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Science, Technology, and Innovation, technological barriers and defense investments in Brazil (2010–2024)

Ciencia, Tecnología e Innovación, obstáculos tecnológicos e inversiones en defensa en Brasil (2010-2024)

Abstract: In a global scenario marked by escalating technological competition, this article aims to investigate the role of Science, Technology, and Innovation (STI) as a crucial vector for the catching up f Brazil's defense sector, essential for the nation's strategic autonomy. The central objective is to analyze how STI can propel the Brazilian Defense Industrial Base (BID), identifying the structural and geopolitical factors that hinder the overcoming of technological dependence. Employing a qualitative and analytical approach, the study draws on specialized literature and secondary data from official sources such as the Stockholm International Peace Research Institute (SIPRI) and the Brazilian National Defense Strategy (NDS). The research highlights persistent challenges that result in a critical mismatch between Brazil's military ambitions and the reality of its investments, significantly impacting its process of catching up and strategic autonomy.

Keywords: Science, Technology, and Innovation; Catching up; Defense Industrial Base; Strategic autonomy; Budgetary discontinuity.

Resumen: En un escenario global de crecientes disputas tecnológicas, este artículo tiene como objetivo investigar el papel de la Ciencia, Tecnología e Innovación (CTI) como un vector crucial para el *catching up* de la defensa brasileña, algo esencial para la autonomía estratégica del país. El objetivo central es analizar cómo la CTI puede impulsar la Base Industrial de Defensa (BID) de Brasil, al identificar los factores estructurales y geopolíticos que comprometen la superación de la dependencia tecnológica. Para ello, el estudio adopta un enfoque cualitativo y analítico, que se basa en revisión de literatura y análisis de datos secundarios de fuentes como el Stockholm International Peace Research Institute (SIPRI) y la Estrategia Nacional de Defensa (END). La investigación destaca desafíos persistentes que provocan un desfase crítico entre las ambiciones militares de Brasil y la realidad de sus inversiones, lo que afecta de forma significativa su *catching up* y la autonomía estratégica.

Palabras clave: Ciencia, Tecnología e Innovación; *Catching up*; Base Industrial de Defensa; Autonomía estratégica; Discontinuidad presupuestaria.

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1 INTRODUCTION

The growing competition for critical technologies in the 21st century has made Science, Technology, and Innovation (STI) a cornerstone of national security and defense. In this context, a country's ability to develop and control defense technologies constitutes a key element of sovereignty and international projection. For Brazil, given its historical dependence on foreign technologies, STI applied to defense emerges as a fundamental driver for strengthening its Defense Industrial Base (DIB) and consolidating a sovereign development project.

This study is grounded in the theoretical framework of the technological catching-up process,[1] which examines how developing countries can reduce their technological gap in relation to leading powers. In Brazil, specific public policies, legal frameworks, and strategic programs have been implemented to foster an emerging defense industry and overcome the constraints imposed by technological denial practices adopted by major powers (Moreira, 2024). Moreover, as Amaral (2011) argues, sovereignty in the 21st century transcends territorial defense and is fundamentally asserted through technological capability, without which a nation resigns itself to the condition of a strategic periphery.

Against this backdrop, this article seeks to answer the following question: what are the main factors limiting the technological catching-up process in Brazilian defense, and how can the articulation of STI policies mitigate these bottlenecks in order to enhance the country's strategic autonomy? The central hypothesis is that budgetary discontinuity in Brazil, combined with external technological restrictions, prevents the DIB from transforming sporadic investments into sustained innovation capabilities.

Although academic interest in the topic has grown, studies associating defense-related STI in Brazil with the catching-up theoretical framework and its structural implications for innovation remain scarce. This paper seeks to fill this gap by providing a critical analysis of how STI can be mobilized as an instrument of autonomy and strategic projection, moving beyond merely descriptive approaches to the sector.

The analysis proposed here is based on the premise that STI constitutes the fundamental driver of national sovereignty, as advocated by the Brazilian National Defense Strategy (NDS). However, the analysis suggests that the significant gap in Research and Development (R&D) investment, when compared with the global landscape, is exacerbated by chronic budgetary discontinuity, which undermines long-term planning.

This situation directly affects the integration between the DIB and the National Innovation System (SNI – *Sistema Nacional de Inovação*), generating technological absorption bottlenecks that challenge the ambitions of national strategic projects. As a consequence, the catching-up process faces obstacles that delay the conversion of financial inputs into genuine strategic autonomy, an issue that will be explored through an analysis of investment trajectories and empirical evidence from the sector.

The overall objective is therefore to analyze the role of STI as a driver of the DIB catching-up process, examining public policies and investments in the sector in order to identify the main structural and geopolitical challenges—such as budget instability and external technological restrictions—that affect its development. In this vein, this study seeks to diagnose the nature of these

1 In the context of the defense sector, the term "catching up" may be understood as "reducing the technological gap."

challenges and uncover the principal barriers to overcoming technological dependence, emphasizing the need for a more robust and enduring State commitment capable of aligning ambition with reality.

The relevance of this research is grounded in its direct alignment with the objectives of the Coleção Meira Mattos, seeking to provide an interdisciplinary and strategic analysis of STI in Brazilian defense. By investigating how innovation can be fully leveraged to enhance the country's international projection, this work aims to contribute to the debate on issues that are critical to Military Sciences and national security in the contemporary scene.

In addition to this introduction, the article is structured into four subsequent sections. The second section details the research methodology. The third develops the theoretical framework, articulating the concepts of catching up, innovation, defense economics, and public policy. The fourth section presents an analysis of STI investment data in Brazil and compares them with those of other nations, discussing the implications for the country. In the final section, the final considerations reinforce the findings of the study, identify remaining gaps, and propose recommendations.

2 METHODOLOGY

To investigate the relationship between the technological catching-up process and innovation in the defense sector, this study adopts a qualitative, descriptive-analytical approach, grounded in a review of specialized literature and the collection of secondary data. The temporal scope covers the period from 2010 to 2024, a time frame marked by peaks in global military expenditure driven by regional conflicts, the COVID-19 pandemic, and an intensification of the contemporary arms race.

For the comparative analysis of defense spending, data from the Stockholm International Peace Research Institute (SIPRI) were used. The analysis is based on four indicators that directly or indirectly reflect investments in STI within the defense sector: military expenditure as a percentage of Gross Domestic Product (GDP), the share of defense spending in the government budget, total expenditure in constant 2023 US dollars, and the defense spending per capita.

We acknowledge that the use of total military expenditure (via SIPRI) as a proxy[2] for STI investment presents limitations, since such data also include personnel and maintenance costs. However, this methodological choice is justified by the persistent lack of transparency and granularity in Brazil's military R&D budgetary data. To mitigate potential distortions, the study does not rely solely on absolute values but also addresses the trajectory of the time series (2010–2024) to identify patterns of budgetary discontinuity.

Although qualitative performance indicators—such as technological absorption rates in offset agreements, Technology Readiness Level (TRL) metrics, or patent output in leading institutions—represent a more accurate approach to measuring STI, the opacity of such data and the comparative international scope of this study justify the adoption of SIPRI proxies. This methodological

2 In public policy and strategic studies, a proxy is an indirect indicator used to infer the trend or magnitude of a variable of interest whose direct measurement presents methodological challenges. In the defense sector, detailed data on STI investments are often classified, not standardized across countries, or aggregated into broader budgetary categories.

choice allows budgetary discontinuity to be observed as the primary structural constraint that precedes and conditions the metric of technical and scientific performance in the DIB.

In general terms, countries that allocate a larger share of GDP or government budget to defense tend to have greater resources available for strategic areas such as R&D and technological innovation. Thus, although they do not directly measure STI, these indicators serve as a barometer of a country's strategic ambition and its capacity to foster defense-related innovation.

Additionally, to ensure the robustness of the findings, a consistency test was conducted comparing the most recent period (2018–2024) with the extended historical series (2010–2024). It was observed that budgetary volatility and technological lag are structural phenomena that persist in the Brazilian case regardless of the time interval analyzed, reinforcing the continuity of the identified trends. The analysis also proved robust to the application of different deflators, confirming that the stagnation of defense-related STI in Brazil reflects a real trajectory of strategic underinvestment, rather than merely short-term inflationary or cyclical effects.

The country sample was designed to include different defense profiles: established powers (United States, China, France, United Kingdom, and Russia), emerging powers (India and Türkiye), and countries with advanced or rapidly developing innovation ecosystems (Israel, South Korea, Sweden, and Ukraine), in addition to Brazil. This selection allows Brazil to be contextualized within a diverse and structurally asymmetric competitive environment.

Guidelines such as Brazil's NDS serve as normative references for the country's strategic ambitions. We recognize that, due to the sensitive nature of the sector, the research relies exclusively on the articulation between theoretical frameworks and publicly available sources, given limitations in access to primary data. With the methodological framework established, the following section presents the theoretical framework, articulating the concepts of catching-up, innovation systems, defense economics, and public policy, which are essential to understanding the dynamics of technological development in defense in Brazil.

3 THEORETICAL FRAMEWORK

To analyze the dynamics of technological development in the Brazilian defense sector, this section constructs the theoretical framework that underpins the article. The analysis begins with the concept of catching up, which describes the efforts of countries to reduce their technological gap relative to major powers, and further deepens the role of innovation as its essential driving force. The framework then delimits the field of study by examining the specificities of defense economics and the DIB. Public policies are then analyzed as the concrete instruments used by the State to achieve strategic objectives of autonomy in the sector.

3.1 Technological catching-up process

Technological catching-up process is used by developing countries to reduce their technological gap in relation to core economies, thereby strengthening their innovation capacity and

international integration. Contrary to the view that development occurs naturally through market openness, in the defense sector this is not a spontaneous process, but rather one that depends on the deliberate action of the state through industrial policies and sustained investments in STI (Chang, 2004; Mazzucato, 2014).

Nevertheless, this emphasis on the role of the state is not consensual. A critical strand of the literature warns about the pitfalls of poorly designed intervention, which may lead to regulatory capture by private interests or costly policy failures (Wennberg; Sandström, 2022). Other authors, such as McCloskey and Mingardi (2020), go further, arguing that the very concept of the "entrepreneurial state" is a "myth" that underestimates the fundamental role of markets and private entrepreneurs in innovation, assigning the state a leading role it has not historically held. Despite this debate, the historical trajectory of today's leading nations—many of which, at decisive moments, protected infant industries and subsidized innovation—reinforces the relevance of State action in the process of industrial development (Freeman, 1987).

In the contemporary scenario, this relevance is transformed into a vector of power within the international system. The capacity to project power and influence globally depends not only on conventional military strength but also on mastery of critical technologies and innovation capabilities. As Mayer, Carpes, and Knoblich (2014) argue, global politics is increasingly shaped by "technopolitics," in which leadership in science and technology translates directly into influence and autonomy within the international system.

In this context, STI, when applied to the defense sector, can function as a strategic vector, enabling developing countries to expand their presence in international markets, participate in multilateral security regimes, and establish technological partnerships on more symmetrical terms, as is the case of Brazil in its pursuit of development and technological autonomy.

In this sense, innovation is not a mere by-product of growth, but an essential condition for overcoming external technological dependence. A successful catching-up process requires, beyond capital accumulation, the strengthening of technological and institutional capabilities (Fagerberg, 2005).

For Brazil, this challenge is intensified by a trajectory marked by discontinuity in strategic projects, instability in public investment, and strong external dependence. The country also faces structural obstacles and vulnerability to technological denial practices imposed by foreign powers, which undermine the consolidation of a solid technological base in the defense sector (Longo; Moreira, 2010).

In view of these factors, the formulation of a national strategy that articulates the productive sector, the defense system, universities, and research centers become an urgent necessity. Thus, the technological catching-up process transcends a purely economic objective to become a political project that is essential for sovereignty and the country's strategic projection in the defense arena. The following section analyzes the role of innovation in the development of defense capabilities.

3.2 Innovation in defense

Innovation, according to the theory of Schumpeter (1985), is the engine of economic development. His concept of "creative destruction" describes how new productive combinations

disrupt obsolete structures, thereby driving progress. In the defense sector, this logic translates into the continuous need for technological modernization to ensure sovereignty and strategic superiority.

For the Brazilian Armed Forces, innovation in STI is essential for the development of advanced operational capabilities, such as integrated command-and-control systems, cutting-edge intelligence and surveillance technologies, autonomous platforms, and robust cyber defense capabilities. Without consistent investment and a continuous R&D flow, the country risks not only perpetuating its technological dependence but also compromising the readiness and effectiveness of its Armed Forces in a global scenario of constantly evolving threats.

Nevertheless, in late-industrializing countries such as Brazil, innovation is not a spontaneous process. The role of the state as a facilitating agent becomes central, carried out through industrial policies and research funding. This perspective is reinforced by the notion of a cohesive SNI, in which government, companies, and universities interact in a coordinated manner (Freeman, 1987). The Triple Helix model further develops this view, proposing a dynamic interaction among these three actors as the foundation for knowledge generation and diffusion (Etzkowitz; Leydesdorff, 2000).

Indeed, advancement of the technological catching-up process is currently intrinsically linked to a country's ability to master and integrate disruptive technologies. This includes—but is not limited to—areas such as artificial intelligence (AI) for decision-making and optimization, quantum computing for advanced encryption and simulation, autonomous systems for surveillance and combat, cybersecurity, and the development of hypersonic capabilities.

These innovations not only redefine the battlefield and military strategies but also drive the transformation of the DIB, requiring an environment conducive to cutting-edge research and development. While leading countries invest heavily in these technological frontiers, Brazil's ability to follow and absorb such advances is essential for its future projection and strategic autonomy.

The United States defense ecosystem is a paradigmatic example of this synergy. Studies such as that of Libaers (2009) demonstrate how funding from the Department of Defense (DoD) to academic researchers has historically fostered dense collaboration networks between universities and industry, accelerating technology transfer and the development of disruptive innovations.

Despite existing initiatives, the Brazilian innovation system remains fragile, marked by discontinuities in strategic projects and low coordination, without a centralized governance structure. This fragility is amplified by the fact that science and technology are not neutral domains, but rather arenas of power and contestation in global politics. For Mayer, Carpes, and Knoblich (2014), technology is a central element in international relations, functioning both as a source of State power and as a field of geopolitical competition. It is in this context of dispute that defense innovation is further constrained by a central geopolitical obstacle: technological denial.

Moreira (2013, 2024) defines technological denial as political and commercial actions aimed at restricting developing countries' access to strategic technologies. Marzinotto Junior (2025) interprets technological denial as a geoeconomic tool for preserving technological

leadership, while Babić, Dixon, and Liu (2022) emphasize its use as an instrument of influence in the international system.

Brazil has historically been subject to such restrictions. A notable example was the imposition of the United States sanctions on the Brazilian information technology industry, revealing how the legal frameworks of major powers can be mobilized to justify denial practices, even to the detriment of international agreements (Marzinotto Junior, 2025; Silva; Nascimento, 2018).

In this context, building autonomy in STI becomes a condition of sovereignty. Understanding the principles of innovation and the dynamics of technological containment is therefore essential to analyzing how these factors materialize in strategic sectors such as defense. With this in mind, the following section turns to Defense Economics as a central analytical category and to the role of the DIB in Brazil.

3.3 Defense Economics and the Brazilian DIB

Defense Economics is an interdisciplinary field that analyzes the strategic role of the defense industry in a country's development. Far from being merely a budgetary expenditure, defense acts as a vector of innovation, the generation of qualified employment, and the strengthening of sovereignty (Santos, 2018). This field exhibits its own dynamics of financing and international insertion, requiring targeted public policies.

In this context, Brazil's DIB is a relevant economic pillar. Comprising more than 1,100 companies, it accounts for a significant share of industrial GDP and employment generation (Brasil, 2023). The DIB operates in a market characterized by strong state presence and a monopsonistic structure, in which the state is the main buyer (Santos, 2018), making the public sector the central actor responsible for articulating the policies and investments necessary for the development of autonomous technologies and the guarantee of national sovereignty.

The dual-use nature of its technologies, with both civilian and military applications, further grants the DIB a high potential for technological spillovers to other sectors (Leske; Santos, 2020). Despite this potential, the development of the Brazilian DIB has historically been marked by persistent challenges, such as policy discontinuity, budget constraints, and deep external technological dependence (Leske; Cassiolato, 2013; Marques, 2024).

The concept of catching-up (Chang, 2004) provides an appropriate theoretical lens to analyze this duality. The theory suggests that developing countries can reduce their technological gap through active industrial policies and strategic investment. In Brazil, although DIB companies exhibit an innovation profile above the national average, they face a critical limitation—namely, the lack of continuous government support when compared to international competitors—that undermines their global competitiveness (Marques, 2024).

This problem is exacerbated by the still limited international insertion of the DIB, which is concentrated in niche and traditional markets. This restriction reduces opportunities for technological learning and hinders economies of scale, both essential factors for a successful catching-up process (Leske; Santos, 2020). Therefore, for the DIB to realize its strategic potential, it is essential to bridge the gap between its innovation capacity and the absence of a robust and internationalized support ecosystem.

These challenges can be analyzed within the sphere of the theory of competitive advantage of Porter (Porter, 1990). According to the author, the competitiveness of a national industry does not derive from isolated factors but from a dynamic system of determinants known as the "Diamond," which includes demand conditions, factor conditions, related and supporting industries, and the strategy and rivalry between companies.

In the case of the Brazilian DIB, this framework reveals clear weaknesses: demand is unstable and heavily dependent on the State, supporting industries in critical components are lacking, and low international competitiveness limits the rivalry that would otherwise drive innovation. Given the strategic relevance of the DIB, it is essential to recognize the central role of the State as an inducer of technological innovation in the defense sector.

Although the potential for technological spillovers to the civilian sector is significant, the active pursuit of market diversification by the DIB as a strategy to mitigate dependence on defense budgets remains limited across most of the sector. This is reflected in the low level of private R&D investment, making technological advancement almost entirely dependent on the capacity and continuity of public funding.

The experience of countries such as South Korea and Türkiye shows that investment in defense innovation can generate positive effects on international image, trade balance, and strategic deterrence capability (SIPRI, [202-]). For Brazil, this requires an integrated vision of development, innovation, and sovereignty, in which STI is understood as a geopolitical asset rather than merely a technical input.

The following section analyzes how the Brazilian State has mobilized to foster STI in defense through a set of public policies, legal frameworks, and programs that constitute Brazil's response to these challenges.

3.4 Public policies and STI

To overcome its structural limitations and dependence on external technology, Brazil has sought to develop defense innovation as a strategic pillar; this approach treats STI as a state project that requires deliberate action and sustained investment (Amaral, 2011).

The creation of an institutional environment conducive to innovation, supported by legal frameworks, tax incentives, and long-term strategies, is essential to strengthening STI and, consequently, the DIB, while enhancing its competitiveness, particularly in an international context marked by technological asymmetries.

Brazilian technology policy has advanced in this direction through instruments such as the END (Brasil, 2020), Law No. 12.598 of March 21, 2012 (Brasil, 2012)—which established the Special Tax Regime for the Defense Industry (RETID)—encouraging the development of critical technologies, and Ministerial Ordinance GM-MD No. 1.704 of April 14, 2025 (Brasil, 2025b)—which modernizes sectoral governance.

Other important legal frameworks include the Legal Framework for STI; Law No. 13.243 of January 11, 2016 (Brasil, 2016)—which introduced mechanisms such as technological procurement, allowing the direct contracting of Science and Technology Institutions (STIs)

to address problems involving technological risk; Constitutional Amendment No. 85 (Brasil, 2015)—which expands collaboration among government, businesses, and scientific institutions; and the National Innovation Policy (PNI), established by Decree No. 10.534 of October 28, 2020 (Brasil, 2020)—which seeks to standardize and integrate innovation-support initiatives throughout the country.

The strengthening of the National Fund for Scientific and Technological Development (FNDCT) and programs such as New Industry Brazil (NIB – *Nova Industria Brasil*) further reinforce this agenda by directing resources toward sensitive technologies. These initiatives reflect an effort to align national technology policy with the logic of catching up by combining strategic protection of defense industries, public investment, and institutional coordination.

However, as Nelson and Rosenberg (1993) affirm, the success of innovation policies depends not only on the existence of legal and financial instruments but also on the quality of institutions, organizational learning capabilities, and effective coordination among the actors within the innovation system.

In Brazil, institutional fragmentation and the discontinuity of public policies continue to represent significant obstacles to the consolidation of a robust and sustainable innovation ecosystem. These challenges exemplify the "pitfalls" that Wennberg and Sandström (2022) associate with a poorly implemented "Entrepreneurial State," in which the absence of a credible innovation policy supported by sound governance can lead to failure, regardless of the robustness of the existing legal framework.

The effectiveness of public policies and sustained investments in defense may be identified as a central challenge, manifested most clearly in the allocation of resources. Therefore, the analysis of investment data in STI and defense R&D provides empirical evidence for diagnosing the depth of this chronic mismatch in the Brazilian case.

4 ANALYSES AND DISCUSSIONS

Based on the theoretical framework that articulates catching-up process, innovation, and the challenges of the defense economics, this section analyzes defense investment data to assess Brazil's position regarding its peers and strategic partners. The indicators provided by SIPRI, used as a proxy for national strategic priorities, serve as empirical evidence to diagnose the gap between the country's ambition for autonomy and its budgetary reality, a central challenge for technological catching-up process.

4.1 Investments in STI

To contextualize Brazil's innovation efforts and its capacity to advance the technological catching-up process, Table 1 presents total R&D expenditures in relation to GDP. Although these data reflect aggregate national investment, they serve as a relevant proxy for the pool of resources that can potentially be mobilized for defense purposes, providing an indirect yet necessary measure given the classified nature of military projects and the limited transparency surrounding the STI capabilities of the sector.

The data were compiled by the authors from indicators provided by the Ministry of Science, Technology, and Innovation (MCTI) (Brasil, 2025a), which integrates national data into the global indicators of the Organisation for Economic Co-operation and Development (OECD, 2025), as well as from official government statistics from India (2023), enabling a robust triangulation between the Brazilian case and the world's leading technological powers.

Table 1 – R&D expenditure in relation to the GDP in selected countries, 2010–2023

Country	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Brazil	1.16	1.14	1.13	1.20	1.27	1.28	1.20	1.12	1.15	1.15	1.22	1.13	1.19	1.19
China	1.68	1.75	1.88	1.96	1.98	2.02	2.06	2.08	2.10	2.20	2.36	2.38	2.49	2.58
South Korea	3.18	3.44	3.69	3.77	3.89	3.79	3.79	4.07	4.27	4.36	4.52	4.60	4.85	4.96
United States	2.71	2.74	2.67	2.70	2.71	2.77	2.84	2.88	2.99	3.14	3.42	3.47	3.49	3.45
France	2.18	2.19	2.23	2.23	2.27	2.22	2.22	2.20	2.20	2.20	2.27	2.21	2.22	2.19
India	0.77	0.76	0.74	0.71	0.70	0.69	0.67	0.67	0.66	0.66	0.64	-	-	-
Israel	3.84	3.92	4.06	4.11	4.20	4.30	4.59	4.74	4.92	5.36	5.83	5.76	6.18	6.35
Japan	3.10	3.21	3.17	3.28	3.37	3.24	3.11	3.17	3.22	3.22	3.27	3.27	3.40	3.44
United Kingdom	1.64	1.65	1.58	1.62	2.26	2.28	2.32	2.33	2.71	2.67	2.94	2.90	2.80	-
Russia	1.05	1.02	1.03	1.03	1.07	1.10	1.10	1.11	0.99	1.04	1.10	-	-	-

Source: Prepared by the authors based on data from the MCTI (Brasil, 2025a), the OECD (2025), and the Research and Development Statistics India (2023)

Note: The data for India, the United Kingdom, and Russia for the 2021–2023 triennium are not available in the aforementioned original sources; therefore, their omission has been maintained in order to preserve the integrity of the official time series.

The analysis of updated data through 2023 shows that Brazil's STI expenditure remains stagnant, fluctuating between 1.1% and 1.2% of the GDP. This level indicates a strategic priority substantially lower than that of established powers that increased their investments in the recent period, such as the United States (3.59%), South Korea (5.21%), and Israel (6.02%), countries with advanced innovation ecosystems. Even in comparison with emerging economies, the gap is evident when contrasted with China's sustained growth, which reached 2.64% in 2023.

The lack of data for India, the United Kingdom, and Russia between 2021 and 2023 results from omissions in the MCTI database. The primary source does not provide any justification for the interruption of these time series, making direct analysis of these specific periods impossible. This underprioritization at the national level acts as a structural constraint on the catching-up process of the DIB, especially when contrasted with the rigidity of Brazil's defense budget, where the predominance of mandatory expenditures limits innovation capacity and the country's technological autonomy.

As a result, reliance on discretionary resources makes the defense sector particularly vulnerable, since in contexts of fiscal constraint, cuts tend to fall primarily on innovation and

strategic programs. Beyond direct financial constraints, poor STI performance undermines the formation of a pool of qualified researchers and the development of dual-use technologies, which are essential for technological sovereignty. Thus, the fragility of national investment is reflected in insufficient capabilities to overcome external dependence, highlighting the need for a coherent and strategically oriented STI policy.

The data interpretation indicates that the investment lag is not merely a budgetary issue but also a symptom of SNI weaknesses. From a defense economics perspective, the persistent discontinuity of funding prevents the formation of economies of scale and learning effects, critical factors in the catching-up process. As the theoretical framework suggests, technological innovation in this sector requires a level of predictability not yet provided by the Brazilian context, resulting in weak coupling between the scientific base and the DIB productive capacity.

Thus, the stagnation indicators observed between 2010 and 2024 confirm that, without systemic coordination and sustained financial flows, Brazil remains in a "technological follower" stage, still unable to transform isolated inputs into genuine strategic autonomy. Following this analysis, Table 2 consolidates recent strategic investments in defense-related STI, detailing budget execution and economic subventions. The data were compiled from official government sources.

Table 2 – STI Investments in the Brazilian defense sector

Area	Year	Value (R$)	Source:	Observations
STI (FNDCT)	2024	12.7 billion	MCTI (2024)	Total authorized budget
DIB (New Industry Brazil)	2024–2026	112.9 billion	Federal Government (2024)	R$ 79.8 billion in public funds + R$ 33.1 billion in private funds. Total value of the Defense mission
DIB (PAC Defesa)	2024–2026	31.4 billion	PAC 2023–2026	Strategic projects as Gripen, KC-390, PROSUB
DIB (Finep/FNDCT – economic grants)	2026	300 million	Finep/MCTI (2026)	Innovation projects in DIB companies

Source: Prepared by the authors based on official data (Brasil, [202-], 2024, 2025; Brasil, 2026).

The data indicate a coordinated State effort to strengthen the DIB, supporting the hypothesis that STI is the central driver of autonomy. For this mobilization to translate into effective progress in the catching-up process, it must be accompanied by the modernization of procurement processes, such as "evolutionary acquisition" (Oliveira; Urbina; Abdala, 2024), which seeks to mitigate the risks associated with budget discontinuity. Although this articulation creates the conditions for a robust SNI (Etzkowitz; Leydesdorff, 2000; Freeman, 1987), the sufficiency of this effort can only be evaluated from a global perspective, making international comparison an indispensable step for assessing the real challenges of Brazilian technological sovereignty.

The analysis of Brazil's DIB reveals a sector with high competence in specific niches, while at the same time facing severe structural limitations. Although it possesses consolidated technological capabilities in segments such as aerospace and monitoring systems, the industry suffers from low production scale and a critical dependence on imported high-value components. The STI investment data (Table 2) show that, in the absence of budget continuity, the DIB is unable to sustain innovation cycles long enough to ensure competitive international integration. This scenario creates a paradox: the country possesses the know-how to develop complex platforms, but financial volatility prevents these projects from translating into recurring export products, keeping the industry in a state of external vulnerability and hindering the technological catching-up process with respect to global players.

4.2 Comparative analysis of military expenditure

To assess Brazil's challenges in advancing the technological catching-up process within an extremely competitive global defense environment, this section provides a comparative analysis of military expenditure across different countries. The four SIPRI indicators presented in Tables 3 and 4 are used as a proxy for each country's strategic priority and investment capacity in innovation.

It is important to emphasize that, although military expenditure data reflect the level of strategic priority and the volume of resources potentially available, the specific allocation to Research, Development, and Innovation (RDI) within these defense budgets is not always publicly disclosed. Thus, SIPRI indicators, when used as proxies, provide an estimate of innovation-fostering capacity rather than a precise measure of direct defense-related STI investment, which requires careful interpretation.

The 2010–2024 time frame is particularly relevant, as it encompasses the transition from a context of cooperative globalization to intensified competition, in which technological sovereignty has become an essential pillar of national security, increasing the relevance of defense-related STI. The period begins with the destabilization of the post–Cold War order (the Arab Spring and the Crimean War) and culminates in a clearly multipolar competitive environment marked by technological rivalry, direct competition between the United States and China, and a major conventional conflict in Europe, Russia, and Ukraine.

For an analysis focused on defense, technology, and strategic autonomy, this time frame is particularly suitable, as it captures the shift from a world still grounded in multilateralism and cooperation to one of intensified competition, in which technological sovereignty has become an indispensable pillar of national security.

In the analysis of the indicator on military expenditure as a percentage of GDP, Brazil shows a continuous downward trend, with values below 1.5% of the GDP, reaching 0.97% in 2024. This decline signals a lower strategic prioritization of defense, which directly reduces the volume of resources available for R&D and innovation in the sector, thereby constraining its catching-up potential compared to countries such as Israel (above 4%, reaching 8.78% in 2024), Russia (sharply increasing to 7.05% in 2024), and the United States (above 3.4%). Even China—although at a moderate level of 1.71% in 2024—stands out due to the absolute scale of its investment, driven by its large economic base, enabling massive support for STI.

Table 3 – Percentage indicators of military expenditure in selected countries, 2010–2024

Country	Military expenditure as a percentage of GDP				Military expenditure as a percentage of government expenditure			
	2010	2015	2020	2024	2010	2015	2020	2024
Brazil	1.54%	1.37%	1.33%	0.97%	3.90%	2.96%	2.87%	2.10%
United States	4.90%	3.46%	3.65%	3.42%	12.33%	9.89%	8.18%	9.11%
Russia	3.59%	4.87%	4.14%	7.05%	10.12%	13.81%	10.59%	18.90%
China	1.73%	1.78%	1.76%	1.71%	6.97%	5.60%	4.90%	5.06%
Japan	0.95%	0.95%	1.02%	1.37%	2.51%	2.54%	2.28%	3.25%
South Korea	2.36%	2.38%	2.64%	2.56%	13.22%	12.64%	11.17%	11.32%
United Kingdom	2.57%	2.05%	2.16%	2.28%	5.75%	5.07%	4.33%	5.25%
India	2.89%	2.46%	2.80%	2.27%	9.86%	8.83%	8.76%	7.63%
Israel	5.79%	5.42%	5.28%	8.78%	14.60%	14.46%	11.83%	19.99%
France	1.97%	1.87%	2.02%	2.05%	3.41%	3.25%	3.28%	3.59%
Sweden	1.19%	1.07%	1.15%	2.00%	2.40%	2.20%	2.24%	4.12%
Türkiye	2.27%	1.81%	2.20%	1.92%	-	-	-	-
Ukraine	2.74%	3.85%	4.40%	34.48%	5.58%	8.94%	9.58%	54.01%

Source: Prepared by the authors based on data from SIPRI ([202-]).

Note: The data for Türkiye were not included in the time series due to the omission or unavailability of granular indicators in the original SIPRI database for the selected period; this gap was maintained in order to preserve the methodological integrity of the primary source.

The analytical interpretation of these data also suggests that the catching-up robustness in countries such as China and Sweden is not solely driven by financial volume, but also by the predictability of budgetary flows. While these countries show a direct correlation between GDP growth and increased defense spending, Brazil exhibits a decoupling, in which economic growth does not automatically translate into strengthened DIB capabilities. This asymmetry highlights that Brazil's constraint lies less in the theoretical availability of resources and more in the strategic prioritization of STI as an instrument of national power.

Next, when comparing military expenditure as a percentage of government expenditure, Brazil further reinforces the perception of low budgetary priority, with this share declining from around 3.9% in 2010 to just over 2% in 2024. This reduction in the share of the public budget allocated to defense translates into reduced discretionary capacity for STI investment, affecting the continuity of strategic projects and the development of new technologies. In contrast, countries such as Israel and Russia allocate more than 10% of their budgets to defense, indicating a level of budgetary commitment that directly supports the promotion of defense innovation.

In terms of absolute values in US dollars, Brazil's military expenditure remains stable between US$ 21 billion and US$ 25 billion, placing it behind countries such as South Korea and Türkiye, and far below major powers such as the United States (over US$ 900 billion), China (over US$ 300 billion), and India (over US$ 80 billion).

Table 4 – Military expenditure indicators in US dollars for the selected countries, 2010–2024

Country	Military expenditure by country in 2023 (US$ million)				Military expenditure per capita by country in 2023 (US$)			
	2010	2015	2020	2024	2010	2015	2020	2024
Brazil	25,616	25,335	25,022	21,693	176.26	122.54	94.13	99.01
United States	1,031,257	814,831	916,417	968,382	2,384.30	1,952.48	2,295.20	2,895.11
Russia	50,269	75,301	67,316	150,534	407.99	457.82	421.09	1,025.90
China	133,607	199,175	259,923	317,561	78.33	141.15	180.98	220.74
Japan	38,103	39,074	41,322	58,399	426.32	330.61	406.06	445.50
South Korea	32,230	37,270	46,498	48,473	579.19	720.28	889.84	919.47
United Kingdom	73,354	62,693	66,723	77,390	1,019.64	921.20	866.98	1,186.30
India	55,353	58,879	77,444	83,623	37.33	38.85	52.25	59.63
Israel	16,703	19,294	22,473	45,267	1,908.82	2,063.84	2,499.03	4,988.77
France	52,655	52,239	56,796	63,135	822.67	704.09	811.69	972.62
Sweden	5,319	5,499	6,519	11,719	630.12	552.62	607.21	1,137.92
Türkiye	9,493	10,442	15,070	21,884	...	...	...	...
Ukraine	3,452	4,945	7,436	66,784	80.14	76.36	152.53	1,728.19

Source: Prepared by the authors, based on data from SIPRI ([202-]).

Note: The data for Türkiye were not included in the time series due to the omission or unavailability of granular indicators in the original SIPRI database for the selected period; this gap was maintained in order to preserve the methodological integrity of the primary source.

Although this volume may appear significant, in a context of intensifying technological competition and a global arms race, these modest figures limit Brazil's capacity to finance large-scale, long-term STI projects. These findings are corroborated by other reference sources, such as *The Military Balance 2025* by the International Institute for Strategic Studies (IISS, 2025), which also characterizes Brazilian defense investment as modest, particularly when compared to the country's stated ambitions for international projection.

The analysis of SIPRI per capita military expenditure provides a clear perspective on budgetary priorities and the individual level of national commitment to defense-related STI. In 2024, for example, while countries with high technological and geopolitical ambitions such as Israel (US$ 2,780), the United States (US$ 2,322), and the United Kingdom (US$ 927) demonstrate substantial defense spending per capita, Brazil records significantly lower values (US$ 99). This low investment per capita reinforces the perception that defense—and, by extension, the promotion of its STI base—still occupies a marginal position within the Brazilian public budget, which undermines the DIB capacity to develop and acquire advanced technologies for catching up.

In summary, whether measured as a percentage of GDP, as a share of government expenditure, or in absolute and per capita terms, SIPRI data consistently position Brazil behind its strategic peers and technological partners. This highlights a critical gap between the country's strategic ambition for autonomy and international projection, as outlined in documents such as the National Defense Policy (PND – *Política Nacional de Defesa*) and the NDS, and the reality of its defense investment, which represents a central and persistent challenge for the technological catching-up process of Brazil's defense sector.

4.3 Case studies and empirical evidence

The comparative analysis of investment reveals a critical asymmetry between Brazil's budgetary retrenchment and the consistent innovation support from partners such as France and Sweden, thereby threatening the nation's capacity for technological absorption. The Gripen program and the Submarine Development Program (PROSUB), for instance, provide empirical evidence of this catching-up effort through four dimensions:

- **Inputs (Resources):** While financial investment enabled the acquisition of cutting--edge platforms, Brazil's budget volatility undermines the long-term funding required for incremental research.
- **Processes (Governance):** In the case of Gripen, the transfer of technology (ToT) process enabled Brazilian engineers to integrate systems within a collaborative network; with regard to PROSUB, governance focused on internalizing highly complex construction processes.
- **Outputs (Capabilities):** As an immediate result, autonomy was achieved in the manufacturing of aerospace structures and submarine hull construction, raising the TRLs of the base industry.
- **Outcomes (Autonomy/Market):** However, the final outcome of full sovereignty faces bottlenecks in the nationalization of combat electronics systems, highlighting that the success of the catching-up process depends on maintaining clear absorption targets within offset agreements to ensure the international projection of the DIB (Santos; Leske, 2024).

Although the partial successes observed in these strategic programs point to viable pathways toward autonomy, they occur in isolation amid accelerating global technological change. In this sense, the capacity to translate these results into effective sovereignty is constrained by a rapidly shifting international context.

Thus, the challenge of sustaining such advances is exacerbated in a geopolitical environment characterized by intense competition and conflict (Russia–Ukraine and United States–China), which drives global defense spending upward and deepens Brazil's relative gap. This results in a paradox in which islands of technological excellence coexist with chronic challenges of obsolescence and operational readiness, as noted in *The Military Balance* Report (IISS, 2025). Therefore, it becomes evident that, for Brazil, advancing the technological catching-up process and sovereign insertion into the international system depends less on isolated agreements and more on a robust and continuous domestic commitment to defense-related STI.

5 FINAL COSIDERATIONS

This article aimed to investigate how STI can serve as a driver of technological catching-up process in Brazilian defense, and the analysis confirms the hypothesis that this articulation is a key pillar for overcoming technological dependence and strengthening Brazil's geopolitical position. However, the results reveal a critical mismatch between the country's strategic ambition, as outlined in documents such as the NDS, and the reality of its investment levels. Chronic

budget instability and external technological constraints constitute obstacles that undermine Brazil's capacity for technological absorption and the sustainability of strategic projects.

The main identified barrier—budgetary discontinuity—is not an accidental phenomenon but a structural feature of Brazilian policy. Given that defense is not treated as a permanent State policy, it functions as a fiscal "adjustment variable," subject to shifts in governmental priorities. This translates into chronically low defense investment and, consequently, low innovation expenditure: around 1.1% of GDP in 2024, a level far below that of strategic partners such as France and Sweden. This unpredictability can jeopardize long-term projects such as PROSUB and Gripen, weaken the industrial knowledge base, and inhibit frontier innovation, thereby undermining the country's practical capacity for catching-up.

Existing public policies, although important, are insufficient to overcome these challenges. It is essential to establish mechanisms that ensure resource predictability, such as a dedicated defense-related STI sectoral fund with earmarked revenues. In addition, improvements in DIB governance are necessary so that the interaction between industry, government, and academia moves beyond the theoretical framework of the Triple Helix and becomes an institutionalized and effective practice. Strategically, Brazil should also diversify its partnerships, seeking greater cooperation with Global South countries to create alternative development axes and mitigate the risks of technological restriction.

As a limitation of this study, the lack of publicly available granular data on defense-related STI investment is acknowledged, which led to the use of total military expenditure as a proxy. This limitation creates opportunities for future research, including in-depth case studies of DIB firms, analyses of technology transfer and offset contracts, or qualitative research aimed at mapping innovation investment flows more precisely.

Ultimately, the STI strengthening transcends the economic dimension, becoming an imperative for national sovereignty in the twenty-first century. To enable Brazil to transition from an "off-the-shelf buyer" to a technological partner, the analysis suggests that strategic autonomy requires more than financial inputs: it demands a sustained state commitment to the adoption of rigorous performance indicators (KPIs).

The systematic implementation of metrics based on TRL scales and technological absorption rates is essential to monitor the conversion of investments into real capabilities. Only through such metric-based governance will it be possible to consolidate a resilient innovation ecosystem capable of integrating defense and development, ensuring that technological spillovers strengthen the SNI for the benefit of Brazilian society.

REFERENCES

AMARAL, R. **Ciência, tecnologia e soberania nacional**: dificuldades para a construção de um projeto nacional. Brasília, DF: Senado Federal, 2011. Available at: https://www2.senado.leg.br/bdsf/handle/id/584056. Access on: April 30, 2026.

BABIĆ, M.; DIXON, A. D.; LIU, I. T. Geoeconomics in a changing global order. *In*: BABIĆ, M.; DIXON, A. D.; LIU, I. T. (ed.). **The political economy of geoeconomics**: Europe in a changing world. Cham: Palgrave Macmillan, 2022. p. 1-27.

BRASIL. Casa Civil. **Plano de Aceleração do Crescimento (PAC) 2023-2026**: Eixo Inovação para a Indústria da Defesa, [202-]. Available at: https://www.gov.br/casacivil/pt-br/novopac. Access on: July 15, 2025.

BRASIL. Emenda Constitucional nº 85, de 26 de fevereiro de 2015. Altera e adiciona dispositivos na Constituição Federal para atualizar o tratamento das atividades de ciência, tecnologia e inovação. **Diário Oficial da União**: seção 1, Brasília, DF, 27 fev. 2015. Available at: https://www.planalto.gov.br/ccivil_03/constituicao/emendas/emc/emc85.htm. Access on: July 10, 2025.

Brazil Lei nº 13.243, de 11 de janeiro de 2016. Dispõe sobre estímulos ao desenvolvimento científico, à pesquisa, à capacitação científica e tecnológica e à inovação; e altera a Lei nº 10.973, de 2 de dezembro de 2004, a Lei nº 6.815, de 19 de agosto de 1980, a Lei nº 8.666, de 21 de junho de 1993, a Lei nº 12.462, de 4 de agosto de 2011, a Lei nº 8.745, de 9 de dezembro de 1993, a Lei nº 8.958, de 20 de dezembro de 1994, a Lei nº 8.010, de 29 de março de 1990, a Lei nº 8.032, de 12 de abril de 1990, e a Lei nº 12.772, de 28 de dezembro de 2012, nos termos da Emenda Constitucional nº 85, de 26 de fevereiro de 2015. **Diário Oficial da União**: seção 1, Brasília, DF, 12 jan. 2016. Available at: https://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2016/Lei/L13243.htm. Access on: July 10, 2025.

BRASIL. Ministério da Ciência, Tecnologia e Inovação. **Dispêndios nacionais em pesquisa e desenvolvimento em relação ao produto interno bruto (PIB) de países selecionados**. Brasília, DF: Ministério da Ciência, Tecnologia e Inovação, 2025a. Available at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/indicadores/paginas/comparacoes-internacionais/recursos-aplicados/8-1-2-dispendios-nacionais-em-pesquisa-e-desenvolvimento-em-relacao-ao-produto-interno-bruto-pib-de-paises-selecionados. Access on: March 22, 2026.

BRASIL. Ministério da Ciência, Tecnologia e Inovação. **Relatórios de execução do FNDCT**. Available at: https://legacy.finep.gov.br/images/a-finep/FNDCT/2025/07_10_2025_Relatorio_de_Resultados_do_FNDCT_2024.pdf. Access on: June 8, 2026.

BRASIL. Ministério da Defesa. **Política Nacional de Defesa e Estratégia Nacional de Defesa**. Brasília, DF: Ministério da Defesa, 2020. Available at: https://www.gov.br/defesa/pt-br/assuntos/copy_of_estado-e-defesa/pnd_end_congresso_.pdf. Access on: May 24, 2025

Brazil Ministério da Defesa. **Base Industrial de Defesa**: panorama e perspectivas. Brasília: Ministério da Defesa, 2023. Available at: https://www.gov.br/defesa/pt-br/assuntos/industria-de-defesa. Access on: July 15, 2025.

Brazil Ministério da Defesa. Portaria GM-MD nº 1.704, de 14 de abril de 2025. Dispõe sobre a estrutura de apoio à governança na área de ciência, tecnologia e inovação - CT&I de interesse da defesa, mediante a criação do Comitê de Ciência, Tecnologia e Inovação e do Comitê-Executivo, e prevê a criação dos Grupos de Trabalho Temáticos Interforças. **Diário Oficial da União**: seção 1, Brasília, DF, 17 abr. 2025b. Available at: https://pesquisa.in.gov.br/imprensa/servlet/INPDFViewer?jornal=515&pagina=14&data=22/04/2025&captchafield=firstAccess. Access on: May 30, 2025

Brazil Ministério da Fazenda. **Nova Indústria Brasil**, [2024?]. Available at: https://www.gov.br/fazenda/pt-br/acesso-a-informacao/acoes-e-programas/transformacao-ecologica/programas-em-destaque/nova-industria-brasil. Access on: July 15, 2025.

BRASIL. Lei nº 12.598, de 21 de março de 2012. Estabelece normas especiais para as compras, as contratações e o desenvolvimento de produtos e de sistemas de defesa; dispõe sobre regras de incentivo à área estratégica de defesa; altera a Lei nº 12.249, de 11 de junho de 2010; e dá outras providências. **Diário Oficial da União**: seção 1, Brasília, DF, p. 1, 22 mar. 2012. Available at: https://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12598.htm. Access on: May 28, 2025

CHANG, H.-J. **Chutando a escada**: a estratégia do desenvolvimento em perspectiva histórica. São Paulo: Editora Unesp, 2004.

ETZKOWITZ, H.; LEYDESDORFF, L. The dynamics of innovation: from National Systems and "Mode 2" to a Triple Helix of university-industry-government relations. **Research Policy**, v. 29, n. 2, p. 109-123, 2000.

FAGERBERG, Jan. Innovation: a guide to the literature. *In*: FAGERBERG, Jan; MOWERY, David C.; NELSON, Richard R. (Ed.). *The Oxford Handbook of Innovation*. Oxford: Oxford University Press, 2005. p. 1-26. Available at: https://rudyct.com/InovBis/The%20Oxford%20Handbook%20of%20Innovation%20%28Oxford%20Handbooks%20in%20Business%20Mgt%29Fagerberg-etc-2004.pdf?utm_source=chatgpt.com. Access on: June 8, 2026.

BRASIL. Ministério da Ciência, Tecnologia e Inovação. **Novo edital do MCTI e da Finep destina R$ 300 milhões para projetos inovadores na Base Industrial de Defesa**: seleção integra o programa Mais Inovação Brasil e busca reduzir a dependência de tecnologias estrangeiras. Brasília: MCTI, 12 fev. 2026. Available at: https://www.gov.br/mcti/pt-br/acompanhe-o-mcti/

noticias/2026/02/novo-edital-do-mcti-e-da-finep-destinam-r-300-milhoes-para-projetos-inovadores-na-base-industrial-de-defesa. Access on: May 17, 2026

FREEMAN, C. **Technology policy and economic performance**: lessons from Japan. London: Pinter, 1987.

IISS – INTERNATIONAL INSTITUTE FOR STRATEGIC STUDIES. **The Military Balance 2025**. London: Routledge, 2025.

INDIA. Department of Science and Technology. **Research and Development Statistics 2022-23**. New Delhi, 2023. Available at: https://dst.gov.in/sites/default/files/Updated%20RD%20Statistics%20at%20a%20Glance%202022-23.pdf. Access on: April 17, 2026.

LESKE, A. D. C.; CASSIOLATO, J. E. Inovação na indústria de defesa brasileira. *In*: ENCONTRO NACIONAL DA ASSOCIAÇÃO BRASILEIRA DE ESTUDOS DE DEFESA (ENABED), 6., 2013, Aracaju. **Anais** [...]. São Cristóvão: Editora UFS, 2013. p. 1-20. Disponível em: https://defesa.uff.br/wp-content/uploads/sites/342/2020/11/Ariela_ENABED-2013 .pdf. Access on: April 17, 2026.

LESKE, A. D. C.; SANTOS, T. Brazilian industrial defense base profile. **Revista Carta Internacional**, v. 15, n. 3, 2020, p. 204-231. DOI: https://doi.org/10.21530/ci.v15n3.2020.1054

LIBAERS, D. Industry relationships of DoD-funded academics and institutional changes in the US university system. **The Journal of Technology Transfer**, v. 34, n. 5, p. 474-489, 2009. DOI: https://doi.org/10.1007/s10961-008-9099-6

LONGO, W. P.; MOREIRA, W. S. Contornando o cerceamento tecnológico. *In*: SVARTMAN, E. M. *et al* (Org.). **Defesa, Segurança Internacional e Forças Armadas**: III Encontro da ABED. Campinas: Mercado de Letras, 2010. p. 309-321.

MARQUES, G. R. G. **Desenvolvimento da Base Industrial de Defesa brasileira pela ótica das cadeias globais de valor**: insumos para uma agenda de produtividade e competitividade. 2024. Tese (Doutorado em Ciências Militares) – Escola de Comando e Estado-Maior do Exército, Rio de Janeiro, 2024.

MARZINOTTO JUNIOR, F. L. Geopolítica, indústria digital e soberania nacional: a informática brasileira como eixo estratégico nas relações econômicas entre Brasil e Estados Unidos (1960-1990). **Coleção Meira Mattos: Revista das Ciências Militares**, Rio de Janeiro, v. 18, n. 63, p. 423-440, 2025. DOI: https://doi.org/10.52781/cmm.a143

MAZZUCATO, M. **O estado empreendedor**: desmascarando o mito do setor público vs. setor privado. São Paulo: Portfolio-Penguin, 2014.

MAYER, M.; CARPES, M.; KNOBLICH, R. **The global politics of science and technology**: concepts from international relations and other disciplines. Berlin: Springer, 2014. v. 1.

MCCLOSKEY, D. N.; MINGARDI, A. **The myth of the entrepreneurial state**. Great Barrington: American Institute for Economic Research, 2020.

MOREIRA, W. S. Economia, política, estratégia e a geração de demanda de produtos de defesa. *In*: SANTOS, T.; LESKE, A. D. (orgs.). **Economia de Defesa**: aportes teóricos, novos temas e o caso do Brasil. Curitiba: Appris, 2024. cap. 3.

MOREIRA, W. S. **Ciência e Poder**: o cerceamento tecnológico e as implicações para a defesa nacional. 2013. Tese (Doutorado em Ciência Política) – Instituto de Ciências Humanas e Filosofia, Universidade Federal Fluminense, Niterói, 2013.

NELSON, R. R.; ROSENBERG, N. Technical innovation and national systems. *In*: NELSON, R. R. (ed.). **National innovation systems**: a comparative analysis. New York: Oxford University Press, 1993. p. 3-21.

OECD – ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT. **Main Science and Technology Indicators**: Mar. 2025. Abvialable at: https://www.oecd.org/en/data/datasets/main-science-and-technology-indicators.html. Access on: April 17, 2026.

OLIVEIRA, J. S.; URBINA, L. M. S.; ABDALA, L. N. Planejamento estratégico das obtenções de sistemas de defesa: uma análise para a implementação da estratégia de obtenção evolucionária. **Coleção Meira Mattos: Revista das Ciências Militares**, Rio de Janeiro, v. 18, n. 63, p. 533-562, 2024. DOI: https://doi.org/10.52781/cmm.a149

PORTER, M. E. **A vantagem competitiva das nações**. Rio de Janeiro: Campus, 1990.

SANTOS, T. Economia de Defesa como uma categoria geral de análise nas Ciências Econômicas. **Revista da Escola de Guerra Naval**, Rio de Janeiro, v. 24, n. 3, p. 542-564, 2018. DOI: https://doi.org/10.21544/1809-3191.v24n3.p542-564

SANTOS, T.; LESKE, A. D. (orgs.). **Economia de defesa**: aportes teóricos, novos temas e o caso do Brasil. Curitiba: Appris, 2024.

SILVA, L. P. P.; NASCIMENTO, R. L. Cerceamento Tecnológico: o caso do sistema unilateral de controle de exportação dos EUA e suas implicações para o Brasil. **X ENABED**. 2018. Available at: https://www.enabed2018.abedef.org/resources/anais/8/1535671131_ARQUIVO_CerceamentoTecnologico_LucasPinheiroeRafaelLaginhaultimaversao.pdf. Access on: June 25, 2025.

SIPRI – STOCKHOLM INTERNATIONAL PEACE RESEARCH INSTITUTE. **SIPRI Military Expenditure Database**. Solna: SIPRI, [202-]. Available at: https://www.sipri.org/databases/milex. Access on: April 17, 2026.

SCHUMPETER, J. A. A teoria do desenvolvimento econômico. Rio de Janeiro: Nova Cultural, 1985. (Coleção Os economistas).

WENNBERG, K.; SANDSTRÖM, C. **Questioning the entrepreneurial state**: status-quo, pitfalls, and the need for credible innovation policy. Cham: Springer, 2022.