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The Changing Economy of Space Application and Exploration: A Catalyst for International Cooperation?

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Abstract

The evolution of the space economy can be understood in terms of three waves. Initially, space programs were driven by government objectives and national security and financed mainly through public funding. Even in this early phase, however, we saw critical international partnerships in support of space activities, such as the UNOOSA Outer Space Treaty (1967). Government support was then gradually replaced by profitable commercial space applications, with companies using their own capital and debt financing. Since around 2000, we have witnessed a third wave, a paradigm shift, in the form of New Space, which has attracted the attention of equity investors such as venture capitalists and private equity firms. This paper shows how the economic evolution of space activities corresponds to changes within international relations, especially geopolitical tensions.

Keywords

space policy, space economy, New Space, international cooperation

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The Changing Economy of Space Application and Exploration: A Catalyst for International Cooperation?

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1. Introduction

The political economy of space activities is changing, and the space sector is growing rapidly. At present, private companies, such as Spire and Planet, produce satellites that are launched by private launch providers, such as SpaceX. Private investors are involved in space tourism and transporting professional astronauts to the International Space Station. With private investors and New Space start-ups playing a growing role in the development of space exploration, the landscape of space programs has been permanently altered. While governments remain interested and invested in space programs, they are no longer the only stakeholders. As such, this Expert Analysis sketches three eras of the space economy, an evolution witnessed over the last seven decades, which has led us to the current web of relationships between governments, established companies, and start-ups. While it is helpful to think of the development of the space economy occurring in different phases in relation to other events, including geopolitics, it is essential to note that phases overlap; common themes run through each, such as national security concerns. In the first two phases (roughly 1950s–1990s) in particular, the context of the Cold War sets the tone not only for space exploration activities, but the boundaries of the space economy.

The first phase of the space economy coincides with what is commonly known as the 'space race', whereas the second phase is linked to an era of arms control and détente. Strategic competition in the early Cold War resulted in significant government spending on military and scientific capabilities, while the later phase of arms control resulted in a drop in government funding. This created an environment where commercial actors emerged as significant drivers of space activity, but it also resulted in high competition between these companies. The end of the twentieth century, and of the Cold War, resulted in mergers of large corporations and relatively low government spending on space activity. These first two phases stand in contrast to the third (contemporary) phase of private investment, as is explored throughout this paper. Taking a historical view on the evolution of the space economy thus allows us to grasp how it changes alongside geopolitical tensions and international relations, and to distinguish between different phases of space funding and activity structures.

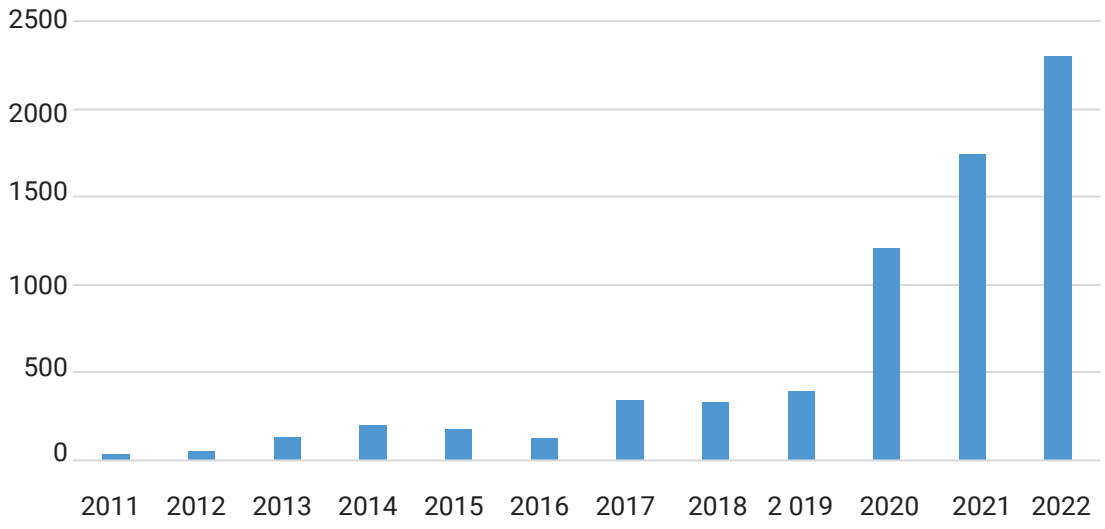
Space has become increasingly crowded. Large consortia are formed with the aim of putting satellite constellations into Low-Earth-Orbit (LEO) to provide better and faster internet connection and a truly global communication coverage, particularly in regions which are not yet sufficiently covered.

1 The basis of this article is a previous publication of one of the authors (Peeters, 2022; 2024), describing the evolution of space business. Here, the dimension of international cooperation has been added (Fey).

These constellations require a large number of satellites to be placed in orbit because satellites circle much faster in LEO. As an illustration of the presently planned constellations, we can refer to OneWeb (648 satellites), Kuiper Amazon (3,236 satellites) and SpaceX's Starlink constellation with at least 4,425 satellites, and the potential of up to 12,000 satellites (Curzi, Modenini and Tortora, 2020; Keane, 2018). Moreover, projects such as Telesat Lightspeed (300 satellites) and a European Connectivity constellation program have been announced. These projects are part of the advent of largely privately financed space activity and the push for more communication coverage will lead to the permanent alteration of Earth's night sky through the sheer number of satellite systems planned. Given these developments, we ask: to what extent can these emerging space industries facilitate international cooperation in space activity?

Before analysing the space economy as a future business sector and potential catalyst for international cooperation, it is useful to recall the evolution of the sector from an economic and international policy point of view. On the latter, we highlight that developments in New Space that have been particularly useful to emerging space countries in becoming actors and collaborators in space. This is a key factor because it takes space activity beyond the bipolarity of the twentieth century and opens the doors for the involvement of multiple stakeholders. While national security interests continue to be driving factors, strategic competition today sits alongside the need for profit. As such, the first phases of space activity remain closely linked to the Cold War and the security interests of nation-states, with commercial actors taking on a more prominent and visible role in the last two decades.

Figure 1. *Number of Smallsats launched (< 600 kg) based on Bryce Tech (2023, p. 6)*



2. Evolution of the Space Economy

We can divide the evolution of the global space economy into three phases, as per Fig. 2. It must be noted though that these are major trends; the different streams in Fig. 2 co-exist; in other words, government spending on space activities persists, mainly via space agencies such as NASA (in the US), ESA (in Europe) and JAXA (in Japan), parallel to commercial space expenditure, and the phases overlap. We find it helpful to distinguish between different phases because significant changes in the space economy are interlinked with development in other areas, such as international politics. Thus, even where we witness phases overlapping, major trends demonstrate that the space economy responds to geopolitical shifts—and vice versa. This is particularly relevant for contextualising the most recent phase: New Space (see below). Here, the entanglement between changes in the US government and the advent of a reliance on Public-Private Partnerships (PPPs) is particularly noticeable.

2.1. Phase 1: Government-driven space activities

The main driver of the first phase was a concern about national security tied to the Cold War tensions between two superpowers, the United States and the Union of Soviet Socialist Republics (USSR); hence the term 'Space Race' was coined. Governments set priorities and provided funding to their respective space agencies, such as the National Advisory Committee for Aeronautics (NACA) in the US (the precursor of NASA).

Figure 2. *Three phases of the Space Economy (1950-present). Source: (Peeters, 2022)*

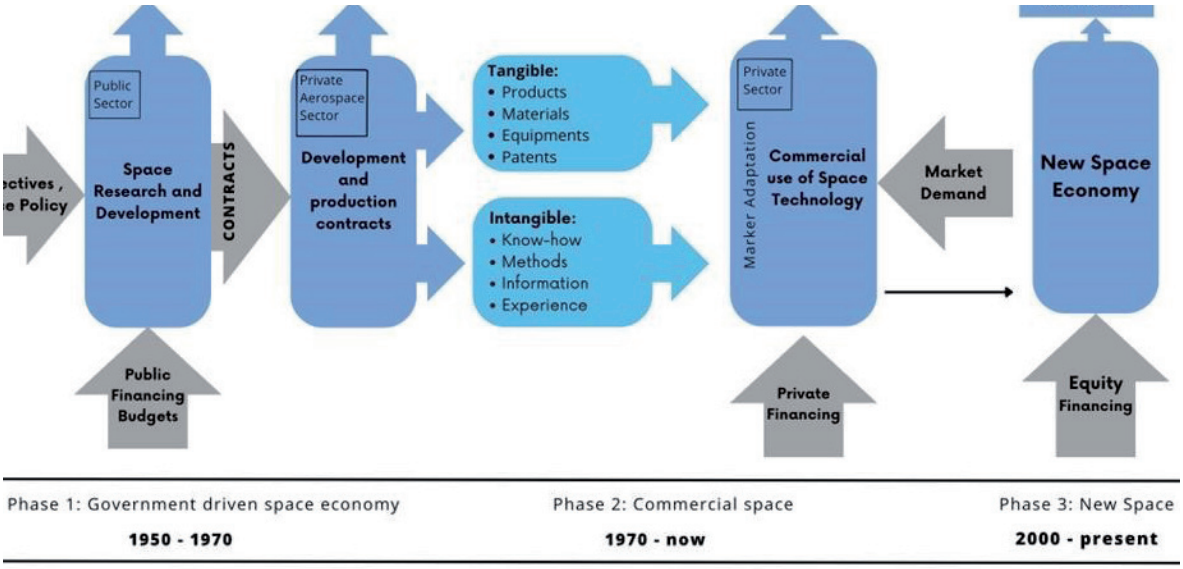


Table 1. *NASA Budget as a Percentage of the U.S. Federal Budget. Based on data from Erickson (2005).*

Fiscal Year	NASA Budget as portion of the Federal Budget
1962	1.18%
1963	2.29%
1964	3.52%
1965	4.31%
1966	4.41%
1967	3.45%
1968	2.65%
1969	2.31%
1970	1.92%
1975	0.98%
1980	0.84%

The launch of Sputnik in 1957 provided a significant boost to national security considerations in the US and fuelled the Space Race, when NACA director Hugh Dryden stated in 1958:

> *It is of great urgency and importance to our country both from consideration of our prestige as a nation as well as military necessity that this challenge [Sputnik] be met by an energetic program of research and development for the conquest of space... It is accordingly proposed that the scientific research be the responsibility of a national civilian agency working in close cooperation with the applied research and development groups for weapon systems development by the military... NACA is capable, by rapid extension and expansion of its effort, of providing leadership in space technology (Erickson, 2005).*

The creation of NASA under President Eisenhower—combining different space-related institutions and a steep increase in budgets—allowed the US to recover rapidly after the USSR's successful launch of the first human spaceflight (of Yuri Gagarin) in 1961. A crucial step in this process took place weeks after on 25 May 1961, when US President John F. Kennedy announced the inception of the Apollo program. Space was declared a national priority with an increase of the NASA budget of 550% between 1961 and 1965 (The Guardian, 2010). Another dimension of Dryden's quote is that of 'national prestige', which he mentions alongside the 'military necessity' of space technology. Space is to be conquered, and the United States is to establish itself as a leader. Of course, 'the moon program was not just about climbing the highest mountain […], but when plugged into the overall U.S. grand strategy of facing the Soviet Union during the Cold War' a moon landing makes

sense 'in this world' (Arnold, 2022, p. 53). In other words, the moon landing was seen as a vital strategic aspect, even if it required significant military and economic investment at a time of war.

As public support for the Cold War was waning in the US, particularly in the shadow of costly proxy wars in Vietnam and Korea, the Space Race constituted a level of competition that was a lot less violent than the rest of the Cold War and served to increase national prestige for both sides of the Iron Curtain. For example, as early as June 1962, based on previous exchanges between US President John F. Kennedy and Soviet General Secretary Nikita Khrushchev, an agreement on scientific cooperation—the Dryden-Blagonravov Agreement—was signed (Ezell and Ezell, 1978, pp. 37-60). Discussions between the two leaders even went so far as to consider a joint US-USSR Moon landing, but these plans were not pursued after the assassination of President Kennedy, who was the driving force behind the idea of US-USSR cooperation in space exploration at the time (Launius, 2019). Cooperation was revived in 1972, which ultimately led to the signing of the 'Summit Agreement Concerning Cooperation in Outer Space for Peaceful Purposes' on 24 May 1972 by US President Nixon and Soviet Premier Kosygin in the context of a 'détente policy' (Muir-Harmony, 2017). These agreements were examples of early strategic cooperation in space between the US and the USSR that went 'beyond space law' and included a 'patchwork' of policies and agreements (Stroikos, 2022). The struggle between the two powers was thus reflected in a practice of strategic restraint which, aided by détente, ultimately served both sides who had realised the danger of warfare in space. And yet, probably the most well-known result of US-USSR cooperation in space was the docking between the US Apollo capsule with the Soviet Soyuz module on 15 July 1975. On that day, for the first time in history, three American astronauts and two Soviet cosmonauts lived and worked together in space (NASA, 2015).

“As such, the first phase of the emerging space economy was firmly embedded within the national security agendas of the United States and the Soviet Union during the Cold War.”

As such, the first phase of the emerging space economy was firmly embedded within the national security agendas of the United States and the Soviet Union during the Cold War. Great power management strategies gradually took over to establish a complex web of rules, norms and policies, all of which continue to influence the management of space (and its economy) today. Moreover, national prestige through successes in space exploration was a part of the strategic toolbox available to both sides. Despite the tension of the Space Race, however, there were efforts on both sides to find a common agenda for scientific advancements in space, ultimately leading to joint space missions towards the end of the confrontation.

2.2. Phase 2: Towards Commercial Space Activities

Some 400,000 people and roughly 20,000 companies were involved in the Apollo program. With an abrupt reduction in government funding after 1969, many companies feared bankruptcy and closures. However, there was an increased military interest in space applications at the same time as the Apollo programmes, leading to further, big programmes in the fi eld of communications (called MILSTAR), navigation (initially called NAVSTAR, afterwards renamed GPS) and Earth observation applications (such as SBIRS). In combination with the knowledge gained from the Apollo programmes, it is evident that US space companies had acquired a wealth of tangible and intangible knowledge allowing them to produce satellite systems based upon their own requirements (Peeters, 2000).

> “Whereas ‘traditional space missions have societal and national benefits as their primary stakeholder needs’, New Space places shareholder profits and returns on investment as central aspects of space activity.”

However, the absence of funding for the Space Race after the successful Apollo Moon landings caused considerable issues for the sector and threatened the economic survival of the industrial complexes involved in the previous phase. At the same time, the same industrial complexes had accumulated invaluable knowledge during this phase and as mentioned, now had considerable technical capability to build satellites and rockets. They decided, therefore, to use their own funding and debt financing to develop new markets. Telecom operators were the first customers ordering high-performance satellites for public telecom purposes. Indeed, it is important to remember that the financial and technical requirements for military projects in general are higher than for commercial operations, which placed experienced companies in an ideal position to respond to such commercial requirements. This led to the secondary loop of the schematic overview in Fig. 2.

One of the major economic effects was a wave of mergers and acquisitions during this second phase. Examples include the acquisition of Grumman by Northrop (now Northrop Grumman) in 1994, the merger of Lockheed and Martin Marietta (now Lockheed Martin) in 1995, and the merger between Boeing and McDonnell Douglas in 1997. As Boatner (1999, p. 940) points out, these major mergers towards the end of the 20th century show that space was a ‘fierce’ market which required commercial actors to respond to changing funding landscapes dictated by national interests. Indeed, a fragmented approach was preferred where contracts for smaller components were given to different companies who were thus not wholly informed about the purpose of their work. This fragmentation of information about space research thus served to control the flow of intelligence during the Apollo era. There was also a need

to have various solid entities to cope with a more volatile market and fewer long-term government orders. To illustrate the transition between Phases 1 and 2, whereas the ratio between government space activities versus commercial space activities was approximately 100:0, this evolved to a ratio of approximately 25:75, in favour of commercial space in the early 2000s. It is important to note that for the foreseeable future, we can expect ongoing constructive and sustained interaction between governmental and commercial space activities, driven by the considerable Research and Development (R&D) efforts required for new applications.

At the same time, a need for a permanently inhabited space station was identified during the 1980s and NASA started the design of the American Space Station 'Freedom'. However, when a preliminary cost estimate of 14.5 billion dollars (in 1984 economic conditions) emerged, it sparked political scepticism regarding the financial feasibility of the project. In 1988, NASA invited space agencies from Europe, Canada and Japan to participate, mainly by providing hardware in exchange for opportunities to send their astronauts aboard and contribute to, as well as perform, their own experiments. This resulted in the Inter-Governmental Agreement (IGA), whereby the name Freedom was replaced by the new name: International Space Station (ISS) (Encyclopedia Astronautica, 2019). Even in a phase of increased commercialisation of space we witness the recurring theme of national security interest as a driver for major space exploration projects, as exemplified by the ISS. While the ISS was a well-known space project, other developments in space technology—particularly in the realm of satellites and rockets—attracted less public attention, even though commercial interest and influenced had increased significantly.

With the collapse of the Soviet Union in 1991, it became clear that a Russian follow-up station to MIR (MIR-2) would not be feasible, even if some modules for the new station had already been produced. US President Clinton realised the political potential and invited Russia to become an additional partner in the ISS endeavour, using the modules designed for MIR-2. Initially, a Phase One agreement was made, whereby seven astronauts worked with their Russian colleagues in the MIR station. Both sides profited from this deal. On the one hand, the involvement of the United States provided a financial value for Russia by keeping their human space programme alive and avoiding a brain-drain of specialists, potentially to other countries interested in missile proliferation. On the other hand, NASA benefitted from the Russian experience in long-duration crewed missions, for example in the area of space medicine. The successful Phase One experience led to an amended IGA which was signed on 29 January 1998, whereby Russia became an additional partner on the ISS. Although responsibilities were clearly divided, transparent coordination was needed for the interface, which represented a next step in international cooperation. As such, the second phase of the space economy evolution was characterised by a widening of the field in terms of who had access to space. While commercial operators expanded space activity in the wake of the Moon landing, international cooperation moved beyond the bipolarity of the early years and instead focused on a joint, more global, effort in establishing a continuous presence of humanity in orbit: the International Space Station.

2.3. Phase 3: The New Space Economy

The concept of 'New Space' remains a contested or 'blurry' concept (Golkar and Salado, 2021, p. 2). As Golkar and Salado (2021) point out, New Space is sometimes confused with related terms like 'commercialisation', but research reveals that New Space is a term describing new business models rather than a new phase of commercialisation; space activity has always undergone some form of commercialisation from its inception.

We can place the start of the New Space phase in the early 2000s. This phase marked a stark departure from government-funded space activities towards a model where space missions are funded by private investors (e.g. SpaceX) and where economic profit of space activity has become more important (Golkar and Salado 2021, p.1). For example, Peeters proposes the following definition of New Space: "Private companies, which act independent of governmental space policies and funding, targeting equity funding and promoting affordable access to space and novel space applications." (Peeters, 2018). An interesting aspect of this definition is affordability. Where traditional space missions were very risk-averse due to high launch costs, New Space has rung in an era of a much higher tolerance towards risk.

Still, there is no universally accepted definition of New Space. Many definitions revolve around the creation of new markets or ecosystems, such as in the European Investment Bank (European Investment Bank, 2019). It has become evident, however, that we are dealing with a complete paradigm shift, which differentiates the New Space era considerably from the previous commercial space phases. Commercialisation alone is not what distinguishes New Space, but it is the intentionality of space missions. Whereas 'traditional space missions have societal and national benefits as their primary stakeholder needs' (Golkar and Salado, 2021, p. 7), New Space places shareholder profits and returns on investment as central aspects of space activity.

Table 2. *Differences Between Traditional and New Space. Source: Peeters (2022).*

Characteristic	Traditional Space	New Space
Main Driver	Hardware Production	Software application
Main Orbits	Geostationary Orbit (GEO)	Low Earth Orbit (LEO)
Orientation	Techno-Push	Application oriented
Design Characteristics	High Reliability, redundancies	Simple design, shorter lifetimes
Engineering	High quality, high cost	Low-cost, low mass
Launch	Dedicated launcher	Rideshare
Intellectual property	Patent protection	Passive protection
Risk acceptance	Risk Adverse	Accept business risks
Financing	Debt Financing	Equity Financing

Much space activity in the New Space environment deals with smaller satellites which, often in constellations, are put in much lower orbits and are produced relatively easily, thus allowing serial production. This reduces the cost of both the satellites and their launches. A comparison between 'traditional' and New Space approaches is proposed in Table 2.

As we can note from this table, New Space satellites are less protected (e.g. against radiation) and the drag in the lower orbit leads to shorter lifetimes. Most New Space tech companies do not see this as a major drawback, as technology is changing rapidly, so satellites tend to be 'old' after three or four years.

A different aspect is the funding model. Whereas in the commercial space era companies were using their own capital or had access to debt financing (in view of proven success records) this is not the case for young entrepreneurs who have in general no access to these funding sources. To realise their ambitions in space, they instead must attract equity financiers, such as business angels or venture capitalists who, in exchange for funding (risk capital) will request a share in the company. The barrier created by the limitation in flow of capital, and the reliance on private investments, is a defining feature of New Space, as will be explored in the following section.

Satellite constellations in LEO will allow for the exploitation of a large variety of applications and create several opportunities. What's more, some entrepreneurial start-ups are already studying even lower orbits called VLEO (Very Low Earth Orbits), which will allow better resolution and more advanced accuracies. Although the emphasis is placed on satellite space applications, where the majority of revenues will continue to come from for quite some time, we cannot ignore the development of small launchers.

Indeed, to place small satellites with a limited mass in these lower orbits, we do not need the previous generation of high-capacity launchers This is leading to new competition globally between launch manufacturers offering to bring a limited number of satellites in very specific orbits. As mentioned earlier, at present smallsats can still be brought into orbit by larger launchers in considerable batches. Replacement of satellites will generate the need for smaller launchers, of which several are under development. An example of such a launcher, under development by the German company ISAR, is shown in Fig. 3.

Figure 3. *Artist impression of a Micro-launcher under development (courtesy: ISAR Aerospace)*

The advantage of smaller launchers for a smallsat operator is that different launch systems can be used to put the satellite in orbit. Although there is no doubt that there is a considerable market for these micro launchers, estimated to be in the order of 50 billion USD by Euroconsult during this decade (Euroconsult, 2022), there will be also fierce competition with potential mergers and acquisitions. So, while New Space offers access to space activity to smaller start-ups and a broader range of stakeholders, it also brings new challenges—such as the continued quest for adequate funding and increased competition.

These satellite constellations will ensure global network coverage. Replacement satellites will be launched from various spaceports around the world, whereby the choice will be driven by the convenience of the location for polar orbit injections. To make those launches possible, rockets will have to be shipped around the world, creating a global network of space activity on Earth. Moreover, the advent of New Space has made space applications more affordable for emerging space nations (see Table 2). To illustrate, the estimate number of countries involved in space activities was at around 30 in 1992 (Euroconsult, 2022), whereas in 2022, 103 countries were registered to be involved in one form or another in space activities—for example, in the field of small satellites like CubeSats, which can be produced at university level with government support. This spectacular increase of more than 340% over 30 years is continuing with a forecast in the same report (Euroconsult, 2022) that around 124 countries will actively participate in the space market by 2030.

Figure 4. *Starship (SpaceX). Photo Credit: Ken Davidian*

Perhaps the most promising new advancement of commercial space applications is Starship (Figure 4), currently under development by SpaceX. Not only will Starship be the most powerful launch vehicle developed to date, but it signals the advent of fully reusable, and thus much lower cost, rockets for frequent space launches. Developed by the business sector, rather than a governmental space agency, we thus witness further the commodification and diversification of who has access to space. Together with the potential for commercial space stations (e.g. by Axiom Space) there is thus renewed attention also to how these developments will impact international cooperation on all levels.

We are already at a point where some crucial space infrastructures are privatised, such as in the case of Starlink. Being the world's largest satellite mega-constellation and operated by SpaceX, Starlink provides access to internet coverage in remote areas of the world. Satellites are also dual-use technologies, meaning they can be used for civilian and military purposes. In inter-state conflicts, these

satellite systems play a critical role. Satellites provide essential service communication, Earth observation and navigation tools. In the war between Russia and Ukraine, the issue of internet coverage by Starlink has come under scrutiny especially because Starlink is a privately-owned constellation. SpaceX initially provided Ukraine with Starlink coverage after debilitating Russian cyberattacks on Ukraine's military communication, but then later changed his strategy and stopped making Starlink's services available to the Ukrainian military (Abels, 2024).

There is much to unpack about this situation, but for the purpose of this paper, two things are worth noting. Firstly, New Space's potential for cooperation extends to the other end of the spectrum: conflict. Where there is cooperation, there is tension, and the advent of privately-owned crucial space infrastructures complicates the governance of these infrastructures. As such, the increase in diverse stakeholders in space needs to be assessed on its own terms. Secondly, if critical communication infrastructures are owned and controlled by private companies without sound regulation, this may severely impact the quality of international cooperation in future space activity. Any further developments in the space economy are likely to be closely intertwined with international relations on Earth, meaning that the study of international cooperation in space must take a multidisciplinary approach.

New Space is encouraging the globalisation of the space economy and fosters international cooperation as well as competition. However, compared to the government-led interest in space we witnessed over the last century, the current wave is driven by the private sector and equity investors. The consequences of this shift and its sustainability—as long as governments continue to be prominent players in space exploration—are likely to be significant. The evolution of the space economy is far from over, but commercial interests will likely have to be balanced with the national security interests of states. Relevant geopolitical examples show us that New Space and the space economy at large need to be taken seriously as sites of international politics.

3. The Future of the Space Industry

OECD has been making a strong effort in the last years to harmonise economic assessments of space activities, simultaneously stressing the point of Purchasing Power Parity when comparing space budgets (OECD, 2022). It is therefore no surprise that different organisations reach different figures of the space economy based on certain assumptions and different methodologies. Because organisations make different assumptions about space activities and use different methodologies, this results in different estimations, sometimes amounting to tens of billions of dollars. Therefore, discrepancies in the reported size of the global space economy can reach several percentage points. As such, there is little certainty as to the exact growth of the sector. Moreover, there was some stagnation in growth levels in the 2019 and 2020 economic years due to the COVID-19 pandemic. And yet, a growth figure of at least $1 trillion USD for the year 2040 seems feasible, if exploration activities, especially lunar and cis-lunar, continue to develop at the rates they are now (Crane, et al., 2020). However, in view of significant development costs and the present economic context, these opportunities will only become feasible through renewed and intensified international cooperation.

Conclusion

This paper has sketched three phases of the evolution of the space economy. Slowly moving away from government-driven space activity, notably in form of the Space Race during the Cold War, space application and exploration now involves a multiplicity of actors, including private and commercial stakeholders. At the same time, it is important to understand how the space economy evolved alongside a changing landscape in international cooperation. Although cooperation between nation-states in space exploration has historically been the norm—even throughout strategic confrontation between powers—the advent of New Space might change how different actors behave and cooperate. As such, the future of international cooperation in deep space exploration, as we increasingly venture towards the Moon and beyond, warrants analytical attention. We contend that reflecting on the different phases of space economy development is an important starting point to chart the future of the space sector and to make better sense of the relationships between different stakeholders –whether inclined to cooperate or not—that will undoubtedly have a profound impact on the future of human activity in space.

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