PUBLIC POLICIES FOR SCIENCE, TECHNOLOGY, AND INNOVATION IN BRAZIL FROM 2000 TO 2023: A STUDY OF THE STATE'S PERFORMANCE

AS POLÍTICAS PÚBLICAS DE CIÊNCIA, TECNOLOGIA, INOVAÇÃO NO BRASIL NOS PERÍODOS DE 2000 A 2023 UM ESTUDO DA ATUAÇÃO DO ESTADO

POLÍTICAS PÚBLICAS DE CIENCIA, TECNOLOGÍA E INNOVACIÓN EN BRASIL DE 2000 A 2023: UN ESTUDIO DEL DESEMPEÑO DEL ESTADO

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ABSTRACT

This article presents a bibliographic study of the Brazilian State's role in formulating and implementing science, technology, and innovation (ST&I) policies from the year 2000 to the present. It is grounded in the premise that the State regulates, promotes, implements, and evaluates programmatic actions through legal, budgetary, and administrative mechanisms—such as Law No. 8,958/1994 and Law No. 9,394/1996—which make the development of ST&I possible. The main objective is to provide a brief contextualization of key public policies during this period and to investigate the extent to which these interventions have contributed to the national advancement of ST&I. The study draws on conceptual discussions about science, technology, innovation, the State, and public policy, based on legal documents, public programs, institutional frameworks, and academic studies (Cavalcante, 2011; Negri, 2021; Ferreira, Silva & Verdeaux, 2018; Tuchi, Morais & Pinho, 2017), with particular attention to financing mechanisms. The findings highlight that public policies and investments in ST&I are essential for social development, especially in improving the population's living conditions. However, discontinuity and centralized governance models that overlook sufficient and diversified funding can hinder innovation-based progress. Thus, smart and consistent investment strategies are necessary to ensure the effectiveness and impact of these policies.

Keywords: Science Technology and Innovation Policy. State. Public Policy. ST&I Funding.

RESUMO

O presente ensaio apresenta um estudo bibliográfico da atuação do Estado brasileiro no que se refere às políticas de ciência, tecnologia e inovação, dos anos de 2000 até o presente. Parte-se da premissa de que o Estado regulamenta, fomenta, executa e avalia ações programáticas por dispositivos legais, orçamentários e administrativos que possibilitam o desenvolvimento de CT&I, como a Lei n.º 8.958/1994 e a Lei n.º 9.394/1996. Portanto, o principal objetivo é apresentar uma breve contextualização de algumas dessas políticas no Brasil ao longo do período definido, na busca de compreender em que medida e com quais interveniências elas vêm contribuindo para a equalização nacional da CT&I? Para tanto, faz-se uma revisão bibliográfica das noções de Ciência, Tecnologia, Inovação, Estado e Políticas Públicas a partir de documentos, programas, instituições e leis, assim como de pesquisas

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sobre a temática (Cavalcante, 2011; Negri 2021, Ferreira; Silva e Verdeaux, 2018; Turchi; Morais e Pinho 2017), perpassando análises de estudos que abordam sobre financiamento em CT&I. As considerações e ponderações são resultados das reflexões sobre o assunto e mostram que as políticas e investimentos empreendidos em CT&I são fundamentais para que haja desenvolvimento social numa perspectiva das melhorias nas condições de vida das pessoas, compreende-se que a descontinuidade e um modelo de governança centralizado que não leve em consideração um orçamento quantitativo suficiente e qualitativamente diversificado não incidirá positivamente no desenvolvimento mediado pela inovação, portanto, se faz necessário investir de forma inteligente para que essas políticas sejam efetivas e cumpra seu papel. O ensaio está organizado em quatro seções principais: introdução; Ciência, Tecnologia, Inovação e Estado: uma abordagem conceitual; O Estado brasileiro e as políticas públicas de CT&I; conclusões e referências.

Palavras-chave: Política de Ciência. Tecnologia e Inovação. Estado. Políticas Públicas. Financiamento em CT&I.

RESUMEN

El presente ensayo presenta un estudio bibliográfico sobre la actuación del Estado brasileño en lo que se refiere a las políticas de ciencia, tecnología e innovación, desde los años 2000 hasta la actualidad. Se parte de la premisa de que el Estado regula, fomenta, ejecuta y evalúa acciones programáticas mediante dispositivos legales, presupuestarios y administrativos que posibilitan el desarrollo de CT&I, como la Ley n.º 8.958/1994 y la Ley n.º 9.394/1996. Por lo tanto, el objetivo principal es presentar una breve contextualización de algunas de estas políticas en Brasil a lo largo del período definido, con el fin de comprender en qué medida y con qué tipos de intervención han contribuido a la equidad nacional en CT&I. Para ello, se realiza una revisión bibliográfica de las nociones de ciencia, tecnología, innovación, Estado y políticas públicas a partir de documentos, programas, instituciones y leyes, así como de investigaciones sobre la temática (Cavalcante, 2011; Negri, 2021; Ferreira; Silva y Verdeaux, 2018; Turchi; Morais y Pinho, 2017), incluyendo análisis de estudios que abordan el financiamiento en CT&I. Las consideraciones y reflexiones son resultado del análisis sobre el tema y muestran que las políticas e inversiones en CT&I son fundamentales para que exista desarrollo social desde una perspectiva de mejora en las condiciones de vida de las personas. Se comprende que la discontinuidad y un modelo de gobernanza centralizado que no considere un presupuesto cuantitativamente suficiente y cualitativamente diverso no incidirá positivamente en un desarrollo mediado por la innovación. Por lo tanto, es necesario invertir de manera inteligente para que estas políticas sean efectivas y cumplan su función. El ensayo está organizado en cuatro secciones principales: introducción; Ciencia, Tecnología, Innovación y Estado: un enfoque conceptual; El Estado brasileño y las políticas públicas de CT&I; conclusiones y referencias.

Palabras clave: Política de Ciencia. Tecnología e Innovación. Estado. Políticas Públicas. Financiamiento en CT&I.

1 INTRODUCTION

Studies in Science, Technology and Innovation (ST&I) have been a field of research that has been taking shape and increasingly arousing the interest of researchers in Brazil. This fact is easy to understand when we are in the present moment, in which the prevalence of ST&I has largely defined social behavior and the conditions of human life. However, with regard to its effective applicability, this permeates, above all, decisions and investments in public policies that can guarantee access and, above all, knowledge, so that its uses are not harmful, but assimilated in a perspective of building a more equitable society, which can use technology to improve people's living conditions.

ST&I is recognized as a fundamental pillar for the development of a nation and can offer solutions to the problems that arise throughout the human historical process. Namely, science provides a more lucid understanding of the world and its practical application involves scientific and technological achievements that condition the ways of living in society. The constant evolution of science and technology provides innovations that, in turn, can improve existing technologies or create new ones.

However, in order for there to be development and effective applicability in ST&I, interaction with the State is of fundamental importance, as it is through the proposition of public policies and investments in research that there are possibilities to boost economic growth, improving the quality of life and promoting advances in various fields.

In this regard, Brazil has implemented a series of policies aimed at ST&I. These, in turn, are based on federal legislation and aim to create a more favorable environment for research, development and innovation to boost scientific and technological progress in the country. However, it is important to emphasize that these policies are not always effective, because, depending on the State, as well as on the investments and how they are implemented, there may be discontinuity, a fact that negatively affects their development, resulting in financial and social losses. That is why this type of policy requires planning, monitoring, and follow-up so that the resources invested have positive results.

In order to contribute to the debate, this essay presents a brief conceptual approach to science, technology, innovation, and the State, starting from a theoretical framework that discusses the subject and brings an approach to public policies in the periods from 2000 to 2023 based on documents, programs, institutions, and laws. It seeks to understand to what extent and with what interventions the public policies implemented have contributed to the national equalization of ST&I? In this aspect, we resort to the studies of Cavalcante (2011), Negri (2021), Ferreira; Silva and Verdeaux (2018), Tuchi; Morais and Pinho (2017), among others.

The considerations and considerations are the result of reflections on the theme and show that the policies and investments undertaken in ST&I are fundamental for social development in a perspective of improvements in people's living conditions, it is understood that discontinuity and a centralized governance model that does not take into account a sufficient quantitative and qualitatively diversified budget will not positively affect the development mediated by the innovation, therefore, it is necessary to invest intelligently so that these policies are effective and fulfill their role.

2 SCIENCE, TECHNOLOGY, INNOVATION AND THE STATE: A BRIEF CONCEPTUAL APPROACH

Science is the result of the process of constitution of humanity in its constant search for answers about life and the understanding of man as a social being. "The etymology of the word science, from the Latin *scientia*, means systematic knowledge, knowledge that is not only theoretical, but also practical [...] " a way of getting to know the world/universe in a more systematic and organized way". Thus, science, discursively, is "a way of knowing the world/universe in a more systematic and organized way" (Pacheco; Martins-Pacheco, 2008, p. 297), based on a "knowledge that includes, in any form or measure, a guarantee of its own validity" (Abbagnano, 2007, p. 157). This implies that science can be refutable, that is, "replaced by others that are (even if apparently) closer to reality and more coherent with other scientific knowledge" (Campos, 2010, p. 16).

Heisenberg (1971) *apud* Ferreira; Silva; Verdeaux (2018), the world appears as a fabric of events, in which connections of different kinds alternate, overlap or combine and, through this, determine the texture of the whole.

Pacheco and Martins-Pacheco (2008) present a characterization of science as follows:

> **- factual**, because it deals with occurrences or facts that manifest themselves in some way; **- contingent**, because its propositions are true or false based on experience and not only on reason; **- systematic**, because it is a logically ordered knowledge, forming a system of ideas (theory) and not dispersed and disconnected knowledge [3] (p.80); **- verifiable**, because only what is proven by the scientific method is considered science; **- fallible**, as it is not definitive or absolute, always representing a stage in the evolution of knowledge; **- approximately accurate**, due to the fact that it is fallible, as the existing theory can be reformulated or improved by new techniques and methods.

Campos (2010, p. 17) also points out some characteristics of science:

> Scientific knowledge is cumulative, recordable and refutable [...], it uses its own language and is based on the articulation between methodological procedures and epistemological foundations, in order to maintain its coherence and apprehend reality

objectively.

Its uses start from verification, description, analysis, study and experiment that can validate hypotheses on a given subject. Therefore, "science is simultaneously a theoretical knowledge (explains the real) and a practical power (handles the real through technique)" (Severino, 2010, p. 110).

Science is constituted from the need that human beings have for a more elaborate understanding of the world, as well as the precise need for the exchange of information, which ends up leading to the elaboration of more structured systems of knowledge organization (Araújo, 2006). In this sense, Maslow (1979) says that science is based on the needs to know and understand (or explain), that is, on cognitive needs. This makes the now unsystematic knowledge become a scientific and methodical work.

One of the scholars who contributed to the understanding of science was Karl Popper, for whom science is constituted through a permanent construction of hypotheses and their interlocution with reality, the succession of thoughts, the search for a totalizing explanation, that is, which is moved by understandings and resolutions moved by criticism and successive refutations. "Before refuting a theory, we are not in a position to know in what sense it needs to be modified" (Popper, 1980, p. 20). In this way, Popper understands that a scientific theory needs tests, experiments that can refute it, if it is falsifiable, it can be considered scientific. According to his view, a strong theory is one that has the ability to resist refutation attempts, if it can answer it gains credibility and acceptance.

Thomas Kuhn (2007) understands that science develops procedurally, so that concepts can be replaced or give rise to others. This occurs through discoveries that break paradigms and resignify concepts through the sciences, and new perspectives and understandings can emerge about what was already in place. The author defines science as "research firmly based on one or more past achievements". These achievements are recognized for some time by some specific scientific community, as providing the foundations for their later practice" (KUHN, 2007, p. 29). However, when weaknesses appear in the questions already analyzed, crises of normal science arise, which will drive the constitution of a theory that can explain or account for these weaknesses. In this regard, Ferreira; Silva; Verdeaux (2018, p. 247) in the article "Scientific progress and non-determinism, based on key concepts of Thomas Kuhn's epistemology" discusses, based on the author's epistemology, perspectives regarding "a genuinely non-deterministic science capable of progress" and state that:

It is essential, therefore, that a new conception in science be intended and made

> possible, so that it entails non-essential aspects of a constant and exact theoretical-experimental relationship (T-E). This conception must be structured based on broad guidelines that can be adapted to new T-E relational conceptions, in a way that is capable of absorbing inevitable inconsistencies and changing from them. (Ferreira; Silva; Verdeaux, 2018, p. 247)

Throughout history, science has shown itself to be a process of construction, of incessant search based on the practical application of theoretical knowledge, norms and values, customs and institutions, which enable the production of results, mobilized to transform the world (Theis, 2011), these, in turn, are scientific and technological achievements that influence and will influence the context and organization of society, in people's way of life, in their activities and in what they think and feel in the face of the various possibilities of their existences.

The production of knowledge, artifacts, and various tools are intrinsically linked to the ontology of the human being, who invents ways to develop conditions of inadaptation to the environment in order to ensure his well-being. This capacity of human action allows not to be satisfied with what is set and conditions together with ideas about situations and things, creating techniques and technologies (Ortega y Gasset, 1963).

According to Ortega y Gasset (1963), technique is a conscious human effort to alter space to overcome the limitations imposed by nature, being ambivalent, and can at the same time be an expression of freedom and a risk of alienation if it is not guided by critical reflection. Its evolution occurs from the different ways that each civilization develops to live. Thus, modern technique, according to the author, is characterized by a high degree of specialization that was possible with the advent of modern science, especially from the seventeenth and eighteenth centuries, it becomes systematically integrated with theoretical knowledge. Technology then emerges, understood as the practical application of scientific knowledge for productive and operational purposes.

Distinct from empirical technique, technology is planned, rationalized, and specialized and stems from research, experiment, engineering, and other artifacts. In contemporary times, technology has become an autonomous and juxtaposed force in the most varied aspects of human life, mediating work, health, education, communication and leisure, among others.

Heidegger (2010), in his essay *The Question of Technique*, argues that modern technology is not just a set of instruments, but a way of framing the world, in which everything — including the human being — comes to be seen as a resource or object of control. Gilbert Simondon in *The Mode of Existence of Technical Objects* (1989), Simondon tries to integrate technology and culture, understanding and arguing about the link between the two concepts,

so technology is not constituted by a set of tools or engineering, but as a complex philosophical reality, deeply linked to human existence, individuation and the development of technical objects.

According to Abbagnano (2007, p. 1.109), technology is understood by three meanings: "1. "Study of the technical processes of a certain branch of industrial production or of several branches; 2. Same as technique; 3. The same as "technocracy" (Abbagnano, 2007, p. 1.109), also in summary, understood as "the set of processes of an art and/or special ability to execute or do something" (Theis, 2011).

> Notwithstanding whether it could be conceived as a composite of accumulated scientific knowledge, technical qualifications, machinery and equipment, logical habits, and material artifacts, technology is more than that. In addition to information, logic, and things, technology is a human enterprise: it is the way human beings live and develop their various activities in specific social and historical contexts, with specific interests and intentions (Theis, 2011, p. 4).

Therefore, the development of technology is related to the actions performed by human beings and to objects created from their needs and ingenuity and the relationships established from such creations. Technology adds the application of empirical/scientific knowledge to develop tools, systems, and solutions that seek to improve living conditions in the social context. It involves creating, modifying, and utilizing devices, machines, systems, and techniques, at different times in history to solve problems, improve efficiency, and meet human needs.

From the earliest inventions to the rise of artificial intelligence, technology has continuously evolved, shaping how we communicate, work, travel, learn, and interact with the world. It constantly evolves and provides innovations, that is, through it, innovation is often carried out. "Innovation is the creation of new realities":

> [...] when it is a creation, it is, at the same time, the process and the result of making something exist that did not exist and, by extension, also of giving new shape or utility to something that already existed. When it is also understood as a *process* , innovation is no longer perceived as the exclusive result of flashes of inventiveness or ingenuity, which are certainly welcome and important. It comes to be understood as a structured set of actions or operations aimed at a result and, therefore, innovation is prone to be stimulated, promoted and managed (Plonski, 2017, p. 7).

At the same time, innovation drives technological development from the identification of needs, problems to be solved, and can boost the creation or adaptation of existing technologies in order to offer more effective solutions, which requires scientific knowledge, investment and, above all, conditions for development and effective applicability.

Therefore, the ST&I triad is fundamental for social, economic and scientific progress, since, as already mentioned, it has conditioned life in society and its form, creating a continuous cycle of improvement and development, driving changes and positively impacting society. However, for there to be development and effective applicability, interaction with the State is of fundamental importance, because it is through the proposition of public policies and investments in research that there are possibilities to boost economic growth, improving the quality of life and promoting advances in various fields.

Höfling (2001, p. 30) understands the State as:

> the set of permanent institutions – such as legislative bodies, courts, the army and others that do not necessarily form a monolithic bloc – that enable government action; and Government, as the set of programs and projects that part of society (politicians, technicians, civil society organizations and others) proposes for society as a whole, configuring the political orientation of a given government that assumes and performs the functions of the State for a certain period.

It is up to the State, through regulation, decisions and actions, to constitute policies, in the sense of organizing them as a system, or in other words, "to implement a government project, through programs, of actions aimed at specific sectors of society" (Höfling, 2001, p. 31). It is through the State, through laws, programs, norms, that actions are proposed and carried out that involve financing and public policies, regulation, investments in research, in infrastructure necessary for scientific and technological advancement. Public policies also shape the environment for innovation and technological development, among others.

It is worth mentioning that public ST&I policies are intertwined with education, since the latter plays a fundamental role in the development of skills, in the promotion of innovation and in the advancement of scientific knowledge. From it, the training and training of teachers, students and the promotion, research in ST&I areas that open up possibilities to build a society with more knowledge and more egalitarian, in the sense of access to a dignified way of life.

3 THE BRAZILIAN STATE AND ST&I PUBLIC POLICIES IN THE PERIODS FROM 2000 TO 2023

Over the last twenty years, Brazil has implemented a series of policies aimed at ST&I that have provided advances and served as bases for continuing its development processes. Table 1 summarizes some of them with laws and institutions.

Table 1

Policies, Programmes, Institutions, Laws

PERIOD	POLICIES, PROGRAMS, INSTITUTIONS, LAWS
(2000 - 2002)	Creation of the National Council of Science and Technology (CCT). Creation of the "Millennium Institutes" program by the MCT. Creation of the Industrial Property Law, the Plant Varieties Law, the Software Law, and the Biosafety Law, in addition to the creation of CTPetro. Creation of the Sectorial Funds (FS).
(2003 - 2010)	Creation of the National Secretariat of Science and Technology for Social Inclusion (SECIS) in 2003. Structuring of an action plan of the MCT presenting the National Policy of Science, Technology and Innovation (PNCT&I), formed by a structuring or horizontal axis (Expansion, Consolidation and Integration of the National System of S, T&I) and by three strategic axes (Axis 1: Industrial, Technological and Foreign Trade Policy (PITCE); Axis 2: National Strategic Objectives and Axis 3: S&T for Social Inclusion and Development).
(2003-2010)	Creation of Law 10.973/04 or the Innovation Law, regulated by Decree 5.565/05, which "establishes measures to encourage innovation and scientific and technological research in the productive environment, with a view to training and achieving technological autonomy and industrial development in the country". Creation of Law 11.079/04, which regulated public-private partnerships by establishing the general rules for the bidding and contracting of public-private partnerships within the scope of public administration. Creation of Law 11.196/05 known as the Good Law, regulated by Decree 5.798/06, which in its Chapter III deals with tax incentives for technological innovation. Elaboration of the ST&I Action Plan (PACTI).

(2011 - 2014)	National Strategy for Science, Technology and Innovation (ENCTI 2016-2022), whose conception is based on the accumulated experience in the field of S&T planning in Brazil started since the 70s with the PBDCT, as well as the recommendations embodied in the "Blue Book". In August 2011, the Ministry of Science and Technology (MCT) was renamed the Ministry of Science, Technology and Innovation (MCTI).
(2015 - 2018)	It is proposed the establishment of a paradigm of collaborative innovation in Brazil, stimulating the strengthening of relations between University and Company and the interaction between the most different components of the National System of Science, Technology and Innovation - SNCTI. It guides the SNCTI to seek solutions to the great social, environmental and economic challenges, contributing to the construction of the foundations of the country's sustainable development. Constitutional Amendment No. 85, of February 26, 2015, which added provisions to the Federal Constitution to update the treatment of science, technology and innovation activities and consequent amendment of the current Legal Framework. On January 11, 2016, Law No. 13,243 was enacted, which improves measures to encourage innovation and scientific and technological research in the productive environment, with a view to technological training, the achievement of technological autonomy and the development of the country's national and regional productive system, under the terms of the Federal Constitution. On February 7, 2018, Decree No. 9,283 was sanctioned by the Presidency of the Republic, to meet provisions of Law No. 13,243 that needed regulation.
2021	Law No. 14,180, of July 2021, is sanctioned, which establishes the Connected Education Innovation Policy, in line with strategy 7.15 of the National Education Plan, approved by Law No. 13,005, of June 25, 2014, with the objective of supporting the universalization of high-speed internet access and fostering the pedagogical use of digital technologies in basic education.
2021	Complementary Law No. 177. Amends Complementary Law No. 101, of May 4, 2000, to prohibit the limitation of commitment and financial movement of expenses related to innovation and scientific and technological development funded by a fund created for this purpose, and Law No. 11,540, of November 12, 2007, to modify the nature and sources of revenue of the National Fund for Scientific and Technological Development (FNDCT), and include programs developed by social organizations among the institutions that can access FNDCT resources.

2023	Regulation of the National Council of Science and Technology – CCT, a superior advisory body to the President of the Republic, within the scope of the Ministry of Science, Technology and Innovation, for the formulation and implementation of the national policy for scientific development. The council was created through Decree No. 75,241, of January 16, 1975, had its structure approved by Law No. 9,257, of January 9, 1996 and regulated by Decree No. 11,474, of April 6, 2023. Reestablishment of the Ministry of Science, Technology and Innovation, through Decree No. 11,493, of April 17, 2023. Approves the Regimental Structure and the Demonstrative Table of Commission Positions and Trust Functions of the Ministry of Science, Technology and Innovation and reassigns and transforms commission positions and trust functions.

Source: Adapted by the authors from Lemos and Cário, 2013.

ST&I policies were based in the late 1940s, with continuity to the detriment of technological advances and their implications. Among them, the Creation of the Brazilian Society for the Advancement of Science – SBPC (1948), the Brazilian Center for Physics Research – CBPF (1949), the Technological Institute of Aeronautics – ITA (1950), the Technological Center of Aeronautics – CTA (1950) stand out. Creation of the National Council for Scientific and Technological Development – CNPq and the Coordination for the Improvement of Higher Education Personnel – CAPES (1951). Creation of the National Bank for Economic Development (BNDE) (1952); Creation of the Scientific and Technological Development Fund (FUNTEC), in 1969, through Decree-Law No. 719, as a financial instrument for the integration of science and technology with the national development policy, based on the experience of the Technology Support Fund – FUNTEC, established in 1964 and managed by the National Bank for Economic Development – BNDES. Launch of the Government Economic Action Plan (PAEG) by the Ministry of Planning and Economic Coordination in August 1964, with the objective of directing Brazil's economic and social policy through political-economic mechanisms to combat inflation associated with institutional reforms (tax and financial). Creation of the Financier of Studies and Projects (FINEP), a public institution created on July 24, 1967, by Decree No. 61,056, which finances research, development and innovation projects in various areas of science and technology. It operates with reimbursable and non-reimbursable resources, offering credit and grants to companies, universities and other research institutions. FINEP has been the Executive Secretariat of the FNDCT since March 15, 1971. Publication of the Strategic Development Program (PED), published in 1967, with the aim of guiding government policy and the elaboration of the Triennial Government Plan for 1968/70. Creation of the National Fund for Scientific and

Technological Development (FNDCT), on July 31, 1969 through Decree-Law No. 719, with the purpose of providing financial support to priority programs and projects for scientific and technological development.

In the early 1970s, the I National Development Plan (I PND) was launched in 1971, which formulated the National System for Scientific and Technological Development (SNDCT), created in 1969 through Decree-Law No. 719 with the objective of financing innovation and science and technology to promote the economic and social development of Brazil. During the period of the government of Ernesto Geisel (1974-1979), the II National Development Plan (II PND) was launched for the period 1975-1979, with a view to continuing the process of the previous year and emphasizing the importance of technological development together with professional qualification. One of the priorities of the II PND was the implementation of the II Basic Plan for Scientific and Technological Development (II PBDCT), which also continued the previous plan, seeking to implement the scientific and technological policy in order to strengthen the technological capacity of the national company (Motoyama, 2004). III National Development Plan (III PND), and as its unfolding the III Basic Plan for Scientific and Technological Development (III PBDCT).

In the 1980s, the promulgation of the new Constitution of the Republic brought significant changes in the field of science and technology (S&T). On March 15, 1985, the Ministry of Science and Technology (MCT) was created through Decree No. 91,146.

Other programs aimed at supporting technological innovations were the Support Program for the Technological Training of Industry (PACTI), through Ordinance No. 134, of December 18, 1998, which aimed to "support the Brazilian effort of modernity and promote the quality and productivity of the housing construction sector, with a view to increasing the competitiveness of goods and services produced by it" (Brasil, 2019), the Industrial Competitiveness Program, through the Decree of February 1, 1991 (Brasil, 1991) and the Support Program for Centers of Excellence (PRONEX), created by Decree No. 1,857, of April 10, 1996, which established PRONEX as an instrument to stimulate research and scientific and technological development in the country, through continued and additional support to the instruments available today, to highly competent groups, which have leadership and a nucleating role in the sector in which they operate (Brasil, 2025).

Currently, the legal bases are mainly addressed by the Innovation Law (Law No. 10,973/2004), which deals with incentives for innovation and scientific and technological research in the productive environment, and by the ST&I Legal Framework Law (Law No. 13,243/2016), which provides for incentives to scientific development, research, scientific and technological training, and innovation. These laws aim to promote scientific and technological

advancement, facilitate partnerships between public and private institutions, and stimulate innovation in the country.

The Ministry of Science, Technology and Innovation (MCTI) is the body responsible for formulating and coordinating the Brazilian science, technology and innovation policy. It is also responsible for defining guidelines, planning and implementing actions aimed at promoting the scientific and technological development of the country, which is done through its main agencies: the National Council for Scientific and Technological Development (CNPq), which acts through the granting of scholarships for students, as well as in support of research and the Financier of Studies and Projects (FINEP), which operates the resources made available by the National Fund for Scientific and Technological Development, which encompasses the Sectoral Funds[3] (Negri, 2021).

In 2006, with the approval of the so-called Lei do Bem (Law 11.196/2005), broad and simplified tax incentives were created for investments in Research and Development (R&D); thus, the government provides companies with the benefit of a reduction in the Income Tax rate and in the Social Contribution on Net Income to be collected on Real Profit. that prove to have invested in technological innovation.

In 2007, Law No. 11,540, of November 12, 2007, came into force, which provides for the National Fund for Scientific and Technological Development - FNDCT, which aims to finance innovation and scientific and technological development with a view to promoting the economic and social development of the country.

From this perspective, in 2013 a credit program for innovation was launched, operated by Finep - the main STI development agency in the country and responsible for the operation of the FNDCT - and by BNDES. According to Negri (2021, p. 4), Brazil also establishes R&D investment obligations for companies operating in regulated sectors, especially in the Oil sector and the electricity sector. According to the author, "although they are resources invested by the concessionaire companies themselves, these programs are managed by the respective regulatory agencies: ANP (National Petroleum Agency) and ANEEL (National Electric Energy Agency)" (Negri, 2021, p. 4).

Thus, based on the laws, that is, the legal guidelines and the bases for programs and

[3] The Sectoral Funds in Brazil are based on the creation of the National Fund for Scientific and Technological Development – FNDCT – in 1969, "through Decree-Law No. 719, as a financial instrument for the integration of science and technology with the national development policy, based on the experience of the Technology Support Fund – FUNTEC, established in 1964 and managed by the National Bank for Economic Development – BNDES. FNDCT resources are used to support innovation and research activities in companies and scientific and technological institutions - ICTs, in the modalities of reimbursable, non-reimbursable financing and investment, and can be implemented directly or decentralized. In direct form, Finep, as Executive Secretariat of the Fund, directly executes the budget; in a decentralized form, the resources are transferred to other partners who are responsible for implementing the action" (BRASIL, MCTI, 2023). Available at:https://antigo.mctic.gov.br/mctic/opencms/fundos/fndct/paginas/sobre.html

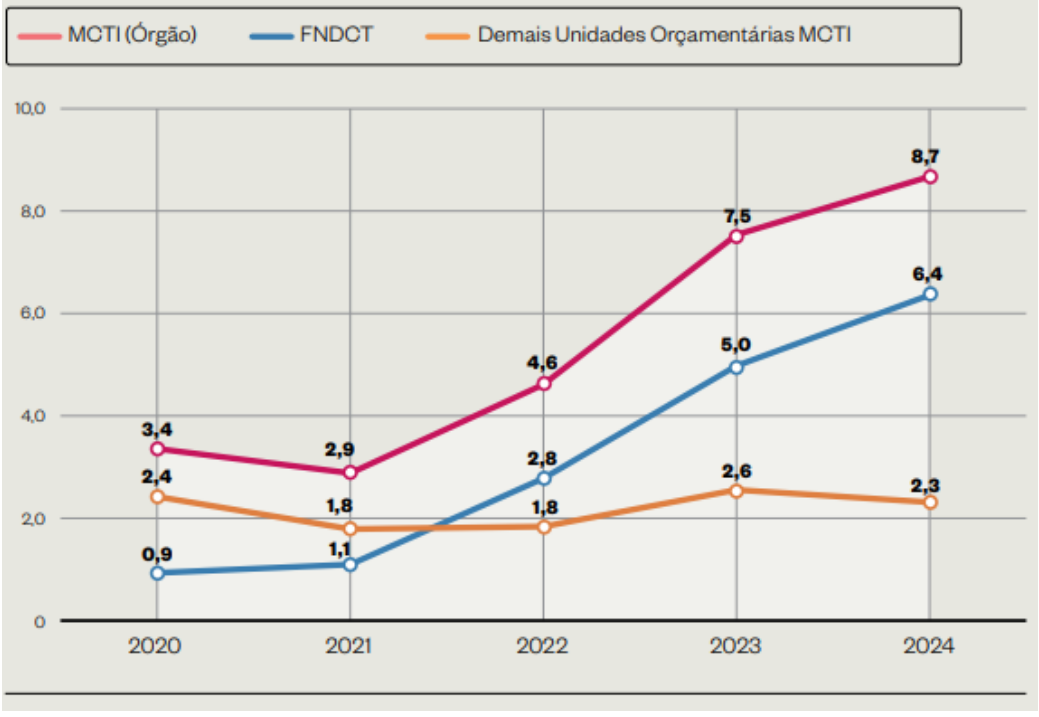
actions for ST&I, Brazil has been proposing public policies for its development. Such policies, in turn, represent a set of effective decisions and measures, resulting from the priorities established mainly from government programs, since one of the main instruments for achieving policies is public financing. However, it is necessary that it is well planned based on scientific and market research so that investments are applied intelligently with a view to its effectiveness.

Currently, investments in Science, Technology and Innovation include strategic programs and initiatives to strengthen this sector, through the National Fund for Scientific and Technological Development (FNDCT), the main federal public funding instrument for science, technology and innovation (ST&I) in Brazil. The Fund is managed by the Ministry of Science, Technology and Innovation (MCTI) and operated by the Financier of Studies and Projects (Finep). It plays a crucial role in promoting scientific and technological development, in addition to boosting economic development, productivity, and innovation, making it possible to face local and global challenges in the search for a fairer society, guaranteeing the rights of citizens.

Data from the budget executed by the MCTI between 2020 and 2024 shows a significant increase in relation to investments.

Figure 1

Committed budget: 2020 to 2024 in current billions



Source: FAPESP/DPCTA/GIP, 2024.

In 2023, R$10 billion were fully executed, of which R$4.9 billion in non-reimbursable resources and the rest in credits for innovation projects in the productive sector. This amount represented a 40% increase in the number of projects contracted compared to the period from 2019 to 2022. In 2024 , the approved budget was R$ 12.7 billion, also fully executed. The resources were distributed equally between reimbursable and non-reimbursable modalities, demonstrating the fund's ability to meet the growing demands of the sector._ (Ministry of Science, Technology and Innovation, 2023).

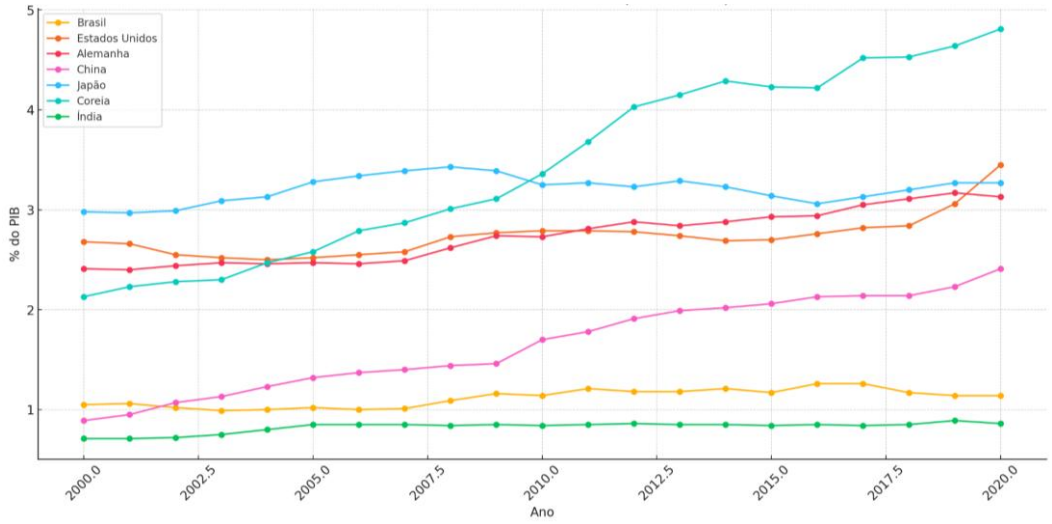
Between 2023 and 2024, the FNDCT supported 2,176 projects under the New Industry Brazil (NIB), totaling more than R$24 billion in reimbursable and non-reimbursable resources. These investments boosted areas such as artificial intelligence, robotics, and defense technologies.

The results of the investments and policies implemented over the study period show important advances in ST&I, especially in the last 2 years, however there is still room for improvement, especially in national investments in relation to gross domestic product (GDP) in ST&I, because, according to the National Indicators of Science, Technology and Innovation 2022[4] have a national expenditure on research and development (R&D) of 1.14%. This percentage is considered very modest compared to countries such as South Korea and Israel that invest more than 4% of GDP in ST&I, China, Germany and Australia allocate more than 2% of GDP to these sectors. Despite the advances that have taken place, especially in the consolidation of institutions, in the design of financing policies and in the adoption of broad legislation to encourage ST&I, causing growth in infrastructure, publications and innovations, there are still large gaps when compared to countries that have invested and continue to invest in research and development (R&D) as a proportion of gross domestic product (GDP).

[4] See document prepared by the Ministry of Science, Technology and Innovation (MCTI).

Figure 2

National research and development (R&D) expenditures relative to gross domestic product (GDP) of selected countries, 2000-2020

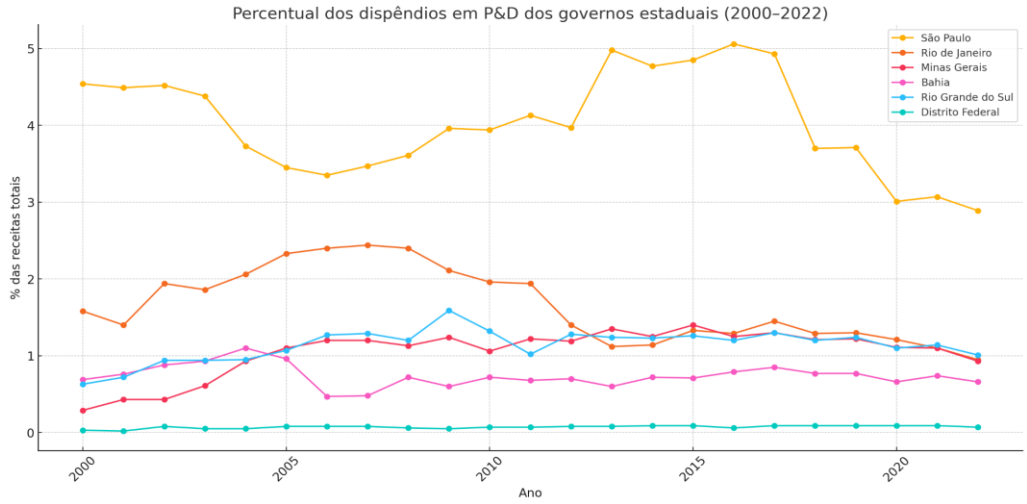


Source: Ministry of Science, Technology and Innovation (MCTI) and Organisation for Economic Co-operation and Development (OECD).

In addition, there are mechanisms that weaken ST&I financing, such as spending and investments, both at the global and national levels, for example, the modest private sector investment and the percentage distribution by states (Figure 2), the absence of a common understanding of the innovation process at the national level and its impacts on the formulation of more effective public policies, taking into account the offers and demands for innovation, as well as potential demands in the decision-making process on investment in innovation added to the increase in innovative technological capabilities (Leal; Figueiredo, 2021). Regardless of points such as those mentioned above, the results in terms of innovation and productivity in Brazil will continue to provide slow economic growth.

Figure 3

Percentage of state governments' R&D expenditures from 2000 to 2022



Source: Ministry of Science, Technology and Innovation, 2025.

From this perspective, the formulation and effective execution of ST&I policies, therefore, is one of the main factors for economic and social development. To obtain positive results, it is necessary for different actors to work together, as is the case of the triple helix, formed by the government, industry and the university (Leydesdorff; Etzkowitz, 1996).

We understand that this partnership is necessary due to the peculiar characteristics of each actor. The government, for example, has the capacity to provide financial resources and infrastructure for the development of research and innovations. In addition, it is responsible for creating laws and regulations that regulate the activity of other actors, such as industry. The industry has practical knowledge about the manufacture of products and the marketing of services. Additionally, it is responsible for providing the government with information on market needs and trends. The university, in turn, is responsible for developing scientific and technological research, in addition to training qualified professionals for the productive sector.

Collaboration between these three actors is therefore essential for economic and social development. The government can create incentives for industry to invest in R&D and for universities to develop quality research; industry can provide financial resources for research and support innovation initiatives; and the university can provide scientific and technological knowledge to the industry.

Importantly, this partnership must be sustainable and oriented towards the desired development goals. The government must establish clear parameters for the use of financial resources and the industry must invest in research related to its products and services. The university, in turn, must establish partnerships with industry to develop quality research. Namely, that scientific and technological research in the field of ST&I is considered one of the

pillars of innovation, being one of the main factors that provides the economic development of a country.

It is in this bias that the action of the State is of fundamental importance in the sense of fostering, through these policies and with the support of the various sectors of society, an environment conducive to scientific advancement, technological development and innovation, aiming at economic growth and the improvement of the quality of life of the population.

4 FINAL CONSIDERATIONS

ST&I, today, is considered a fundamental pillar for social development in contemporary societies. As already mentioned, this triad plays an important role in improving conditions, as it drives progress by creating new knowledge, technologies, and innovative solutions. Through the intelligent use of ST&I, it is possible to advance in areas that are essential for social improvement and development, such as health, education, environment, communication, among others.

In the field of health, for example, ST&I has been enabling the improvement of people's quality of life through the development of treatments and medicines, positively impacting the prevention and fight against diseases, in addition to improving health systems, especially with regard to communication, information and access. Regarding education, technology has been expanding learning opportunities from the proposition of teaching methods in different areas of knowledge. With regard to the environment, CT&I has proposed sustainable solutions, boosting renewable energies and developing cleaner technologies and responsible practices. In addition, technological innovation aligned with knowledge drives economic growth and can provide a better quality of life for people. However, it is worth noting that its uses must be based on a democratic perspective of access.

Therefore, the relationship between ST&I and the State is fundamental for the development of policies aimed at this field, and it is up to the State to promote scientific and technological advances, involving the various sectors of society in an intelligent and effective way, through the formulation of laws and financial support, as well as through the organization, planning and evaluation, in order to confer success and its continuity.

Over the last few decades, in Brazil, there have been efforts to create policies aimed at scientific research and technological innovation. Laws and programs were created to implement actions, as well as its scope of action was expanded through the partnership between public institutions, the private sector and universities.

However, the trajectory of programs and investments has been marked by identity fragility, lack of coordination, absence of a common strategic plan and broad adherence by

participants, budgetary challenges, with oscillations and contingencies, excessive bureaucracy and instability in policies, which has negatively impacted the continuity and progress of ST&I projects. structured and structuring and with a clear vision of the country, in addition to the necessary strengthening of public policies in accordance with them, ensuring adequate resources, stability and incentives for research, innovation, training of qualified professionals and access to all so that these policies have a positive impact on the Brazilian social context.

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