RESEARCH
PAPERS

Fondazione CSF

EUROPE'S SPACE TRILEMMA

FRANCESCO NICOLI
GIORGIA CONTE

MAY 2026
NEW SERIES NO. 003

Fondazione CSF

Europe's Space Trilemma

Francesco Nicoli
Giorgia Conte

ISSN: 2038-0623
ISBN: 979-12-80969-24-8

Authors

Francesco Nicoli

Visiting Fellow Fondazione CSF

Giorgia Conte

Politecnico di Torino

Abstract

Europe faces a trilemma between strategic autonomy, budgetary constraints, and a lack of privately driven technological catch-up. Dependence on US space assets is increasingly difficult to reconcile with the geopolitical role of satellite infrastructure, yet Europe's fragmented institutional architecture and limited public demand constrain the scale needed for reusable launchers, large constellations, and downstream space-based services. At the same time, a purely public response would be fiscally demanding and politically complex to justify, and, on its own, unlikely to generate the private-sector risk-taking required for competitive industrial transformation. Europe can ease the trilemma only by changing the pivotal unit of action: consolidating demand at EU level, using procurement as market design, and requiring substantial private co-investment in reusable launch capacity and scalable satellite manufacturing. Ultimately, we argue that strategic autonomy in space will depend on a new public-private settlement in which the EU becomes the central actor for demand aggregation, security-relevant infrastructure, and market creation, while ESA remains focused on science and exploration.

Keywords: European space policy; strategic autonomy; space economy; reusability; public procurement; industrial policy; EU defence; satellite infrastructure; market creation; public-private investment

Introduction

In 2005, Europe, like China, conducted 5 orbital launches, the US 12, and Russia 26. Twenty years later, in 2025, Europe conducted 8 launches, Russia 17, China 93, and the US 180. Earth's near space is increasingly central to economic activity, military resilience, and regulatory contestation; yet, while China and the US rush to develop their orbital economies, Europe is left behind (Terzi and Nicoli 2024; Veugelers et al. 2025).

Without action, US and Chinese companies (which have already disrupted the commercial launch sector, where Europe used to lead 20 years ago) might soon challenge European industries in telecommunications and computing, too, thanks to the next generation of direct-to-cell satellites (a direct threat to large telecom operators) and the coming space-based computing satellites. Moreover, while the space economy is expanding rapidly, the war in Ukraine has repeatedly shown how critical control over space assets is for state survival and strategic autonomy, as well as for Europe's own economic well-being (Draghi 2024).

The changing economics of space

Europe used to have, with Ariane 5, one of the cheapest and most reliable commercially available launchers in the 2000s (Veugelers et al. 2025: 35). Over the next decade, Ariane 6 is instead predicted to become one of the most expensive launchers on the market. Even though, in business terms, the launch industry is relatively small, at about 13 billion in annual value within a total space economy nearing 500 billion annually (ESA 2025), launch costs have always represented the critical bottleneck of the sector. Without cheap and reliable access to space, a vibrant space economy simply cannot develop. Despite legacy industry representatives often claiming that space launch demand is not reactive to price because it is primarily led by public needs, our own calculation (using the most complete dataset on launch costs available) shows that, with relatively high confidence, a 1% decrease in costs is associated with about a 1.4% increase in launched mass, a proxy for demand, which suggests sizeable elasticities (Figure 1) (Terzi and Nicoli 2026).

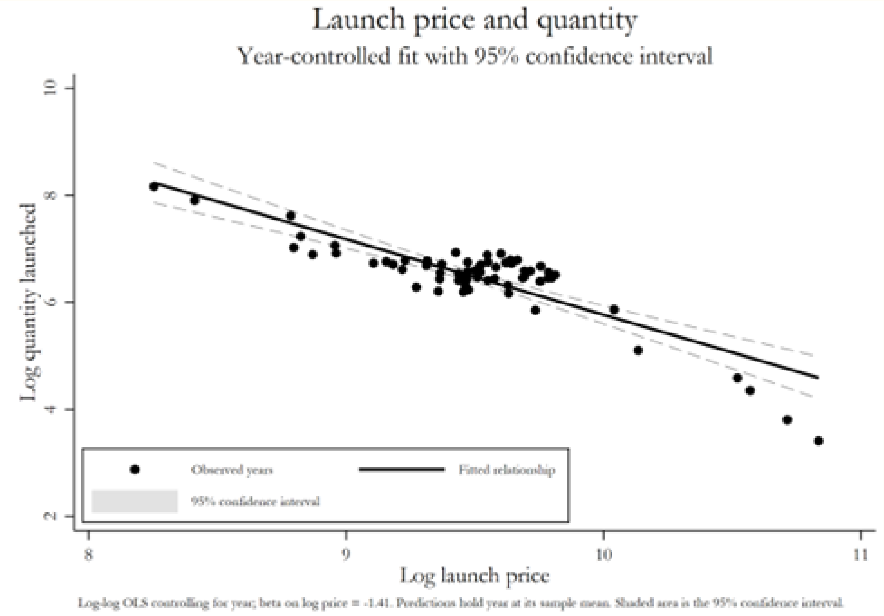

Figure 1- Launch price and quantity relationship

Source: computed from Terzi and Nicoli (2026), space launch dataset, annualised version. Data available upon request

In fact, this is not unlike the global shipping industry. While the shipping industry is large, it represents only a fraction of the global value of retail sales, but without shipping industries, retail sales would collapse and prices would rise substantially. Europe's lack of credible affordable launches, therefore, constitutes a challenge both for the commercial and for the defence sector. In fact, unlike the shipping industries, the inherent dual use nature of space activities means that launching markets tend to be geopolitically segmented, making the lack of cheap and independent access even more problematic. Moreover, the interactions between commercial and security uses of space go beyond the dual -use nature of space: the cost reductions generated by the commercialisation of space enable larger, cheaper, and more resilient military applications. As argued elsewhere (Nicoli and Terzi 2026), there is a positive, self-reinforcing dynamic between the availability of reusable boosters and the rate of development of the whole space economy (Figure 2). Reusable boosters, economically, make sense only when they are relatively large and costly to build, making reuse worthwhile, and when they launch frequently enough to amortise the additional costs of development, refurbishment, and lower capacity compared with expendable alternatives. In turn, they provide lower launch costs. If launch costs are sufficiently low, they will produce a structural change in the satellite manufacturing industry (Eugeni et al. 2022).

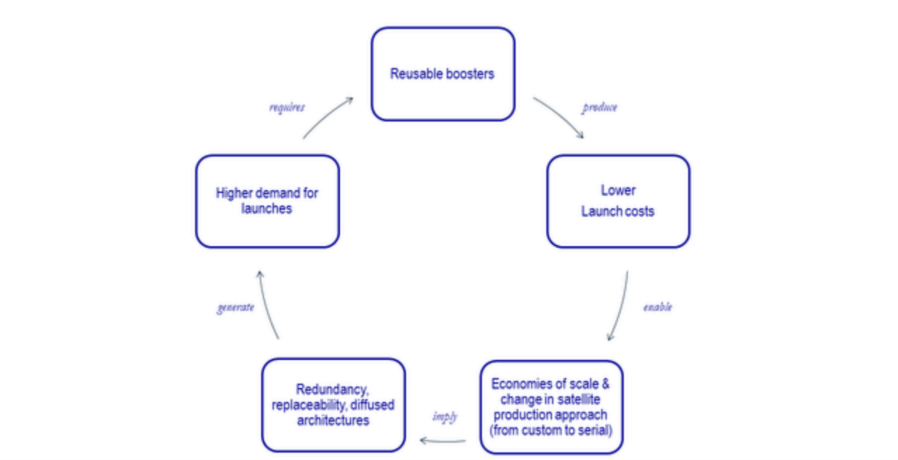

Figure 2- Self-reinforcing loops in the space economy.

Adapted from Nicoli and Terzi (2026)

Rather than extremely costly, nearly hand-assembled artefacts whose every gram is optimised for long-duration survival in space over a span of decades, the changing economics of launch means satellites can now be produced at scale on an assembly line, do not need to be optimised down to the last fraction of a gram, and do not need to last for decades, as they can be replaced frequently and relatively cheaply with updated versions. In turn, this allows manufacturers to switch towards serial production. Modern satellite production lines look more like electronic assembly lines and less like laboratories; as an example, SpaceX is producing more than 340 Starlink satellites a month. This new production approach allows economies of scale to kick in, further reducing the unit cost of the satellites. The two reductions in cost (launch and manufacturing) therefore build on each other, making distributed architectures like Starlink, Starshield and Amazon LEO possible.

Distributed architectures treat every satellite as a node of a system; functionality is provided by the entire system, and loss of a single node, or several nodes, does not critically endanger functionality. Moreover, single nodes can be replaced at low cost, while the network remains operational. These features make distributed constellations extremely resilient to adversary interference, provided cheap launches can be reliably procured in reasonable time to replace losses. In turn, the switch towards distributed low-Earth-orbit architectures implies much higher demand for orbital launchers, helping to generate economies of scale in the launch industry too, making reusable boosters financially sustainable, and restarting the cycle. Even when external demand does not yet exist, that is, when there are not enough operators willing to procure a new launch vehicle, launcher manufacturers can endogenously generate their own demand, as SpaceX has done, by designing and launching their own constellations.

This seems to be the current dominant strategy: without even accounting for next-generation AI and computing satellites, current plans for constellation deployment amount to more than 65,000 satellites by the end of 2035; of these, only about 350 are European, while 38,000 are American and 27,000 Chinese (Ferrari 2026). The lion's share of these constellations comes from companies that also own a reusable launch vehicle, like SpaceX or Blue Origin.

From economics to security

These mega-constellations are likely beginning to affect the calculus of military planners. As shown in several episodes in the war in Ukraine, secure satellite communications, even when privately held, can play a pivotal role in modern conflicts (Abels 2024). While the Russian armed forces were able to disable Ukraine's satellite communications early in the conflict through a cyberattack on Viasat satellites, they have been unable to cope with Ukrainian use of Starlink and Starshield. In turn, exerting influence or political pressure on SpaceX's owner, Mr Musk, has become a strategic goal for Russian influence operations (see reporting by Burgess 2023, as well as analysis by Bergmanis-Korāts et al. 2025 and Robert Lansing Institute 2026). While Starlink is nominally a civilian network and indeed has fewer dual-use capabilities than other satellites, its sister constellation, Starshield, has nearly all the features of standard Starlink satellites.

In fact, the advent of these hybrid dual-use constellations is reversing a decades-long trend (Figure 3). In Figure 3, we use a novel dual-use dataset that classifies all satellites launched since 2000 on a continuous dual-use index, moving beyond the classical dichotomous relationship between purely civilian and dual-use tools (Conte 2025). The dual-use index looks at the specific sensors, orbits, domain applicability and institutional linkages of each orbiting satellite, merging more than 20 indicators into a composite index. As shown in Figure 3, the overall trend prior to the advent of Starlink V2 was a generalised shift towards products with substantially lower dual-use capabilities, culminating with Starlink V1, which had a final score of 0.38, a decades-long low. Starlink V2, thanks to upgraded sensors and communication capabilities, scored 0.48 and is largely responsible for the noticeable inversion of the trend after 2020; more importantly still, Starshield, which uses upgraded Starlink V2s, scores 0.89 on the index with minimal, targeted changes relative to the civilian version. To sum-up, the post-2020 trend is telling, since next-generation constellations, including Starlink V3, Amazon LEO, and three separate Chinese projects, will score even higher while remaining nominally civilian-focused.

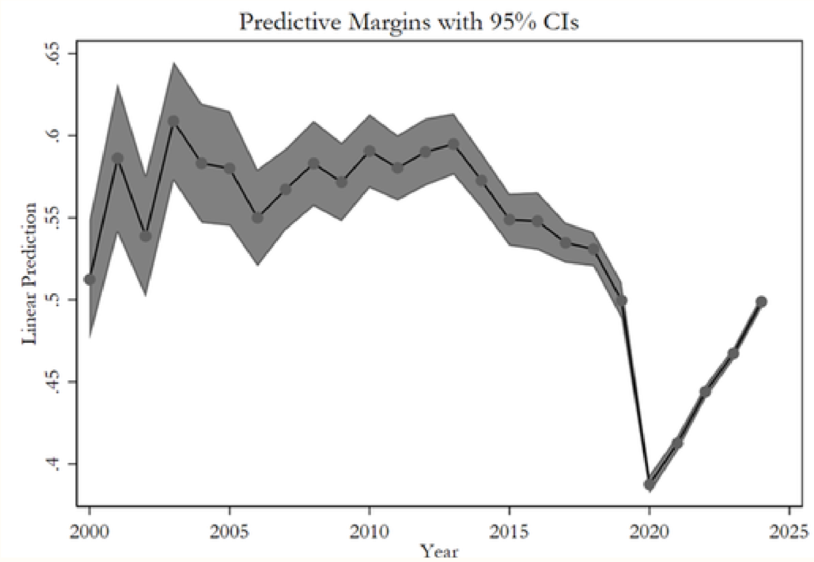

Figure 3- Predicted dual use index over time

Source: Conte (2025). Data available upon request

Europe, and indeed Russia, have, for now, no response to the emergence of large-scale, dual-use constellations. Europe has neither the vibrant space economy needed to compete in the space domain nor the adequate counterspace capabilities that would allow it to disable a sufficient number of adversary satellites. Granted, France and especially Russia do have anti-satellite capabilities, according to the 2026 Secure World Foundation report (Secure World Foundation 2026). However, these are not tailored to this emerging challenge. Earlier anti-satellite capabilities were largely designed around a limited number of high-value orbital assets: if surveillance, communications, or navigation depended on scarce satellites then direct-ascent weapons (rockets launched from Earth towards an orbital target) or co-orbital systems (satellites designed to grab, hit, or otherwise disable other satellites in close proximity) could plausibly degrade an adversary's operational capacity.

Distributed constellations change that calculus. When functionality is distributed across hundreds or thousands of satellites, single-point attacks become largely ineffective, and resilience increasingly depends on network depth rather than on the hardening of individual platforms. For this reason, the Russian Federation has been accused by the US Congress of having violated the Outer Space Treaty and having placed a nuclear warhead in space (Samson et al. 2025). Nuclear-generated HEMP radiation can disable multiple satellites on entire orbital planes, but of course cannot discriminate between friendly and enemy targets. They are therefore a desperate weapon of last resort, whose use would be met with anger also among Russia's closest allies, like China. Nonetheless, the fact that such prospect is realistic and that a likely nuclear-carrying satellite has already be already identified, suggests that the Russian government (i) takes the treat of Starlink very seriously, and (ii) is unable to find a coherent, conventional response to it.

Moreover, next-generation mega-constellations, such as Starlink V3 with direct-to-cell capabilities, extend the geopolitical significance of space beyond military communications and launch autonomy. Today, states retain substantial leverage over internet access because terrestrial infrastructure, telecom licenses, data centers, fibre networks, and mobile operators remain embedded in national jurisdictions and, ultimately, under the coercive power of the state. But if users can connect directly to orbital networks through ordinary devices, national authorities may find it harder to interrupt or filter access to information. On the one hand, this has democratic and humanitarian values when authoritarian governments restrict communications, because it may weaken established state censorship tools as authoritarian states scramble for countermeasures (Gent 2024). On the other hand, it also creates a hybrid-security problem: private constellation operators may become arbiters of nformation access inside sovereign states, sometimes even challenging legitimate decisions by elected governments, as briefly happened between SpaceX and Brazil in 2024 (Sa Pessoa and Maisonnave 2024).

Europe's Space Trilemma

Against this backdrop, observers and policymakers have often approached Europe's delays in space development from separate standpoints. Traditionally, many have pointed at the fragmented nature of European space policy: not only are competences divided between entities with overlapping mandates, but the membership of these organisations is fragmented (Figure 4). The European Space Agency, a non-EU organisation that includes the UK but excludes several EU member states, is primarily focused on civilian and science functions, although it is now beginning to cooperate on secure communications constellations with clear military implications. Conversely, NATO can rely on some space assets provided by its member states, which neither overlap fully with ESA nor with the EU. However, the great majority of these space assets are provided by the US military or by other US-based actors, such as SpaceX, creating a clear vulnerability in terms of strategic autonomy.

Finally, the European Union has recently launched the European Union Agency for the Space Programme, EUSPA, which, jointly with the EU Commissioner for Defence and Space, is tasked with developing a proper EU-wide, strategically autonomous civilian and military programme, which some see as competing, respectively, with NATO and ESA functions.

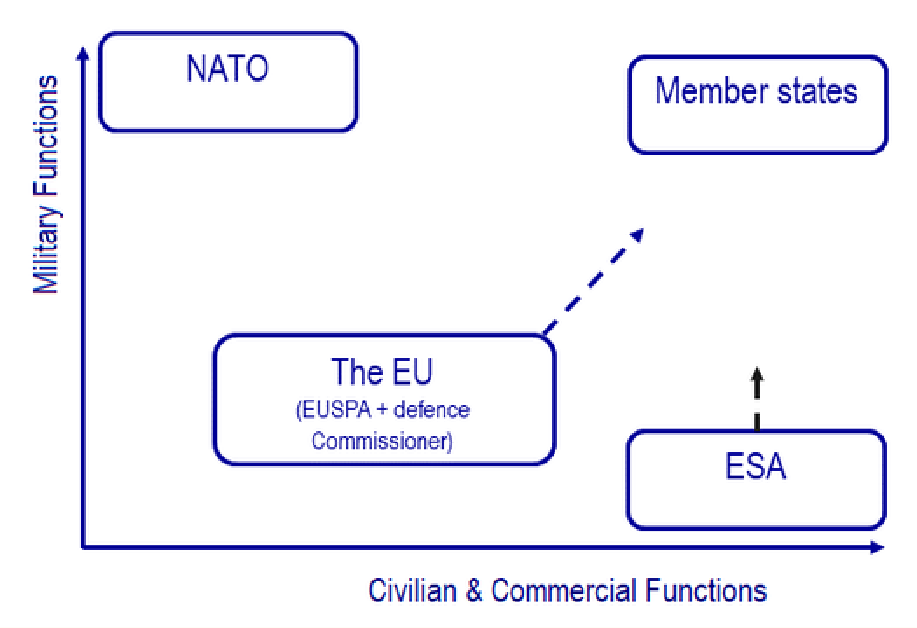

Figure 4 - Fragmentation in European space-related functions and their evolution

Member states also retain considerable independent margin of action in the space domain. These overlapping functions but separate memberships imply that funding is often dispersed across programmes that risk replicating capabilities and, often cannot achieve the critical mass needed for genuine technological breakthroughs; moreover, they ensure that EU countries remain dependent on US space assets when it comes to defence, intelligence, secure communications, and targeting. Even under current EU-sponsored plans, such as IRIS^2, the US would continue to enjoy wide dominance in security-oriented space assets; the scope for EU constellations is therefore seen by some as limited to providing secure government communications (Cabroni and Gilli 2026).

Others, however, believe that Europe's space problem reaches beyond programme management and is associated, inter alia, with industrial dynamics.

Industry players, especially, identify the main issue in limited public budgets. By some metrics, the consolidated civilian and military public expenditure in the US is over 60% of the world's space expenditure, and more than four times the EU's total. For industry actors, this lack of public investment is problematic because it prevents the public sector from acting as a core customer that procures their launches. If public demand is limited, they argue, there is little point in scaling up technological development to achieve rocket reusability, the key to current US success, because reusability only pays out, in terms of private profits, if demand increases. While this argument willingly ignores the fact that more than 70% of the increase in US launches has come from private rather than public demand, it is true that NASA did act as anchor customer for SpaceX in the early 2010s, allowing the company to exploit economies of scale and in turn lower its rockets' costs across the board.

Finally, others identify Europe's critical bottleneck exactly in the lack of private risk-taking: after all, SpaceX and Blue Origin, the only two entities successfully landing a rocket booster so far, developed their technology independently from public requests and with substantial private risk-taking. Their investment in reusable rocket technology was a risky bet, which they took; European players, instead, reason as legacy providers who do not take any risk unless they are fully guaranteed success by public backing. This line of reasoning points at a lack of corporate investment among legacy players, and an inadequate risk-taking culture among large aerospace conglomerates in Europe, as the main reason for Europe's falling behind (Veugelers et al. 2025). In this setting, a space policy built around prestige missions, protected procurement, and incremental launcher development is poorly matched to the structure of competition. While each of these explanations has merit, each is likely incomplete on its own. They complement each other and produce sharp trade-offs. To understand these, we can visualise the three challenges as a trilemma. Europe wants to achieve three objectives: to develop strategic independence from the United States; to operate within limited and politically contested public budgets, without subtracting resources from other scientific endeavours or the welfare state; and to compete in a sector increasingly shaped by reusable launchers, high-throughput satellite production, and large constellations while continuing to carry on with business as usual, that is, without a fundamental change in the way private industry players approach reusability and satellite production at scale (Figure 5).

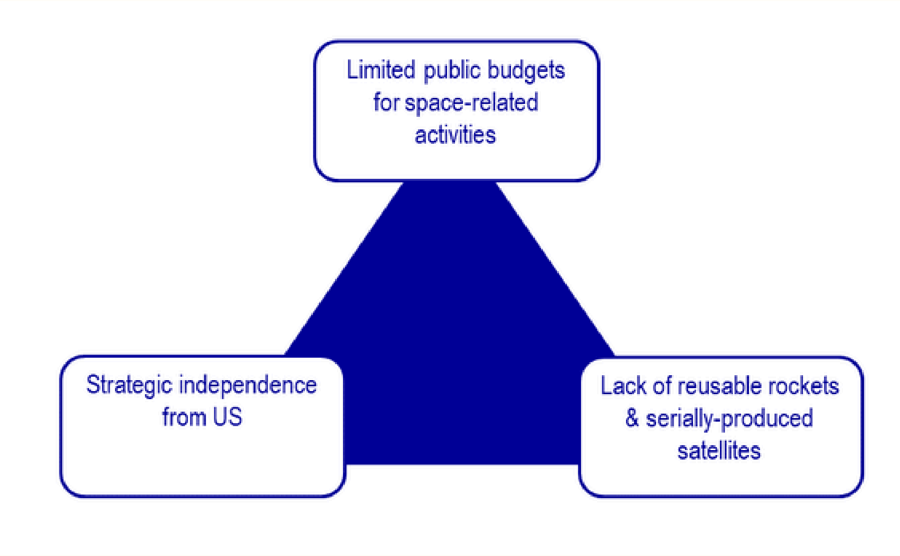

Figure 5- Europe's Space Trilemma

These three objectives are jointly unstable and can lead to the paralysis we observe. Strategic independence without a scalable launch and satellite-production base requires very large public expenditure. Budget discipline without technological catch-up deepens dependence on foreign launch, connectivity, and data infrastructures. Technological catch-up without a market capable of sustaining scale is unlikely to arrive through fragmented national procurement alone; a European SpaceX would address only part of the problem. A single firm could reduce some costs, but it would not automatically produce a competitive market, a reliable legal settlement, a shared security doctrine, or a sustainable orbital regime. Reusability can generate monopoly rents when only one provider controls the technology.

Escaping the Trilemma

Europe can ease the trilemma's force field only by changing the unit of action. National programmes are too small to sustain the demand, procurement discipline, and legal harmonisation required by the new economics of space. Purely intergovernmental coordination is too slow when launch technology and satellite manufacturing are moving through steep learning curves, especially when anchored into georeturn. A purely regulatory response is also insufficient, because legal harmonisation without market creation would reduce some transaction costs while leaving the scale problem unresolved.

While there are no silver bullets, the critical issue, in our view, is to address two bottlenecks simultaneously: the public should recognise the importance of space and put forward clear, large public demand for certain innovative space assets. At minimum, an EU-wide Starlink would be needed to ensure strategic autonomy; this could grow from, but should not be limited to, IRIS^2. However, more innovative designs should also be on the table, including space-based solar power and computing satellites. These three applications, targeting security, climate, and digital markets, would each require substantial public investment. Crucially, however, this should not happen without substantial private investment and risk-taking by private entities at two levels: launch technology and scaled satellite manufacturing. The public can provide an initial anchor for scale, but only alongside, and as a partial guarantee for, sizeable private investment in the same sectors and activities. This investment cannot be, and should not be, risk-free; European space corporations need to have an honest conversation with their shareholders and explain that long-term growth might require medium-term sacrifices. Companies like Blue Origin and SpaceX, for instance, ran losses for years before achieving technological success. Without risk-taking, European space firms will simply be leapfrogged by bolder companies that are more willing, or more capable, of taking risk.

Regulation also has a role to play. Innovative procurement approaches, including EU-wide joint procurement (Beetsma and Nicoli 2024) and staggered competitions to protect smaller firms, need to be introduced at scale and beyond pilot projects such as ESA's European Launch Challenge, which targets only demonstration launches. Indeed, technology policy has to distinguish demonstrators from scale. European reusable-launch projects, small-launcher initiatives, and industrial consolidation efforts are useful only if they converge towards an operational cadence and economies of scale that can change costs and incentives. The political economy of reusability (Nicoli and Terzi 2026) is unforgiving: fixed costs fall per launch only when launches multiply and launcher size grows, and demand expands only when lower prices, credible services, and downstream business models reinforce one another. In other words, policymakers need to be fully aware that they need to act not only as buyers, but also, and primarily, as market designers.

It is hard to think that European countries can achieve all this under the current institutional fragmentation and overlapping mandates. In fact, to ensure that Europe can have true strategic autonomy and efficient allocation of resources, the EU needs to become the central actor in space. On the one hand, continued reliance on NATO, in practice US, space assets would mean not addressing the strategic autonomy issue; Europe needs to reduce its reliance on US assets, even though nothing prevents the EU from then committing those European assets to collective NATO defence. On the other hand, ESA remains constrained by its old georeturn principle and by its excessive focus on science vis-à-vis market creation or defence. It is ill-equipped and ill-endowed to expand beyond its policy comfort zone, and it should not be required to do so. ESA works best when it can focus on its primary mission: science and exploration. In the long term, the EU should therefore become the central hub for space spending, contracting ESA directly when appropriate for civilian missions, but also acting autonomously when required to stimulate markets or provide security assets.

Typically, a trilemma implies that at least one condition needs to be relaxed. But as shown, Europe will catch up in space only if private and public actors successfully strike a grand bargain, leading to more public demand but also much higher private investment and risk-taking. Europe's space trilemma will only be solved if two, not one, of the constraints are addressed simultaneously, and it is impossible to do so without a comprehensive rethinking of the European space sector that places a novel public-private entente at its core.

References

Abels, J. (2024). Private Infrastructure in Geopolitical Conflicts: The Case of Starlink and the War in Ukraine. *European Journal of International Relations* 30(4): 842-866. DOI: 10.1177/13540661241260653.

Beetsma, R., and Nicoli, F. (2024). *Joint Public Procurement as a Tool for European Union Industrial Policy*. Bruegel Policy Brief 18/2024. https://www.bruegel.org/policy-brief/joint-public-procurement-tool-european-union-industrial-policy

Bergmanis-Korāts, G., Isupova, M., Vecmanis, R. R. (2025). Virtual Manipulation Brief 2025: From War and Fear to Confusion and Uncertainty. Riga: NATO Strategic Communications Centre of Excellence. https://stratcomcoe.org/publications/virtual-manipulation-brief-2025-from-war-and-fear-to-confusion-and-uncertainty/320/

Burgess, M. (2023). 'Elon Musk Mocked Ukraine, and Russian Trolls Went Wild'. WIRED, 25 October. https://www.wired.com/story/elon-musk-mocked-ukraine-russian-trolls-went-wild/.

Cabroni, G. and Gilli A. (2026). *Per Aspera ad Astra: Undersea Cables, Satellites for Telecommunications and the European Strategic Autonomy*. IEP@BU Policy Brief 52. https://iep.unibocconi.eu/sites/default/files/media/attach/PB52_Per%20aspera%20ad%20astra.pdf.

Conte, G. (2025). *Assessing the True Extent of Dual-Use Potential in Satellites Through a Spectrum-Based Classification Model*. Master's thesis, Politecnico di Torino.

Draghi, M. (2024). *The Future of European Competitiveness: A Competitiveness Strategy for Europe. European Commission*. https://commission.europa.eu/topics/strengthening-european-competitiveness/eu-competitiveness-looking-ahead_en

European Space Agency (2025). *ESA Report on the Space Economy 2025*. Paris: ESA. https://space-economy.esa.int/documents/tJMabTj61KkdGVOtF6SKw6wGSxicen6ajUWamCG3.pdf.

Eugeni, M., Quercia T., Bernabei M., et al. (2022). An Industry 4.0 Approach to Large Scale Production of Satellite Constellations: The Case Study of Composite Sandwich Panel Manufacturing. *Acta Astronautica* 192: 276-290. DOI: 10.1016/j.actaastro.2021.12.039.

Ferrari, M. F. (2026). *Launch Demand Implications of LEO Mega Constellations: A Scenario-Based Analysis of Deployment Scale and Economic Footprint*. Master's thesis, Politecnico di Torino.

References

Gent, E. (2024). China Extends the Great Firewall Into Space. *IEEE Spectrum*, 23 October. https://spectrum.ieee.org/satellite-internet-china-great-firewall

Nicoli, F. and Terzi, A. (2026). Economic Growth in Space: Rocket Reusability as an Economic Problem. In Polanco, R. and François, J. *Regulating space-based commerce.* Bloomsbury Academic Press. (forthcoming)

Robert Lansing Institute (2026). *Hybrid War Goes Orbital: Russia's Threats Against SpaceX and the United States*. 6 February. https://lansinginstitute.org/2026/02/06/hybrid-war-goes-orbital-russias-threats-against-spacex-and-the-united-states/.

Samson, V., Walton, S. and Brett, K. (2025). *What We Know About Russia's Alleged Nuclear Anti-Satellite Weapon*. Broomfield, CO: Secure World Foundation.

Sa Pessoa, G.and Fabiano M. (2024). Musk's Starlink Backtracks and Says It Will Comply With Judge's Order to Block X in Brazil. *Associated Press*, 3 September.

Secure World Foundation (2026). *Global Counterspace Capabilities: An Open Source Assessment*. Broomfield, CO: Secure World Foundation.

Terzi, A. and Nicoli F. (2024). *Space Possibilities for Our Grandchildren: Current and Future Economic Uses of Space*. European Economy Discussion Paper 211. European Commission, Directorate-General for Economic and Financial Affairs.
DOI: 10.2765/392340

Veugelers R., Sekut, K. and Nicoli, F. (2025). Relaunching Europe's Space Economy. Bruegel Blueprint 36. Bruegel. https://www.bruegel.org/sites/default/files/2025-08/Bruegel%20Blueprint%2036.pdf

RESEARCH PAPERS

Fondazione CSF

Fondazione CSF
Piazza Arbarello, 8 - 10122 Turin - Italy
Via dei Montecatini, 17 - 00186 Rome - Italy
155, Rue de la Loi - 1040 Brussels - Belgium
www.fondazionecsf.it