Space Systems and Space Sovereignty as a Security Issue

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Abstract

Since the beginning of space activities, the global community speculated about the relation between planet Earth and the space environment, and on the potential offered by the space enabled services to safeguard a country's political, economic, and social sovereignty. Through the decades, space technologies progressively enhanced global safety, by improving domestic and international coordination and strategies. In particular, this chapter will focus on the relation between space systems and the security issues linked to a state's sovereignty.

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Introduction

Space has always been the stage of humankind's greater achievements and the focus of inspiring collaboration among nations, mainly within the scientific domain. The space sector has always been considered a strategic resource, able to contribute to the pursuit of a multitude of political, social, and economic objectives of a country (Darnis et al. 2016). The ability to access to satellite capabilities and operate them has always been critical to both the major powers on the international geopolitical stage and also the global community as a whole. The space environment has acquired greater importance, not only for the institutional actors but also for non-state actors, scientific and academic institutions, international organizations, and all other players that use space technologies and services in order to improve their activities. Outer space resources embrace all kind of applications, ranging from global communications to farming, from weather forecasting to environmental monitoring and climate change, from navigation to surveillance and disaster management. Being critical to the well-being of all countries and people, it becomes imperative that all humankind can access and enjoy its many benefits. Therefore, given its importance and practical utilization, space has become a particularly challenging conundrum of public policy.

Space is also interlinked to the concept of security, safety, and defense. Within the security and safety context, space infrastructures and services are key elements to the political and strategic dimension. Whether we take into consideration international agreements and policies or situation of crisis and disasters, space-based capabilities appear to be strategic and effective instruments, critical to the well-being as well as safeguarding the sovereignty of states. Furthermore, the increase of dual-use space systems, which are blurring the line between military and civil space-based missions, is linked to public returns of investments in proprietary assets. The progress in technological advancements seems today to be inadequately regulated by the 1967 Outer Space Treaty (OST), and an update should be envisaged. In the last years, the concept of space security is being linked to the idea of having a dedicated space force, but this proposal is still being object of discussion among the spacefaring nations. This chapter will focus on the security and defense concerns of space-enabled capabilities linked to the sovereignty and interests of a state, by examining the issue from different angles, in particular those connected to the security, defense, political, and economic dimensions. The objective of this discussion is dual: we want to highlight the importance of space assets as strategic elements for the security and well-being of the sovereignty of a state.

Notion of Sovereignty and Jurisdiction

The increasing awareness of vulnerabilities has led to a debate about state sovereignty. Given that this term carries some weight, it is worth defining it within the context of this discussion. Sovereignty, once a relatively uncontested concept, lately had become a question of rivalry within the national and international relations

theory (Alshdaifat 2018). In the context of contemporary public international law, we can define sovereignty as the basic international legal status of a state that, within its territorial jurisdiction, is not subject to governmental, executive, judicial, or legislative jurisdiction of a foreign state or to foreign laws other than public international law (Steinberger 2013).

Sovereignty is a legal principle by which each state is entitled to exercise exclusive control and supreme authority within its boundaries. Article 1 of the Montevideo Convention of Rights and Duties of states of 1993 indicates "*the state, as a person of international law, should possess the following qualifications*: *Permanent population, a defined territory, government, capacity to enter into relations with other states*" (Montevideo Convention 1933). Furthermore, Article 2 of the Charter of the United Nations recognizes that all states are equal and sovereign because they all are politically independent. Sovereignty can therefore be considered the benchmark for the doctrines of responsibility, jurisdiction, and nationality. The concept of jurisdiction refers to the power of the states to affect its nationals, property, and circumstances, and therefore reflects the basic principles of sovereignty, equality of states, and non-interference in national affairs. The competence of states in respect to their territories is generally attributed to their sovereignty and jurisdiction, but a distinction in the two terminologies should be noted: while sovereignty can be intended as the legal personality of a state, jurisdiction refers to the rights, claims, powers, and freedoms of a state and therefore refers to its regulatory authority to make and enforce rules upon people.

The notion of sovereignty applied to outer space has been introduced as an object of discussion, following the launches of the first satellites in 1957, and then further developed, with the creation of the OST. in 1967. Articles I and II of the treaty affirm that all space activities shall be undertaken in the sovereignty-free outer space, including the Moon and other celestial bodies. Furthermore, outer space is recognized to be *res communis*, which according to Roman law is the "*property of all*," that is outer space is not subject to private ownership. However, the exclusion of sovereignty in outer space laws does not exclude the exercise of certain sovereign rights by states in space (Zhang 2019). Article VI of the Outer Space Treaty, as *lex specialis*, recognizes the concept of jurisdiction to be applicable to a state's activities in outer space, and asserts that states are responsible for all *governmental* and *nongovernmental* space activities. Article VI does not make a distinction as to whether the activities at issue are the state's own activities or those of private actors. Given that space activities are undertaken by a state (and/or nongovernmental body) by means of objects and infrastructures, a state's supervision over the said activities invites concurrent jurisdiction over it: this *quasi-territorial jurisdiction* provides space objects with a nationality and converts them into pieces of quasi-territory of a particular state (Von der Dunk 2011). The concerns encompassing the concept of sovereignty, however, have become more critical in recent decades, as the growing lack of natural resources and the need for national security are major issues of the twenty-first century.

In this perspective, also non-spacefaring countries are going to procure or develop their own space infrastructures in order to be independent and to strengthen their own sovereign jurisdiction. As a consequence, the protection of space infrastructures becomes fundamental to guarantee continuity of the space services. The sovereignty of a state could have implications also in the removal of satellites, or part thereof, when it is classified at the end of its life as a debris. New Active Debris Removal (ADR) technology and investments from the private sector have voiced doubts on how to deal with these activities being the satellite, or part thereof, a sensitive element for a state. Analogous considerations can be done for other types of technologies, such as On-Orbit Services (OOS), where the private sector is investing to supply services. There is no clearly defined legal framework that reconciles the sovereignty needs and the return on investment for the private sector.

Why Does Space Security Matter?

At the dawn of the space program, civilian and military space systems were developed by the Soviet Union and the United states according to their respective competitive strategies. In particular, during the years of the Cold War and the nuclear buildup, the two nations wanted to detect the construction of the nuclear arsenals from afar and find storage and preparation sites for the missiles through the use of observation and early warning satellites, which later became one of the benchmarks of the strategic dialogue that opened in the late 1960s. In order to keep outer space a safe environment and prevent its weaponization, the 1967 the Outer Space Treaty was drafted and signed by 132 countries. The idea behind the treaty was to have a dedicated document clearly indicating that the use of space is a privilege for the whole humanity and, hence, state sovereignty cannot be extended to outer space. However, countries started to progressively understand the strategic value offered by the ownership of space assets, and they started to invest more heavily in space activities for competitive, defensive, political, and economic reasons.

Space applications have quickly become a powerful asset in the new geopolitical strategic arena, as governments have started to integrate and use space systems for various purposes. The new role of space activities as a component of state power has opened up new debates nationally and internationally that could radically change the world scene at a political, economic, and industrial level. Although the threat of the Cold War is now over, countries should still be prepared to address a multitude of security problems that could arise without warning and in unpredictable ways.

We can identify two dimensions of security offered by the space environment:

1. *Security from space* that entails the contribution of space systems in achieving enhanced security on Earth and encompasses Earth observation satellites, early-warning systems, navigation satellites, and electronic intelligence systems to guarantee security for the country and for international cooperation, such as food and water security, study of climate change, management of natural resources and disasters, migration, border control, environmental protection.

2. *Security in space* that is focused on the protection of the assets in the outer space environment against natural and human threats.

Over the past decade, international fora have pursued legal frameworks for responsible conduct in space, but as of today, the international community has not reached a general consensus on new laws or regulatory norms. The first step in developing new legal frameworks must be based on a realistic, and holistic, assessment of risks and threats (Hitchens and Johnson-Freese 2016).

Space Systems and Security from Space

Nowadays, the link between space and sovereignty appears to be stronger than ever, and a lot of non-spacefaring countries are in the process of acquiring these capabilities. Governments (civil and military) act as both facilitator and regulator to support national development in order to guarantee independence and autonomy. In the spacefaring nations, government funding supports the technological advancements of their national industries to maintain competitiveness and to support high-performance programs development. This approach has been followed also by the non-spacefaring countries that are motivated by self-sufficiency to serve national policy interests (sovereignty). Accordingly, they procure Earth Observation (EO) space systems equipped with cybersecurity capabilities in order to fulfill a more immediate dual-use role, or they develop their own national manufacturing capabilities motivated by the growth opportunity of qualified labor, and an increase in local industry's competencies. Within the context of homeland security, space assets contribute to strengthen both external and internal security of states together with other platforms (e.g., ground-, air-, and sea-based ones) (Directorate-General for External Policies of the Union 2014). The demand of satellites for security objectives has increased in the last few years motivated also by the growing number of threats, expeditionary missions in remote environments, as well as an increased number in humanitarian relief missions. These operations, and in particular the civilian and humanitarian ones, are likely to characterize the states' security efforts in the years ahead.

State Sovereignty and Homeland Security

National governments have intensified their commitment to homeland security, increasing their operational activities in domains such as border control and maritime surveillance missions. When contextualizing the development and management of space capabilities for security and defense of a state's sovereignty, it must be borne in mind that a state constantly features both public and private actors. states worldwide are progressively shaping and implementing an inclusive approach to security, one that takes into account synergies among different technologies and services, and tries to make the best of existing resources and

capabilities. The space sector represents a strategic resource, able to contribute to the pursuit of a multitude of political and socioeconomic objectives. As mentioned before, space is also naturally tied to the constantly evolving concept of security, which is not always tied to the offense-defense dimension. In this framework, space assets, encompassing a wide spectrum of performances, can answer to both civil and military needs, originating from the growing number of global challenges (natural and man-made) as well as non-state actors that are present on the international scene. In the face of these new security challenges, a state requires timely and reliable information, either when it is operating on its own territory or when it is involved in international matters. Besides the daily sovereign affairs within its territory, a state must also keep into consideration its commitments towards the global community, borne to safeguard its own interests or necessary to maintain the stability of the international landscape. The production of information relevant to security in the shape of satellite based information, if coupled with in-situ, aerial, and other source of intelligence, represents a strategic tool able to influence decision-making processes at both national and international level.

At national level, security relies on governments, represented by institutional actors (e.g., space agencies, ministers of defense, minister of interior, and minister of foreign affairs, etc.) and is hence related to national sovereignty: in particular, homeland security is an especially critical element in the overall security of a country, as it does not only protect the state from attacks but also ensures the safety of people by helping government bodies to prepare for and mitigate damage from various security threats (Wu and Wang 2018). Effective homeland security operations rely on information collection, integration, and analysis. Hence, a secure and integrated intelligence network is required. The dual-use tied to space-based data and information is particularly useful in making sure that the sovereignty of a state is protected *internally*, through the creation of a stable environment for its people, and *externally*, through the protection of national sovereignty and interests against foreign interference and violation. Remote sensing intelligence can help government bodies in establishing border security and ensure territorial protection by monitoring national borders and territorial seas.

The satellite infrastructure contributes also to the homeland security department in the fight against attacks perpetrated from non-state actors. Institutions and public structures, which are related to the image of a state or are symbolic of a state's power, can quickly become targets of attacks. For example, the attacks of the 11 September 2001 targeted symbols of American power. The term *non-state actor* is a very broad one and can refer to any entity or force that is not directly controlled, integrated into, or legally part of a sovereign state (Boyce 2013). Non-state actors can range from terrorists to ruthless guerrillas, or even to private and commercial entities. One of the top priorities of a country's homeland security is to protect its people from groups or individuals that, for political, religious, or economic motives, engage in terrorist attacks, criminal acts, or actions that threaten national safety and security. In this context, one of the main problems of the protection of national sovereignty is the

possibility of incurring in asymmetric warfare against non-state players engaged in terrorist attacks.

There are many different definitions of terrorism. Some of these would suggest that an act only counts as terrorism if it directly causes death or injury to innocent people, while other definitions are much broader. For the purposes of this chapter, we will define terrorism as the *unlawful use of violence and intimidation (. . .) in the pursuit of political aims* (Oxford English Dictionary). Terrorist acts will differ based on the behavior and characteristic of the criminal group, and how it would respond to different types of government actions. Groups could attack governments or military targets to gain autonomy from their existing regimes, or could attack civilian moved by political or religious motives. Attacks could target a state's technologies: one example was the use of jamming during Operation Iraqi Freedom, in which insurgents deliberately jammed commercial satellite communications used by the US military. In case of an attack against space systems, terrorist groups would more likely engage in cyberattacks (Coleman and Coleman 2017), or in practices to degrade an orbit, or to disable communication links, or blind surveillance satellites to reduce a state's military advantage. For example, the Liberation Tigers of Tamil Eelam (LTTE) frequently hacked government networks and websites to engage in propaganda and, in 2007, pirated a US satellite to broadcast to other countries.

To enhance national security, the market trend highlights major requests to protect the space assets from cyberattacks. Cybersecurity encompasses aspects related to computing and network that will include the satellite and having an impact on all elements within the network topology and connected computers. As a consequence, this capacity extends to data delivery and cloud systems. The protection of space-based assets enables secure data integrity, data availability, data confidentiality, and resilience. A set of regulations, stemming from spacefaring countries, has been put in place to address the business practices with the aim to preserve national security and to comply with international obligations. These regulations are applicable to both institutional and commercial programs, and could help to prevent future non-state actors to acquire their own capabilities in space, with the intent of using them to launch direct attacks. A 2016 research paper stated that "*cyber threats against space-based systems include. . . well-resourced organized criminal elements seeking financial gain; (and) terrorist groups wishing to promote their causes, even up to the catastrophic level of cascading satellite collisions*" (Livingstone and Lewis 2016). It is important to not underestimate non-state actors that carry out asymmetric attacks to influence states, and this is true for the space segment as it is for the ground one. According to Miller (2019), "*current technology makes space an offense-dominant domain. Despite the cost and technological difficulty of reaching space, it is relatively easy to carry out attacks, at least compared to the cost of defending capabilities in space*." Therefore, it is important to develop defense capabilities in the space domain in order to reduce the chances of an attack and be prepared in case of one.

State Sovereignty and the Military Domain of a state

With respect to the relationship between state sovereignty and military space operations, the potential of space capabilities for military operations represent a key element in the analysis of space as a strategic resource of a state. In particular, military reconnaissance came to be viewed as a staple in a state's exercise of territorial sovereignty, whereas having knowledge of the adversary's military and industrial abilities was considered essential to receive an accurate situational awareness and to prevent foreign intervention. Even today, despite the proliferation of scientific and commercial satellite data, the technology's military roots continue to be evident: for example, defense departments still control the lion's share of high-resolution satellite imagery.

The prominence of the defense domain continues to be of critical importance in safeguarding the sovereignty of a state. As it is often remarked, the security of its own citizens, who gave their allegiance to the sovereign entity, is the first duty of a state. Hence, with this consideration in mind, the use of the defense industry to assure the safety of its citizens and security of its territory against internal and external threats can often become a necessary function (Yeo 2014). Overarching goals, both civilian as well as military, have been defined and adapted to match the changing security environment. Space assets can provide strategic help to support the operative theaters in case of international cooperation for crisis management operations. Significant changes feature not only the miniaturization of technologies for small satellites but also the launch services encompassing new generation low-cost launchers that offer speedy rocket launches in short time

Military Activity in Space

It is worth mentioning that the legality of military activities in space is tied to the 1967 OST (de Gouyon Matignon 2019). Most significant from a military perspective is Article I, which stipulates that space is "*free for exploration and use by all states without discrimination of any kind, on a basis of equality and in accordance with international law and there shall be free access to all areas of celestial bodies*," hence not explicitly prohibiting the use of satellites to perform surveillance, reconnaissance, communications, and other functions without authorization of other states, even during peacetime. Other articles of the OST bear on the military use of outer space, such as Article IV, which calls for the de-weaponization of space: "*States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner. The Moon and other celestial bodies shall be used by all states Parties to the Treaty exclusively for peaceful purposes. The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military maneuvers on celestial bodies shall be forbidden. The use of military personnel for scientific research or for any other peaceful purposes shall not be prohibited. The use of any equipment or facility necessary for peaceful*

exploration of the Moon and other celestial bodies shall also not be prohibited." Historically, military space operations have been nonthreatening in character and raised very few contentious legal issues. They have typically consisted of space control (passive defensive counter space missions) and space support, while space warfare has always remained purely notional. The legal architecture governing military operations in space was originally designed for space exploration and commercial applications, and the resilience of the applicable law in the face of the challenges arising from the changes in the global political landscape has yet to be determined (Schmitt 2006).

Peaceful Use in the Defense Domain

There are questions about the interpretation of the term *peaceful* as it can be intended as either *non-military* (broad interpretation) or *non-aggressive* (narrow interpretation). In particular, the narrow interpretation could explain how it is imperative for a nation to retain its right of self-defense, as expressed both in customary law and in Article 51 of the Charter of the United Nations. For example, the United states provide that the term "peaceful purposes" allows for "*intelligence-related activities in pursuit of national defense*". Through this, it is possible to adopt a "battlefield awareness" model, thanks to which the programs that have defense purposes can focus on information collection for tactical applications. In this sense, space systems are viewed as strategic enablers that offer better knowledge to a state's military operations through value-added information that increase the ability of a state to apply precision military force. National military bodies can rely on space support provided by numerous kind of satellites, such as Satellite Communications (SatComs), Intelligence, Surveillance and Reconnaissance (ISR), Position Navigation and Timing (PNT), although potential adversaries could develop anti-satellite skills, that, supported by an array of sensors, would be able to attack space systems through multiple manners (e.g., cyber, electronic, missiles, directed energy weapons, jamming) (Defense Intelligence Agency 2019). The level of modernization of technologies has completely reinvented satellite utilization in modern warfare, where battles can be won or lost depending on who has the most sophisticated, secure, and specialized infrastructure. Space offers persistent coverage, and, unlike ground vehicles or aircrafts, satellites are unfettered by earthly features such as atmospheric drag or terrain. Through remote sensing real-time intelligence, military targets can be detected and battlefield features (e.g., ground terrain, weapon equipment, enemy location) can be unveiled and a strategic support within the operative theater can be provided.

Satellites offer capabilities to monitor and, in addition, provide warning messages against the transportation and launch of ballistic missiles and enemy movements inside and outside a country's frontier. Navigation systems deliver guiding information to accurately strike targets. Space-based sensors provide the first indication of attacks and terrestrial sensors provides follow-up information useful for countries to deliver the appropriate defensive and/or offensive response. The space dimension becomes indispensable to answer to the prerequisites of precision, efficacy, and promptness that are essential to military operations.

The Dawn of New Regulations and Space Policy Directives

As we have seen, nowadays, space systems represent a significant constituent of national defense by means of aiding government bodies in the creation of an active and dependable defense strategy. In recent years, a number of countries have started to recognize space as a distinct location or concept where conflict can take place, such as on land, sea, air, or space, or within digital systems (Liptak 2019). Indicative of the likelihood of the space domain to become more and more interlinked with the defense industry are, indeed, the 2019 recent events, which saw the re-establishment by the Trump's Administration of the U.S. Space Force, followed closely by the creation of the French Space Command by President Macron. Born as a way of "proactive prevention," the newest branch of the American and French forces will protect the interests of their respective countries in space. In the wake of these events, also the North Atlantic Treaty Organization (NATO) turned its attention to space as an "*operational domain*" over concerns that enemies of the Western military alliance could cause chaos by jamming satellites. NATO's Secretary General Jens Stoltenberg reportedly said that there was no question of weapons being deployed, but the alliance had to protect civilian and military interests (Boffey 2019). There will always be a case of discrepancy between the non-territorial nature of space and the principle of state sovereignty, whereas the notion that the jurisdiction, affairs, and entities within a territory are solely business of that territory becomes more complex when there are no physical lines. However, given the defense department role and use of resources in space for the purpose of national defense, and for the purpose of this discussion, reference should be made to Article VI of the OST that attributes the responsibility of the activities of the governmental entities and their contractors to states.

Space Systems and Security in Space

One of the fundamental principles of the concept of sovereignty of a state is autonomy. In the modern international system, countries continue to perceive themselves as independent units and strive to preserve their autonomy and decision-making ability. The space systems are classified as critical infrastructures on which states rely for their well-being. As technological and cost barriers to space lower, more countries and private entities partake in space infrastructure construction and rely on ownership of space assets.

Today, a significant proportion of the economies and infrastructures of modern states depend on such technologies. In this framework, it is easy to see how space-based service interruption would severely affect a large number of activities. Thus, protecting them by reducing their vulnerability is becoming critical for the sovereignty of a state.

There are several cases of space threats that would put at risk the safety of infrastructures in space, such as space-debris collisions, or the uncontrolled reentry of a spacecraft. Other than uncontrolled disasters, with the rapid increase in space

technologies comes also the risk of utilizing space systems for direct attack purposes (e.g., North Korea recently tested ICBMs missiles to ascertain they can use these weapons against Japan and the United states). Space debris around the Earth constitute a considerable hazard to both crewed and unmanned space operations. Objects in LEO could impact or be impacted by pieces of debris, and the force generated by the impact could be so powerful to damage or render inoperable the satellite or even create more debris, causing a collisional cascade effect known as Kessler Syndrome.

Another threat to space assets could be represented by adversaries jamming communication and navigation systems, or blinding imagery satellites or other strategic sensors. Physical or cyberattacks against ground infrastructures can also threaten space assets capabilities. The outer space and cybernetic environments have been intertwined. Hence, they find themselves facing common threats that they would need to be addressed by common strategies. In particular, it is worth reminding the attack against NASA in 2010–2011, in which NASA's computers experienced more than 5,400 incidents of unauthorized access and attacks by malicious software (Protalinski 2012). According to the investigations carried out, the attacks may have come from individuals wanting to test their abilities, foreign intelligence services and criminal enterprises wanting to profit from the information gained.

The international community needs to recognize the level of dependence modern societies have on space assets and capabilities. Many institutional and private actors rely on the space sector to create a set of strategies, initiatives, and programs at a national and international level. The last few years have seen a rekindle of the strategic great-power competition for the conquest of the space environment, which has become object of interest of the major global actors. China and the United states, as in other dimensional domains, are first in line in the newest space race, especially when it comes to strengthening their position in an environment that has numerous implications, particularly economic and strategic. Compared to the historical space race of the United states versus the Soviet Union, the newest race sees the involvement of numerous countries, other than the aforementioned China and the United states: even though Russia remains a great power in the space segment, other countries like France, Israel, India, and Japan are making their voices heard. As the new space race reaches the heart of the competition, it could have a strong impact on the balance of power in the world. How this will affect to the concept of state sovereignty remains to be seen and should be the object of investigation by policy makers.

Vertical Territorial Sovereignty

The debate over the delineation of the boundary between outer space and state sovereignty precedes the beginning of the space race; however, following the launch of Sputnik in 1957, two legal concepts concerning spaceflight started to be the object of discussion of policy makers. Originally, when the United states and

the Soviet Union started their expansion towards outer space, they tacitly assumed that international law did not prohibit it, and the other countries did not protest as well. Today, following the ever-changing space technology, it is easy to notice how the understanding and implementation of a state's sovereignty in outer space needs to be addressed legally. A state's sovereignty remains important for the security of the state. As of today, the delimitation of outer space and airspace is still not regulated and therefore sovereignty cannot be presumed. It has happened that disagreements arose in this matter, like in the case of the 1976 Bogotá declarations regarding the supremacy of equatorial states over geostationary orbit (Polkowska 2018).

Concerning vertical extension of sovereignty, it should be recalled that according to the Chicago Convention of 1944, states hold absolute and exclusive jurisdiction in relation to their respective air space. However, the 1967 OST establishes that outer space cannot be subjected to national claims of appropriation (Bittencourt Neto 2012). The problem of defining a state's extension of vertical sovereignty is primarily based on the lack of a natural boundary separating air and space. In the years following the Chicago Convention, states have taken different positions on the matter, but as of today, there is still no general consensus. For example, after the launch of the Sputnik, the Soviet Union claimed vertical sovereignty without a defined upper limit. South Africa, on the other hand, pinned down outer space as "*the space above the surface of the Earth from a height at which it is in practice possible to operate an object in an orbit around the Earth.*" The United states' position in the matter changed repeatedly between the 1950s and 1960s, yet with a 2003 regulation, and with the purpose of defining the qualifications of an astronaut, the U.S. Air Force defined *space* as the area of 50 miles (80.4 km) above the Earth's surface (Reinhardt 2007). The attitude of states generally varies depending on the current political and economic situation. However, the exercise by the state of unlimited control and power in the air is also a condition for the security of the state and its citizens (Shrewsbury 2003). The security issue is therefore an essential argument in favor of the concept of territorial authority.

Delimitation is also important to ensure equal access to space for all states. In the words of John Cobb Cooper, "*unless [the upper boundary of national airspace] is fairly close to the Earth's surface, few states will be able to put a satellite into orbit... without passing through the national airspace of other states. In other words, few states will be free of a political veto by other states in planning orbital flights*." As more and more states are developing their own domestic space launch capability, only few of these new space powers will be able to freely access space, or utilize the most efficient launch azimuths, if neighboring states can claim sovereignty up to even 62 miles (100 km). Setting a low vertical limit on state sovereignty will ensure all states have equal access to space (Reinhardt 2007).

Another issue raised by the absence of an international definition of the space boundary is liability for space activities. The *Liability Convention* imposes absolute liability on the launching state for damage caused on the surface of the Earth or to aircraft in flight by the state's "*space object*" or the "*launch vehicle and parts thereof*," as in the case of the uncontrolled reentry of the Soviet Union satellite Kosmos 954 over northern Canada.

As space becomes more and more economically and politically important due to the inexorable progress of science, the issue of vertical sovereignty will continue to grow. Defining the limit between a state's sovereign territory and free outer space could also add clarity to all the treaties that are written in a functional manner without defining where space begins.

Space Systems and Economic Sovereignty

In a world of mutual dependence, economic sovereignty hinges on the ability to protect economic power. In order to safeguard its sovereignty, the aim of a state should be to become a player in all fields that are vital for the resilience of the economic system, and that could contribute to shape the global community's future in a critical way. Today, economic sovereignty becomes a geopolitical power and economic relationships can be used as broader geostrategic goals.

The economic sovereignty agenda of a country should hold several objectives, such as boosting a state's research, scientific and technological base, protecting assets critical to national security, promoting a level playing field in national and international competition, and employing policies to strengthen a state's monetary and financial autonomy (Leonard et al. 2019). The concept of economic sovereignty inspired major initiatives in fields such as energy, geopositioning, artificial intelligence, computing and, of course, aerospace. Space is considered by states a strategic economic domain as it is a major enabler and multiplier (Zervos 2017), while being borderless and virtually unregulated by existing treaties. This characteristic makes outer space one of the main tactical elements of a country and offers states numerous opportunities for leadership and partnerships.

In the consideration of space applications within the economic dimension, it is important to remember that space applications are considered *public goods*, and hence, since the dawn of the space race, they have been mainly funded by public investments. The underlying rationale for public space investments is the concept of *market failure*. Space is an *externality-inducing* industry, and thus governments are needed to manage the externalities into a socially optimum outcome. Furthermore, there is a risk linked to the *underinvestment* within the upstream segment of the space value chain and the long development of programs, commonly regarded as high-risk (Return from Public Space Investments 2015). As a result of these market failures, together with the security considerations associated with the space technologies, the responsibility for production and control of space assets has been historically laid on government institutions. The latter in turn reap the benefits in the form of direct revenues, of territory and disaster management, and indirect revenues, in the form of education and qualified employment. Space activities stimulate the development of new technologies – as an innovation factor, as a competitiveness factor, and as a key to the consolidation of national industrial capabilities and internationally recognized economic power on the world stage. In a world where international alliances are of particular importance for national and worldwide security, the inter-alliance specialization offered by space becomes critical for stability and economic profile of states. A state's strategic autonomy is strengthened by national ownership of

assets for the defense and security applications. It is worth mentioning also that the space industry is subject to economies of scale and scope. In this context, it is possible to notice that space technologies can boost the economic growth of a nation and establish the technological advantage of countries. This is illustrated in the case of the military satellites, which the spacefaring nations domestically produce, due to both the demand side of the country (countries tend to select their home industries to enhance their economies of scale and scope, other than for security reasons) and also the supply side (on which trading restrictions are applied in order to safeguard technologies as trade can rapidly diminish technological gaps).

In particular, the export restrictions play a significant role within the sovereignty of a state (Noble 2008). Keeping the technological edge is perceived as a form of dominant power from countries. As the demand for space-based security is very high, when it comes to exporting major space powers are inclined to protect critical technology. As national security issues are gaining prominence everywhere, so is the relationship between national security and economics. As economics is becoming again an area of great-power competition, economic tools are employed to secure geopolitical advantage. The strategic intent of export control is to keep sensitive technologies out of the hands of potential adversaries and guarantee to a particular state a larger market share. Export control of space technologies in a particular state are, usually, more concerned with the relative performance of foreign systems to those of the state of origin. It is important to protect a country's technological lead and strategic independence through the prevention of the proliferation of technologies and systems to potential adversaries. This is compatible with space systems, as well as the strategic nature of space security, and the fact that industries subject to economies of scale have been long considered strategic to the sovereignty of a country.

However, it is important to keep in mind that economic sovereignty does not mean containing the spread of technology at all costs. In the current interconnected world, technological leadership also depends on continuous innovation and investments benefits stemming from cooperation. While it is important for a state's sovereignty to protect its core assets – especially when security interests are at stake – economic sovereignty does not mean resisting to globalization. A state's competitive advantage also helps to increase the qualified human capital at a remarkable rate. In every business environment – and undoubtedly in the space sector – it is vital to have access to individuals with technical training. An educated workforce fuels the economy of innovation of a state. Accordingly, innovation creates competition and competition creates jobs that, in turn, create growth. Space activities also impact the economic sovereignty of a state through their ability to increase dramatically the capacity of humans to act and to interact with other people or countries with increasing strength (European Space Agency 2005).

Conclusion

Through this discussion, we have seen what important effects space has on modern sovereignty. Space systems reinforce the exclusive structure of sovereignty and its potentiality to foster decisions within its territory and on the world stage. To prosper

and preserve their independence in a world of geopolitical competition, states must address globally the space and security challenges. This could involve creating a new idea of sovereignty that sees the space environment as part of their identity, power, and bureaucratic interests. Creating an environment tailored to such incentives requires work to be done at the legal and policy levels.

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