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Francesco Crespi, Rosario Cerra and Francesco Zezza

Coopetitive Technological Sovereignty: A Strategy to Reconcile International Collaboration with Knowledge and Economic Security

In the next 20 years, we will witness the convergent development of a complex system of frontier technologies that, together, will profoundly revolutionise the economy and society. In this perspective, the ability to generate, access and utilise these “frontier” technologies will decisively contribute to defining the geostrategic role that various economies will be able to assume in the international context (Archibugi et al., 2025; UNCTAD, 2023; Cerra & Crespi, 2023).

International tensions, particularly between China and the US, extend beyond trade and are driven by fierce technological competition for technological and industrial dominance. This competition involves the configuration of global value chains and geostrategic concerns, including the security and resilience of digital networks, energy, space, marine domains and international financial infrastructure. In this context, the notion of technological sovereignty gained relevance in recent years, highlighting the role of autonomous technological capacities in shaping global strategic interactions (Crespi et al., 2021; Cerra & Crespi, 2021; Bellanova et al., 2022; Caravella et al., 2024; Edler et al., 2023). The recent appointment of an Executive Vice-President to the new European Commission for Technological Sovereignty, Security and Democracy, appears to be coherent with increasing attention on these issues.

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So far, the debate on technological sovereignty has mainly emphasised the dimensions of technological *competition* as a playing field for shaping global geostrategic dynamics. Doing so highlights the fact that industrial, research and innovation policies can no longer merely aim for a generic increase in national competitiveness. Instead, these policies must become tools to deliberately guide economic agents to act in ways that generate security externalities favourable to states’ strategic interests (Staab et al., 2024).

The next step is to recognise that solving specific scientific and technological problems require going beyond the capacities and expertise available to individual companies or states. In particular, the great global challenges such as the development and governance of new digital technologies (especially artificial intelligence), climate change, the transition to sustainable energy and growth models, health, security, and demographic and migratory phenomena, can be addressed more effectively through *cooperative* efforts (Huang & Soete, 2025; UNCTAD, 2024).

In this respect, technological sovereignty does not imply the necessity of pursuing a complete technological autonomy that challenges the international division of labour and the search for autonomous technological capabilities in all fields deemed strategic. It does, however, suggest the need for a single country – or a federation of states, as in the case of the European Union – to develop or maintain, with regard to fundamental technologies, its own autonomy or the lowest level of dependency possible. This indicates, in particular, the importance of avoiding unilateral dependencies.

Achieving this goal through a techno-nationalist approach would be highly inefficient, as well as practically unfeasible. Hence, misinterpreting technological sovereignty as techno-nationalism leads to the development of closed research and innovation policies, which inherently fail to ensure the objective of technological sovereignty (Lee et al., 2024).

Building on these considerations, this contribution aims to highlight the potential of “coopetition” as a strategy to manage the tensions between competition and cooperation in a context of growing technological complexity and global rivalries for achieving technological, economic and military supremacy (Cerra & Crespi, 2024).

Following previous literature on coopetition (Brandenburger & Nalebuff, 1996; Corbo et al., 2023; Gernsheimer et al., 2021; Katsaliaki et al., 2024), we can define it as a strategy capable of simultaneously combining cooperative and competitive dynamics between two or more entities to achieve mutual and significant advantages, thereby increasing the ability to effectively respond to the complex challenges posed by technological innovation, markets and geostrategic processes.

In particular, the paper explores competition and cooperation activities in science and technology by analysing recent trends in international scientific collaborations, co-patenting among major global players and data from EU-funded research projects. Additionally, we propose the notion of coopetitive technological sovereignty as a framework strategy for managing international relations, particularly in science and technology. Finally, the policy implications for the EU with respect to its economic security and strategic autonomy objectives are discussed.

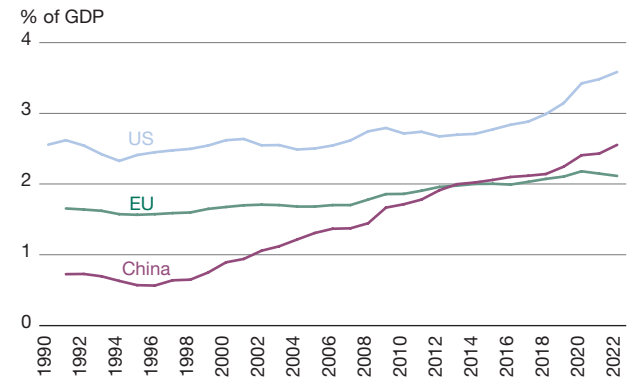
Competition and cooperation in science and technology in a changing world

The hyper-globalisation process that characterised recent decades has significantly increased the systemic interdependence of various countries, often through the promotion of commercial, technological and productive cooperation activities that have not always been conducted in a fully conscious way. On the one hand, these processes have facilitated international trade, productive specialisation, and thus the growth of the global economy. On the other hand, they have also triggered the emergence of major economic, financial, social, environmental and geopolitical imbalances (Guarascio et al., 2025; Reljic et al., 2021; Stamegna et al., 2024; Stiglitz, 2018a).

In this context, while the European economy faces prolonged stagnation, China continues to rise as a major economic and geopolitical power, and the global leadership role of the United States is increasingly in question (Kirshner, 2024; Streeck, 2024). Geopolitical tensions have fuelled protectionist policies, with growing political support for reshoring and friend-shoring initiatives (Draghi, 2024; Farrell & Newman, 2019, 2023; Laffan, 2018; Schwarzer, 2017).

In response to China's rapid ascent, the US has reoriented its strategy, treating China as a strategic rival rather than an economic partner (Ma et al., 2024). This shift is evident in legislative measures like the Innovation and Competition Act and Strategic Competition Act, economic sanctions on Chinese firms such as Huawei, and restricted high-tech exchanges in R&D and academia

Figure 1
Gross domestic expenditure on research and development, 1990-2022



Source: Authors elaboration on OECD data.

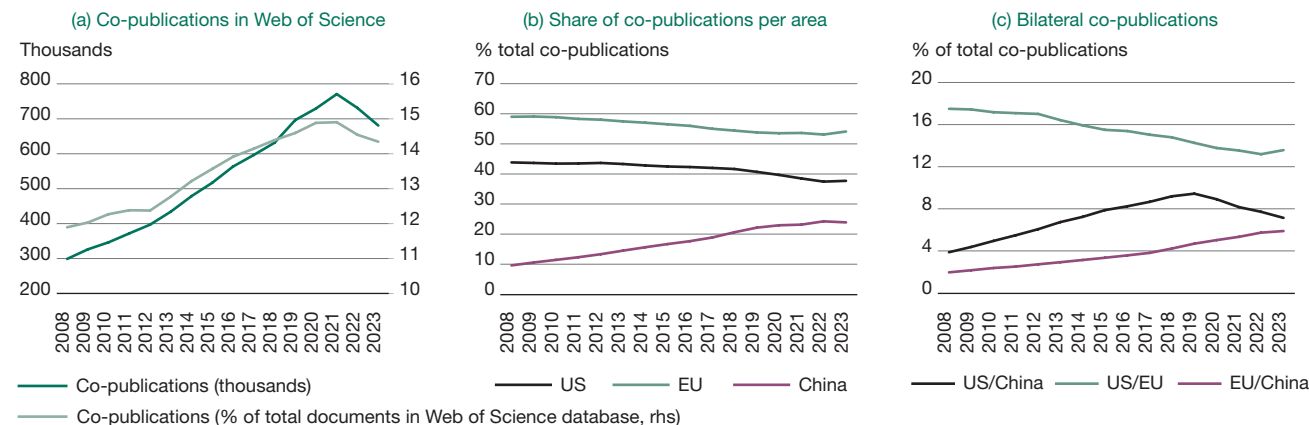
(Fajgelbaum & Khandelwal, 2022; Hopewell, 2021; Stiglitz, 2018b; Yuan, 2020).

International tensions, especially between China and the United States, go beyond trade disputes and are fueled by intense technological rivalry aimed at achieving dominance in technology and industry. This competition is shaped by geostrategic considerations and encompasses the structuring of global value chains, the security and resilience of digital networks, energy systems, space, maritime domains and the global financial infrastructure. Amid these developments, technological sovereignty has become a central theme in political discourse, reflecting a trend towards prioritising domestic production and forming closer ties with trusted partners to navigate global uncertainties (Crespi et al., 2021; Edler et al., 2023).

Currently, the landscape of technological competition is dominated by the US and China, while the European Union's competitive position has been declining (Archibugi et al., 2025). A straightforward illustration of this trend is provided in Figure 1, which shows the R&D investment intensity relative to GDP across these regions.

The US has consistently maintained the highest level of gross domestic R&D spending (GERD) as a percentage of GDP throughout the observed period, with recent growth fuelled by significant investments in digital technologies. Despite US leadership, China has made substantial progress, with GERD rising from 0.6% in 1996 to 2.6% in 2022, surpassing the EU by 2013. The EU lags, with a GERD-to-GDP ratio of 2.1% in 2022, trailing the US by 1.5 percentage points and China by 0.5 percentage points.

Figure 2
Scientific co-publications, 2008-2023



Source: Authors' elaborations on Clarivate Incites data, extracted in September 2024.

Unlike its competitors, the EU has not experienced the AI-driven GERD boom, with a decline in the post-pandemic period, raising concerns in Brussels (Draghi, 2024; European Commission, 2024a).

This trend partially explains the US's technological leadership in frontier technologies, China's extraordinary progress over the past decade, and the European research and innovation system's delays (Draghi, 2024).

International scientific collaborations

However, technological competition is not the only dynamic in international research and innovation activities. Cooperation in science and technology is crucial for achieving ambitious goals, such as, for instance, advancements in artificial intelligence (AI) and quantum technologies (UNCTAD, 2023, 2024). These require comprehensive knowledge integration, long-term projects and collaboration among specialised institutions and experts. In contrast, isolation poses a significant barrier, disrupting knowledge integration and collective learning that are essential for major scientific and technological advancements (Huang & Soete, 2025; Karplus et al., 2025).

Interestingly, the current phase is marked by a significant ambivalence. On the one hand, digital technology advances facilitate efficient data and knowledge transfer, while global challenges like climate change and pandemics demand stronger scientific collaboration and coordinated policies. On the other hand, escalating geopolitical tensions and conflicts drive policies that hinder cooperation, making it risky or costly.

The importance of research collaboration is evident in the substantial volume of multi-author publications from different countries, which often garner more citations and involve leading scientists in high-profile projects (National Science Board, 2021). Openness in the scientific system, including facilitating visits by foreign scholars and fostering international collaborations, enhances the development of a strong scientific foundation and cultivates "soft power" in international relations (Wagner & Jonkers, 2017). Moreover, research mobility and collaboration have brought widespread benefits to China and other participating countries (Lee & Haupt, 2021).

In this respect, Figure 2 shows the dynamics of international scientific co-publications indexed in the Web of Science database (2008-2023) for the EU, US and China. Co-publications, which account for about 15% of all publications, have more than doubled from 300,000 to over 770,000 between 2008 and 2021. However, this share declined from 15% in 2021 to 14.3% by 2023 (Figure 2a).

The increasing involvement of Chinese researchers in international scientific cooperation is reflected by China's share of global international collaborations, which rose from 9.6% in 2008 to 23.9% in 2023. Symmetrically, the US and EU saw slight decreases, from 43.6% to 37.7% and from 59% to 54.1%, respectively (Figure 2b).

Looking at bilateral collaborations, Figure 2c shows that in recent years China-US and China-EU collaborations have followed a diverging trend. While the former declined from 9.4% in 2019 to 7.1% in 2023, the latter increased from 4.7% to 5.9% over the same period. The decline in China-US collaborations can be partly attributed to pandemic-

related travel restrictions, visa denials and communication challenges due to blockages, illness and funding issues. However, if the decline was solely pandemic-driven, similar trends would be expected in China-EU relations, which is not the case.

This phenomenon reflects escalating political tensions between China and the US, particularly in science and technology. These tensions intensified with the US government's 2017 investigation into illicit technology transfers and the increased intensity of Federal Bureau of Investigation's scrutiny. The Department of Justice reported that 80% of economic espionage prosecutions involve conduct benefiting the Chinese state, with a China nexus in 60% of trade secret theft cases (Subbaraman, 2021). These political tensions have strained scientific cooperation, prompting increased restrictions on collaborative activities between universities on both sides of the Pacific (Gilbert, 2023). Following the investigation's conclusion in 2022, several Chinese scientists were arrested, and both the US and Chinese governments implemented measures to address technological security risks (Gilbert, 2023; Subbaraman, 2021). This led to a rise in "brain return" to China and a decline in China-US dual affiliations.

EU-funded research projects

In contrast, the EU's research system remains notably open, as further evidenced by data on EU-funded collaborative projects under the Framework Programmes for Research (FP) involving non-EU partners. Table 1 provides a detailed analysis of collaborations with the US, Russia, China, Japan and Korea.

The data indicates a significant rise in international collaborations during the FP7 and Horizon 2020 programmes, highlighting the EU's strong commitment to global scientific partnerships. The US emerged as the leading non-EU partner, participating in nearly 3,000 projects, followed by China and Russia, with Russia playing a prominent role prior to Horizon 2020. Collaborative projects increased across all partners, except Russia, over the three programming cycles (FP6 to Horizon 2020). For Horizon Europe (2021-2027), data are incomplete due to ongoing calls, but a notable absence of Russian collaborations is observed.

Co-patenting

International technology cooperation can also be examined through co-patenting activities. Figure 3 presents co-patenting trends for the US, China, India, France, Germany and Italy with other G7 and BRICS countries for the period 2000-2021. Figures show that US co-patenting activities with other G7 countries declined from 83% in 2000

Table 1
International collaborations of member states in EU-funded projects

	Framework Programme				Total
	FP6	FP7	Horizon 2020	Horizon Europe	
Period	2002-2006	2007-2013	2014-2020	2021-2027	
Budget, billion euro	16.3	50.5	77	95.5	283.3
Number of collaborative projects					
USA	337	437	1499	689	2962
Russia	291	326	137	..	754
China	198	232	282	77	789
Japan	27	103	176	87	393
Korea	18	54	84	43	199
EU contribution, million euro					
USA	811	2220	4430	1900	9361
Russia	1390	1560	631	..	3581
China	813	874	1200	221	3108
Japan	125	529	534	242	1430
Korea	96	284	821	426	1627

Source: Authors' elaborations on European Commission data, 2024.

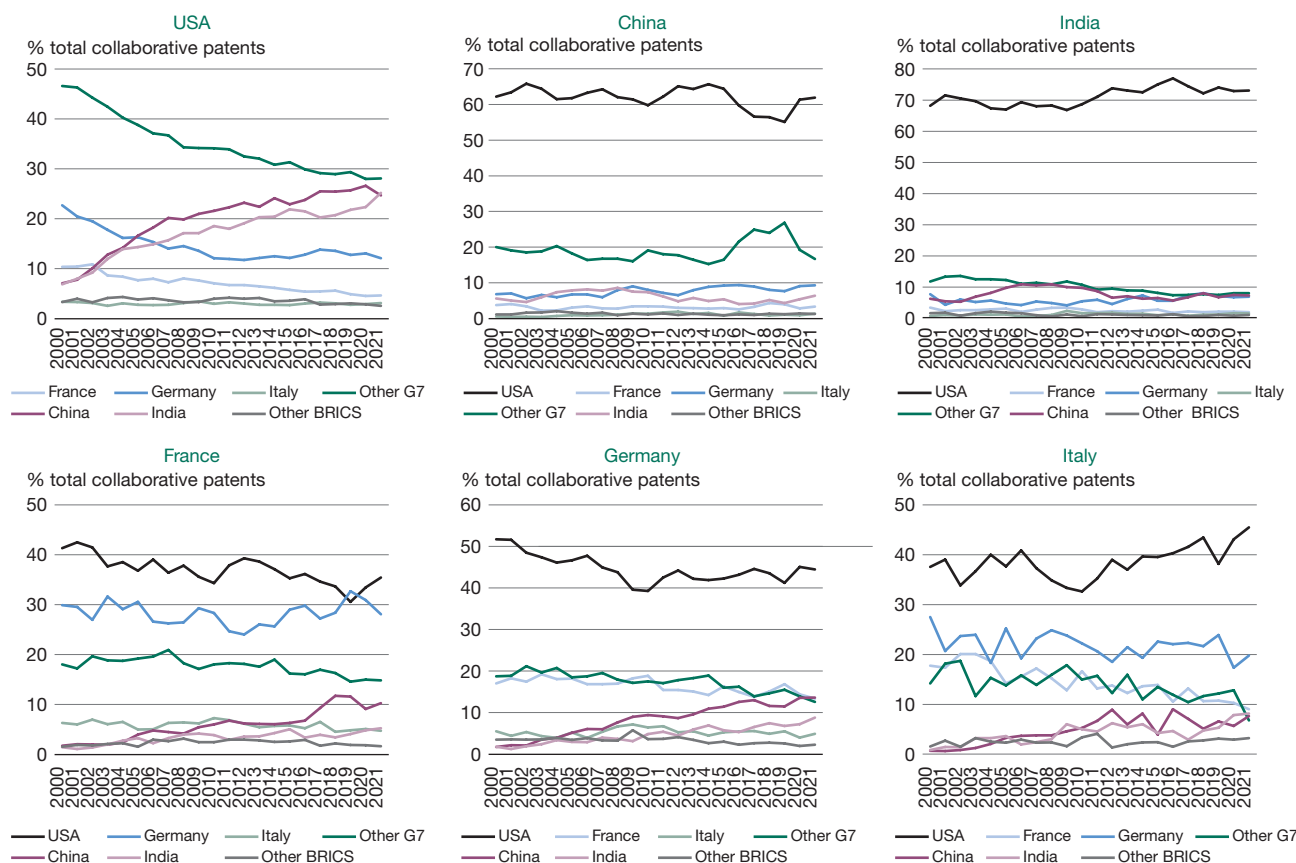
to 48% in 2021, while collaborations with China and India rose, globally, to 50%. Interestingly, unlike scientific publications, co-patenting with China shows no significant decline post-2016, except in 2021. This seems to indicate that the inertia in collaboration activities between the US and China in the technological field, which have been primarily carried out by companies, has been greater compared to the case of collaborations in scientific research.

China and India maintain the US as their leading partner, with over 60% and 70% collaboration shares, respectively. Notably, China's co-patenting with Germany grew from 6.8% in 2000 to 9.3% in 2021, reflecting strong technological ties. Among European countries, the US remains the main partner, although the share of co-patents decreased for France and Germany while increasing for Italy, from 37.5% to 45.4% between 2010 and 2021. Additionally, collaborations with China have grown significantly for France and Germany, reaching 10.2% and 13.6% respectively by 2021, while Italy's share stands at 7.7%. Italy's engagement with India is higher than France and Germany, at 8.1%.

Toward a European strategy for coepetitive technological sovereignty

The preceding analysis highlights the relevance of both competition and cooperation forces shaping international

Figure 3
Co-patenting activity of selected G7 and BRICS countries, 2000-2021



Notes: Figure shows the share of co-patents of USA, China, India, France, Germany, Italy along with other G7 and BRICS countries, as percent of total co-patents between G7 and BRICS countries.

Source: Authors' elaborations on OECD data.

relationships concerning the development of both scientific and technological knowledge.

Given increasing knowledge complexity involved in technological innovation activities, it is unrealistic for a country to maintain all technological and production capabilities, despite the political appeal of such an approach. This is especially true with the increasing integration of sectors and the growing importance of general-purpose technologies like AI and quantum technologies, which demand extensive knowledge integration (Guarascio et al., 2023).

For instance, the semiconductor industry involves globally distributed value chains from chip design to utilisation. Achieving technological sovereignty in semiconductors through isolated policies is impractical. National attempts to maintain all technological capabilities risk promoting inferior technologies, reducing international competitive-

ness. Moreover, unilateral pursuit of technological sovereignty could lead to redundant investments in innovation, stalling progress across multiple domains (Lee et al., 2024).

This implies that pursuing the development of stronger domestic technological capabilities while collaborating internationally to leverage complementary knowledge is essential. In a context marked by rising geopolitical tensions and intensifying competition for achieving technological, economic and military supremacy, the ability to strategically manage relationships at the international level becomes a fundamental element maintaining the benefits from cooperation without compromising the objectives in terms of technological sovereignty, economic security and strategic autonomy.

In this perspective, we claim that coopetition is the most suitable way to develop an effective approach to manage

international interdependences in science and technology and address current and future challenges. We hence define coopetitive technological sovereignty as a structural and longitudinal strategy in which states compete for technological leadership while deliberately collaborating, in an informed way, with other countries to generate essential critical technologies through the use of complementary knowledge.

Following this approach, selecting appropriate countries for cooperation is crucial. While any country contributing to technological innovation can be a potential partner, considerations of national security are essential.

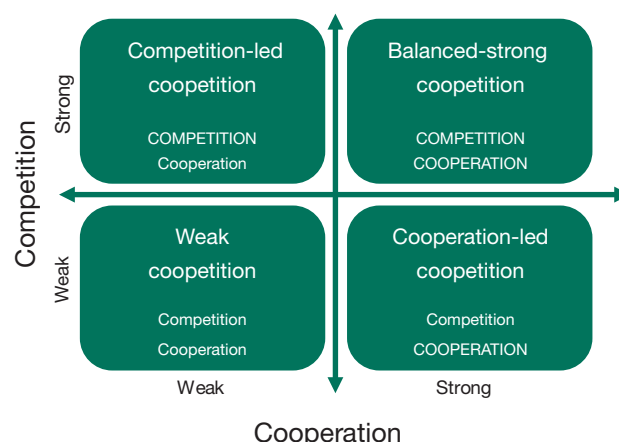
In this perspective, states must implement a coopetition governance system involving different organisations, i.e. governments, ministries, agencies, universities, research centres and companies. This system enables informed policy decisions that balance the benefits of collaboration with the risks, which vary by partner and technological field.

In particular, it is important for organisations to be able to dynamically assess where to place research/innovation international activity within the scheme shown in Figure 4 and, consequently, define the appropriate strategies. The following scheme outlines the case of cooperation-driven coopetition, where strong cooperation and weak competition occur; competition-driven coopetition, characterised by weak cooperation and strong competition; balanced-strong coopetition, which involves both strong cooperation and strong competition; and weak coopetition, where both are low. The positioning of each activity under scrutiny in one of the four quadrants will be the result of a thorough assessment of different elements, including the type of partners involved, the type of implied knowledge exchanges, the type of scientific/technological domains considered and the type of research activities (e.g. basic or applied) to be carried out. Subsequently, different coopetitive strategies to manage the relationships can be implemented in order to maximise cooperation opportunities while mitigating eventual risks.

The proposed approach appears to have particular relevance for the EU, where a swift strategic response, particularly in industrial and innovation policy, is necessary to leverage existing competencies and technologies (European Commission, 2024a).

Addressing persistent disparities with global leaders requires EU countries to transcend both national and single-market boundaries to establish international collaborative networks. This is essential for accessing complementary knowledge and fostering joint technological development.

Figure 4
Coopetition modes



Source: Authors' adaptation from Park et al. (2014).

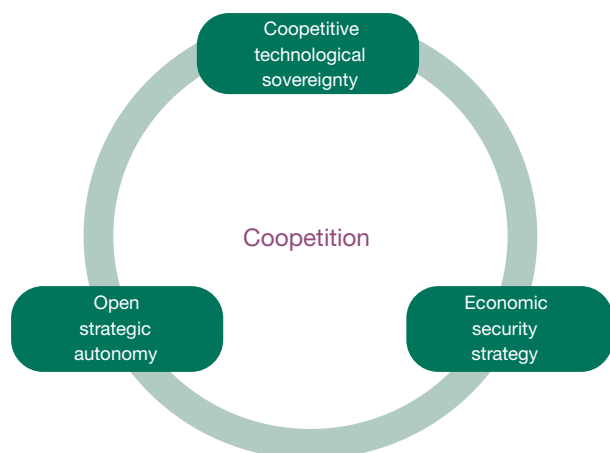
This shift offers a chance to propose a policy approach that integrates investment and industrial policies in high-tech sectors with strategic international collaborations. The dual focus on technological competitiveness and security – physical, digital, economic and social – necessitates the combined approach offered by a coopetitive technological sovereignty strategy. The European Commission's guiding principle for international research cooperation, “as open as possible, as closed as necessary,” underscores this approach (European Commission, 2024b).

Moreover, coopetition could become a core paradigm for effectively implementing the broader EU strategies on economic security and open strategic autonomy.

Strategic autonomy reflects the EU's capacity to act independently in critical policy areas. The term “open” emphasises the EU's commitment to multilateral cooperation where feasible (Cagnin et al., 2021), balancing autonomy with interdependence to protect economic interests and European societal values. In parallel, the EU's economic security strategy focuses on revitalising domestic policies for strategic sectors and forming multilateral partnerships to enhance economic resilience and collective security (European Commission, 2023).

In any case, the implementation of European coopetitive technological sovereignty, open strategic autonomy and economic security must consider the delicate balance of competencies between European institutions and member states, alongside their varying priorities and interests (see Figure 5). Tensions between national and European sovereignty, competition among member

Figure 5
Coopetition as a core strategy for EU policies



Source: Authors' elaboration.

states, and disparities in technological and production capabilities further complicate this process. Indeed, the EU's role is limited in coordinating member states' actions, as economic security remains within the realm of national security, leaving responsibility to individual states. This decentralised authority presents coordination challenges that can, however, be at least partially addressed if we recognise that even member states interactions are characterised by coopetitive dynamics. In this respect, the development of a governance system for the strategic management of coopetition activities could also promote the reconciliation of different national interests.

Conclusions

The analysis presented in this article emphasises how, in the current historical phase, the dynamics characterising interactions among states have become intrinsically and structurally coopetitive. Hence, adopting a coopetitive technological sovereignty strategy is not only essential for the European Union but also a realistic pathway to navigating the complexities of the global technological and geostrategic landscape.

While the role of competition in the international technological race has been particularly stressed in the current debate, the provided analysis demonstrates that both competitive and collaborative forces are shaping international relationships related to the development of scientific and technological knowledge. In particular, bilateral collaborations in scientific publications show that a diverging trend has emerged in recent years between

China-US and China-EU collaborations. While China-US collaborations have been declining, China-EU collaborations have been continuously increasing. This evidence suggests that the EU's research system remains notably open, as further evidenced by data on EU-funded collaborative projects under the Framework Programmes for Research involving non-EU partners.

Considering that the EU is lagging behind technological global leaders, the openness of the EU research system is essential for accessing complementary knowledge and fostering joint technological development. However, given the challenges related to increasing geopolitical tensions and economic security concerns, international relations in the sensitive field of scientific and technological activities should be carried out by adopting an informed and thorough approach.

To this end, it is necessary to build a governance system for coopetition that can involve, at various levels and in a coordinated manner, the institutions and organisations responsible for defining and implementing policies, to evaluate case by case and systematically the intensity of risks and opportunities arising from collaboration activities. This can be built by developing and spreading an organisational culture of coopetition within different public organisations. This goal can also be realised through the development of training activities for the acquisition of cross-disciplinary and advanced skills capable of enabling the comprehension and management of coopetitive-type relationships. In particular, training paths could be focused on advanced skills in strategy and management of coopetition, economic diplomacy, negotiations and conflict management, aimed at improving policy management in complex and multi-stakeholder scenarios.

In conclusion, pursuing a strategy of coopetitive technological sovereignty can be understood as a practical means to leverage the dual forces of competition and cooperation in science and technology. This would promote the benefits of cooperation without compromising economic security and strategic autonomy objectives.

Moreover, an effective management of coopetitive relationships among countries can help address the major challenges that global society is facing. Climate change, pandemics, population aging and digital transformation are difficult to tackle with the technological capabilities of a single country. Without concerted efforts within the international community, no single nation can effectively manage potentially catastrophic crises, as demonstrated by the collaborative international development of COVID-19 vaccines.

Given that the objectives related to major global challenges, in many cases, align with the interests of individual nations, this is precisely the area where it is possible to develop strategies for cooperative technological sovereignty based on large-scale international cooperation. In so doing, such strategies could also reduce global security risks arising from the progressive decoupling processes between different regions of the world.

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