POLITECNICO DI TORINO

Master's Degree in Engineering and Management

Master's Degree Thesis

Strategic Responses of Global Powers to the Rise of LEO Mega-Constellations

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July 2025

Acknowledgment

A mia madre, a mio padre e a mia sorella —
con amore e gratitudine, per sempre.

Abstract

In recent years, the emergence of low Earth orbit (LEO) mega-constellations has reshaped the strategic landscape of outer space. These large-scale satellite infrastructures are not only technological innovations but also instruments of economic influence, digital sovereignty, and geopolitical power. This thesis investigates how major global powers, the United States, China, Russia, and the European Union, have responded to the rise of LEO mega-constellations.

The research introduces a framework based on two structural variables: the political regime type (democratic vs. authoritarian) and the level of market development (high vs. low). These variables are used to predict national strategies in space, resulting in a matrix of four ideal types: private sector leadership, development guidance, development collaboration, and development denial. Each case study evaluates a country's political and economic structure and strategic posture.

Findings show a strong alignment between predicted and actual behavior: the U.S. promotes commercial leadership through companies like SpaceX; China centralizes state-led deployment; Russia adopts a strategy of disruption rather than development; and the EU coordinates institutional collaboration through public investment and regulation. The thesis concludes that internal structural conditions shape national strategies in the evolving space domain. Policy recommendations are proposed for the European Union to enhance its strategic autonomy and industrial capacity, alongside reflections on the limitations of the study and directions for future research.

Contents

List of Tables

Acronyms

ASAT
Anti-Satellite

CASC
China Aerospace Science Corporation

COPUOS
Committee on the Peaceful Uses of Outer Space

DA-ASAT
Direct Ascent Anti-Satellite

DEW
Directed Energy Weapon

DoD
Department of Defense

EGNOS
European Geostationary Navigation Overlay Service

ESA
European Space Agency

EU
European Union

EUSPA
European Union Agency for the Space Programme

EW
Electronic Warfare

FCC
Federal Communication Commission

GII
Global Innovation Index

GNSS
Global Navigation Satellite System

IRIS²
Infrastructure for Resilience, Interconnectivity and Security by Satellite

ISR
Intelligence Surveillance and Reconaissance

LEO
Low Earth Orbit

MIIT
Ministry of Industry and Information Technology

NASA
National Aeronautics and Space Administration

SDA
Space Department Agency

SLR
Satellite Laser Ranging

SSST
Shangai Spacecom Satellite Technology

UN
United Nations

US
United States

Chapter 1

Introduction

The central focus of this research is to explore how global powers react to the development of Low Earth Orbit (LEO) mega-constellations. By examining the strategic, economic, and political responses to the rapid expansion of satellite constellations in LEO, this study aims to provide a comprehensive understanding of the motivations, challenges, and implications driving the actions of key spacefaring nations. Through a qualitative analysis, the research seeks to uncover the diverse ways in which global powers navigate this emerging domain, balancing their national interests with the broader dynamics of international space governance and competition.

In the last decade, the development of LEO mega constellations has transformed the global space panorama, raising significant reactions from the main global powers. Programs like Starlink, OneWeb, Kuiper and GuoWang are redefining the telecommunications sector with direct implications for economy, security and governance of space. While the private sector has a role increasingly central, sovereign states adopt different strategies to respond to these innovations, balancing the opportunities offered by the mega constellations with threats to national security and seeking regulations. The expansion of these satellite infrastructures raises geopolitical tensions. The increasing competition between US, China, Russia and EU highlight divergent approaches to the management of this new technology. On the one hand, there is an acceleration of investments and a growing militarization of low orbit. On the other, efforts are emerging to regulate the use of LEO mega constellations through international agreements.

The thesis is structured in the following way: Chapter 2 provides the context, reviewing the literature and proposing the research demand. Chapter 3 illustrates the theories utilized to interpret the global dynamics of the powers and raising the hypothesis, while Chapter 4 presents the methodology utilized for the analysis. Chapter 5, 6, 7 and 8 are dedicated to the qualitative analysis of a single state while Chapter 9 presents the comparative analysis. In the end, Chapter 10 provides a final synthesis of the results.

Chapter 2

Context, Literature review and research question

2.1 Context

In recent years, the space sector has undergone a profound transformation, driven by a combination of technological advancement, geopolitical ambition, and economic liberalization. What was once a domain dominated by superpower competition during the Cold War has evolved into a complex, multipolar environment where both states and private actors compete for strategic, scientific, and commercial advantage. The post-2000s era, referred to as the "New Space" age, has been marked by the rise of commercial space companies, the miniaturization of satellite technologies, and a dramatic reduction in launch costs, all of which have lowered the barriers to space access and stimulated innovation. At the same time, space has re-emerged as a critical domain for national security, with increasing concerns over dual-use technologies, anti-satellite capabilities, and the militarization of orbital infrastructure. This convergence of commercial and strategic interests has made space a main actor of 21st-century power projection and industrial policy. Moreover, the growing deployment of mega-constellations in low Earth orbit (LEO), the ambition to extract resources from celestial bodies, and the persistent issue of space debris have raised urgent questions about governance, sustainability, and equitable access to outer space. These developments are expanding in the absence of updated international legal frameworks, challenging the capacity of existing treaties, such as the 1967 Outer Space Treaty, to manage the realities of modern space activity. As a result, national space strategies are not only expressions of technological capability, but also reflections of broader economic models, political ideologies, and visions for global order. Understanding the strategic and institutional choices made by key spacefaring powers provides essential insight into the emerging architecture of global space governance and the tensions that may shape its future evolution.

2.2 Literature review

Over the past two decades, outer space has re-emerged as a strategic domain shaped not only by scientific ambitions and national pride, but increasingly by geopolitical rivalry, commercial opportunity, and urgent sustainability concerns. As the number of state and private actors in orbit continues to grow, space is no longer the exclusive domain of superpower space agencies, but a contested environment with different stakeholders where commercial competition and national security intersect. In this rapidly evolving landscape, understanding the political, economic, and strategic motivations of key actors has become essential to evaluating the future trajectory of global space governance and cooperation. This literature review surveys the existing academic and policy research on space strategies and developments through a comparative lens, focusing on the major actors shaping today's space environment: the United States, China, Russia, and the European Union. These four actors represent not only diverse geopolitical interests, but also fundamentally different models of state-market interaction, regulatory frameworks, and approaches to space governance. The review also incorporates two thematic sections, Global Space Governance and Space Sustainability, both of which have become central concerns in the context of increasing congestion in Earth orbit and the proliferation of commercial satellite constellations.

2.2.1 US

The literature argues that the close relationship between the US government and private space actors, like through NASA's commercial crew and Cargo Program, has allowed for rapid advancements in satellite deployment and space-based communications[NASA, 2025].

According to the Astropolitik [Dolman, 2005] approach, the space competition is a natural extension of geopolitics' rivalries on the Earth, with nations aiming to dominate in orbit to secure strategic advantages. This view of the space raises the interest of the Department of Defense to control this sector to avoid threats and to establish soft power.

The DoD is expressing a strong interest in the services offered by the satellite communications and every branch of the US military is increasingly incorporating commercial satellite communications into their operations where traditional space assets are at risk of being disrupted [J. Wong, 2023]. This is pushed particularly by the Space Force, established in 2019, which prioritizes partnership with private companies to expand military space capabilities without relying solely on government-owned assets.

Satellites supplied by the US have been a key factor in the Ukraine war, providing a significant strategic advantage to Ukrainian forces. US commercial and government satellites, like SpaceX's Starlink constellation, have provided secure communications, even in areas where traditional infrastructure has been destroyed. This permitted Ukraine to maintain coordination between military units, conduct intelligence, surveillance, and reconnaissance (ISR) operations, and monitor Russian troop movements in real time [Gurantz, 2024].

At the same time, US is acknowledging the rising threats in Low Earth Orbit (LEO), especially from China's rapidly expanding counterspace arsenal, which includes directed-energy weapons, robotic satellites, and anti-satellite (ASAT) missile systems. China is building a large ISR satellite fleet and leveraging these tools to monitor U.S. forces, thus enabling potential long-range strikes. Similarly, Russia continues to develop both reversible (e.g., jamming, cyberattacks) and irreversible (e.g., ASAT weapons) counterspace capabilities[US. Department of Defense, 2023]. These developments highlight the vulnerability of the U.S. and its allies to hostile space activities.

Since US is dominating this market, they fear restrictions on commercial growth and historically resisted international efforts to regulate mega constellations contrasting the EU's efforts on space regulations. Simultaneously, the DoD continues to promote norms of responsible behavior in space, including commitments not to conduct destructive DA-ASAT testing and to cooperate internationally through transparency measures[US. Department of Defense, 2023].

The concerns are regarding the conviction of the US to believe that a regulation-free environment is sufficient and that rules can be developed only after gaining experience. This means that US are encouraging other nations to unilaterally claim the right to appropriate space resources without international coordination [R. Jakhu et al., 2017]

2.2.2 China

China, instead, perceives LEO mega constellations as a strategic threat due to their potential to provide global surveillance, internet services and military advantages to adversaries. To respond, China has pursued a highly ambitious and state-driven space program aimed at establishing itself as a global space power. This includes the development of powerful launch vehicles such as Long March 5 and the planned Long March 9, which will enable interplanetary missions and potential lunar landings. Furthermore, the completion of the Tiangong Space Station solidifies China's capacity to maintain a sustained human presence in space, a clear signal of its long-term strategic positioning in orbit[Namrata, 2021].

One of the most significant expressions of the response to the threat of US is the Qianfan project ("Thousand Sails"), a satellite constellation program led by Shangai Spacecom Satellite Technology (SSST), and a part of a broader portfolio that includes GuoWang, with 13000 satellites[Bagno, 2024], and Hongyan. Qianfan aims to rival Starlink not only in scale, targeting 14,000 satellites, but also in functionality, with ambitions ranging from global internet provision to military integration[S. Nystrom and Garretson, 2025].

From a geopolitical standpoint, China's satellite infrastructure is deeply embedded in its Belt and Road Initiative, particularly within the framework of the "Space Information Corridor". This initiative aims to extend digital connectivity to underserved regions, such as sub-Saharan Africa, where internet penetration remains low. While ostensibly driven by development goals, the literature notes that these efforts also serve to entrench infrastructure dependency, as recipient countries become reliant on low-cost but highly integrated Chinese technologies, often supplied by state-owned enterprises[S. Nystrom and Garretson, 2025]. This creates long-term strategic leverage for Beijing at the expense of Western digital and political influence[R. Nadège et al., 2019].

In addition to geopolitical utility, Qianfan enhances China's capabilities in the domains of propaganda and information control. This digital strategy aligns with China's doctrine of "cognitive warfare," which seeks to shape global public opinion and influence political decision-making abroad. The satellite constellation is positioned as a tool to amplify authoritarian messaging, support friendly regimes, and undermine Western narratives, particularly in regions where China becomes the dominant source of digital content delivery[S. Nystrom and Garretson, 2025].

At the same time, China appears to be running at least one, and possibly up to three, programs focused on developing direct-ascent ASAT capabilities. This seems confirmed according to *China's Space and Counterspace Capabilities and Activities report* [M. Stokes and Easton, 2020, p.3]:

> "China's significant investments in space and counterspace capabilities may prove threatening to U.S. space assets and military efficacy. China's space infrastructure is complemented by its growing capacity to deny adversarial powers access to the same space assets, as evidenced by advancements in kinetic and non-kinetic counterspace capabilities. China's approach to modernizing its space presence includes an emphasis on military-civil fusion (MCF) and the development of dual-use technology that buoys both military and economic growth. Should China's capabilities surpass those of the United States, the erosion of the U.S. military's ability to contest the PLA in a potential future conflict will be at risk."

Since 2005, China has engaged in a series of increasingly sophisticated tests, indicating a sustained institutional effort. Its capabilities against LEO targets are likely mature and may already be operational via mobile launchers, while systems targeting medium and geostationary orbits appear to remain in the developmental or experimental phase. China is also believed to possess significant electronic warfare (EW) capabilities aimed at disrupting GNSS and satellite communications. In addition, China is reportedly developing directed energy weapons (DEWs) for counterspace purposes, including lasers and high-powered microwaves. Research and testing activities are ongoing at multiple locations, though there is little information available on the operational maturity of these systems. Whether China intends to deploy its offensive counterspace assets in future conflicts remains uncertain, it is equally plausible that these systems are designed primarily for deterrence, particularly against U.S. space assets[B. Weeden, 2024].

Given the threat on national security by US mega constellation, China has also taken a proactive stance in shaping international space regulations, advocating for greater state control over satellite networks. This regulatory approach aims to limit US commercial dominance in LEO mega constellations while promoting alternative governance structures more aligned with China's interests[UN. Committee on the Peaceful Uses of Outer Space, 2021].
Simultaneously, China is making alliances with Russia and other emerging space nations to challenge Western space dominance. These efforts indicate China's ambition to reshape the global space order, reducing reliance on Western-led institutions[K. Pollpeter, 2023].

2.2.3 Russia

For decades, the Russian space sector has faced persistent challenges, including underfunding, outdated infrastructure, low productivity and systemic corruption. The Ukrainian conflict has only accelerated a long-brewing crisis that has roots in the post-Cold War era[Starchak, 2024]. Today, the space program suffers from a shortage of qualified personnel, obsolete technology and facilities and ineffective leadership. As Russia's space sector continues to decline, the country is being forced to reassess its role in outer space and at the same time perceives the superiority of the United States in military satellite systems and commercial space services as a major strategic threat[F. Vidal, 2024].

This threat perception is compounded by a lack of confidence in Russia's space industrial base. Russian-made satellites still depend on imported electronic components, and the overall economic state of the space industry remains inefficient. Additionally, the number of available launch vehicles for military purposes is expected to be limited in the long term. Given this situation, Moscow realizes that it cannot compete directly with the West in space or achieve parity in military space capabilities. As a result, Russia is inevitably leaning toward an asymmetric approach in military space affairs.[Luzin, 2024]

In this context, the Kremlin may pursue two main strategies. The first involves developing a nuclear-powered spacecraft capable of massive electronic jamming of enemy satellites. In addition, existing ground-based Satellite Laser Ranging (SLR) systems, while not built for hostile purposes, could theoretically be used to temporarily impair the optical payloads of foreign satellites[B. Weeden, 2024]. Although past programs remained largely at the developmental stage, in November 2021 Russia demonstrated a successful DA-ASAT intercept against a satellite in LEO. This test, more than a decade in the making, confirmed Russia's operational potential in this domain. Its range also appears to be limited to LEO, with no indication of capacity to target satellites in higher orbits such as medium Earth orbit (MEO) or GEO[B. Weeden, 2024]. Despite technical, organizational, and financial challenges, Moscow is committed to a long-term research and development program in this field.

The second option is an orbital nuclear explosion designed to disrupt satellite communication and Earth observation constellations through the mass destruction of satellites. The objective would be to eliminate more satellites than US companies could replace within an acceptable timeframe. If a nuclear weapon were to detonate while on orbit the moment of detonation releases intense X-rays, gamma rays and ultraviolet photons which can damage satellites, specifically solar panels and onboard electronics, within direct line of sight. Beyond the initial blast a large volume of ionized particles is injected into space, become trapped within the Earth's magnetic field and intensifying the natural Van Allen radiation belts for extended periods. In LEO it may take up to 300 days for radiation levels to normalize. Consequently, satellites exposed to intense radiations are likely to suffer partial or total failures, losing functionality and in some cases the ability to maneuver[V. Samson, 2024].

Even though Russian authorities officially deny any such plans, merely threatening to use this tactic could be advantageous for the Kremlin from both a political and technical standpoint[Faulconbridge, 2024].

In response to perceived dominance in the space domain, Russia has advocated for stricter international regulations to oversee the deployment and operation of LEO mega-constellations. At the same time, the establishment of bilateral behavioral norms could serve as a confidence-building measure between Russia and the United States[Sankaran, 2022].

2.2.4 EU

The EU has emphasized the importance of maintaining strategic autonomy in space, particularly considering the growing dominance of non-European mega-constellations. Its space policy is guided by the need to guarantee access to critical space-based services, such as communication, navigation, and Earth observation, without depending on external actors. As outlined in the 2016 Joint EU/ESA Statement, this strategy is built upon three main pillars: the integration of space into European society and the economy, the development of a globally competitive European space sector, and the assurance of autonomous, safe, and secure access to and use of space[M. Aliberti, 2020].

This has led to increased investment in home-grown capabilities, such as the Galileo, Copernicus and EGNOS programs, as well as the development of the EU's own satellite constellation initiatives like $IRIS^2$ [Parlamento europeo e Consiglio dell'Unione europea, 2021].

At the same time, the EU established EUSPA, a new agency tasked with managing and overseeing the strategic aspects of space programs, while ESA remains in charge of technical operations. Moreover, the new EU Space Programme Regulation (Reg. 2021/696) formally included security and defence among the Union's key priorities and introduced protective measures to limit non-EU access to EU-funded projects, thereby reinforcing strategic control and safeguarding European interests[Cellerino, 2023].

$IRIS^2$ (Infrastructure for Resilience, Interconnectivity and Security by Satellite), is a new multi-orbital constellation designed to provide secure and high-speed connectivity services to European governments, businesses and citizens. This initiative aims to strengthen Europe's digital sovereignty, ensuring resilient and secure communications. This constellation, even if not classified as mega constellation given its small size, comprehend more than 280 satellites distributed between MEO and LEO orbits, combining advantages of both positions to guarantee an efficient covering. The estimated budget is 10 billion euros, financed through EU's funds, ESA and private investments. This represents an important step toward the strategic autonomy of Europe in the telecommunications sector[Orliac, 2025].

The other role of EU is to be an advocate for the sustainable use of space, especially considering the increasing congestion in LEO caused by satellites. Issues such as space debris, frequency interference, and the environmental impact of satellite launches is central to the EU's regulatory agenda. The EU supports the international efforts to develop guidelines for space sustainability, while also implementing its own regulatory frameworks to ensure responsible behavior in space.

2.2.5 Global Governance and Space rights

There is a necessity of space regulations, particularly focusing on US, and highlighting the strategies for the relative development of a new set of norms[Dickey, 2021]. The legislation's decisions have to acknowledge the creation of consensus inside the state they are taken, selecting the starting international partners, employing mechanisms to establish international commitment and defining a target for the critical mass of support. It has to be considered that developing regulations arise difficulties and opportunities because the norms must balance national interests and geopolitical dynamics but at the same time adopting certain rules permit to prevent conflicts and improve the space management. The US have a central role in this since they have the technological and industrial leadership in the sector, and the creation of the Space Force highlights how much the United States values the space dimension and its role in strategic defense[M. Thomas, 2024]. Thanks to this initiative, they are able to oversee key advancements and essential space infrastructure, solidifying their position as a leading power in the global space sector and their diplomatic power permitted them to drive different treaties, like the Outer Space Treaty (1967).

The Outer Space Treaty, formally known as the *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, is one of the most important international agreements governing space activities. It was adopted by the United Nations General Assembly in 1967 and has since been ratified by over 110 countries, including all major spacefaring nations. The Outer Space Treaty was drafted during the Cold War, a time when both the United States and the Soviet Union were rapidly advancing their space programs. There was a growing concern about the potential militarization of space and the need to prevent an arms race in outer space. The treaty establishes a framework for the peaceful use of outer space and sets several fundamental principles, like the prohibition of National Appropriation of the space and transparency and cooperation[United Nations, 1967].

Actually, this is not enough and presents some limitations like ambiguities in the text that don't address issues such as private space activities or the use of non-nuclear weapons in space. Even the emerging technologies, like the mega constellations are raising questions about how the treaty applies to new activities.

2.2.6 Space Sustainability

According to the ESA report on the Space Environment (2024) the lower earth orbit is increasingly crowded. More than 35.000 space objects are tracked, of which 9.100 are active satellites and the remaining are debris' fragments sufficient to cause damages to operative infrastructures. The growing density of space debris increase the risk of Kessler Syndrome, a scenario in which the collision between objects generates other fragments, making some orbits not utilizable. This phenomenon can compromise the future space missions and the integrity of orbital infrastructure[European Space Agency, 2024a].

To face this challenge different solutions were developed such as the "Zero Debris" approach, where the ESA has introduced, through the Zero Debris Charter, the aim to guarantee within 2030 the absence of new debris generation and more stringent regulations for the future missions[European Space Agency, 2023]. Other approaches are the active remotion of debris, where the items already present in the orbit are captured and moved away, and creating protection system for the space vehicles like the Whipple Shield, thin panels designed to fragment the impacting object and disperse its energy minimizing damage[The Aerospace Corporation, 2023].

In the end, the International Cooperation seems to be the key to an efficient management of the debris, since the space is a strategic asset, and all the efforts should be done to preserve it and for the future generations. In addition to the Outer Space Treaty (1967) there are the Guidelines of the Committee on the Peaceful Uses of Outer Space (COPUOS) which provides recommendations to mitigate the space debris and to promote the cooperation.

2.3 Research question

Despite the vast literature, there are some aspects that remain unexplored, like an integrated approach that combine economic and political analysis to explain the reactions of the global powers. This research is intended to combine economic, politic and strategic point of views, offering a complete qualitative analysis and comparing the different global powers, responding to the question *How do Global Powers react to the development of LEO mega constellations?*

To address this question, the research adopts a two-step approach. First, a theoretical model is developed, which integrates the political structure of each actor with the level of market development in the space sector. This framework allows for a structured understanding of the key variables shaping national responses. Subsequently, the model is applied in an empirical analysis, conducted through a comparative case study of selected global powers, in order to assess how the theoretical expectations align with observed policies and strategic choices.

Chapter 3

Theory

The literature review has outlined the global powers' empirical foundations for understanding their strategic, economic and political responses. However, while the literature details these responses, it lacks a systematic framework for comparing and explaining them.

The objective of the model is to have a systematic categorization that provides a structured way to analyze different countries. It enables direct comparisons between different political-economic models and their impact on space policy, being at the same time flexible to be expanded to include other future emerging space powers without breaking its structure. It can also help forecast how states will react to future development in LEO mega-constellations. The main function of this model is to distinguish the political structures of powers and the levels of market development, trying to explain how the different combinations of these two variables react to the development of LEO mega-constellations, while at the same time giving a context of the possible presence of strategic rivalries.

3.1 Political System: Democracy vs. Authoritarian

The concept of political system refers to the structures that govern how political power is acquired, exercised and limited within a state. It encompasses not only the institutional framework, like the existence of elections, rule of law, and separation of powers, but also the broader political environment, including the level of civil liberties, freedom of expression, and the role of opposition forces and independent institutions. The political system, in this sense, directly shapes how decisions are made, how authority is distributed, and how state strategies are implemented.

To operationalize this concept for analytical purposes, the research introduces a binary variable that classifies each state as either a democratic or authoritarian regime. The variable "political system" is based on the political pluralism, powers separation, respect of civil liberties and democratic participation. Although political regimes exist on a continuum, this model adopts a dichotomy where Democratic regimes are characterized by free and fair elections, civil rights, institutional transparency, and multiparty systems. Authoritarian regimes, instead, are characterized by concentrated power, non-competitive or rigged elections, and limited or absent civil liberties.

To assess the political system of the countries this research relies on internationally recognized indicators. How these indicators are used is explained in the following chapter Methodology.

3.1.1 Democratic regime

Democratic systems encourage an economic environment that is both open and competitive, fostering active participation from the private sector. One defining feature of democracies is economic decentralization, where decision-making authority is shared among multiple stakeholders, such as local governments, private businesses, and non-governmental organizations. This model supports privatization and market liberalization by shifting certain responsibilities from the state to private entities, thereby enhancing economic growth through competitive dynamics[Gatti, 2002].

In democratic societies, liberalization policies are frequently implemented to ease legal constraints on private sector involvement across different industries. By opening markets to competition, these policies drive efficiency and encourage innovation. For example, reducing restrictions in trade and financial sectors enables private companies to thrive in a more dynamic and competitive landscape[Gatti, 2002].

Deregulation refers to the process of reducing government intervention in markets, granting the private sector greater independence. In democratic contexts, this approach is often used to boost efficiency and economic productivity by eliminating bureaucratic obstacles that might otherwise impede business activities[Feleppa, 2008].

3.1.2 Authoritarian regime

A non-democratic regime, instead, tends to centralize the control seeing the space as a strategic sector to manage for military and political purposes[J. Allen, 2024]. In authoritarian systems, the concentration of power at the top means that technological infrastructures are seen as tools for regime stability and control. The state seeks to avoid the emergence of powerful, autonomous private actors that could challenge its authority[B. Rosenfeld, 2024]. These governments view control over information, economic resources, and strategic infrastructure as essential for regime survival. Centralizing these sectors allows regimes to prevent the rise of autonomous actors who could challenge state authority and to enhance domestic surveillance and control[S. Bradshaw, 2021].

At the same time, in authoritarian states, advanced technologies are seen not merely as economic tools but as instruments of hard power and geopolitical competition. Space infrastructures are valued for their dual-use applications, civil and military, and considered essential for secure communications, intelligence, electronic warfare and deterrence[Johnson-Freese, 2007].

In contrast to democratic systems that often promote decentralization and open market participation, non-democratic or authoritarian regimes tend to centralize power, especially in sectors deemed vital for national sovereignty and regime stability. Among these, space has increasingly been recognized as a strategic domain to be tightly controlled and managed primarily for military and political objectives. This centralization is rooted in the nature of authoritarian governance, which concentrates decision-making authority within a small ruling elite, reducing the influence of independent institutions and actors[J. Allen, 2024].

Within such political structures, technological infrastructures are not viewed as platforms for innovation or commercial growth, but rather as tools to ensure regime continuity, societal control, and political dominance and authoritarian leaders actively work to avoid the emergence of strong, independent private actors, especially in high-tech sectors, that might develop the capacity to challenge state authority or offer alternative sources of influence or loyalty[B. Rosenfeld, 2024].

In these contexts, control over information systems, financial networks, and strategic infrastructure is considered essential for the survival of the regime. By centralizing authority over these sectors, authoritarian regimes not only diminish the influence of potential rivals but also strengthen their capacity for domestic surveillance and population control. This approach is a strategy in which state-controlled or affiliated institutions systematically deploy digital tools to shape public opinion and suppress dissent, thereby consolidating central power and restricting any form of opposition[S. Bradshaw, 2021].

Furthermore, advanced technologies such as space systems are viewed not merely as economic resources but as instruments of national power, deeply rooted in the broader strategies of geopolitical competition. Space infrastructures, such as satellites and ground control systems, are particularly prized for their dual-use capabilities, enabling both civilian applications like weather monitoring and telecommunications and military functions such as intelligence gathering, secure communications, and electronic warfare[Johnson-Freese, 2007].

Unlike liberal democracies, where innovation and private enterprise are often encouraged, authoritarian regimes typically prioritize national security over economic liberalization. This approach results in a strong emphasis on achieving technological sovereignty, often through the development of domestic technologies that can replace foreign ones, aiming to minimize strategic dependence on external actors and preserve autonomy in critical infrastructure[A. Shahbaz, 2018].

Economically, these regimes often operate under a model where the state plays a dominant and often monopolistic role in directing national development[D. Sallai, 2021]. Strategic sectors are typically controlled by state-owned or state-affiliated enterprises. Research and development efforts are not market-driven, but rather steered toward objectives determined by political leadership, which views technology not as a means of economic progress alone but as an instrument of national strength[Andrews, 2017]. In this context, private innovation does exist, but it is invariably shaped, limited, and subordinated to the broader strategic and ideological priorities of the state.

A further characteristic of authoritarian systems is the lack of institutional checks and balances, which significantly impacts how decisions are made and policies are implemented[L. James, A. Renwick and M. Russell, 2023]. In these regimes, decision-making power is concentrated within a narrow elite, often excluding other branches of government, civil society, and independent oversight bodies. This concentration effectively minimizes the influence of key stakeholders such as academic institutions, non-governmental organizations, and private actors. As a result, public discourse is stifled, and debates around critical issues are often absent or tightly controlled. The consequence is a political environment in which policy outcomes are dictated from the top, with little room for contestation or democratic deliberation[A. Chaguaceda, 2025].

3.2 Market Development: High vs. Low

The second key factor of this model is the level of market development, which refers to the structural capacity of a national economy to sustain innovation, technological competitiveness, and investment in strategic sectors such as space.

To operationalize this concept, the research constructs a variable that categorizes states into two types: High Market Development and Low Market Development. This classification is based on a set of measurable indicators like the GII and governmental expenditure in space programs.

This variable captures not only economic performance in a traditional sense (GDP, trade, industrial capacity), but also a country's institutional ability to foster private-sector initiative, allocate capital efficiently, and support large-scale infrastructure projects like LEO mega-constellations. The level of market development influences who drives innovation, how quickly technologies can be adopted, and what resources are available for national space initiatives. This is especially relevant for mega-constellations since they are capital-intensive, requiring billions in long-term investment; technologically complex, as they demand advanced manufacturing capabilities and robust data infrastructure; and they are inherently high-risk and high-reward, where investors must be prepared to absorb significant uncertainty.

3.2.1 High Market Development

In states characterized by high market development, the economic system is often marked by a robust, competitive, and globally integrated private sector. These countries typically exhibit mature financial markets, abundant venture capital, and efficient institutions that facilitate entrepreneurship, research, and innovation. The private sector plays a central role in driving technological advancement, often taking the lead in developing complex infrastructures such as LEO mega-constellations. Governments in these contexts act primarily as regulators and enablers, offering support through favorable policies, public procurement, or coordination with defense agencies. The presence of a thriving ecosystem of firms, research centers, and funding mechanisms enables rapid development cycles, international competitiveness, and a strong degree of technological autonomy. This model allows for commercial expansion and global leadership in the space domain.

3.2.2 Low Market Development

In states where market development remains limited, the structural conditions necessary for a thriving private sector in high-tech industries are often absent. As a consequence, governments may find themselves compelled to take on a more direct leadership role in driving technological advancements. When sufficient resources are available, state authorities might actively fund and oversee large-scale projects, such as mega-constellation satellite programs, ensuring that these initiatives align with national priorities and strategic interests.
However, in cases where financial constraints or institutional weaknesses hinder state action, governments may be unable to effectively intervene in high-tech development. This can lead to a scenario of strategic inaction, where progress stalls due to a lack of both public and private investment. Alternatively, states facing such limitations may adopt a more defensive posture, prioritizing the protection of existing assets rather than pursuing ambitious technological advancements. In both situations, the absence of a strong market and institutional support significantly restricts a country's ability to compete in cutting-edge industries, potentially leaving it dependent on foreign actors for critical technological capabilities.

In order to clearly present the structure of the theoretical model, the following table 3.1 summarizes its main components and the relationship between them.

	Democratic regime	**Authoritarian regime**
High market Development	Private sector leadership	Development Guidance
Low market Development	Development collaboration	Development Denial

Table 3.1: Theoretical model

3.3 Strategic Rivalry

Strategic Rivalry can be defined as an antagonistic relationship between comparable competitors who perceive each other as threatening enemies. This type of rivalry involves persistent and structured competition, often driven by security concerns, economic power, and international status[W. Thompson, 2022]. The rivalries are important since they define alliances, drive the security policies, modify the global economy and influence the internationals orders.

While the two core structural variables, political system and market development, offer a solid framework for understanding the domestic foundations of space strategy, they are not sufficient on their own to explain the full range of behaviors adopted by global powers in response to the development of LEO mega-constellations, since states do not operate in isolation. Their choices are also shaped by external pressures, namely their relative position in the international system and the strategic behavior of rival actors. To capture this dynamic, it is necessary to combine the internal view with the logic of strategic rivalry. Strategic rivalry is an influencing factor that interacts with a state's internal tendencies while also shaping its perception of the external environment, especially in response to the intentions, real or perceived, of its adversaries and competitors. This means that even if a state's internal structure suggests a certain course of action, its actual behavior may change depending on the level of geopolitical competition it perceives. In some cases, these expectations may be intensified, or even completely reversed, based on external pressures and strategic considerations. This combined method is particularly important because it avoids the risk of structural determinism. States are not entirely determined by their political or economic institutions, but they also react and sometimes deviate from expected paths in response to external threats and opportunities. An analysis of the strategic rivalries may help to explain why similar regimes might diverge in their space strategies, or why dissimilar regimes may converge on certain behaviors, such as investing in dual-use infrastructure or restricting foreign space services.

3.4 The Hypothesys

The reactions of global powers to the emergence and rapid expansion of Low Earth Orbit (LEO) mega-constellations are shaped by a complex interplay of economic, political, and strategic considerations. These reactions vary significantly depending on the institutional architecture, economic model, and perceived rivalries of each state. The global space race, particularly in the LEO domain, has become a mirror reflecting the broader patterns of international order, competition, and technological governance.

In liberal democracies characterized by open political systems and advanced market economies, the development of LEO mega-constellations tends to be guided by market-driven logics. These states often rely on public-private partnerships, fostering innovation through competition and leveraging the capabilities of major aerospace corporations. The involvement of companies like SpaceX, Amazon, and OneWeb illustrates how these democracies encourage private sector leadership in expanding orbital infrastructure. This approach believe that the space domain can act as a driver of economic growth, commercial opportunity, and global connectivity, while also serving national interests such as secure communications and international prestige.

In contrast, authoritarian regimes with centralized economies tend to adopt a different strategy. Their space policies are often based on a defensive and strategic rationale, in which space is viewed not only as a domain of opportunity but as a critical arena for power projection, national sovereignty, and regime survival. In these regimes the state plays a dominant role in funding, controlling, and directing space programs. Here, the development of mega-constellations is not simply a technological advancement but a geopolitical instrument, as a way to enhance military capabilities, expand surveillance capacity, and reinforce global standing. These regimes often view technological self-reliance in space as essential to avoid dependence on Western infrastructure and to assert autonomy on the international stage. Furthermore, the space sector is leveraged as a tool of domestic legitimacy. Authoritarian governments invest heavily in space as a symbol of national prestige and modernity[D. Mindell, 2009], using it to cultivate internal consensus and nationalist sentiment. Publicized satellite launches and ambitious programs serve to demonstrate regime competence, discipline, and global relevance. Beyond symbolic value, however, Earth observation systems and secure communications networks can be deployed to surveil citizens, suppress opposition, and manage crises, all under the guise of national security.

This divergence in strategic orientation is further intensified by global rivalries and the growing competition over access to orbital space and related resources. As space becomes more congested and contested, the risk of fragmentation and regulatory divergence increases. Political rivalries are not only replicated in space but amplified by the absence of binding international governance frameworks for LEO activity. These rivalries drive states to adopt distinct postures: democracies leaning toward openness, interoperability, and public-private coordination; authoritarian states emphasizing control, securitization, and technological sovereignty.

Chapter 4

Research Design and Methodology

4.1 Research Design

This research adopts a comparative case study approach to examine how global powers respond to the development of LEO mega-constellations. The aim is to identify and explain the differences and similarities in national strategies by analyzing the domestic political-economic structures and international strategic dynamics.

The comparative method was choiced for two reasons. First, it allows for systematic case comparison, which is essential to test the theoretical model proposed in Chapter 3, based on the intersection of political system (Democratic vs. Authoritarian) and market development (High vs. Low). Second, the approach enables contextual interpretation of complex national dynamics, trying to capture strategic intent.

This approach goes beyond simple descriptive comparison. The research seeks to understand why states act differently, despite facing the same technological revolution in space, and how their responses are conditioned by both their internal institutions and their position in the global strategic order. The use of structured, focused comparison makes it possible to evaluate the explanatory power of the model and identify any anomalies or hybrid behaviors.

4.2 Case selection

The four cases selected, and showed in Table 4.1, represent a diverse and theoretically significant sample. These are all major geopolitical actors with substantial engagement in the space domain. They were selected using purposive sampling, based on their variation across the two independent variables outlined in the theoretical framework.

	Democratic regime	**Authoritarian regime**
High market Development	US - Private sector leadership	China - Development Guidance
Low market Development	EU - Development collaboration	Russia - Development Denial

Table 4.1: Case studies selected

4.2.1 High market development – Democratic regime (U.S)

A country that exhibits both a democratic political system and a highly developed market economy is typically characterized by a strong and dynamic private sector, which plays a leading role in driving technological progress and industrial growth. In such contexts, the overall economic model is founded on principles of free competition, open markets, and continuous innovation. The political framework not only allows but actively supports this model through liberal economic policies, fostering an environment where businesses can thrive with minimal bureaucratic constraints. Regulations are generally designed to be pro-market, creating clear and predictable rules that protect investment and promote fair competition. Moreover, the government frequently provides incentives such as tax benefits, research grants, or public-private partnerships, with the explicit aim of encouraging private enterprise. This synergy between governance and economic structure allows the private sector to assume a leadership position in strategic industries, including the development of advanced infrastructures like satellite mega-constellations.

US, since they are a democracy with an economic system based on competition, adopt a market-driven approach to the development of mega constellations, favoring the participation of the private sector and technological innovation. However, the strategic rivalry with China and Russia forces the US to integrate national securities aims, like the creation of the Space Force and supporting private programs like Starlink.

4.2.2 High market development – Authoritarian regime (China)

The absence of democratic mechanisms, such as checks and balances, electoral accountability, and institutional transparency, allows governments in non-democratic regimes to exercise a high degree of centralized control over strategic industries, including the aerospace and satellite sectors. In these systems, the state retains the decisional authority to determine the direction, pace, and priorities of technological and industrial development, often bypassing market forces or the interests of private stakeholders. As a result, the development of critical sectors is not guided by competition, consumer demand, or profitability, but rather by long-term national strategic goals that align with the political, military, and ideological objectives of the regime.

This centralized control enables the government to mobilize resources efficiently and coordinate efforts across multiple state entities, ensuring that industrial policies serve the broader national agenda. At the same time, such an approach often involves deliberate efforts to minimize reliance on foreign companies, particularly in sensitive or security-related domains. By restricting foreign involvement and investment, the state seeks to reduce technological dependency, increase resilience against external pressures or sanctions, and foster the growth of domestic capabilities. In doing so, the regime promotes the development of local technology ecosystems, encouraging state-owned enterprises and politically connected firms to assume leadership in innovation and infrastructure building, even in the absence of open market competition.

China being a non-democratic regime with a centralized statal economy, will adopt a strategic and defensive approach to the mega constellations' development, focusing on technological independence, national security and national prestige. The rivalry with the US pushes China to develop more advanced technologies to compete for the control of the orbits.

4.2.3 Low market development – Democratic regime (EU)

A democratic state characterized by a low level of market development is likely to adopt a strategy based on collaborative development, which involves close cooperation between the public sector, private enterprises, and international partners. In this model, the state assumes a facilitating and coordinating role rather than acting as the sole driver of innovation or investment. The collaboration often extends beyond national borders, including foreign governments, international organizations, and multinational corporations, particularly in sectors that require high capital intensity and advanced technological capabilities, such as aerospace, satellite communications, and digital infrastructure.

The rationale behind this approach lies in the structural limitations of underdeveloped markets. In these economies, the private sector is typically not mature or financially robust enough to support large-scale strategic investments on its own. Start-ups and local firms often lack access to sufficient capital, skilled labor, and research and development capacity. At the same time, the democratic nature of the political system prevents the kind of top-down, centralized intervention that is more common in authoritarian regimes. Without a strong state apparatus capable of directing industrial policy in an authoritative way, democracies with limited economic resources tend to compensate by building coalitions of actors and creating institutional frameworks that encourage public-private partnerships and international support.

This openness to cooperation becomes an essential component of national strategy. It allows the state to leverage external expertise, financial resources, and technological know-how while maintaining transparency and accountability, which are fundamental features of democratic governance. In the context of space infrastructure or satellite systems, for example, this might involve participating in multilateral initiatives, co-investing with global partners, or providing regulatory incentives to attract foreign companies willing to operate locally. Ultimately, this model aims to bridge the gap between ambition and capability, ensuring that technological advancement is possible even in the absence of strong internal market dynamics.

EU is a democracy which adopts a collaborative and regulative approach to the mega constellations, promoting cooperation between members and private firms. This strategy tries to balance the competition with the other global powers through the promotion of common norms for a sustainable use of the Space.

4.2.4 Low market development – Authoritarian regime (Russia)

In political systems characterized by a high degree of power centralization, the government maintains tight and often uncompromising control over the economy, including key sectors such as technology and industrial development. This centralized authority often translates into a regulatory environment where private companies are heavily constrained, both in terms of operational autonomy and strategic decision-making. Innovation, particularly in sensitive or high-tech areas like space technologies, is not driven by market forces or entrepreneurial initiative but is subject to strict state oversight. In such a context, private firms are rarely permitted to pursue independent research or commercial ventures in strategic sectors, as the state remains wary of any form of technological activity that it does not directly control or supervise.

Political leaders in these systems tend to view space technologies primarily through a security and sovereignty point of view, rather than as an opportunity of economic growth or international cooperation. Space is perceived not as a commercial frontier, but as a domain with potential risks to national stability, especially due to its dual-use nature and capacity to enable independent communication, global positioning, or satellite imagery. The idea of a decentralized and privately-driven satellite infrastructure is often considered incompatible with the regime's emphasis on information control, surveillance, and strategic secrecy. As a result, innovation is subordinated to political priorities, and space becomes a tool of governance rather than entrepreneurship.

Moreover, the generally underdeveloped state of markets in such economies further exacerbates the situation. Many of these states are highly dependent on natural resource extraction, particularly energy exports, as their primary source of revenue, which further entrenches their reliance on state-managed sectors and discourages diversification into knowledge-intensive industries. Moreover, the public sector remains dominant, absorbing a large share of investment, labor, and infrastructure, often at the expense of private sector growth. This economic configuration inhibits the development of a robust innovation ecosystem and limits the emergence of competitive private actors capable of contributing to advanced technological fields such as space.

Despite its limited economic resources, Russia continues to invest in space military technologies, particularly in anti-satellite (ASAT) systems, as part of its strategy to preserve strategic influence and counterbalance Western dominance. Space remains a key domain for Russia's national security, enabling it to project power, maintain parity with the U.S. and NATO, and assert itself as a major actor in global space affairs.

4.3 Case Study Analysis

This section presents how the analysis is conducted for each of the four selected global powers, with the goal of understanding how their internal characteristics and external strategic dynamics influence their response to the development of LEO mega-constellations. Each case study is divided into three core analytical components, aligned with the theoretical model outlined in Chapter 3. First, the political structure is assessed, focusing on regime type, in order to determine whether the state operates as a democracy or an authoritarian regime. Second, the economic and market structure is analyzed through selected indicators to evaluate the level of market development. Third, the presence of strategic rivalries is examined to identify whether the state perceives other powers as geopolitical or technological threats in the domain of space infrastructure, and whether it reacts accordingly through balancing strategies or direct competition.

Following the individual assessments of each global power, this work offers a comparative analysis across the four cases. This synthesis highlights patterns, validates the theoretical typology, and illustrates how combinations of political and market structures, along with international rivalry, shape different national approaches to LEO mega-constellations.

4.3.1 Analysis of the Political Structure

In this research, the classification of a state's political structure, as either democratic or authoritarian, is based on a combination of qualitative variables and quantitative indicators that capture the institutional quality, degree of political openness, and the level of civil and political rights. This binary distinction is operationalized using a multi-dimensional approach that relies on recognized democracy indexes and global governance models (Table 4.2).

The entities that provided the data also provided, often, a panel of shades to categorize the score reached by each country, but for the scope of this work a dichotomy is used. For instance, the political rights score can range between 0 to 40, with different nuances of authoritarianism that can decrease every 5 points. In this case, the work consider values minor than 20 as authoritarian regime and major than 20 as democratic. The same logic is applied, and specified, to the other indexes.

The *Freedom of Election* analyzes if the elections are free, regular and competitive and if exists a real possibility to have governmental's power alternance. The index used is the political rights score which enable to identify if the elections are free or not based on the score assigned. If higher than 20 it's Free, otherwise it isn't [Herre et al., 2013c].

The *Political power separation* variable can assume the value of Balanced or Executive based on its score, and indicates if there is a real separation between legislative, executive and judiciary power. Using the horizontal accountability normalized index, the work define as Executive values minor than 0.5 and Balanced otherwise [Coppedge et al., 2025].

The *Civil rights* parameter, instead, is measured through the Civil liberties index and indicates if civil rights are present or not in the country of interest. Values higher than 5 indicates the presence of liberties [Herre et al., 2013a].

The *Information Freedom* indicates the level of press freedom that a country has and the values that can assume are: Free or Censored. To respect the dichotomy the value of benchmark assigned is 70, the same decided by the *Reporters without Borders Organization*. Major than 70 is considered Free, otherwise Censored[Reporters Without Borders, 2024].

At the end, the *Political participation*, analyzes if citizens can organize, protest, influence public debate and if it is active or hindered. The benchmark value is 5, more than it is considered Active, otherwise Repressed [Herre et al., 2013b].

Together, they ensure that the classification of states into democratic or authoritarian is not only empirically grounded but also theoretically coherent with the broader framework of the thesis, which seeks to link internal regime type with national strategic behavior in space policy. The

Dimensions	Index	Democracy	Authoritarianism
Freedom of Elections	Political rights score	Free	Not Free
Political Power separation	V-Dem: Horizontal accountability score	Balanced	Executive
Civil rights	Civil liberties score	Present	Absent
Information Freedom	Press Freedom	Free	Censored
Political Participation	V-Dem Political participation	Active	Repressed

Table 4.2: Political Structure Variables

use of multiple overlapping sources also enhances validity and reliability, avoiding the bias of relying on a single index or typology.

4.3.2 Analysis of the Economic Structure

To assess the level of market development in each case study, this work relies on an approach based on different indicators that capture both the structural and functional aspects of economic capacity and technological autonomy. Three key indicators (Table 4.3) have been selected based on their relevance to innovation sectors like space, and their ability to provide comparability grounded in reliable international datasets.

The *Governmental expenditure in space programs*, evaluate a state's capacity and willingness to invest in the development of strategic space infrastructure, including satellite manufacturing, launch systems, and LEO mega-constellations. Governmental investment reflects not only the availability of financial resources but also the political prioritization of space as a domain of national interest. It serves as a proxy for the structural maturity of the space sector [Nova Space, 2024]. Importantly, this measure includes both civilian and military spending—encompassing national space agencies (such as NASA or ESA), space-related defense expenditures (through the U.S. Department of Defense or the Chinese PLA), as well as investments by intelligence and security services involved in orbital systems. For the purpose of this thesis, a threshold of $5 billion per year, derived from empirical analysis, is set as benchmark for High Market Development.

The *Global Innovation Index* is employed as a composite measure that includes infrastructure, education, human capital, technological outputs, and institutional frameworks for innovation. To categorize if a country presents high market development or not, the threshold choosen is 50 points since the range is between 0-100. Scores below 50 could indicate limitations in innovation financing, R&D capacity, or policy barriers that reduce the possibility to participate in complex domains like space infrastructure. Instead, a score of 50 or more indicates that a country has reached a baseline level of maturity in its innovation ecosystem. This means that it has a solid infrastructure, research institutions, and integration between academia, government, and industry [Dutta et al., 2024].

In the end, the *Annual number of objects launched into space* measures a nation's industrial output, technical capacity, and operational maturity in the space sector. It includes satellites, payloads, scientific instruments, and crewed or uncrewed missions. While it does not differentiate between civil and military payloads, the indicator effectively captures whether a state is consistently active in space and capable of sustaining its own infrastructure [Mathieu et al., 2022]. A threshold of 120 space objects launched per year, derived from empirical observations, is set to distinguish states with High Market Development. This specific threshold was chosen because it represents approximately 1% of the total number of active satellites in orbit as of 2025, which stands at 12,149[NanoAvionics, 2024]. While this percentage may seem numerically modest, it has substantial analytical value: contributing 1% of global satellite deployments annually reflects an economy with the industrial scale, launch cadence, and technological maturity required to sustain meaningful presence and influence in orbit.

Dimensions	**High Market Development**	**Low Market Development**
Governmental expenditure in space programs	>5B$	<2B$
Global Innovation Index	>50pt	<50pt
Annual number of objects launched into space	>120	<120

Table 4.3: Benchmark values of Market Development Variables

4.3.3 Analysis of the presence of strategic rivalries

This work intends rivalries as situations in which a state explicitly perceives another actor as a strategic challenger within the space domain, with particular attention to the deployment and implications of LEO mega-constellations.

To assess the presence of strategic rivalries among global powers, this thesis adopts a qualitative approach based on official documents, strategic behavior, and geopolitical narratives. Evidence includes official government statements, space policy white papers, military doctrines, and asymmetric countermeasures, such as anti-satellite weapons or regulatory restrictions. The goal is to determine not just whether a state acts differently, but whether those actions are shaped by a competitive logic aimed at maintaining or altering the global balance of power in space.

Chapter 5

Analysis of US

The United States is widely recognized as the global leader in both space innovation and satellite infrastructure development and through the lens of this theoretical model the US is expected to exhibit a response characterized by private-sector leadership in the deployment of LEO mega-constellations. This section confirms that expectation by analyzing both the structural conditions and the observable strategic choices undertaken by the United States in the space domain.

5.1 Expected Reaction According to the Model

The strategic behavior of a global power is expected to be shaped by two key structural variables: its political system and the level of its market development. In the case of the United States, these variables place it firmly in the quadrant of democratic regimes with high market development. Based on this classification, the model predicts that the US will respond to the emergence of LEO mega-constellations through a strategy centered on private sector leadership, facilitated by the state. This includes regulatory support, procurement policies, and strategic contracting that empower market actors to take the lead in both the development and deployment of space infrastructures.

As shown in Table 5.1, the political system of the United States meets all the criteria for a mature democracy. The score for political rights (33) significantly exceeds the threshold ($<$20) used to identify authoritarian regimes. The horizontal accountability score, as measured by V-Dem, is an high 0.9, reflecting the robustness of institutional checks and balances across the executive, legislative, and judicial branches. Additionally, the

U.S. exhibits strong performance in civil liberties (8.5/10) and political participation (8.89/10), indicating a vital public sphere and competitive pluralism. While the press freedom score (66.59) falls slightly below the ideal, it is still well within the range of democratic systems that tolerate dissent and journalistic scrutiny. Together, these indicators confirm that the US political system is leading innovation and support a liberal and market-oriented governance model.

On the economic side, Table 5.2 confirms the United States as a case of high market development. The governmental expenditure in space programs, which exceeds $79 billion annually, is the highest in the world by a wide margin. This budget includes civilian (NASA) and military (US Space Force) components, showcasing a state capable of sustaining innovation across multiple domains. Furthermore, the U.S. ranks well above the reference threshold in the Global Innovation Index (62.4), reflecting a highly developed ecosystem for science, technology, and entrepreneurship. The most striking indicator, however, is the number of space objects launched annually: more than 2,200, driven primarily by commercial operators such as SpaceX, which accounts for over 50% of global satellite deployment[National Herald India, 2024]. This combination of state investment, private initiative, and technological dynamism creates the ideal structural environment for the commercial leadership model predicted by the theoretical framework.

Index	**Value of reference**	**Score**	**Result**
Political rights	<20	33	Free
V-Dem: Horizontal accountability	<0.5	0.9	Balanced
Civil liberties	<5	8,5	Present
Press Freedom	<70	66,59	Problematic
Political participation	<5	8,89	Active

Table 5.1: Political Structure Variable's score of United States

Dimensions	**Value of reference**	**Score**	**Result**
Governmental expenditure in space programs (billions$)	>5	$79,68 billions	High
Global Innovation Index	>50	62,4	High
Annual number of objects launched into space	>120	2,263	High

Table 5.2: Economic Structure Variable's score of US

5.2 Actual Behavior

The empirical evidence from the past decade aligns and confirms the behavior predicted by the model for a democratic and highly market-developed power. The US has not only embraced the rise of LEO mega-constellations but it has also actively enabled this transformation through a public-private strategic ecosystem. At the center of this approach there is SpaceX's Starlink, the world's largest and advanced LEO constellation, which has already launched thousands of satellites and plans to expand toward a global broadband network. The most significant factor is that Starlink has received substantial regulatory support from the Federal Communications Commission (FCC), launch access through NASA contracts, and even defense funding for military integration via the Space Development Agency (SDA).

This strategy shows how the US supports innovation by encouraging competition among private companies. Instead of directly managing space projects, the government acts as a supporter and main customer. For example, the Department of Defense hires commercial companies to provide services like satellite communication, Earth observation, and secure networks. This way, private companies grow stronger, and the country still meets its security goals. The approach helps save time and money, while also keeping the US ahead in technology without going against free-market values.

At the same time, the United States now sees LEO mega-constellations as an important part of its competition with other major powers, especially China. Official documents like the 2022 U.S. National Defense Strategy[U.S. Department of Defense, 2022] call China a key challenge, pushing the US to invest more in advanced space systems. In this context, companies like SpaceX aren't just businesses, they're seen as important national tools. Their technologies help show US strength, secure global communications, and support military goals. A clear example is Starlink in the Ukraine war, where a commercial system ended up playing a critical role by providing reliable communication to both military and civilian users.

Chapter 6

Analysis of China

China's actual behavior confirms the model's expectations since it acts as an authoritarian state with high market development, implementing a state-led development strategy that integrates innovation with national security. To confirm this, the GuoWang constellation is not just a communications project but it is a strategic asset guided by the state to reinforce China's autonomy and influence in the emerging global space order.

6.1 Expected Reaction According to the Model

Based on the theoretical framework developed in this thesis, China falls into the quadrant of states characterized by an authoritarian political structure combined with high market development. Such states are expected to adopt a strategy of "development guidance", where the state plays a dominant and centralized role in directing technological innovation. In this configuration, innovation is not suppressed but, on the contrary, it is strategically promoted and controlled from the top to ensure alignment with national priorities and regime stability.

As shown in Table 6.1, the political structure of China clearly reflects the characteristics of a consolidated authoritarian regime. The score for political rights is -2 (well below the threshold of 20), and the horizontal accountability score (0.165) indicates a system where the executive dominates institutional checks. Other democratic indicators, such as civil liberties (0.9), press freedom (23.36), and political participation (3.33), all fall below or close to the lower thresholds, confirming the absence of independent media, pluralistic competition, or political participation in policy processes. Together, these indicators define a political system that concentrates decision-making, creating a high-capacity but low-transparency environment.

At the same time, as shown in Table 6.2, China also meets the criteria for high market development. The governmental expenditure in space programs, estimated at $19.89 billion, exceeds the benchmark of $5 billion and reflects sustained investment in space infrastructure. Its Global Innovation Index score of 56.3 surpasses the threshold of 50, confirming that China has developed a mature innovation ecosystem supported by both public and semi-private institutions. Furthermore, China launched 266 space objects in a single year, more than twice the threshold of 120, highlighting a highly active and vertically integrated industrial base. These figures reflect a country that, even if not market-driven, is capable of leading its industrial and financial resources at scale, particularly in strategic sectors such as space.

Index	**Value of reference**	**Score**	**Result**
Political rights	<20	-2	Not Free
V-Dem: Horizontal accountability	<0.5	0.165	Executive
Civil liberties	<5	0,9	Absent
Press Freedom	<70	23,36	Censored
Political participation	<5	3,33	Repressed

Table 6.1: Political Structure Variable's score of China

Dimensions	**Value of reference**	**Score**	**Result**
Governmental expenditure in space programs (billions $)	>5	19,89 billions$	High
Global Innovation Index	>50	56.3	High
Annual number of objects launched into space	>120	266	High

Table 6.2: Economic Structure Variable's score of China

6.2 Actual Behavior

Empirical developments confirm the expected behavior outlined by the model. Over the past decade, China has started a strategy to assert itself as a leading space power, with strong state leadership and coordination across the civil, military, and industrial domains. The country has launched the GuoWang ("national network") project, a state-owned LEO mega-constellation initiative aimed at deploying over 13,000 satellites for global broadband coverage [Julienne, 2023]. The program is controlled and funded by the central government and integrated into China's broader Digital Silk Road strategy [Council on Foreign Relations, 2024]. These initiative is focused not only on the commercial sector but also on national power and strategic autonomy.

Unlike the United States, where the private sector plays a leading role, in China, mega-constellations are developed exclusively through state-owned enterprises, particularly the China Aerospace Science and Technology Corporation (CASC)[Jones, 2024]. This centralized control ensures that technological development aligns with regime objectives, such as securing domestic communications networks, challenging Western digital infrastructure dominance, and projecting influence in the Global South by offering satellite services to partner countries.

The Chinese government also uses regulatory, financial, and military tools to strengthen its position. For example, spectrum rights are managed by the Ministry of Industry and Information Technology (MIIT), and commercial companies must follow strict guidelines[US-China Business Council, 2020]. At the same time, China has heavily invested in ASAT capabilities, showing that its space strategy is not just about development, but also about defense and competition, especially with the United States[Waterman, 2024]. This aligns with a model of strategic rivalry, where space infrastructure is seen as an area of conflict and a tool for geopolitical alignment.

Chapter 7

Analysis of EU

In the context of this analysis, the European Union constitutes a distinctive case, as it does not represent a unitary state but rather a supranational entity composed of multiple member states, each exhibiting diverse political and economic characteristics. For a detailed explanation of the methodology used to assign index values, including the aggregation procedures, please refer to the appendix.

7.1 Expected Reaction According to the Model

Despite this complexity, the EU can still be positioned within the model as a case of a democratic political structure combined with low market development. This configuration leads the model to predict a reaction characterized by "development collaboration" a strategy driven by public-sector coordination, regulatory leadership, and shared investments, rather than by market dynamism or private-sector initiative.

As shown in Table 7.1, the EU scores very high on all indicators of democratic governance. The score for political rights (37), civil liberties (8.4), and political participation (7) all indicate a robust and participatory democratic environment. The horizontal accountability index, measured at 0.908, suggests strong institutional checks and balances, while the press freedom score (77) confirms a free and pluralistic media landscape. These values are consistent with the EU's political identity and from this perspective, the EU fits perfectly into the "democratic" side of the model.

However, as reflected in Table 7.1, the EU does not meet the criteria for high market development. The governmental expenditure in space programs amounts to approximately $2.98 billion per year, falling below the $5 billion benchmark. This funding, although significant, is fragmented between the European Space Agency (ESA) and national agencies, and lacks the unified strategic scope seen in the space budgets of the U.S. or China. The Global Innovation Index (GII) score for the EU is 46.02, below the threshold of 50, indicating an innovation ecosystem that, even if present, does not reach the maturity required for global technological leadership. Finally, the EU's annual number of objects launched into space (86) falls short of the high-market threshold of 120, further confirming a limited industrial development in the LEO segment.

Based on this structural configuration, the model expects the EU to adopt a collaborative, regulation-based response to the rise of LEO mega-constellations. Rather than competing directly through commercial dominance, the EU is expected to prioritize strategic autonomy through institutional coordination, public investment, and regulatory initiatives that enable commercial deployment.

Index	**Value of reference**	**Score**	**Result**
Political rights	<20	37	Free
V-Dem: Horizontal accountability	<0.5	0.908	Balanced
Civil liberties	<5	8,4	Present
Press Freedom	<70	77	Free
Political participation	<5	7	Active

Table 7.1: Political Structure Variable's score of Europe

Dimensions	**Value of reference**	**Score**	**Result**
Governmental expenditure in space programs (billions$)	>5	$2,98 billions	Low
Global Innovation Index	>50	46,02	Low
Annual number of objects launched into space	>120	86	Low

Table 7.2: Economic Structure Variable's score of EU

7.2 Actual Behavior

In line with theoretical expectations, the EU's actual behavior in response to the development of LEO mega-constellations reflects a strategy of development collaboration, shaped by regulatory leadership and multilateral coordination rather than direct technological competition. The EU does not possess a private-sector actor comparable to SpaceX or Amazon

Kuiper, nor does it adopt a centralized industrial strategy like China's GuoWang. Instead, the Union has positioned itself as a regulatory power.

The most visible expression of this strategy is the creation of IRIS², a European LEO constellation initiative launched in 2022 [European Space Agency, 2024b]. Unlike its American or Chinese counterparts, IRIS² is not driven by private innovation or central planning, but by collaborative governance, involving ESA, the European Commission, and consortia of European aerospace firms such as Airbus and Thales Alenia Space[European Commission, 2024].

In parallel, the EU has increasingly integrated space policy into its broader digital and security agenda. Documents such as the EU Strategic Compass [European External Action Service, 2024] and the EU Space Strategy for Security and Defence [European External Action Service, 2023] position space as a domain of critical infrastructure, requiring coordinated investment and resilience. However, these strategies emphasize norm-setting and public investment, not market-driven expansion. The EU also plays a key role in international regulatory forums, advocating for responsible behavior in space, sustainability of satellite constellations, and fair access to orbital slots.

Chapter 8

Analysis of Russia

Russia's behavior in the space domain aligns with the model's expectations, as it acts as an authoritarian state with low market development, adopting a strategy of strategic denial rather than innovation or commercial expansion. Instead of building competitive LEO mega-constellations, Russia leverages its space capabilities to reinforce its geopolitical positioning and military deterrence posture. This confirms the theoretical forecast: in the absence of market development and democratic openness, Russia's space strategy is controlled by the state and the behavior is reactive and shaped by security imperatives.

8.1 Expected Reaction According to the Model

According to the theoretical model, Russia falls into the quadrant of global powers characterized by an authoritarian political structure and low market development. States with this configuration are expected to adopt a strategic behavior defined as "development denial". This approach does not prioritize the creation of competitive mega-constellations or commercial infrastructure in space. Instead, it tends to emphasize the militarization of counter-space capabilities and the use of space primarily as a tool for state security and geopolitical deterrence. In such systems, the state lacks the economic and institutional conditions to enable industrial innovation and thus compensates through defensive behaviors.

As shown in Table 8.1, Russia's political structure confirms its classification as a consolidated authoritarian regime. The country scores 4 in political rights, 2.1 in civil liberties, and 2.22 in political participation, all below the democratic thresholds. Its horizontal accountability score

(0.115), reflects a political system dominated by the executive, with minimal institutional checks and no independent judiciary administration. Press freedom is also severely limited (29.86), suggesting that public discourse and media scrutiny are tightly controlled by the state. These data point to a regime that concentrates power at the top, limits internal pluralism, and is unlikely to delegate strategic authority to private actors in sensitive sectors like space.

Russia's economic indicators, presented in Table 8.2, confirm its classification as a low market development case. Governmental expenditure in space programs is approximately \$3.96 billion, falling below the \$5 billion threshold. Russia was historically a space leader, but over the last decade the space budget has significantly declined, and is now insufficient to sustain the development of independent LEO mega-constellation infrastructure. Additionally, its GII score is 29.7, below the benchmark of 50, indicating a weak innovation ecosystem, limited private-sector participation, and institutional barriers. Although Russia launched 98 space objects, close to the high development threshold, it remains just below the benchmark, and many of these launches are military or state-managed missions rather than commercial or constellation-related projects. Together, these variables predict a state that will prioritize control and strategic denial over innovation or market-driven expansion in the space domain.

Index	**Value of reference**	**Score**	**Result**
Political rights	<20	4	Not Free
V-Dem: Horizontal accountability	0.5	0.115	Executive
Civil liberties	<5	2,1	Absent
Press Freedom	<70	29,86	Censored
Political participation	<5	2,22	Repressed

Table 8.1: Political Structure Variable's score of Russia

Dimensions	**Value of reference**	**Score**	**Result**
Governmental expenditure in space programs (billions\$)	>5	\$3,96 billions	Low
Global Innovation Index	>120	29,7	Low
Annual number of objects launched into space	>100	98	Low

Table 8.2: Economic Structure Variable's score of Russia

8.2 Actual Behavior

Russia's actual strategic behavior in the space domain is aligned with the expectations derived from the theoretical model. As an authoritarian state with low market development, Russia does not pursue leadership in commercial innovation or large-scale infrastructural expansion in low Earth orbit. Instead, it adopts a posture of strategic denial, treating space primarily as a military and geopolitical domain rather than a commercial or innovation-driven frontier. This behavior reflects both its internal structural constraints, given by a limited private sector and a weak innovation system, and its external competition with the West, particularly the United States.

A main characteristic of Russia's approach is the development and deployment of counter-space capabilities with the objective to reduce the strategic advantages of rivals rather than building alternative infrastructures. Russia has actively tested anti-satellite (ASAT) weapons, most notably in November 2021, when it conducted a kinetic ASAT test that destroyed one of its own defunct satellites, generating thousands of debris fragments in low Earth orbit [International Institute for Strategic Studies, 2021]. Although officially justified as a routine defense test, the action was interpreted as a signal of deterrence to Western powers and a demonstration of Russia's ability to disrupt satellite-based communication systems if necessary. This aligns with Russia's broader military doctrine, which treats space as a critical enabler of Western military superiority.

In addition to kinetic capabilities, Russia has also invested in electronic warfare systems capable of jamming, spoofing, and blinding satellite signals. These tools have been deployed in operational contexts, particularly during the war in Ukraine, where Russian forces have reportedly attempted to interfere with the functioning Starlink, used by Ukrainians [P. Mozur, A. Satariano, 2024]. Such actions underscore Russia's reliance on tactical disruption rather than technological parity, where instead of competing in the development of parallel infrastructures, Russia seeks to undermine or block the effectiveness of existing systems deployed by rivals.

Furthermore, Russia has gradually withdrawn from many forms of international cooperation in the space sector. Its relationship with the

European Space Agency (ESA) has deteriorated since 2022, and participation in joint projects with Western institutions has largely ceased. This reflects a broader strategy of strategic isolation and self-reliance, in which space policy is subordinated to military objectives and geopolitical confrontation. Unlike the US or China, which see space as a platform to expand their commercial and technological influence, Russia views it more as a strategic battleground where the focus isn't on progress, but on limiting others' access and capabilities.

Chapter 9

Conclusions

This thesis set out to investigate how global powers respond to the rapid development of LEO mega-constellations, an emerging infrastructure with far-reaching implications for communication systems, digital sovereignty, and geopolitical competition. Through a comparative analysis of four major actors, the United States, China, Russia, and the European Union, this research has shown that state responses to technological shifts in space are deeply conditioned by internal political and economic structures. They are not merely the product of industrial capacity or strategic foresight, but of the configuration of power, governance, and market organization within each actor.

The theoretical model developed in this study combines two core variables: the nature of the political regime (democratic vs. authoritarian) and the level of market development (high vs. low). These variables were operationalized using concrete indicators, such as space-related expenditures, innovation capacity, and launch activity, to predict four distinct strategic postures toward mega-constellations: private sector leadership, development guidance, development collaboration, and development denial.

The case studies have largely confirmed the model's expectations. The United States, as a democratic state with a highly developed market, exemplifies a model of private sector leadership. Its strategy relies on enabling commercial actors such as SpaceX, supported by a mix of regulatory facilitation and strategic military procurement. China, in contrast, acts as an authoritarian state with high market development, confirming the model's prediction of a state-led development strategy: its GuoWang constellation is centrally coordinated and globally oriented. Russia, with its authoritarian system and weak innovation economy, reflects a strategy of strategic denial, focusing less on infrastructure creation and more on counter-space capabilities and disruption. Finally, the European Union, a democratic but fragmented market actor, pursues a logic of development collaboration, relying on public coordination, regulatory frameworks, and strategic partnerships, as exemplified by the IRIS² initiative.

This comparative framework not only reveals structural logics but also provides lessons for policy. The EU, in particular, emerges as a case where democratic institutions are strong, but industrial performance and market autonomy remain limited. The European Union struggles to act as a unified player in space because of divided responsibilities between agencies, low investment, and a weak private space sector. These challenges haven't stopped the EU from responding, in fact, it has strong regulatory influence but they do limit its ability to compete equally with countries that are more commercially driven or better coordinated.

Lessons learned and areas for improvement include:

- Boosting Investment Capacity: With a space budget of approximately $3 billion, the European Union currently falls short of the financial thresholds required to remain globally competitive. To develop robust and scalable space infrastructure, substantially increased investment is needed, particularly through centralized EU-level funding, rather than relying primarily on individual member states.

- Market Mobilization: The lack of globally leading private space companies in Europe signals the need to strengthen the venture capital ecosystem and lower entry barriers for space-related entrepreneurship. A more dynamic and supportive market environment is essential for encouraging innovation and private sector growth.

- Streamlined Governance: Governance in the European space sector is currently fragmented among ESA, the European Commission, and national agencies. This reduces efficiency and delays decision-making. A more centralized and coherent governance structure would enhance the EU's capacity to act swiftly and strategically in space initiatives.

- Innovation Ecosystem Development: Although the EU performs well in research, as reflected by its Global Innovation Index score (46.02), the transition from research to application remains slow and uneven. Enhancing technology transfer mechanisms and support for industrial scaling is critical to fully realize the economic and strategic potential of European space innovation.

If the EU aims to move toward the "High Market Development" quadrant, it must reinforce its industrial competitiveness, reduce internal fragmentation, and adopt a more agile and investment-driven approach to strategic infrastructure, while preserving its core democratic values and regulatory strengths.

At the same time, this thesis present also its limitations. Measuring the EU as a single case required aggregating diverse data from multiple member states, which risks smoothing out internal asymmetries. Moreover, the binary classification of regime type and market development, while useful analytically, may obscure important nuances in how states operate in hybrid or transitional forms. The study also focuses exclusively on LEO mega-constellations, and does not address how states behave across other strategic space domains such as lunar exploration, in-orbit servicing, or planetary defense.

These limitations open the door to future research. The model proposed here could be extended to include emerging space powers such as India, South Korea, or the United Arab Emirates, offering a more diverse comparative sample. Furthermore, investigating the role of alliances and multilateral platforms, such as the Artemis Accords or the Belt and Road Space Initiative, could help refine our understanding of how space power is not only national, but increasingly networked.

Ultimately, this thesis demonstrates that LEO mega-constellations are not merely a technical innovation, but a geopolitical event, reshaping how states project power, organize their economies, and define sovereignty in orbit. The framework developed here offers one possible way to interpret these shifts, and to understand how political and economic structures shape technological futures. For the European Union in particular, the challenge is not to mimic others, but to leverage its unique strengths to act more decisively in a domain that will define much of the global order to come.

Appendix A

How the different variables for the political structure are calculated for European Union

Since the main datasets (V-Dem, Freedom House, GII, World Bank) do not offer aggregate data for the EU, the work is based at Member State level, collecting values for all 27 member states to offer a complete analysis.

The aggregation methodology consists of two consecutive steps. First, data for each index are collected for all individual member states, including their respective population sizes. Subsequently, a weighted average is calculated, using population as the weighting factor. This approach enables a comprehensive statistical representation and ensures that the relative demographic significance of each member state is accurately reflected in the aggregated results.

Member State	Population Size	Political Rights	V-Dem: Horizontal accountability	Civil Liberties	Press Freedom	Political Participation
Sweden	10536632	40	0.989	9.4	88.32	8.33
Spain	48347910	37	0.885	8.8	76.01	7.22
Slovenia	2120461	39	0.900	8.5	72.60	7.22
Slovakia	5426740	37	0.689	8.2	76.03	6.11
Romania	19059479	35	0.587	7.1	68.45	5.56
Portugal	10578174	39	0.932	8.8	85.90	6.11
Poland	36687353	33	0.906	7.7	69.17	6.67
Netherlands	17877117	39	0.954	9.4	87.73	8.33
Malta	552747	35	0.705	8.5	60.96	6.67
Luxembourg	666430	38	0.898	9.7	83.60	6.67
Lithuania	2871585	38	0.972	8.5	81.73	6.67
Latvia	1877445	37	0.923	8.2	82.90	6.67
Italy	58993475	36	0.939	7.1	69.80	7.22
Ireland	5307600	39	0.948	9.4	85.59	8.33
Hungary	9592186	24	0.582	6.8	62.98	4.44
Greece	10405588	35	0.654	8.8	57.15	7.22
Germany	83280000	39	0.979	9.4	83.84	8.33
France	68287487	38	0.954	8.2	78.65	7.78
Finland	5583911	40	0.971	9.7	86.55	7.78
Estonia	1370286	38	0.969	8.5	86.44	6.67
Denmark	5946952	40	0.978	9.4	89.60	8.33
Czech Republic	10864042	36	0.954	9.1	80.14	7.78
Cyprus	1344976	38	0.764	8.8	63.14	6.67
Croatia	3859686	34	0.91	6.8	68.79	6.11
Bulgaria	6446596	32	0.866	7.7	65.32	5.56
Belgium	11787423	39	0.915	8.5	81.49	5.00
Austria	9131761	37	0.919	8.5	74.69	8.89
EU(27)	**448804042**	**36,905**	**0.908**	**8,403**	**76,903**	**7,347**

Table 9.1: Political and Civil Indicators by EU Member State (2023)

Appendix B

How the GII score is calculated for European Union

To obtain the Global Innovation Index (GII) value for the European Union as a whole (EU27), the average of the individual GII scores of its 27 Member States was calculated. This approach provides a composite indicator that reflects the general innovation performance of the EU, based on the assumption that each Member State contributes equally to the overall score. While this method does not account for differences in population size, economic weight, or innovation capacity across countries, it offers a simplified and consistent means of comparison with other global regions or entities.

Member State	**GII score**
Sweden	64.5
Spain	44.9
Slovenia	40.2
Slovakia	34.3
Romania	33.4
Portugal	43.7
Poland	37.0
Netherlands	58.8
Malta	44.8
Luxembourg	49.1
Lithuania	40.1
Latvia	36.4
Italy	45.3
Ireland	50.0
Hungary	39.6
Greece	36.2
Germany	58.1
France	55.4
Finland	59.4
Estonia	52.3
Denmark	57.1
Czech Republic	44.0
Cyprus	45.1
Croatia	36.3
Bulgaria	38.5
Belgium	47.7
Austria	50.3
EU(27)	**46.02**

Table 9.2: GII by EU Member State (2024)

Appendix C

How the Annual number of objects launched into space is calculated for European Union

To obtain the Annual number of objects launched into space for the European Union (EU27) a simple sum of the launches for each country is done for the year 2024. It was also considered the launches made by the European Union itself.

Member State	**Launches in 2024**
Sweden	2
Spain	8
Slovenia	
Slovakia	1
Romania	
Portugal	2
Poland	2
Netherlands	
Malta	
Luxembourg	8
Lithuania	
Latvia	
Italy	11
Ireland	
Hungary	1
Greece	
Germany	7
France	22
Finland	7
Estonia	
Denmark	1
Czech Republic	
Cyprus	
Croatia	1
Bulgaria	
Belgium	4
Austria	
European Union	4
ESA	5
EU(27)	**86**

Table 9.3: Number of launches by EU Member State (2024)

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