micro- and macro- levels. There are at least three main difficulties associated with topics pertaining to the "outer space economics": (i) one comes from the debatable character of several theoretical stances in social sciences – i.e., noticing subtle disputes over the epistemological/methodological, as well as the doctrinaire/ideological takes on some concepts; (ii) another one pertains to the very physical barriers between subject-investigators and investigated objects – i.e., we make insights on the governance of space affairs, which look pretty remote, both temporally and spatially; (iii) a final one relates to the gap between purely scientific arguments and pragmatic political / public policy approaches – i.e., in space affairs, we are dealing with (super-)power rationales.

According to a popular definition, the space economy is “the full range of activities and the use of resources that create and provide value and benefits to human beings in the course of exploring, understanding, managing and utilizing space” (OECD, 2019). This brings together public and private actors involved in producing and provisioning space-related goods and services, ranging from the research, development and innovation (RDI) activities, the designing and deployment of critical space infrastructures (e.g., ground stations, launch vehicles, nano-satellites etc.) to space-enabled applications (e.g., navigation equipment, satellite phones, meteorological services etc.) and the scientific knowledge thereupon. However, what is seen as the “space economy” exceeds the mere “space sector”, given the quantitatively/qualitatively wide off-springs on the whole society (Georgescu et al., 2019).

Out of the variety of outer space economics and business topics that began and keep up capturing the attention of researchers, this article duly addresses three intermingled concerns: (i) the (more or less) enterprise-incentivizing character coming from the international institutional space governance arrangements; (ii) the part small and medium enterprises (SMEs) can play in a competitive domain dominated by big corporations and governments; (iii) the manners and measures in which SMEs from a developing country such as Romania can insert and immerse themselves within the global value chains of space exploration and exploitation. This article starts with a review of the (still scarce) literature in the field, then it surveys the international legal framework for space affairs, connecting it to

the landscape of global space economy, ending with a brief case study on “size and significance” in the space sector.

Literature review

From scientific exploration to economic exploitation

Modern space quest is usually divided into three phases (Sommariva, 2018). The first stage, called the “inventions stage”, occurred at the beginning of the twentieth century and included the research and innovations of scientists with potential space use (viz., including Hermann Oberth, born in Sibiu and raised in Mediaș and Sighișoara) who laid the foundations of space missiles. The second stage, between 1950 and 1970, comes with expanding innovations devoted to exploration projects, military concerns, as well as the first concrete economic thoughts seeing Cosmos as a commercial sector having infrastructure development needs to be addressed by public administration. In the third stage, after the 1970s, the economy of cosmic space developed rapidly, merging commercial and governmental character. On a superficial level, press releases on cosmic exploration have formed some stereotypical thinking, closer to the government framework, seeing cosmic space as a humanity public good to be nourished by great responsible nations to the benefit of all nations; but in the background lies the tough race for geopolitical supremacy, via primacy in exploring (and exploiting) the (yet) “unknown”.

In an industry worth over 360 billion dollars (Bryce Space and Technology, 2019), space exploration and exploitation started out as governmentally-funded and run operations. During the third stage of the modern space quest, the private component greatly increased. Weinzierl (2018) sees COTS (Commercial Orbital Transportation Services) in the US as a main channel for the decentralization of space, following the rise of the New Space companies like SpaceX and Blue Origin, which are trying to tackle the last bastions of state monopoly: the launch of goods and people. There is a significant difference between the size of the space economy and the overall impact of space in the wider economy. Space, through the nature of the services it encompasses, has a strong mediating role (Pietroni and Bigiardi, 2019). Most of the benefits of the cosmic economy, however, were brought at the level of the private consumer as a managed spillover effect of the prior served needs of state agencies involved in cosmic missions. Bryce Space and Technology (2019) estimates that over 5 trillion dollars in GDP value across multiple sectors of the US economy are mediated by space.

From geopolitical pride to economic/business profit

The suborbital space tourism may be considered as one layer of the in-depth framework of space exploration, established by the successful launch by the Soviet Union of the Sputnik I satellite in 1957 (Ruhaeni and Izadi, 2020). The next frontiers of space tourism are now set by private aerospace companies aiming to send humans to Mars (Platt et al., 2020). Mars Base Camp, a collaboration between the National Aeronautics and Space Administration (NASA), Lockheed Martin and the Space Exploration Technologies Corporation (SpaceX), the latter being founded by tech entrepreneur Elon Musk, seems to have the leading initiatives in space tourism.

The colonization of Mars by SpaceX is argued by Elon Musk, inter alia, through a metaphorical language such as “life insurance” or “humanity’s backup drive”, outlining the human civilization as a multiplanetary species (Reddy, 2018b). The reusability of the launch vehicle technology promoted by SpaceX, as the one used in the launching of its first Falcon
Heavy rocket in 2018 (Shammas and Holen, 2019), is becoming the norm in the industry, with many other players intending to import this revolutionary technological concept in order to maintain their competitiveness on this vivid emerging market.

Although the space industry is debating the viability of SpaceX business model, its real effect is not in making profits but in leading a permanent change in the space industry. The challenge is to convince the audience that the colonization of Mars, while not technically possible at this moment, can be pursued, or at least put to test, in the near future. While the costs associated with the commercial space travel are high, the prices are expected to drop as more private entities will organize outer space trips (Reddy, 2018a). Yet, space stakes go beyond tourism, as the marketability is far broader (MacDonald, 2014).

**From state forces nudge to market drivers narrative**

The notions of “space commerce” and “commercialization of space” may be defined as the activity of providing products or services by the private sector, directly connected and dependent on a space segment (Vedda, 2004); companies such as SpaceX are examples of how the private sector can respond to the demands of the public sector (Salter and Leeson, 2014), transporting cargo and crew to the International Space Station. The general temptation is to see the outer space as the next phase and more adventurous phase of the neoliberal capitalist quest for new markets and profits generated from outer space tourism, placement of satellites or related ventures. The commercial activity in space has gradually shifted from a state-funded system towards the private system, were the technological and marketing skills are two of the forces in the pursuit of profits (Tchalakov, 2015). Such new orientation, driven by private entities, has been labeled by the space industry as “New Space” and was linked to the arrival of the American capitalist mindset in the outer space, especially in the 2010s (Shammas and Holen, 2019).

New Space industry was consolidated through the Semi-Annual Investments Summits, focused on finance capitalism and networking between investors and specialists (Valentine, 2012). The advocates of the New Space industry, who want to be known as a new generation of libertarians, pushing the space odyssey beyond the obsolete state bureaucracy habits, have found a reliable political partner initially under the Obama administration (providing for a significant funding for private corporations) and then under the Trump administration. The US has been highly active in the outer space sector through the signing of the Space Policy Directive 1, which calls for the “return of humans to the Moon”, adopting the National Space Strategy and recreating the National Space Council, with the Artemis program following the Apollo lunar legacy (Prunariu, 2022). The regulatory reform is also in line with such actions, aiming to encourage both individual and legal entities’ initiatives in space, in a strengthened governmental and non-governmental collaboration to undertake new activities (Tronchetti and Liu, 2018).

**Methodological option**

This paper takes the form of a scientific essay, in which we argue the role of small and medium enterprises in the outer space economy. We do so by suggesting a possible alternative to the de facto situation (with the existing institutions and policies). Thereupon, the analysis method used in the essay is that of a comparative economics exercise of judgment, of factual vs. counterfactual nature, in which the locus is set on an “is-might” comparison between the current state of outer space affairs and a potential alternative in which an
institutional reform might well open the doors for more entrepreneurial venture in the outer space economy. We adopt the “neoliberal”/ “free market” stance of a highly competitive market sector and posit that private venture into space business should be encouraged in order to to create an entrepreneurial ecosystem that the outer space economy can then benefit from.

In terms of the methodological approach, we deliberately employ an exploratory research by which we try to create a picture of the conditions needed for the creation of such an ecosystem through institutional reforms. We do not attempt to provide a detailed, nor a highly accurate picture of space entrepreneurship, but we only try to encapsulate how more entrepreneurial spirit could contribute to the flourishing of the outer space business, with its direct impact upon Earth’s economy, and what needs to happen for this to become a reality.

The essay also uses an “across-case” research approach, in which features of several selected space entrepreneurship businesses are used in order to serve the purpose of the essay. While dealing with the space economy, the essay further takes a longitudinal research approach, more precisely time-series bound, since the references to events in the history of space exploration are necessary for a better understanding of the selected cases, as well as for the advancement of possible solutions. This longitudinal approach allows us to observe the changes in the economics and politics of space exploration across time and, based on them, launch suggestions of reforming the space business mindset, realistically yet proactively. In what concerns data collection, this desk essay rests upon a “historical-comparative” research approach in which data on events or conditions of space economics are scrutinized.

Because of the historical-comparative and longitudinal dimensions, we opted for the form of a scientific essay, since it allows room for more versatile interpretation and deliberation, necessary for forwarding, or at least inspiring, the more pragmatic proposals of potential institutional reforms for the creation of a truly lucrative, entrepreneurial space ecosystem. Moreover, this approach helps us identify the most promising avenues for further research in a field of inquiry that needs to evade intellectual-institutional path dependencies.

The “Law and Economics” of the outer space (for business purposes): on why “res publica” translates into “res nullius”

The (political) laws
The legal framework covering outer space international relations is made of the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (better known as the Outer Space Treaty, or OST), reinforced by the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (informally, the Moon Treaty, or MT) – endowing space, in the eve of the Cold War conflictual competition with pacifist utility, to the benefit of all humanity. The treaties’ provisions, though ambiguous and interpretable on the magnitude of governmental surveillance over non-governmental space activities, forbids signatories sovereignty claims over space and other celestial bodies and their militarization, mandating countries to provide emergency financial assistance to astronauts, requiring nation-states to monitor their own public and/or private space missions, as well as granting them with “veto powers” regarding space projects developed privately by third-parties (Alewine, 2020; Salter, 2017; Bouvet, 2002).
The unfolding of the “entrepreneurial space” paradigm, new business models and
niche markets, with high cost projects mainly led by governmental agencies (Kreisel and Lee,
2007), invited the increase of private actors involvement in space commercial activities and
the need of a global regulatory framework covering issues pertaining to sovereignty and
property rights in the outer space (Pop, 2008). Noteworthy, the terrestrial inspirations were,
respectively, for the OST, the 1959 Antarctic Treaty – that prevents governments from
establishing sovereignty, but providing no specification for granting property rights or for
regulating economic activity –, and, for the MT, the 1982 Law of the Sea Treaty – the aim of
which is to regulate seabed mining up to a point that it prohibits this from happening at all.
The paradox or the irony is that these pieces of unowned “heritage of mankind” are, as well,
un-inheritable. Still, things are not as clear as they may look in terms of ownership rights
stipulations, but some say that precisely such equivocations might be used to set things right.

The economic law
One of the fundamental facets of human existence – as well, the central problem of economics
– is represented by the scarcity of resources (Dumas and Turner, 2015). Despite the infinity
of the Cosmos, scarcity will always be an inescapable reality, accompanying whatever human
advancements into the outer space, as any steps will be ultimately finite (Jaki, 1979; Tipler,
1981). Therefore, even in outer space, the range of ends continues to be more extensive than
that of means, and people need to economize resources to avoid dilapidation and degradation.
This economic problem begs the question of who should be entitled to muster the appraisals
of human needs and also be empowered to master the resource-allocation process, because
the economic system or institutional arrangement (Schumpeter, 1942) is a critical premises in
incentivizing (economic motivation) and informing (economic calculation) entrepreneurial
decisions on Earth and in Cosmos alike (Stringham, 2015; Friedman, 2014).

There are still queries on how property rights really stand under the OST (in
comparison to the more explicit, yet poorly ratified MT): are they permitted, outlawed, or
neither? Some say that property claims are explicitly prohibited by Art. II of the OST (“Outer
space, including the Moon and other celestial bodies, is not subject to national appropriation
by claim of sovereignty, by means of use or occupation, or by any other means”), since
property requires jurisdiction. Others say that the very existence of the MT annuls the OST
alleged outlawing of private property in space – for, if OST sufficed, there would have been
no need for MT. The MT is more explicit, but in fact weaker – being ratified by no major
spacefaring nation (Figure 1) –, whilst OST is ambiguous, but still leaves room for
interpretations that do not exclude legalization of space ownership. Particularly this
divergence of views could facilitate a resolution (Buxton, 2004; Gorove, 1969; Hertzfeld and
von der Dunk, 2005).
The “Business Economics” of the outer space (macro vs. micro): the difficulty of “doing business in no man’s land”

From wandering for solutions...

What if governments of the world simply recognize the property claims of any individual or corporation that meets certain conditions, regardless of citizenship or nationality, and without engaging in physical defence for these property claims (that could be suspected of sovereign behaviour or “national appropriation”)? The general recognition of the property rights of the citizens or corporations of other states is by no means an “act of national appropriation”, being a core “rule of engagement” in international affairs (though the enforcement of any rights is critical, for otherwise it might mean empty talk).

Nonetheless, the idea is that the outer space status-quo is not fully prohibitive to property rights, aspect that may be clarified without the need for a (costly) renegotiation and rewriting. Practical solutions are to be found precisely based on the particular experience of the American Frontier conquest (Simberg, 2012). Briefly, granting (or, better said, allowing) the retention of property in the form of enough/fair shares of the claimable space territories (used as collateral for homesteader-investors to attract further financing/capital for space projects) shall be a workable way for spurring outer space entrepreneurship.

A lucrative proposition has been made a decade ago by The Space Settlement Institute. The Space Settlement Prize Act (2012) instructed that “all US courts and agencies shall immediately give recognition, certification, and full legal support to land ownership claims based on use and occupation [...] for any private entity which has [...] established a permanently inhabited settlement on the Moon, Mars, or an asteroid, with regular transportation between the settlement and the Earth open to any paying passenger”. In the
meantime, a pro-market, pro-business piece of legislation had been passed in the US (Weinzierl, 2018).

Challenging both Article II of the OST – which practically prohibits nation-states or non-governmental actors to commercially approach celestial bodies (Larsen, 2021) – and Article 11(2) of the MA, the *Spurring Private Aerospace Competitiveness and Entrepreneurship Act* – SPACE (2015) allows US stakeholders to focus on profit, not only on science. This marks the US government’s will to create and develop a flourishing space entrepreneurial sector, for which defining, deploying and defending property rights are essential.

...To reasonable breakthroughs

Currently, a veritable “prisoner’s dilemma” reigns, due to the lack of sovereignty to support property rights, with actors unilaterally tending to give up on their space activities, although a cooperation might be mutually beneficial. Still, as space is expected to became the business/commercial “final frontier”, in search for minerals, metals, water and other resources on celestial bodies, and as capital requirements are huge and exceed the public means of sovereign states, a global, private space-entrepreneurs environment needs to be created, yet based on a different philosophy than that of seas/Arctic (Kirchner et al., 2020).

As thoroughly argued by representatives of “analytical anarchism” (Powell & Stringham, 2009; Anderson & Hill, 2004), property rights and rules do not, *theoretically*, have as prerequisite the existence of sovereign states as protectors and enforcers, even if *historically* this is the standard. Thus, property resources of celestial bodies and the norms for adjudicating disputes can be self-enforcing and recognizable by third-party sovereign actors, even if not “jurisdictionally”. Private law can be the “star”-solution thanks to the advantages it provides in stabilizing/grounding the expectations of private actors and in the flexibility/adaptability with regard to outer space peculiarities in terms of doing business.

The stakes of a *private-proprietary* approach are huge: rational exploitation of both hyper-costly (and profitable) mineral resources – deemed so scarce given the unfolding of the Fourth Industrial Revolution, as well as exacerbated by COVID-19 pandemic fractures in value chains, is quoted by NASA at USD700 quintillion only in the asteroids, apart from Moon and Mars. Common sense economics argues that precisely *private law* bridges information and incentives of self-interested actors, tech entrepreneurship and social wellbeing, even more so if aiming to “import” critical resources from the hostile Cosmos to Earth (Figure 2).

Creating “space” for enterprising industriousness in the outer space via pro-market (pro-business) is critical not only for big corporations, but for SMEs as well. In both the United States and the European Union, it has been acknowledged that whilst prime contractors (big corporations and large consortia) have the best visibility in the space economy, SMEs provide critical products and services. In spite of such importance of SMEs, the topic of space ownership rights has received rather low attention until now.
The “Business Economics” of the outer space (the SMEs edition): before (and in addition to) size, incentives do matter

Revisiting/resolving misalignments between the private and government space sectors

With the space business becoming an ever-increasing ecosystem, entrepreneurs and their small and medium businesses have to find their places in a constellation that, to much extent, was and mainly still is dominated and regulated by governmental institutions and policies, some of them with adverse effects on space marketization. As the “earthly” records acknowledge, the more artificial institutionalism and (inter)national politicization, the less entrepreneurial venture (Reisman, 1998).

A survey undertaken in the United States (Popp, 2018), following a more in-depth assessment by the US Department of Commerce, identified three main sources of hindrances between the commercial sector and the US space-related authorities:

- “red tape” (e.g., regulatory barriers and burdensome acquisition/contracting processes thereupon);
- “culture” (e.g., different expectations on the operational climate and different views of information partaking);
- “organization of bureaucracy” (e.g., insufficient staffing and underfunding of relevant governmental agencies).

The solutions indicated by the respondents in the survey imply, amongst other things, the transparentization of procurement procedures, the lowering of time-related transaction costs and the set-up of a level-playing field between Old Space and New Space enterprises.

The democratization of the space sector access for businesses, inside and across nations

Lamine et al. (2021) identify great potential for space business thanks to the extremely innovative character of the space industry. This claim is demonstrated in practice by the
figures published by the European Space Agency: in 2020, 1800 SMEs generated 3.9 billion annual turnover within the EU space sector, with 33,000 employees (ESA, 2022). Else looked at, each employee generated 118 million euros in 2020, an indication of the high concentration and specialization of the sector. In this regard, governmental space agencies need to be aware of their crucial role in promoting space entrepreneurship, as they have to create the framework and the necessary programs that can allow SMEs be part of the game alongside and among “vested-interest”, large contractors.

Similar to UKspace (the trade association of the British space industry), NASA runs the “Lunar CATALYST” program, based on partnerships with businesses to develop spacecraft and rockets. However, such programs need to ensure an open and equal access to any kind of businesses, irrespective of size or age, as a lucrative extension of the principles of space democracy (Simsarian, 1963). Structural imbalances, technological differences and geopolitical polarity make it improbable for many countries and their domestic business sector to substantially contribute to the space industry (Leloglu and Kocaoglan, 2008). De-bordering space economy, in a market-based, competitive-cooperative manner, which is both participative and profit-oriented, is the proper trajectory.

The OECD (2021) acknowledges that governments are multi-faceted players in the space economy, having more functions at once: owners, investors, developers, operators, regulators etc. In order to contribute to a more competitive (and “neoliberal”) market sector, which encourages private innovation and value creation, governments also have to help and encourage SMEs to engage in the space business. For example, most SMEs will need to use already existing public facilities such as vacuum chambers or wind tunnels in order to be able to develop a product. Such logistics are out of range for the majority of SMEs which may need to enter public-public-partnerships. Attention is to be paid to avoid the distortion of markets by creating “dependency” on public funding and facilities.

Case study: the business side of the Romanian space ecosystem and its institutional traits
The participation of Romanian entities in the European space programme(s) is mainly predicated on the membership of Romania in the European Space Agency starting with 2012. Romania’s general ESA involvement is justified by its interests in having access to critical space services to which Romania can also be part of the governance entity, such as navigation, positioning and timing (the Galileo GNSS), Earth Observation (Copernicus/GMES), or the future GOVSATCOM for secure government communications via satellites and more in support of its society, economy and government.

Preparatory steps and historical heritage
During the pre-accession period (2006-2012), the ESA cooperation allowed Romanian entities to access technology transfers and attract investment to increase its aerospace capacity.

Entities were initially made up of legacy state capabilities, organized as National Research and Development Institutes (so-called INCDs, like the National Institute for Aerospace Research “Elie Carafoli” – INCAS), relevant university departments in science and engineering (such as the University Politehnica of Bucharest etc.), “legacy companies” like Electromecanica Ploiești, Microelectronica S.A., Elprof S.A., or IOR S.A. (Industria Optică Română – Romanian Optical Industry), other relevant parts of the military industrial complex, and the local subsidiaries of foreign companies (Thales, Deimos etc.).
The enterprises coming from abroad implanted in Romania for two main reasons: to benefit from the still existing human resources and knowledge base that were the legacy of civilian and military aerospace (and rocketry for the latter) investments of the Communist period, and to access opportunities that would come through the country’s accession to ESA. Foreign European companies became mostly established through greenfield investments but, in some cases, they also purchased local companies, including privatized state assets.

One notable area of investment that was not rooted in the Communist period was the IT sector for space, with Romania emerging as an important (relative to its overall industry) provider of software for space systems (such as Thales and CS Romania). Later on, Romanian start-ups in the Western sense also emerged and there is a growing emphasis from ESA on encouraging spin-ins: companies from other sectors turning their core capabilities and products towards the space sector.

The ESA effect and the “geo-return” principle

The main avenue for Romanian involvement in European space activities came through ESA because of the “geo-return” principle, whereby the payments made by a state to ESA should be reflected in the research contracts and acquisitions in the space field that the state attracts. It is not a rule that countries should get as much as they put in, and there are notable ESA participants that do not manage to do so, such as Portugal, Austria and Norway. The countries can either see this as the price of being involved in governance decision-making for European space projects on which they are critically reliant or this may become a political issue that reverberates up to the highest level. To avoid this happening with the new, post-communist members (of whom Poland and Romania were the first entrants, followed by Hungary, Bulgaria, Croatia etc.), the ESA established the Industrial Incentive Schemes (IIS). The post-communist members were rightly thought to be unable to compete on an equal basis with the established entities from the West and would have very scarce geo-return. Through the IIS, funds would be allotted for a country’s internal industry. Local subsidiaries of foreign companies were welcomed to participate (and represented around half of spending in Romania). This became an added reason for their expansion, but rules were put in place to prevent the transfer of work to other entities within the group – for instance, it is explicitly stipulated that the most relevant portion of a project had to be completed within the local subsidiary, trained personnel could not be cycled out to other entities, intellectual property rights had to remain in the property of the local subsidiary etc.

In addition to this, all ESA Member States could choose to fund optional programmes within ESA in addition to the mandatory ones (GDP-based). The optional programmes allowed states to decide on their scientific and industrial interests and allocate more money to one project or another (or to particular steps in the project), which would be reflected in work orders for their own aerospace sector to fulfil the objectives of the programme. In some cases, this entailed a project of discovery on the part of ESA to identify programme-relevant capabilities in new entrants to see on what exactly the money could be spent and whether intermediary investments needed to be made for the product or service to reach the needed technology readiness level at the expected time. Geo-return type contributions entail the delivery of components and sub-assemblies, testing, delivery of additional equipment such as ground control equipment, support services, basic research etc.

Romania participated in ESA space missions such as HERA (the first planetary protection mission of ESA), JUICE, EUCLID, MetOp-SG, PROBA-3, Biomass and in development
programmes such as the Copernicus (formerly GMES) Earth Observation satellite constellation, the Ariane 6 and Vega launchers, the Space Rider spaceplane and ARTES NEOSAT satellite platforms. Wider programmes of interest for Romania include the General Technology Support Programme (GSTP), the Space Situational Awareness (SSA) Programme, the European Exploration Envelope Programme (E3P) with its Lunar Lander and (un)manned exploration support components like SciSpacE and ExPeRT, the Earth Observation Envelope Programme (EOEP-5), as well as the Navigation Programme (NAVISP).

In ESA terms, this entails a Romanian participation in categories such as Generic Technologies and Techniques, Earth Observation, Science, Space Transportation, Telecommunications, Space Safety, Exploration.

The financial hardships of Romania’s space odyssey
Something that cannot really be accounted for in Romania’s cooperation with the ESA is the ongoing saga of non-payment of dues, which led to the first instance where an ESA Member State lost its voting rights. Despite several years of non-payment and the accumulation of over 100 million euros in debt, the ESA Programmes with Romania continued to function as if the sums had been paid, though it should be noted that numerous ESA Members have had payment delays in the past, including France. Despite the non-payment impasse, Romania continued to up its promised contributions by selecting more optional programmes and becoming, at least on paper, the largest of the medium participants in ESA.

Not only did the optional programme involvement of Romania continue, which could be justified on the basis of not interrupting planned sequences, but the Romanian Industrial Incentive Scheme run by ESA continued as well, which displayed significant goodwill. This shows the extent to which Romania’s aerospace industry has come to rely on ESA project evaluation, selection, funding, management and results integration as an organizing principle in its aerospace industry. Finally, a first tranche of 66 million euros has been approved by the Romanian Government in November 2022 to cover part of the debt towards ESA, and voting rights (which were lost in July 2018) were restored (Bratu, 2022).

In the long-run, it is expected that Romania will develop a more vibrant space start-up sector and will invest in having Prime Contractor capability for competitive ESA bids, while trying to retain more of the added value created through ESA projects.

Conclusion
Space economy challenges are unique. They are mainly related to the gigantic distances between celestial bodies (severely burdening the logistics of future cosmic supply chains), their gravitational forces (guilty for the cost of lifting payloads from various planetoids) and the inauspicious climate (adding to the scarcity of resources for human survival). Also, an associated hurdle to space activities involves their financing, which can be managed by attracting private investors alongside governmental subsidies and building a lucrative space infrastructure. But this is not just a problem of political will or business size, but, first and foremost, of institutional design, conducive to (rewarding) risk-taking and finance provision.

Here the crux is the very issue of national sovereignty and its relationship with private appropriation (a universal pillar of a sound business/entrepreneurial climate) and the manifest need for a friendly regulatory framework. More and more voices speak about bringing to the forefront the option of combining “hard (intergovernmental) law” with “soft (commercial) law”, resulting into a “smart space law”, which builds up on the existing OST,
stimulates cooperation within international organizations (public and private) and facilitates an international financing mechanism in support for private entrepreneurs, large and small, which, together with state agencies, co-work to unfold a genuine commercial space economy.

Our essay surveyed the existing literature on outer space economics, broadly defined, as well as the thinner segment observing SMEs contribution, noticing the institutional inertia that impede progress in much steeper pace and advancing common-sense solutions to the case of Romanian involvement in the European space programmes. Further research might be devoted to: the analysis of the interplay of stakeholders (among which, SMEs) in lobbying for more permissive/stimulating legislation worldwide; the power-structures in the world economy and the room left for SMEs to be part in a traditionally governments-corporations affair; or the comparative advantages of space-compatible SMEs from a country like Romania.

The nature and degree of involvement from small and medium enterprises alongside big corporations is not just a simple extrapolation of the problem of the asymmetrical “terms of trade” in space affairs, which deter minor countries in relation with great spacefaring nations/entities (US, EU, China, Russia, India). Besides the blunt reasoning in terms of pure power politics and its translation in powering economic undertakings under governmental observance, it is for the benefit of all stakeholders to understand that, just like in our “Earthly cradle”, enlightening on and then enforcing the right mix of democratic and capitalistic institutions remains the ethical and efficient “royal route” of development towards the stars.

References


