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FAPERJ Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro
INCT/PPED Instituto Nacional de Ciência e Tecnologia em Políticas Públicas, Estratégias e Desenvolvimento

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Rio de Janeiro – Brazil
2020

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Published in Brazil by Ideia D.

This book was produced with financial support from the National Council for Scientific and Technological Development (CNPq) and the Carlos Chagas Filho Research Support Foundation (FAPERJ)

Editing and proofreading
Daniel McNaughton

Translation
Logos Traduções e Consultoria

Graphic design
Ideia D

Cataloguing in Publication Data – Débora Costa Araujo CRB-15/284

S797
State capacities and development in emerging countries / Ana Célia Castro ; Renato Raul Boschi (editors) – Rio de Janeiro : INCT/PPED ; CNPq ; FAPERJ ; Ideia D , 2020.

490– p. : il.

ISBN 978-65-5726-005-0

1. Emerging countries – Economic policy. 2. Emerging countries – State capabilities. I. Castro, Ana Célia. II. Boschi, Renato Raul. III. Title.

CDD – 330.9
0007 CDU – 338.1

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Introduction

The recovery of the State's role in globalized capitalism

Renato Raul Boschi • Flavio Gaitán • Ana Célia Castro

1. INTRODUCTION

The texts collected in this volume share the general guideline of addressing the issue of the State's role in development processes from a particular viewpoint, that of the notion of State capabilities. This concept focuses on the State regarding its capacity to act, or rather to perform interventions, considering the combined action of institutions and political agents, including decision-makers and the public bureaucracy. From this perspective, support coalitions are also relevant, as pertains their ability to being brought together for a national project within a given timeframe. The recovery of the State's role as regards these capabilities, therefore, comprises the construction of bureaucracies efficient in specific areas in the formulation and implementation of public policies. In this sense, the analyses undertaken herein have reviewed the capabilities in important, concrete dimensions for the assessment of a developmental project within a context of a globalized capitalism under reconfiguration, resultant of the impact of the systemic crisis that originated at its center, the subprime crisis, and of changes in the relative position of a few emerging countries, with a strong driving role having been played by China. These dimensions, or aspects, were analysed through comparisons among Brazil and the other countries of the BRICS bloc (Russia, India, China and South Africa), according to the relevance of the topics covered in each case. Given the importance of regional issues, a comparison with Argentina regarding some dimensions was also included.

Understanding the recomposing and the success of the given countries in promoting policies to attain higher levels of development entails, as mentioned,

focusing on the strategic dimensions of State capability. In the first place, those dimensions bureaucratic in nature concern competences in processes required for the viability and the bringing to fruition of such strategies. In the second place, the specific capacities are those required for refitting the productive matrix through industrial policies and for driving a country forward by means of a vision of processes of technological innovation, which also requires considering sustainability and the availability and preservation of natural resources – energy and others – as central elements. From the viewpoint of structural dimensions, State capabilities were analysed in a number of strategic arenas in pursuit of a developmental project.

2. REDEFINING THE CONCEPT OF DEVELOPMENT: A THEORETICAL REFLECTION

Development is a polysemic concept, the meanings of which have changed over time since the first studies on productive factors and causes of arrested development up to the United Nations' current reports on sustainable development. In the present line of study, socioeconomic development is understood as a dynamic involving the diversification of the productive structure, innovation and national control over the economy, particularly among post-colonial nations and, at the same time, the creation of new jobs, distribution of income and social inclusion, in other words, a project involving social welfare correlated with citizens' rights. In this sense, development refers to both the qualitative aspects of the process of capital accumulation and economic growth and to social protection and sustainability, connecting short-term goals with a long-term perspective through concern for natural resources and environmental protection.

Policy is a key component of this dynamic, which is not limited to achieving economic growth, neither in terms of process nor of the institutions devoted to these goals. Thus understood, development is an internal process that nations undergo, closely associated with the emergence and consolidation of States with capabilities to intervene in the economy and in society. Furthermore, a central aspect of the notion applied herein is that development involves, simultaneously, internal processes and changes in the relative power among countries in the international sphere.

The project started from the assumption that institutional advantages are fundamentally connected to the State's role regarding the generation of capabilities for the formulation and implementation of policies and, at the same time, in the forging of support coalitions for a development agenda. In order to assess the conditions for executing this agenda, the project focused on a group of countries with which Brazil shares a few traits, such as an accentuated dynamism in recent internal trajectory and an expanding role in the international arena. Thus, relevant parallels were sought within the BRICS bloc with the addition of Argentina, often used as a benchmarking reference because of its regional importance and geopolitical similarity to Brazil. One of this study's research axes alluded to a particular understanding of how center-periphery relations are reconfigured in the international capitalist system after cyclical crises, and furthermore, the strong driving role played by China in this context.

As mentioned above, the reconfiguration certain countries undergo and their success in promoting policies to attain higher levels of development involves State capabilities, bearing in mind also that the central developed nations stand out for their solid State capabilities. To begin with, there are capabilities that are bureaucratic in nature and concern the practical enforcement of the implemented strategies; subsequently, the specific capacities for refitting the productive matrix through industrial policies and for enabling formulating a strategic vision for technological innovation, able to impelling the country forward, which also requires considerations of sustainability and of the available natural resources – energy and others – as central elements.

Another axis refers to the possibility of expanding the domestic market through the adoption of social inclusion policies with distributional effects, which, in turn, changes people's consumption patterns. It is important to note that this window of opportunity is relevant for a rather small number of countries, both given the size of their domestic markets and the specific elements of their respective trajectories. In other words, countries with large populations and repressed demand due to high economic inequality will grow the fastest as a result of such policies. Here, the importance of labour protection should also be highlighted as a central element in the development dynamics.

The change in direction of a development project or the change in national trajectory as a result of a development project with these characteristics presupposes another axis – the presence of support coalitions. In this sense, an inclusive project that benefits both the capital (most often, industrial capital) and labour sectors is essential for the formation of a social pact. The eventual definition of development as a national project thus acquires centrality, legitimized through democratic institutions. In this context, new arenas for negotiation and participation, resulting from the institutionalization and expansion of democracy, constitute comparative advantages.

In the field of political economy, the literature on the varieties of capitalism reviews the interaction patterns of strategic actors (particularly the company) in different production systems. Hall and Soskice (2001) present two idealized types of capitalist economies: coordinated market economies and liberal market economies. Within this theoretical framework, Becker (2009) makes a distinction between ideal types and empirical cases, noting that national economies may find themselves closer to one ideal type than another or may combine elements of the different types. Another line of studies (Schmidt, 2006; 2007; Boschi, 2011) highlights the importance of the State and its institutions for the configuration of the varieties of capitalism and of the modalities of development.

The central point of this literature – in an orientation similar to that developed by the French Regulation School – is precisely to point out that differentiated performance, competitiveness and even catching-up strategies are the result of a combination of different dimensions, or factors, in the production systems and institutional environments within which the economic actors and companies operate. In other words, endogenous processes are impacted by the standpoints of their modes of foreign insertion. This also means that internal productive arrangements are subject to changes that modify their configurations among the varieties of capitalism, whether trending towards market-coordinated systems or towards steering through centralized coordination with a greater or lesser degree of State activity. It would be worthwhile, thus, to identify the processes of institutional change over a period of time, verifying the extent to which a given country approaches or departs from these ideal types.

The different trajectories and institutional matrices engender different varieties of capitalism, in which State coordination plays a role marked by greater or lesser centrality. Certainly, in the case of emerging countries the State is a decisive vector in breaking with inefficient standards, hardened structures and vicious circles of inequities through the effective introduction of a new pattern of development. Hence the importance of assessing how State elites, placed in prominent positions, devise strategies for a country in the medium term in view of the available policy tools; it is equally important to map out the main lines of current policies that are capable of defining new trajectories. Comparative analyses of market expansion dynamics through proactive policies and the forging of domestic coalitions of support are central dimensions influencing the success of such national strategies, especially in terms of liaison building between political coalitions and the international arenas with a view to occupying competitive spaces in the new scenario.

Institutions shape the relations among actors, the modes of policy implementation, and their outcome and impact. In this sense, reviewing the political and institutional settings is a key dimension in the possibility of enhancing Brazil's relative position in the international scene. The strengthening of State capabilities is expressed both in the areas that are strategic for a development agenda (social policy, education and technical training, investment in science and technology, capacity for pursuing an international agenda, macroeconomic development policy) and in the potential ability for consensus building around a development agenda (establishing liaisons among strategic actors, the forging of support coalitions, the capacity to maintain policy stability).

It has been argued that trajectory continuity, as regards the role of the State, has generated an accumulation of capabilities in the sphere of the public bureaucracy, in terms of capacity for policy setting and implementation. The association between State capabilities and the strengthening of democracy (Tilly, 2007) moreover, favors the generation of negotiated, consensual results and builds credibility in the international system, which in turn has a positive impact on the level of foreign investment in the country (in this regard, China's extensive consensus-building process is a clear asset). Democratic institutions may raise transaction costs, but they reduce uncertainty deriving from erratic decision-making. Moreover, the neo-corporatist cores bridging government and civil society, as well as an efficient structure for representation of business interests, converge

towards producing more effective responses to external challenges. Consequently, changes in the relative power positions in the international trading arena may be expected. As regards Brazil, a more virtuous combination of State, market, civil society, and corporative interests could prevail (Crouch, 2011), which tends to wear out in several central countries as a post-subprime crisis of alternatives. However, the controversial Brazilian impeachment process of 2016, lubricated by a significant distribution of raises among the legislative and judiciary, belies the stability of progressive development coalitions in Brazil. In just a few months, social and environmental rights were slashed, social and development investments were severely curtailed, and labour rights have regressed to nineteenth-century levels (see http://www.nytimes.com/2017/01/05/opinion/the-end-of-the-world-in-brazil-its-already-here. html).

The marked degree of State action in strategic areas and its capacity to coordinate the demands of the several relevant actors, would lead one to highlight the relevance of *democratic governance*. The World Bank defines governance as a heightened degree of cooperation and interaction among State and non-State actors in public-private decision networks, including government, civil society, and the market. In another sense, governance can be understood as the creation of favorable conditions for government action, constituting part of its public management attributes and capabilities. In this sense, the nature of the political institutions bears a strong impact on the resultant economic performance: transparent political processes, guaranteed by a stable democratic regime, increase a country's credibility and positive external image. Governance, in short, relates to conflict resolution and involves the need to implement coherent, effective and sustainable policies in a democratic environment, which in turn requires the participation of strategic actors for the resolution of economic problems and pursuit of development strategies.

3. KEY FINDINGS

The present discussion on State capacities is adressed through a theoretical point of view by **Celina Souza** and **Flavio Fontanelli**, focusing on the concept of State capacity, defined as a a broad and ambiguous concept that involves several dimensions: political, institutional, legal, territorial, administrative and technical.

The authors make a significant contribution by demonstrating that the analysis of State and its capacities must include a thorough construction of concepts, variables and indicators.

In a similar way, **Celina Souza** demonstrates that the quality of State institution performance depends, to a large degree, on the proper management of its resources – financial, human and technological – and the effectiveness of its the benefits that accrue to its target audience. The author contends that amongst State institutions, the task of formulating and implementing public policies falls particularly to the government, in which three institutions are conjoined: the Executive, the bureaucracy, and the public administration. Her review, however, focuses on one of these institutions – the bureaucracy – from the perspective of the concept of State capability.

A major contribution this study brought was clarifying from a theoretical viewpoint that the rationalization of the bureaucracy was a political process that has not occurred in South America, contrary to Weber's predictions, based on a single bureaucratic model. Through a comparison between Brazil and Argentina, the author emphasizes that the construction of rational bureaucracies was the solution adopted by political leaders in face of an environment where political uncertainty was rife – especially during elections. Her review shows that the political rationales driving the bureaucratic processes in the two countries, despite their initial commonalities, followed different paths after the countries' redemocratization processes in the 1980s. The author makes the case that the political actors who engendered democracy in Argentina and in Brazil had different agendas, which led to different trajectories regarding the bureaucratic system. Where Brazil pursued the professionalization of the bureaucracy by recruitment through competitive admission tests, in Argentina the appointment system was maintained; however, in both countries this was seen as a strategy that would enhance institutional stability. Following this analytical key, the author combines the concept of trajectory with the thesis of the rationality of political actors as the determinant of the type of institutionalized bureaucracy that ensued. The course explains, albeit only partially, why Brazil was able to revitalize its system of bureaucratic recruitment after redemocratization, whereas in Argentina the old system remained in place.

Another important contribution was emphasizing the need to think bureaucratic capabilities in their concrete arenas, as bureaucratic quality is far from being evenly distributed across government agencies, in both Brazil and Argentina. The author identifies as the turning point of these different trajectories the decision made by the Brazilian Constituent Assembly, when drafting the 1988 Constitution, to change the form of recruitment of the bureaucracy to professionalized competitive admission exams, which did not occur as a result of redemocratization in Argentina. Although there is evidence that the Brazilian bureaucratic system and companies created in Brazil during the Vargas regime (1930–1945) were stronger and more resilient than those in Argentina created by Perón (1946–1955, 1973–1974), the explanatory power based on the trajectory is limited to elucidating why Brazil followed a path, and Argentina, another. (Alternatively, the anthropological approach could also be taken, and the contrast merely be noted, rather than elaborate an analytical key only to then reject it, and then offer no other solution.) For the specific case of Brazil the author showed, by developing a *bureaucratic quality index*, that even though the country ranks high, when the index is broken down several government agencies still reveal shortcomings, particularly when it comes to ensuring a professional and stable bureaucracy. Regarding Argentina, interviews reveal that redemocratization maintained a bureaucratic system that does not meet the Weberian requirements. Argentine public servants are governed by several different legal regimes; most are recruited based on personal or party ties. The Argentine bureaucracy also lacks clear rules and procedures capable of reducing uncertainty, beingstrongly constrained by election cycles.

3.1 – Innovation

A few chapters in this volume address the role of innovation in both the private and the public sectors. The relative position of a country or region in the international community is increasingly dependant upon its ability to generate and expand the use of technology, seen as a key factor for achieving competitive advantage that, in turn, enables the attainment of a greater presence in world markets. A historical review demonstrates that development processes are based on the massification of technological diffusion as a way of ensuring the irreversibility of social progress. This is suggested by the dynamics both in classic development

models, such as the industrial revolution during the nineteenth century (United States, Germany, Japan); the recent industrialization by the Newly Industrializing Countries (NICs) in the second half of the twentieth century (the pioneering Asian Dragons of Singapore and South Korea, and latter-day Tigers of Malaysia, Thailand and Vietnam); and is further illustrated by the most recent case of Ireland. Unlike Latin America, whose growth phases were based on the export of low-value-added raw materials and foreign industry subsidiaries without technology transfers, these countries invested vast sums in research and development, university systems, technological renovation and cutting-edge industrial manufacture.

This perspective, specifically applied to agricultural innovation, comprises the focus of **Ana Célia Castro**'s work. The author examined the present States' capability to formulate, conduct and implement (and, in some cases, to assess) science, technology and innovation policy, comparing Brazil, China and Argentina, to demarcate comparative advantages and institutional disadvantages. One of the main conclusions of the study is that the existence of a structured consensus as to which industries should be encouraged and promoted by the entrepreneurial State – and wherein the technological frontier in such sectors lies precisely – depends, first of all on the existence of a rearguard of institutions capable of carrying out prospective (and retrospective) studies that can effectively subsidize the decision-making process; second, on a continual exercise of technological foresight, subject to periodic reviews; third, on a capability to take into account conflicts of interest, but also the capability to neutralize them after a structured consensus has been defined; and last but not least, the possibility of having an innovation funding system that is well-grounded. Two preconditions seem essential to the coordination of the countries' modernization process: structured visions of the future must be established, and the State capabilities to implement such visions must be present. According to the author, this does not require a continuum of skills or competencies, but rather a variety of decision-making process regarding long-term strategies and proper coordination during the design and execution of technological policies.

The chapter by **Antônio Márcio Buainain**, **Solange Corder**, and **Maria Beatriz Machado Bonacelli** approaches innovation policies from a different point of view: it aims to review the evolution of innovation funding and point out factors

within the system that reduce its effectiveness. The article analyses the trajectory of the Brazilian policy for science and technology of the last 20 years by focusing on different strategic initiatives, such as the Sectoral Funds and the creation of the National Fund for Scientific and Technological Development (FNDCT). At the same time, it describes the main instruments available for innovation funding, their particularities, and the way resources are allocated. By examining the strengths and weaknesses, the authors demonstrate that Brazil has a robust and complex national innovations system that stands out when compared to the forms of institutional support for innovation that exist in middle-income countries as a group. This is due to the persistence of the importance of innovation for Brazilian society. On the other hand, there is room for improving Brazil's capacity in this area, given problems such as a lack of coordination between different agencies and levels of government, regional concentration, discontinuity between administrations, the negative impact of economic fluctuations, a lack of density and scope to support broader innovation processes among small- and medium-sized companies, and political constraints. In that sense, the article shows that political support and State capacities – in particular in planning and mechanisms for transparency regarding objectives, conceptualization, and instruments – are key elements for consolidating a national innovation system.

3.2 – Industrial policies

The second substantive dimension regarding State capabilities concerns the formulation and implementation of industrial policies and constitutes a specialization within the aforementioned innovative capability. As pointed out in a number of chapters in the present study, development necessarily involves change in the productive structure. In Latin America, this issue has been thoroughly discussed, especially because of the tense relationship that has historically prevailed between the agricultural and manufacturing industries. The "unbalanced manufacturing structure" argument, for instance, denounced an industrial sector that absorbed capital without having generated it and an agricultural sector that was responsible for the generation of such capital yet had much slower growth. The diversification of the productive matrix, as we have seen, has required the formulation and execution of sectoral policies – for which financing was as crucial as having a clearly defined strategy – for the rural, industrial and service sectors.

Neoliberalism imposed the idea that sectoral policies were not only unnecessary but even harmful, as they constitute a focus of corruption and rent-seeking.[1] From the viewpoint of developmental strategy, conversely, such policies are essential in order to generate competitiveness.

The chapter by **Ignacio Godinho Delgado** defends the view that the ability to innovate is even more crucial for sustaining growth in countries that have completed the rural-urban transition that follows industrialization. According to the author, these transitions, when completed without having generated the capability for endogenous innovation, may lead to a loss of competitiveness called the *middle-income trap*. Thus, policies capable of addressing these challenges are circumscribed by their historic catching-up and reform trajectories in the cases of China, India and Brazil. Drawing conclusions for the Brazilian case, Delgado suggests that country, having effected its rural-urban transition between 1950 and 1980, when the gross domestic product (GDP) grew at an average annual rate of 7.5%, currently lacks this drive to boost growth. The author points out that, when the country went through the same transition period as China and India (at a slower pace) are now, the participation of the manufacturing sector in the GDP reached 33%. A last 'second wind', typical of accelerated growth patterns observed only during transition processes, has as its basis simply the demand for overcoming the precarious urban and economic infrastructure built during Brazilian industrialization; and the possibility of incorporating the poorer population in the mass consumer market, for instance through income transfer and labour-rights policies. The author concludes that expectations of Chinese-level growth rates would be, however, a totally unrealistic outlook for Brazil.

The author also addresses the importance of macroeconomic policy, pointing out that in Brazil, far more so than in China and India, policies for productive investment must be formulated that can circumvent the pitfalls of high central bank interest rates and an appreciated exchange rate. In addition, as in China and India, the fundamental dilemma will be developing policies that enhance the innovative capability of economic agents.

[1] Rent-seeking means, literally, searching for income. It involves seeking to increase one's share of existing wealth without creating new wealth.

The chapter also makes the point that the dilemmas of Brazilian industrial policy in a scenario of escalating competitive pressures do not entail, nevertheless, merely defining the best policy instruments. In addition to coping with the currency and interest rate dilemmas, other issues that must be addressed pertain to certain legacies from the developmental trajectory whichtend to diminish today more strongly then in the past the effectiveness of industrial policy, amongst which are the Brazilian tax structure; the heavy participation of multinationals in the industrial structure, affecting the impact of innovation policies; and, of course, the deficiencies in the Brazilian infrastructure, another inheritance from *old developmentalism*.

The author holds, however, that in spite of the aforementioned dilemmas, *old developmentalism* bequeathed to Brazil, as well as a diversified industrial structure and an expressive domestic market, institutions that survived the economic reforms and that are pillars of development, such as the National Bank for Economic and Social Development (BNDES) and Petrobras. The latter's presence in the scenario opened up by the possibilities of the deepwater pre-salt oil and gas exploration fields enables the glimpsing of trajectories capable of overcoming the present difficulties, mitigating the sequelae from the balance of payments that have always accompanied periods of growth and, at the same time, meeting old demands in the areas of health and education. Thus, such a scenario creates a *window of opportunity* for making choices regarding what can and should be preserved in the current industrial structure, and what conversely should be promoted to hold *central* positions and constitute core activities under new technological paradigms, such as new energies and biotechnology.

From an institutional point of view, the author highlights one of the central ideas in the theoretical approach adopted in this work, which pertains to the need for making choices within the framework of a national project that will involve the creation of permanent arenas for interaction between the private and public sectors and thus for consensus building around the policies and initiatives to be implemented. According to Delgado, this requirement has been absent in the Brazilian industrial policy ever since the old developmental period, which prevented the creation of mechanisms to generate commitment and mutual trust.

A further positive consequence of institutional coordination mechanisms would be the fostering of the continuity of industrial policies endowed with greater accountability and, furthermore, relatively immune to the fluctuations inherent to the political cycle.

3.3 – Infrastructure

The third substantive dimension of State capability geared towards development is the possibility of generating infrastructure, defined as the set of engineering structures and facilities, usually with relatively long lifecycles, that form the basis for providing the services deemed necessary for the development of productive, political, social and personal purposes (IDB, 2000). This includes the provision of electricity, heating and other forms of energy; telecommunications; transportation; and water and sanitation systems, amongst other utilities. Following this approach, the chapter by **Alexandre de Ávila Gomide**, **Raphael Amorim Machado**, and **Ana Karine Pereira** analyses the influence of infrastructure project implementation arrangements on the production and reproduction of social inequalities, focusing on two cases, the Belo Monte Dam and Trans-Nordestina Railway. The authors show that, initially, both initiatives did not incorporate adequate consideration of social impacts, arguing that it was due to the limited capability of the implementation arrangements to identify the interests of vulnerable stakeholders, the delay in incorporating demands, and the asymmetrical distribution of power within the arrangement. In this sense, the planning instruments in both projects proved to be flawed in terms of anticipating impacts. That said, the authors do demonstrate the impact of social mobilization on the transformation of both projects over time. The study thus shows the importance of social coalitions in terms of influencing public policies, despite acknowledging that the changes made in response to the social mobilization were insufficient with regard to the reversal or mitigation of the negative impacts generated by the projects. This chapter contributes to the study of relational State capacities, the importance of strategic actors, the configuration of institutional arrangements – including the role of the representation of stakeholders' interests – and the timing of the implementation of public policies.

3.4 – Social protection

The forms of social protection that make up the fourth dimension, herein called structural, form the present research agenda on State capabilities. For this purpose, it is of fundamental relevance to the current development strategies that the centrality of social policies and the ensuring of labour rights be reaffirmed. The relevance of labour rights and their relation with social security policies is analysed by **Arnaldo Provasi Lanzara** by comparing the systems for social protection in South Africa, Argentina and Brazil. Having overcome the challenges of the neoliberal period, the author points to the recent resumption of social development strategies in a democratic environment – at least, until the recent regime shifts back to neoliberal regimes through elections in Argentina and a controversial impeachment process in Brazil claiming a fiscal rule that was legalized the following week – as having provided these countries with a new *critical context* that saw a trend towards converting distributive conflict into an axis based on labour and social protection.

With effect, the strife during these processes highlights the difficulties each of these countries faces in the current scenario in consolidating this developmental trend. Lanzara's study highlights, in particular, the importance of public regulation of waged labour and of social security for structuring heterogeneous labour markets that coexist with high levels of informality. In spite of the limitations that derive from the dilemmas typically associated to economic opening and competitiveness boosting, analysis reveals that there is still considerable leeway for the State to reproduce forms of labor regulation and social protection similar to those that prevailed during the Fordist cycle of capitalist regulation in Argentina and Brazil.

Regarding the reduction of socioeconomic inequality, the study demonstrates that it is very difficult to find a way out of poverty without an explicit commitment by the State to the creation of stable, quality jobs. Social inclusion attained merely through an increase in consumption, for instance through income redistribution policies, becomes, the author showed, extremely fragile without the support of stable employment and other forms of social protection.

3.5 – International insertion

The internationalization of the production matrix and of all processes that accompany the international projection of a country is also fundamental to the new development dynamics. In this sense, for Brazil, not only regional dynamics matter, but also – and primarily – the impact of China's action, both as an importer of raw materials and as a producer of manufactured goods, supported by the low cost of labour and low exchange rates. The relationship with China is liable to generate, as suggested in recent studies by Bresser-Pereira (2014), the so-called 'Dutch disease'. Ultimately, this could mean the risk of aggravated deindustrialization and productive specialization in lower-value primary products.

The chapter by **Anna Jaguaribe** stresses the importance of China the for Brazil, focusing on the evolution of China's technological development policy from 1985 to the present day. The author discusses the reform of the National Innovation System, the strategic objectives of technological planning, the main actors and policy instruments involved in planning and China's vision of global integration. The argument put forward by the author is that the reform process and in particular the pursuit of technology policy and its association with industrial policy led to the establishment of a particular technical- and industrial-policy paradigm in China, which was the product of its historical-structural peculiarities, the political evolution of its reform process, and an international context conducive to economic internationalization.

From the author's perspective, the prevailing institutional framework was the key to consolidating the available windows of opportunity. Thus, the national innovation system that was built starting in 1985 achieved consistency across objectives, interests, targets, rules and ongoing policy instrument reviews, so as to represent a particular modus operandi in the relation between the State and the market. In the Chinese experience, the State's role in technological policy assumed a strategic focus on *knowledge*, in contrast with modalities of innovation policies that simply capitalize on the market failures of other players. The technical and industrial policy in China also stands out from other Asian experiences of catching up, due to the use of foreign direct investment in the reform of industrial industries; the particularities of the financial system, which favors State companies; and the market creation process itself, which was unique in that it is driven by the State.

In this sense, the author concludes that the challenge facing Chinese innovation policy today, thirty years after the beginning of the reform process, lies not so much in the institutional deficiencies of the model, commonly attributed to the State, but in the difficult task of governing the choices and contradictions arising from the passage from an innovation system based on catching-up policies to a full-fledged innovation economy.

From the point of view of lessons applicable to the Brazilian case, it may be affirmed that the central aspect highlighted in Jaguaribe's analysis pertains not only to the need to establish goals for technological innovation policy with ampler consensus building, but also the generation of a technological matrix of one's own that is capable of making the country competitive in the international arena. Few countries have accomplished the transition from simple growth to a truly innovation-based development process.

Another chapter reviewing external, international factors as conditioning the building of State capabilities for development, is that by **Maria Antonieta Leopoldi**, who analyses the changes in Brazilian capitalism over the last two decades. The chapter investigates the development policies geared towards the internationalization of the economy, which were elaborated and executed by several agencies and ministries, that eventually became sedimented under the Brazilian foreign policy and diplomatic agenda. The author sets out to demonstrate in a particular manner how the Brazilian agenda over the last few decades has focused on the country's integration into the international economy through effective State action. To this end, the chapter examines the country's initiatives for the expansion of foreign trade: the attracting of foreign multinationals to the country, and also the implementation of policies for the strengthening and internationalization of Brazilian multinational companies; and the identifying of government agencies engaged in this project of active international integration and of the arenas created for the integration of the bureaucracy, the business community, organized labour, politicians, academia and consultants. The author's argument is that all of these industries were active in the country's international insertion process, whether through support coalitions that involved different State arenas (including forums, business chambers and councils) or through direct market liaising.

One of the chapter's contributions is to highlight that, in the current phase of globalized capitalism, economic growth depends on the construction of a domestic agenda that integrates with the international one. For this purpose, it is essential to understand that development depends on the strengthening of State capabilities to act simultaneously on the domestic and international levels. The author, however, does not propose a deterministic interpretation whereby national trajectories are driven by external factors alone. External processes, such as the long debt crisis in Brazil with escalating hyperinflation from the 1980s until 1994, provoke responses and reorient strategies, but do not dictate national trajectories by themselves – those trajectories depend on domestic choices and on the State's and society's capabilities to implement the latter. Thus, a new concept of development connected to the coalition led by the Lula administration was implied by the adoption of a new perspective on foreign policy that was not simply reactive, as during the neoliberal period, but entailed a more assertive posture in favor of national interests.

The analysis undertaken by Leopoldi, which also covers the case of Argentina, has the additional merit of incorporating the regional issue as an important element in this strategy. In a world marked by the formation of and competition between large economic blocs channeling investment and trade, regional association could be a factor that helps boost development. The differences between the experiences of Argentina and Brazil are appraised in this text regarding the possibilities of establishing domestic pacts for development with their respective strategic elites.

A third chapter addressing the issue of foreign influences on development policy is that by **Fátima Anastasia** and **Luciana Las Casas**, which deals with State capabilities regarding regional integration, the exercise of leadership and the dynamics of cooperaton among countries and their participation in multilateral organizations.

The authors examine the State capabilities for bilateral international cooperation between Brazil and China and between Brazil and South Africa in the areas of foreign trade and human rights, based on the theoretical assumption that political institutions affect the behaviour of actors, the dynamics of interaction among them, and the results of the game. Employing the distinction proposed by Acemoglu and Robinson (2012) between 'inclusive' and 'extractive' institutions, the authors formulate the hypothesis that under 'inclusive' institutions one would

expect to find State capabilities concurrently associated with the containment and expansion of the State, in line with the construction of a State committed to the promotion of freedom and prosperity. The analysis by Anastasia and Las Casas based on these concepts points out the different *types* of State capability present in the three countries. In China, a contrast may be observed between on the one hand heightened administrative and executive capability, and on the other, a deficit in legal, relational and political capabilities. (Rather, politically China employs an alternative concept to democracy, that of collectivism, wherein their *collective presidency* there is an extensive consensus-building process that is in many ways more comprehensive than decision-making under democracy, as it replaces the electoral dispute with giving everyone a say in concrete policy – leaving a smaller range of variables open for discussion, to be sure, but resulting in more cohesive planning nonetheless). In South Africa and Brazil, along with an increased complexity in the networks of actors and agencies constructed with a view to the design and implementation of international cooperation on the topics of foreign trade and human rights, one may also perceive a greater development of legal, relational and political capabilities. The authors understand international cooperation as an eminently political phenomenon that refers to the mutually agreed interactions among two or more actors in the international arena with no direct relation to their volume of bilateral trade. An important aspect of this analysis is the finding that the presence of similar capability (in kind and in degree) at the domestic level facilitates cooperation among States at the international level. In this sense, with regard to both both issues – human rights and foreign trade – Brazil would have a greater margin of cooperation with South Africa than with China, due to common values, albeit with the latter a greater trade agenda is present. In summary, the authors highlight in their analysis the importance of extra-economic elements in bilateral relations between countries and the presence of natural affinities. This point acquires centrality in view of the formation of new strategic partnerships in recent years to which Brazil is a party, such as the BRICS bloc, the Community of Latin American and Caribbean States (CELAC), the India-Brazil-South Africa Dialogue Forum, (IBSA) and even the Southern Common Market (Mercosur), which has Argentina, Paraguay and Uruguay as core members and Bolivia, Chile, Peru, Colombia, Equator and Venezuela as associates,

whose core purpose addresses a number of concerns that go beyond trade, such as a rejection of regimes established by military coup.

4. CONCLUSION

The discussion of the different dimensions of State capability shows that the concept of development in the current context is very complex, requiring liaising between the State capabilities in the domestic and foreign spheres. Thus the task at hand is to overcome a long tradition of industrialization producing for the domestic market, typical of closed economies, and the export of low-value-added products such as commodities, in which interest in exports trade, in addition to securing the necessary capital for the industrial process, has less relative weight. Holding that the resumption of a development process hitched to economic internationalization in this century has become more complex does not, however, disregard the relevance of windows of opportunity in international value chains.

On the contrary, even though a subset of the studies on the new developmentalism confines analysis to economic issues, the chapter by **Flavio Gaitán** and **Renato Raul Boschi** in this volume holds that the possibility of consolidating a developmental platform bears direct relation to the ability to forge support coalitions for a national development project, capable not only of designing and executing a development agenda, but also of blocking potential opposition from strategic actors with alternative propositions. The regime change in Brazil, in 2016, is a clear example of such opposition. The eventual formulation of a national development project – something increasingly fundamental in a world-spanning capitalism, under ongoing redefinition – closely depends on domestic support coalitions that internalize new common goals and visions in favor of a project that will unite sustainable growth with income distribution, i.e. reversing the vicious cycle of the neoliberal period in which the State played a less central role. The most relevant example in Brazil of such a developmental coalition, strengthening industrial capital (in detriment to financial rent-seeking capital) and labour rights, was the one brought together by Vargas (1930–1945). The fragility of the coalition forged by the Labour Party (2003–2015), in face of the controversial impeachment process of 2016, suggests that groundwork – specifically a media structure where the conservative press is counterbalanced by progressive vehicles of equal

weight to enable the plurality of messages, as is foreseen in media theory – will be required in the future to ensure the stability of any development coalition in face of neoliberal, rent-seeking interests. The importance of coalitions is expressed in the choices of productive modalities and welfare schemes observed in some cases in Latin America. On the one hand, there is a path that favors the internal market through the incorporation of masses into the consumer market, in which wage and social policies play a central role (Brazil, Argentina under Labour governments and Uruguay); and on the other, there are economies whose option for development are based on the foreign market and, consequently, wages and domestic consumption play a lesser role (Mexico, Chile and Colombia). In our view, the different modes of development reflect different choices in face of similar dilemmas of coordination. In turn, the central role of the elites in a regional perspective could be achieved in terms of the building of support coalitions that can overcome the pitfalls of adopting protectionist measures that may lead to conflict among some of the most important economies in the South Americanregion.

The elites have always acted under situations of uncertainty and constant redefinition of objectives and goals in their policy agendas, in particular in areas such as those highlighted here as being a priority for consolidating a development platform. The analyses that comprise this volume, specifying points of this agenda, strive to contribute to the strengthening of Brazil's State capabilities, to enable the meeting of the current challenges and the surpassing of the narrow confines of mere economic growth to attain the effective implementation of a new development platform.

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CHAPTER 3

COMPARED INNOVATION POLICIES AND STATE CAPABILITIES: BRAZIL, CHINA AND ARGENTINA[1]

Ana Célia Castro

[1] This chapter is a modified version of Castro (2015).

1. INTRODUCTION

Industrial development policies, gradually abandoned worldwide throughout the 1990s, have had a strong comeback after the recent economic crises, today tending to coalesce with science, technology and innovation policies. These policies reaffirm the fundamentally strategic nature of their choices and goals, and highlight the relevance of good governance or coordination in their implementation.

In this paper, the main focus of analysis is governmental capability and potential to not only reach technological parity with more advanced countries (catching-up) but, above all, wherever possible, to overcome the leaders (leapfrog) in certain industries or areas of knowledge – even if active leapfrogging to surpass the frontier leader is an unlikely phenomenon, as the structure that would enable this would also have enabled not falling behind in first place, and vice-versa; passive leapfrogging, such as African countries reaching online banking before traditional banking, does not enable overcoming the leaders at the frontier, only to reduce the gap. Therefore, the main objective of this study is to review State capabilities to formulate and implement innovative strategies and bypass and avoid pitfalls among middle-income countries, namely Brazil, China and Argentina (Angang, 2003; Wade, 2012).

A comparison is done among middle-income countries through a review with cross-fertilization potential, i.e. capable of generating knowledge that may be relevant not only for strategic decision-making processes, but also for the governance of knowledge[2] on innovation policy. More than appointing an exemplary or model case for emulation,[3] what is striven here is to examine the extent case studies suggest challenges or reveal impasses and bottlenecks that will hinder Brazil from to best applying existent institutional advantages during the design and implementation of innovation policies.

For an appraisal of decision-making processes regarding science, technology and innovation policies, this study will consider:

- the complex institutional architecture of the national innovation systems wherein such strategies are formulated – which institutions support them, and how is knowledge governance coordinated,[4] in Brazil, Argentina and China;
- the relation between the decision-making level and the supporting structure – research institutes, think tanks, universities, among others – i.e the institutional structure that supports the strategic decisions;
- the existence, or lack thereof, of an effort to carry out technological foresight;
- the governance structures and relations of power, where these are discernable; and
- the conventions, shared beliefs, and consensuses behind the visions of the future that influence the overall direction and choices made.

2 On this concept, see Burlamaqui, Castro and Kattel (2012).

3 The notion of *exemplary case* is in stark contrast to the belief that paths are multiple, that trajectories are dependent on the past, and that variety is conducive to the development of creative solutions. 'Institutional monoculture', as Evans warned (1993), is harmful and vicious.

4 The set of institutions and policies that regulate the production, dissemination, use, and protection of knowledge. The study focuses, based on a comparison among these three countries, on the industrial and technological policies, national innovation systems, competition regulation, and the intellectual property protection system in place and the legal framework that defines it. See Burlamaqui, Castro and Kattel (2012).

Field research was conducted in the three countries, through a questionnaire built upon the assumptions listed below.

1. The learning processes that occur in national innovation systems are inseparable from the international experience in that technological field. In this sense, national innovation systems should consider global innovation and networked technology generation processes: international experience counts.
2. The institutional diversity characteristic of each case study is relevant to explain their different trajectories and each State's capability regarding its technological policy.
3. Geography carries explanatory power, in that it reveals a particular allocation of resources. Furthermore, industrial chains, even though adopting international standards, have national characteristics. Institutions are essentially national and local, resulting in singularities that would be missed if abiding by hypotheses of globalized processes and products. Finally, history and trajectory count; there is noticeable path-dependence.
4. The participation of domestic companies in global value chains does not ensure their technological catching-up. Their success will depend on the value chain, and the position the company occupies in the overall production process.
5. Science, technology and innovation policies have a prospective dimension and reveal shared beliefs, expressed in the innovation strategies for the future within each country. Considerations for a low carbon economy and sustainable development are recurrent and widespread. These conventions could be summarized, particularly in the Brazilian and Chinese cases, as *promoting sustainable development with social inclusion.*

2. THEORETICAL AND CONCEPTUAL INSPIRATION

According to Celina Souza, regarding the definition of State capabilities: 'Simply put, one may define State capability as a set of tools and institutions

available to a State to set goals, shape them into policies, and implement them' (Souza, 2015, p.8),[5] or, according to Evans (1993), a State's capacity for *action*.

Regarding the definition of State capability, specifically policy implementation capacity, the following definition is extremely useful – especially when it comes to innovation (Karo and Kattel, 2014): 'Policy capacity - three interlinked policy choices: nature and sources of technical change and innovation; funding economic growth; public management to deliver and implement policy choices. It is not a continuum of abilities but rather a variety of modes of making policy'.

As mentioned above, a state's capability to formulate, drive, implement and, in some cases, evaluate science, technology and innovation policy is the theme of this paper. The goal is to compare state and policy-driving capacities in the national innovation systems in Brazil, China and Argentina, to the extent that they shed light on the identified dimensions: institutions, strategies, coordination mechanisms, funding, and implementation of innovation policies. As observed by Evans (2011, our italics), comparisons in this case are relevant 'for looking at how innovation is actually organized *and how it might be organized better*'.

The most recent literature on innovation and its public systems emphasizes the role of the entrepreneurial State and its fundamental contribution to the development of middle-income country policies, and also of developed countries such as the US (Weiss, 2014; Mazzucato, 2013; Block and Keller, 2011; Primi, 2014). This literature, with robust interpretative power, contributes to building consensus around the role of innovation in catching-up and leapfrogging processes in developing countries. However, these processes are vulnerable to being ensnared

5 'Considering the concept's comprehensive scope, a breakdown of its components could help guide empirical application. The *political* component concerns the "rules of the game" that govern political, social and economic behavior. Worthy of note here are the formal and informal institutions that influence the political party system; Executive-Legislative relations; and the channels of intermediation of interests and of conflict resolution. The *public policy* component concerns the *institutions* and *strategies* that influence *policy* decisions, their formulation and execution. This component comprises (a) the identification of the main characteristics of the systems that govern specific policies; (b) analyses of the specific political trajectories; (c) *maps of the intra-governmental coordination mechanisms, or of executive coordination*; (d) the construction of the bureaucratic capacity and of degree of professionalization of the bureaucracy, to assess the conditions under which policies are formulated and implemented; and (e) the fiscal and tax system, i.e. income and expenses, to assess a State's ability to levy taxes in order to fund policies, for the provision of public goods, and the redistribution of income between different social groups' (Souza, 2012).

in the technological pitfalls most common among countries under rapid productive transformation. Industrial policy – and with it, the innovation policy – has been considered key to overcome the so-called developmental threshold.

Wade (2012, pp. 223–240) states:

> Industrial policy can be seen as a strategy of the State, from a medium to long term perspective, with the goal of promoting new technological and industrial capacities in companies of a higher order than already existing in the economy and beyond what so-called market forces could promote. These capacities determine productivity, the quality of products and ability to eliminate product lines or introduce new products or processes and, therefore, determine the capacity of competing with other companies in other economy, especially in the third wave of globalization we are experiencing.

In this journey, innovation as a core component of developmental industrial policy seems to be crucial for success; perhaps even, metaphorically, the very key to open the gate that separates developed from developing countries. Countries that have crossed this threshold were capable of reaching the technological frontier, in the most important industries of their economies. Moreover, these countries are in many cases those that today effectively define the technological frontier in these industries.

Topics such as those developed by Coriat, Orsi and Weinstein (2002),[6] above all the existence of a technological paradigm strongly based on science (classified as *science based 2*), are important for the analysis of national science, technology and innovation systems. In industries on the technological frontier such as biotechnology and information technology, financial dimensions (capital markets) and intellectual property (the local relevance of patents and of the intellectual property system) are inextricably intertwined, are all integral components of the new paradigm.

The same may be said of the concept of *secondary innovation*, developed by Wu, Ma and Xu (2010), which places at the center of the discussion the education and training (Teece, 2009) required to ensure that middle-income countries will not be jeopardized by the pitfalls at the technological frontier. There are at least three

6 The classification proposed by the authors is rooted in the seminal paper by Pavitt (2005), which defines these industries as 'science-based, scale-intensive, and supply-driven'.

considerations regarding the technological pitfalls that middle-income countries must overcome. The first refers to the position of industries and companies in some countries as suppliers (subcontractors) in a given global value chain (Wade, 1997). In this case, the trap lies in their difficulties with technological qualification, and the hindrance that derives from their position within the value chain. Even technological catching-up seems difficult to attain, even when becoming the main objective to be sought. This goal is facilitated by the fact that these technological paths are well known, having been trodden by leading countries. At the opposite end of the scale are the industries and companies with the ability to not only keep up with, but to overcome technologically, the countries trailblazing the frontier. This was, or might still come to be, the situation of the few countries that have been capable of crossing the threshold of technological development. In an intermediate situation are countries such as Brazil and China, where some industries already are at the technological frontier – in Brazil, low-carbon tropical agriculture, deepwater oil prospecting and production, and small and medium aircraft production, for example – while other industries definitely cannot claim international competitiveness. In these cases, the coexistence of paths called *secondary innovation* is possible.

When the technological trajectory is not yet fully defined in a particular industry sector, according to Wu, Ma and Xu (2010), countries may move in different ways or through alternative paths, but tend to come across limits in their technical expertise – situations characterized as crises in the development process. When these limits are overcome, a national trajectory comprising a particular correlation of factors is established, providing the country with a competitive advantage with which to blaze ahead. Innovation and the national system in which it is embedded seem to be the 'trick' or secret to enable the industries where a country enjoys comparative institutional advantage to reach the technological frontier. This is another element that the comparative analysis among Brazil, China and Argentina sought to pinpoint.

This seems most all the more likely to occur when the structuring of a consensus is plausible – or rather, where structured consensus is present – regarding (*a*) which industries should be encouraged and promoted by the entrepreneurial

State,[7] (*b*) where exactly does the innovative frontier lie and (*c*) which countries have attained it. The compared case studies seems to suggest this consensus-structuring process depends on (*i*) the existence of a supporting infrastructure of institutions capable of carrying out prospective and retrospective studies, which are in turn actually taken into account during the decision-making process; (*ii*) the continuous exercise of technological foresight, subject to periodic review; (*iii*) the capacity to take into account the conflicting interests among stakeholders, but also to neutralize them after structured consensus is built; and finally, (*iv*) a financial system is present to fund innovation – a necessary condition, but which must be subject to effectiveness reviews. This is not about the need for, returning to Karo and Kattel (2014), a *continuum of skills* or competencies but, above all, a variety of decision-making processes regarding the long-term strategies, and of proper coordination during the elaboration and implementation of technological policies.

3. COMPARED INSTITUTIONAL ARCHITECTURES OF THE NATIONAL SYSTEMS FOR SCIENCE, TECHNOLOGY AND INNOVATION: BRAZIL, ARGENTINA AND CHINA

3.1 – Design and legal framework

When comparing the institutional architecture of the national systems for science, technology and innovation in the three countries, the methodological approach taken this study, it may be pointed out that Brazil has by far, taken as a whole, the most complex and articulate institutional arrangement, compared to those in Argentina and China.

In Argentina, the arrangement of components is similar to that in Brazil; nevertheless, the entire structure is at an earlier stage of construction, but revealing a similar configuration when envisioning the near future.

In the case of China, the institutional design, or architecture, does not seem to reveal the existing, and possibly effective, decision-making ability – much less its characteristic *consensus-structuring* process on the innovation strategies to be

[7] The structuring of a consensus on which industries shall be primarily supported by the innovation policy is not, to be sure, the only possible strategy, but it seems necessary or at least the most effective in middle-income countries. In countries such as the United States, as Block and Keller (2011) pointed out, the consensus is to support companies at all technological frontiers, wherever these may be.

adopted – which will be seen as follows, a unique characteristic, and a definite strong point.

The complex Brazilian institutional architecture – it must be pointed out once more, more complete than those in Argentina and China[8] – characterizes its national innovation system (annex figure A.1). As an example of how the system's coordination or governance evolves, there is, in Brazil, a National Council for Industrial Development (Conselho Nacional de Desenvolvimento Industrial, CNDI),[9] established by the 'Greater Brazil' Plan (Plano Brasil Maior, PBM – 'Greater' in this sense meaning not spatially, as an extended area such as commonly used in metropolises, but 'Bigger' in the temporal sense of inducing growth), which seeks to integrate the several different interests in the formulation of innovation policies.

First of all, the importance must be noted, starting in the 1950s, of a research generation system with emphasis on the education of qualified personnel. The structure of the Brazilian SNCTI (Sistema Nacional de Ciência, Tecnologia e Inovação – National System for Science, Technology and Innovation,) sought to integrate educational, research and innovation funding systems; the latter is composed mainly of the National Bank for Economic and Social Development (Banco Nacional de Desenvolvimento Econômico e Social, BNDES), the Funding Authority of Studies and Projects (Financiadora de Estudos e Projetos, Finep)

8 It can be said that the concern with agricultural innovation and world leadership in tropical agriculture dates from remote periods of Brazilian economic history, including the sugarcane (ca 1550–1750) and coffee (ca 1830–1930) cycles of. In this regard, see Castro (1976).

9 The CNDI is structured as follows: 'CNDI consists of thirteen ministers, the President of National Bank for Economic and Social Development (BNDES) and fourteen representatives of civil society, and has the function of establishing the general strategic guidelines and support the management system's activities. Competitiveness Councils – the management committee is the body that monitors and supervises the implementation of the "Greater Brazil" (PBM) program, while the executive secretariat handles administration. The two are coordinated by MDIC, the Ministry of Development, Industry and Foreign Trade. The secretariat's duties include establishing Executive Committees and Sector Competitiveness Councils, the former competitiveness forums. The members of Competitiveness Councils are appointed by the Production Development secretariat in MDIC, in partnership with the private sector. The group is responsible for the deployment of objectives and for strategic guidance of PBM regarding their industry's value chains. The Brazilian Agency for Industrial Development (ABDI) is responsible for administrative support to the Steering Committee, the Executive Secretariat, and the CNDI'.

and 'sector' or industry-specific funds,[10] the National Council for Scientific and Technological Development (Conselho Nacional de Desenvolvimento Científico e Tecnológico, CNPq) and the Higher Education Personnel Improvement Coordination (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, CAPES).

As the systems in Argentina (figure A.2) and China (figure A.3), the Brazilian arrangement has a legal framework composed of several laws and decrees.

In Brazil, the legal framework has been established since 1951 with the creation of CNPq and CAPES (Box 1, below). In this sense, the building of a national science and technology system occurred early, compared to Argentina.[11] In the case of China, the current framework is far more recent than the Brazilian, but on the other hand the tradition of innovation remounts to ancient Chinese history.[12]

The Argentine legal framework (Box 2), by contrast, has much more recent changes, and is marked by high discontinuity. The Argentine arrangement has, today, the following principal elements:

- an Intellectual Property Law of 1996, similar to Brazil's and passed the same year, both under the umbrella of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS); and

[10] The Sector Funds of Science and Technology, created in 1999, are funding instruments for research, development and innovation. There are 16 Sector Funds, 14 industry-specific and two 'transverse', the first focused on university-company interaction (Fundo Verde-Amarelo, FVA), the second intended to support the improvement of the infrastructure of ICTs (Science and Technology Institutes). Revenue derives from contributions levied on the exploitation of natural resources belonging to the Union, tax on Industrialized Products (VAT) of certain sectors, and Intervention Contribution in the Economic Domain (CIDE) levied on the acquisition of technology transfers from abroad. Except for the Fund for the Technological Development of Telecommunications (FUNTTEL), managed by the Ministry of Communications, the resources of the other funds are allocated to the FNDCT and managed by Finep through its Executive Secretariat. The Sector Funds were created as additional funding sources for the development of sectors strategic for the country. http://www.finep.gov.br/a-finep-externo/fontes-de-recurso/fundos-setoriais/o-que-sao-fundos-setoriais

[11] Concern with technological progress has been present since the end of the sugarcane cycle, in the late eighteenth century, in the Brazilian Colonial period, with the modernization of sugar mills. The introduction of machines in coffee processing, and of systematic agricultural research for export products, were done precociously by research institutes, such as the Agronomic Institute of Campinas, founded in 1887 by Emperor Dom Pedro II.

[12] In this regard, see the classic *The Man Who Loved China* (Winchester, 2008).

- an Innovation Law of 2002, which redefines the Science, Technology and Innovation System and creates the Technological Scientific Office (Gabinete Científico Tecnológico, GACTEC) – another law similar to its Brazilian counterpart.

Box 1. Legal framework of the National Innovation System (Sistema Nacional de Inovação, SNI) in Brazil – main laws and decrees (1951–2011)

1) Law 1310, of 01/15/1951. Creates **CNPq**, then called National Research Council, and has as primary responsibility to coordinate and stimulate national scientific research.

2) Decree 29741 of 11/07/1951, creates **CAPES**, whose acronym originally meant National Campaign for Higher Education Personnel Training, in order to "ensure the availability of qualified personnel in sufficient quantity and quality to meet the needs of public and private enterprises aimed at the development of the country" (Decree No. 29741/1951, art. 2, item A).

3) Decree 61056 of 07/24/1967, creates **Finep**.

4) Decree 1808, of 02/07/1996, passes Finep's Statute or by-laws.

5) Decree 9146 of 03/15/1985, creates the **Ministry of Science and Technology**.

6) Law 9257 of 01/09/1996, creates the National Council of Science and Technology (Conselho Nacional de Ciência e Tecnologia, **CCT**) as an advisory body to the Presidency.

7) Decree 4728 of 06/09/2003, passes the Statute and the Decree 4728 of 06/09/2003, with CNPq by-laws and organizational chart.

8) Law 10973 of 12/02/2004, the **Innovation Act**, with incentives for investment funds for innovation; regulates the relationship between universities, research institutions and companies.

9) Law 11080 12/30/2004, creates the Brazilian Industrial Development Agency (Agência Brasileira de Desenvolvimento Industrial, **ABDI**). It was regulated by Decree No. 5.353, of 01/24/2005 which also created the Brazilian Industrial Development Council (Conselho Nacional de Desenvolvimento Industrial, **CNDI**), advising the President and recommends national policies and measures to promote industrial development.

10) Law 11196 of 11/21/2005, the Technological Goodwill Law or Lei do Bem, established tax incentives for innovation. However, this law was repealed under austerity measures in 2016.

11) Decree 5563 of 10/11/2005, regulates the Tax Incentives for Innovation Law (Law 10973 of 2/2004).

12) Decree 7540 of 2/11/2011, creates the PBM program and regulates a new CNDI responsible for managing the PBM.

Source: *Red de Indicadores de Ciencia y Tecnología* (RICYT).

Box 2. Legal framework of the Argentine SNI: main laws and decrees (1996–2007)

1) Law 25,030 / 1996. **Intellectual Property** Law.

2) Law 25,457 / 2002. Determines the institutional structure of the **National Science and Technology System**.

3) Law 25,922 / 2004. Law for the Promotion of the **Software Industry**.

4) Decree No. 380/2005. Creates the Argentine **Nanotechnology Foundation**.

5) Law 26,270 / 2007. Modern **Biotechnologies** Development Law.

Source: RICYT.

These laws are complemented by decrees that either introduce or strengthen forms of scientific assessment, instruments such as government procurement policy, and public-private partnerships (PPPs).[13]

3.2 – The importance of innovation funding as a SNCTI requirement

The Brazilian SNCTI framework sought to integrate, as has been shown above, the educational system (public and private universities), research institutions, and funding sources for innovation through BNDES, Finep and industry and sector funds managed by the Ministry of Science, Technology and Innovation (MCTI). In this sense, defining the funding sources for science, technology and innovation activities is an explicit and, from the angle of the legal framework, an integral and distinctive trait of the Brazilian institutional architecture. This does not occur in the cases of Argentina and China - even though the latter funds innovation far more effectively, with much less red tape and hassle. Even though resource sources in Brazil are formally defined, in practice they already were scant and highly bureaucratic to acess, even before the profound institutional, political and economic crisis the country faces, starting in 2015.

In the Chinese case, the funding sources are not explicitly shown in the innovation system's organizational charts, which however does not seem to represent an obstacle to innovation funding, because funding is provided directly via the banking system. The proximity of the agencies with companies at the

13 Information extracted from the interview with Fernando Peirano, Secretary for Science Policy, Technology and Innovation of Argentina.

national, sector, regional, and especially the local level, ensures funding, provided that the companies:

- have been positively evaluated with regard to their actual contribution to China's technological and industrial development;
- operate within the industries elected as a priority; and
- are preferably state-owned, or are partners of state-owned companies.

This structure lends support to the conclusion that (product or process) innovation is the starting point for the Chinese funding process. In this sense, the company is the relevant unit of analysis – particularly, of course, state-owned companies. This is undoubtedly a difference to be emphasized.

Innovation funding, by contrast, is identified as a definite weakness in the Argentine system. In this case,[14] a proper innovation funding system integrated to the institutional architecture is absent, as can be seen in figure A.2 in the annex. Only starting in the Plano Argentina Inovadora 2020 has strengthening the national technological system been sought – rendering it coherent, bringing it closer to the productive industrial apparatus. Recently, Argentine sector funds were created. Unlike the Brazilian sector funds, negotiated during the privatization of state companies and based on contributions from these companies, Argentine sector funds are financed by multilateral credit agencies such as the Inter-American Development Bank (IDB) for the industries, and the World Bank, for general purpose technologies.[15] Also, there are college-funding programs to educate the

14 This was explained during an interview with Argentina's Minister of Science, Technology and Productive Innovation, Lino Barañao.

15 These are associative instruments split between the public and private sectors, with ample resources (between $5 million and $10 million per project) for initiatives that are implemented through public-private consortia (universities and companies). This is one of the requirements to be eligible for financing. The other is that the result of the initiative produces as a counterpart a marketable product. The projects have an expected duration of four years, and its assessors are international. In turn, funding by multilateral organizations has decreased over time, since the latter became discredited after the 1990s. The Development Bank of Latin America (Corporacion Andina de Fomento, CAF) is gaining enough prominence in recent years. Concerning government procurement, it is not geared to productive innovation. This information was extracted in an interview with Fernando Peirano, Secretary for Science Policy, Technology and Productive Innovation; and Ruth Lanheim, Secretary of Planning and Policies of the Ministry of Science, Technology and Productive Innovation.

so-called *technology managers*, through the Fondo Argentino Sectorial (Fonarsec). As in Brazil, partnerships with the private sector are sought, to mitigate the shortage of funding for innovation. There is a significant limitation in Argentina of capital for funding projects, compounding to the shortage of human resources.[16] The opportunities identified in science and technology are hindered, to a point, by the limitations in State capability to pursue them – whether through failure in intrastate liaising, management of innovation projects, or shortage of trained personnel.

In the Brazilian context, in spite of the existence of a solid legal framework, established innovation funding institutions, available resources, and policies that seek to promote funding to companies, the actual, effective result is far from assured. The relation between government agencies and companies is very distant, in comparison with in the Chinese system. The requisite flexibility to tend to the companies is absent, as is an intersection between the demand and the supply of innovation funding. According to the interviews requirements and constraints, legal procedure, red tape, and controls are all too abundant, especially regarding the Courts of Auditors, equivalent to the General Accounting Office. There is an absence of new companies actually able to deliver what they promise. Regarding an explanation as to the causes of these anomalies, this will be seen below.

The Chinese case is quite exemplary in this respect. Regarding the implementation of the Twelfth Five-Year Plan, still in progress, and specifically its innovation policies, six dimensions are highlighted which set it apart from all previous Plans: first, it ensures the necessary and required capital investments – or rather, direct investments – are supported by corresponding indirect instruments such as tax credits and preferential tax policies.[17] The second difference is the emphasis on demand-side policies, to promote innovation activities. The third feature refers to an emphasis on the trade and industrialization of the research projects, that is, in their innovative dimension, which required marginal changes

16 Interview with Horace Cao, from the Instituto Universitário Ortega e Gasset.

17 By the end of 2012, spending on research and development of the entire economy reached ¥1.2 trillion, or slightly more than $300 billion in direct resources, added to another $100 billion in indirect resources. Information from the interview with the vice president of the Chinese Academy of Science and Technology for Development (Casted), Wang Yuan, and Professor Zhang Junfang.

in China's Law of Science and Technology. The fourth difference is an emphasis on the promotion of employment, on creating jobs, in the policy formulation process. The Chinese government introduced preferential policies for start-ups and small and medium enterprises. The fifth change are the new funding instruments, especially the promotion of innovations funding through the capital market: (*i*) new financial instruments and products to support start-up companies, from the beginning of research and development activities, up to the process of product incubation and funding; and (*ii*) the establishment of government guidance funds in different cities of China, such as Beijing, in order to reduce risk at an early stage, when venture capital is most necessary for a company.

With regard to the last point, the Association for the Promotion of Funding and Investment in Science and Technology conducts research on the required funding and investments. This institution is organized into two departments. The first is concerned with physical investments themselves and with tax policies, while the second is geared towards strengthening the banks and the capital market. Regarding investment, since 1985 the Chinese government seeks to connect science and technology with their financial aspect and the funding that will enable their pursuit. In 2007 a cooperation system was created bridging several science- and technology-intensive industries and the financial departments, not only of the central government, but also of local governments. Entrepreneurship-support policies, with an emphasis on funding in particular of small and medium companies, complement the support framework.

4. COMPARED STATE CAPABILITIES IN THE SCIENCE, TECHNOLOGY AND INNOVATION SYSTEMS: BRAZIL, ARGENTINA AND CHINA

4.1 – General questions

In Brazil, the ministries' performance[18] on behalf of innovation occurs through the research and development government agencies. Essentially their research institutes, which operate on Open Innovation principles,[19] integrating

[18] MCT; MDIC; Ministry of Agriculture, Livestock and Supply (MAPA); Ministry of Mines and Energy (MME); Ministry of Health (MOH); and Ministry of Defense (MD).

[19] See, in this regard, Chesbrough (2006).

the research centers of the institution or ministry itself, universities – in specific occasions – and, eventually, companies. As an example, we could cite:

- the Ministry of the Environment, through the Leopoldo Americo Miguez de Mello Research Center (Cenpes), Petrobras, and Eletrobras' Center for Electric Energy Research (Cepel);
- the Ministry of Agriculture, through the Brazilian Agricultural Research Company (Embrapa);
- the Ministry of Health, through the Oswaldo Cruz Foundation (Fiocruz);
- the Ministry of Defense, through the Air Force Technical Center, of Nuclebras Heavy Equipment (Nuclep), and the Army Technology Center; and
- the Ministry of Industry and Trade, through various institutions belonging to its structure – the National Institute for Industrial Property (INPI), the National Institute for Metrology, Standardization and Industrial Quality (Inmetro), the National Institute for Technology (INT), among others – as may be seen on the right side of figure A.1 in the annex.

In Brazil, the role of government agencies such as the Center for Strategic Management and Studies (CGEE) and ABDI is exercised, amongst other triggers, by the commissioning of relevant systemic studies, mainly retrospective, on the characteristics and challenges the Brazilian innovation process faces or has faced. However, pending better judgment, the level of synergy observed in China is clearly absent – among the studies, consensus building and strategic choice of industries to be supported.[20] Recent programs such as Finep's Inova Empresa may be changing this perception. However, the relationship between the advisement rearguard with its studies and projects, and the strategic decision-making leadership, does not seem to exhibit the same behaviour or the same level of synergy. Processes are slow, bureaucratic, and arbitrary.

Comparison with the Argentine system illustrated in figure A.2 in the annex, reveals the following differences: (*i*) the presence of the Argentine Ministry of Foreign Affairs, which does not happen in Brazil, in the National Commission

[20] It was not possible to assess the Argentine case in this regard, because the interviews took place before the fieldwork in China, where this hypothesis was developed.

on Space Activities and the Argentine Antarctic Institute – while the equivalent Brazilian agencies are connected to Defense or Development; and (*ii*) lower structural complexity of Argentine research and development agencies, more recent than their Brazilian counterparts.

China has a more centralized structure, in which the main ministries that coordinate research and development activities are, basically, the Ministry of Science and Technology (MOST), responsible for the National Science and Technology Program, and the Ministry of Education (MOE). The other ministries are represented by the scientific academies, such as the Chinese Academy of Science (CAS) and, to a lesser extent, the Chinese Academy of Social Science (CASS). The coordinating role of China's National Natural Science Foundation is the key to the governance of knowledge in China.

Two important differences between Brazil and China are worthy of note. First, the science and technology government agencies in Brazil, connected to the ministries, enjoy relative autonomy, and are undeniably centers of production of innovation, in many cases producing the knowledge of the frontier of their respective fields. Embrapa and Cenpes, in particular, among the several public research companies, are acknowledged as world leaders in their fields – low-carbon tropical agriculture and deepwater oil production.

In the Chinese case, according to interviews, coordination is done through MOST, through CASTED (Chinese Academy of Science and Technology for Development) and CAS, which act as think tanks. It is responsible for the non-obvious task of integrating all technology foresight activities under a single strategic long-term vision, embodied in the choices on the supported industries and technologies. What is emphasized here is that the tighter, more coherent coordination that occurs, in principle, in a system where the knowledge governance and strategic coordination are two sides of the same coin, a structure which seems more effective. The construction of structured consensuses depends on this interaction between foresight exercises and strategic choices. This process is what Angang (2003) calls *collective presidency*.

The second difference is that the integration between government agencies and college education is being built, in Brazil, in a sporadic manner. This connection

- involving public research companies, federal and state government research institutes, and state universities and research support foundations – has depended on special programs, projects and actions by initiative of research institutes, which have enabled the little that has been achieved in this direction.

Paradigmatic, showcase, noteworthy examples include the Crop Consortia (coffee, sugarcane, soy) coordinated by Embrapa, which join universities, institutions, and several stakeholders. The coffee consortium joins over fifty institutions, with many different objectives. The agreement between Cenpes and the Federal University of Rio de Janeiro (UFRJ) is another case in point. This partnership provides funding for postgraduate scholarships – for the education of human resources in oil and gas – as well as research on deepwater prospecting, drilling and production, done in partnership with universities and institutes. One of the programs supported by the consortium is UFRJ's ocean research program.

Accepting the representation described in figure A.1 in the annex, the Brazilian university system, represented on the left side of the figure, does not spontaneously connect with government R & D (research and development) agencies, located on the right side of illustration. Of course, the autonomy and management of graduate education cannot be subject to the whims of medium-term government plans, which may change in emphasis according to policy, and to programmatic government strategies. Strictly speaking, CAPES seeks to mitigate this trend by launching programs and projects of interest to ministries and agencies, guiding graduate research in the direction of desirable long-term goals.

Up to this point, a comparison was sought of the most preeminent knowledge governance structures in the SNCTI architectures (National Systems for Science, Technology and Innovation). The following subsection highlights the key aspects of the strategic decision-making and government coordination processes, noting their similarities and differences and, particularly, seeking to determine comparative institutional advantages and disadvantages among the countries.

4.2 – Decision-making processes and governmental coordination

With regard to a comparison among the institutional architectures of the national innovation systems, the dimension or aspect that most closely converges with the main objective of this study – the coordination of decision-making for

innovation policies – sheds light on their comparative State capabilities. The figures presented in the annex, and in particular the interviews, are the main grounds for the following analysis. Within lies highly relevant material for understanding what is effective, and what is not, in the conduct of science, technology and innovation policy. What is sought is to understand how State capabilities to formulate and implement strategies for institutional change and innovation will reflect and determine this process. In this sense, through the greater or lesser coordination of strategic decisions, it is possible to clarify their compared State capacities to formulate and implement innovation policies, and identify the comparative institutional advantages that each country was able to build.

Regarding this last issue, some specificities from each country are deserving of mention in the next subsections.[21]

4.2.1 Brazil

First of all, it is necessary to cast a glance upon the governance structure and coordination of the PBM, wherein management and decision-making occurs at the MCTI. Figure A.4 in the annex details in first place the levels of (*i*) senior advising, (*ii*) management and decision-making and (*iii*) liaising and detailing. However, fieldwork results suggest that systemic coordination seems to act more in an advisory capacity, recommending policy directions, than effectively in the formulation and coordination of policies, in stark contrast to the Chinese practice. There is a high degree of autonomy at the decision-making management level. This feature seems common to the three cases. What sets them apart, perhaps, is the degree of influence on the strategic decisions that the advising structure seems to hold. Coalitions of interest are relevant for pipelining of indications from the industry-specific instances and institute coordinations to the higher advising level – in Brazil through the CNDI, whose management is the President's responsibility.

The CNDI consists of thirteen ministers, the BNDES's president and fourteen representatives of civil society. Its function is to establish general strategic guidelines and support the management system's activities. The Competitiveness

21 This last point, in fact central in our analysis, will be approached from a comparison Brazil-China (subsections 4.2.1 and 4.2.2), because we understand that our fieldwork in Argentina was insufficient to clarify the strategic decision-making processes.

Councils – their steering committees being the supervision and monitoring body, overseeing plan implementation – rely on an executive secretariat responsible for system management, all of which is coordinated by the MDIC.

Among the duties of the executive secretariat are the creation of executive committees and industry-specific Competitiveness Councils, the former competitiveness forums. The members of the competitiveness councils are appointed by the Production Development Secretariat of the MDIC in partnership with the private sector. As a whole, the group is responsible for the breakdown of the objectives, and the strategic direction of PBM within their industry's value chains. ABDI is responsible for administrative support to the steering committee, the executive secretariat, and the CNDI.[22]

With regard to the vision of the future contained in the PBM, which exercises a coordinating role in decision-making processes, it is inferred that the plan sought further integration of industrial policy along the axes of the Brazilian chains that have proven more dynamic, focusing on short-term bottlenecks but, supposedly, with a prospective vision. However, it must be observed that the PBM was in force before the current political and economic crises, and before the investment-slashing law PEC 241 which severely curtails State outlays, passed by the current non-elected administration. Their effects on the PBM must be evaluated – and it is likely that the PBM has been, in effect, revoked.

Regarding the addressed bottlenecks the foremost priority seems to be the qualification of human resources for the manufacturing industries. There is a permanent investment in capital that not necessarily finds a counterpart in human resources. There is clearly a gap in human resources in Brazil, as in Argentina, in the latter a more extensive one. The industrial structure does not induce, or produce, significant human resources training. The increase in investment entails in formation of fixed capital, which is renewed but suffers rapid obsolescence. Rapid loss of competitiveness tends to occur, with the upgrade of machinery and equipment without the necessary technological capability to skip steps, obtain new patents, or create intangible assets, resulting in a set of innovations that generates

22 The PBM's website contains relevant information on its operation - <http://www.brasilmaior.mdic.gov.br/noticias/1017>. Accessed: 13 May 2014.

lower value at the technological frontier and quickly loses its additional added value.

In second place, the Brazilian economy remains specialized in the exploitation of natural resources – some requiring high technological capability, others less so – but the specialization in primary resources is incontestable. Part of the equipment and capital goods, as well as the microelectronics, are imported. Dependence on certain imports contributes to low generation of positive externalities and an incomplete productive structure.[23] There is also a great heterogeneity in the Brazilian productive structure, in which low-tech industries coexist with high-tech ones. Labour is still largely unskilled, and rarely will the machinery and equipment industry lie at the technological frontier.

As shown in the figure A.4, systemic coordination and industry-specific bodies – executive committees and competitiveness councils – lie on the liaising and detailing level of strategies and policies. These dimensions that appear in the figure – foreign trade; investment; innovation; education and professional qualifications; sustainable production; strengthening of small businesses; special action for regional development; and consumer welfare – are all on the innovation policy agenda, but is in fact at the policy management and decision-making level that the major decisions are taken, often in an isolated, arbitrary manner. In fact, the CNDI, under the coordination of the Presidency is the PBM's decision-making body, to which the industrial, technological and innovation policies are subordinated.

In figure A.5, Governance of the Inova Empresa (Company Innovation) Plan, the same observation as before applies. The steering committee, formed by the Chief of Staff, MCTI, MDIC, Treasury Department, and the Secretary for Medium and Small Enterprises, is responsible for the guidelines, monitoring and evaluation of the plan, and decision-making and coordination. The executors of the Inova Empresa Plan – BNDES, Finep, and partners – are the main Brazilian institutions for funding investment and innovation. Once again, funding innovation is an

23 One interviewee cited the example of the livestock: 'For example, Brazil has the largest herd in the world, insertion in exports as well as imports. But this does not necessarily generate positive externalities, and may even generate negative ones such as deforestation, and does not complete the productive structure'.

integral and fundamental part of the plan – which does not necessarily ensure, however, that its modus operandi will ensure agility and flexibility during implementation. The 'Innovation Room' seems to be the locus of manifestation of interest, both by companies and business associations, and it is this instance that conflicts of interest are handled and coalitions architected.

Neither in figure A.4 nor in figure A.5 will one find or envision science and technology's role as a supporting rearguard behind production, carried out by government institutions for research and development, nor any role that private sector research institutes could play. This feature contrasts glaringly with organizational routines and decision-making processes in China – as in Argentina – as we shall see. This seems to be the main difference between the experiences in China and in Brazil, and this poses an undeniable institutional comparative advantage for China:[24] a solid supporting research rear-guard, rooted in strategic decision-making.

The decision-making and the liaising among the several different instances and levels in Brazilian innovation policy-making may be described as follows. Initially (1990–2000s), the board that makes the main decisions had not been formally appointed, but this was subsequently formalized. At first, the council was formed by the of BNDES's president and board, Finep, MCTI and its executive secretariat, Embrapa, the Ministry of Development (MD), MDIC and the Ministry of Communication.

The Executive Committee of the PBM is scheduled to meet every two or three months to assess ongoing policies and outline future proposals, seeking to accommodate all ministerial bodies. In the case of innovation, the Systemic Committee for Innovation draws policy from the findings of the industry-specific committees endorsing, in principle, those pertaining innovation and making any necessary adjustments. The Executive Secretariat is the dispute settlement body, responsible for periodically summoning the ministry secretariats. The Chief of Staff of the Presidency is the liaising and dialogue instance, which takes place between the Chief of Staff, the MCTI, MDIC and BNDES. CGEE (Centro de Gestão e Estudos Estratégicos, Strategic Studies and Management Center) and

[24] The concept is discussed by Coriat and Weinstein (2002).

ABDI work together with the Executive Coordination of the 'Greater Brazil' Plan. The main executors of the plan are BNDES, Finep, the MCTI and the MDIC. The Treasury Department has the power to summon and define government proposals.

Finally, the governance of the National Fund for Scientific and Technological Development (Fundo Nacional de Desenvolvimento Científico e Tecnológico, FNDCT) is somewhat complex with regard to the interaction among resources, grants, policy – making and decision-making – figure A.6 in the annex illustrates the process.

Conflicts within the bureaucratic structure exist, largely, as a result of the conflict between the demand for innovation and the choice of strategic industries to be privileged. The Chief of Staff is the final arbiter, connected to the Presidency, choosing topics and industries, examining policy measures and expenses. The negotiating and conflict resolution process does not only include the concerned ministries; the Treasury Department also exerts discretionary power.

4.2.2 China

The Chinese case bears very specific characteristics, which are key for understanding the construction of their comparative institutional advantage. It is important to note that the mere architecture of the Chinese innovation system, described in figure A.3 in the annex, does not reveal these peculiarities. We started out with the hypothesis that technological choices in China were geared towards catching up with the technical frontier dictated by the United States, and in this sense, parity was originally its main objective. However, the concept of *endogenous innovation*, which has guided the formulation of innovation policy in China, contrasts with the notion of a process of mirroring external sources. On a smaller scale, one may question the existence of so-called national standards, or if the concept of 'endogenous innovation' is used as a policy tool.

The main conclusion reached during field research is that the Chinese innovation system successfully reverts – or rather, subverts – the structure that has been described thus far, characterizing the Brazilian and Argentine systems. The technological innovation that emerges from their economic system is at the top of the innovative system, and not its base. Private and public research is not at the point of arrival, but of departure, of the process. The second layer of the

system is the strategic decision advising apparatus, exercised by research institutes, think tanks, universities, and other entities. The strategic choice-making process is the result of consensus building, of a collective creation process of structured consensus.[25] And herein lies their greatest contribution to innovation policy theory.

The Chinese national innovation system, based on the allocation and distribution of science and technology resources, may be characterized, according to the structured consensus on this system, by its five constituent parts, as follows.

1. The technological innovation system. The Chinese government supports the principle that companies should play a leading role in innovation activities, and believes that the market should guide innovation, which should integrate universities and research institutes. This consists of innovative companies, technological innovation consortia, and technology innovation platforms.
2. The production of scientific knowledge, led by universities and academies, such as the Chinese Academy of Sciences.
3. The National Defense System, based on civil and military use. It is focused on development, sharing and usage, and focuses on dual-use technology for civilian and military purposes.
4. The regional innovation apparatus, based on different regions and their distinct needs for economic and social development. In these cases, there are different science and technology resources. For example, the eastern region is very different from the western region, thus their respective regional innovation systems are quite different.
5. Action through science and technology platforms, such as science and technology parks, promotion centers, and incubators. The goal is to commercialize and industrialize research results, and put them on the market.

From the point of view of decision-making, MOST (Ministry of Science and Technology) practices routine consultation with provincial governments and other ministries, on a regular basis. The purpose of the query is solving the

25 See, on this topic, Angang (2003).

problems faced by local governments. There is also an ongoing dialogue among the several departments of the central government. For example, MOST maintains a coordination mechanism with the Chinese banking system to guide banks in the promotion of innovation funding. There are also coordination mechanisms among public policies such as industrial, investment, import and export policies. These policies are formulated by different departments, and therefore must be coordinated to achieve common goals. Not necessarily will the prime minister or high-level government officials lead these processes; usually, they are conducted among different departments within the same hierarchical level in a natural, regular, ongoing manner. One would emphasize here the close, organic relation between research, think tanks, and strategy formulation, as this seems to be a unique trait that sets the Chinese system apart from the Brazilian and Argentine ones.

The five-year plans are characterized by a lengthy, comprehensive gestation and policy-making process. Full-scale plan reviews occur every five years, complemented by interim midterm assessments, which is currently done by key departments committed to the industries or issues under evaluation. In the recent past, however, when the Council of State made policies for science and technology, almost all the ministries had to be involved in the final decision process. Currently, the government holds meetings to collect opinions and recommendations from companies, universities and research centers – and even the public, through online participation through the Casted website. These reflections, it seems, actually subsidizes the decision-making processes, according to the interviewees.[26]

It is important to draw attention to this process, which corresponds to what has been called by Hu Angang, a main ideologist in the Chinese Communist Party and economist at Tsinghua University with great influence over policy, as *collective presidency*. According to the author, consensus building for policy through ample consultation is an important, fully institutionalized feature in the strategic

26 'And the great projects in the plan, such as the Strategic Emerging Industries project. I am also the head redactor of the two public policy documents relating to the development of strategic emerging industries. In this case, there were sixteen ministries. So we had several chances to meet with local governments and entrepreneurs through a consultation process. They took up two years to do it, from the beginning until the end, when the plan was formulated, perhaps more than two years'. Interview with Dr. Mu Rongping, CASTED.

decision-making process for industrial and science, technology and innovation policy.[27]

Regarding this issue, whether or not the consultation process is institutionalized, the think tanks are responsible for strategic studies for the development of science and technology, and of the emerging strategic industries, for the five upcoming years. The Five-Year Plan for Economic and Social Development, among the most important five-year plans, focuses specifically on the development of strategic emerging industries and specific (industry-specific) skills and capabilities required for innovation, science and technology. Thus, the plan is also implemented by research organizations such as CASTED.

China's Twelfth Five-Year Development Plan, regarding science and innovation, points to two sets of goals: (*i*) comprehensive – benchmarking with forty countries with relative technological leadership in certain industries, observing their trajectory and development trends; and (*ii*) specific – related to local development. Thus, global and national innovation indicators are compared, continuously monitored by CASTED – the institution responsible for producing and monitoring these indicators – and which acts as main think tank for the MOST, with eight different research institutes. The monitoring of countries with technological leadership in certain industries focuses, very reasonably, on the United States, Germany, Japan and South Korea and doubtlessly also takes into account geopolitical and therefore strategic issues.

As examples of specific science and technology industries and project funds, respondents cited the following cases:

- the manufacture of large aircraft, nuclear electric power generation reactors and integrated equipment, with investments of around ¥100 billion;

27 Angang (2003, p. 11) asks, 'There are also basic questions that concern the decision-making process. Where can we obtain information about decision making? Who makes the decisions? What methods or mechanisms should a decision maker use?' The two perspectives that inform the so-called 'collective presidency' are information gathering and the structure of knowledge in collective leadership. 'Therefore, is necessary for them to engage in frequent and full exchange of information to greatly reduce the asymmetry regarding information and knowledge and the accompanying uncertainty' (idem, ibidem).

- emerging new industries, using new materials;
- electronic vehicles and environmental protection industries;
- mobile telephony – companies like Huawei, Lenovo and Xiaomi are leaders in smartphone sales in China; and
- street lighting with LED lamps.

The plan is also concerned with improving the innovative capability of traditional industries, and has the objective of pursuing green manufacturing.[28] Another goal is the encouragement of science for the quality of life (clean water resources, health, and distance education, for example). The transformation of the national innovation system proposed in the Twelfth Five-Year Plan is based, therefore, on four points: (*i*) companies should play the leading role in the market; (*ii*) innovation coordination should comprise several different regions and agencies; (*iii*) the local level should be emphasized; and finally, (*iv*) institutional reform of government agencies should occur.

5. CONCLUSION

In summary, the following findings seem to point to the following comparative institutional advantages by China, and which are both cautionary and suggestive of paths, for Brazil and Argentina.

1. The Chinese innovation system inverts – or rather subverts – the Brazilian and Argentine systems' modus operandi. The technological innovation that emerges from the real economic system *is at the top of the innovation system, and not at its base*. Private and public research is not the point of arrival, but of departure.
2. The second layer of the system is an advising apparatus for strategic decision-making, exercised by research institutes, think tanks and universities, among others. The comprehensive consensus-building process involved in the concept of 'collective presidency' is the most innovative aspect of the advising structure.

[28] The share of high-tech industries in the gross domestic product (GDP) should not exceed 20%, thus a continuous concern with traditional industries which account for most of China's GDP.

3. Technology foresight exercises are performed on an ongoing basis, permanently and under periodic review, and are fundamentally considered in structuring the consensuses as to which industries to invest in, for the definition of long-term strategies.
4. Funding for innovation, it seems, is ample and not restricted to certain industries or types of companies according to capital structure. It is not subject to over-bureaucratic or excessive control, and is provided by the banking system. This last feature – it not being rooted in the innovation system's institutional arrangement – should not be considered an institutional comparative advantage, but a peculiarity, of the Chinese system. In principle, in this regard, institutional comparative advantage would be on the side of the Brazilian system. On the other hand, perhaps freedom and absence of excessive red tape stimulates creativity, and poses a significant Chinese advantage.

The strategic choices seem based on consensus building, a collective process of creating structural consensus. It was not possible to observe the need for coalitions of interests, characteristic of Western representative democracies, present in the Brazilian and Argentine decision-making. The Chinese innovation system does seem, indeed, to be the result of a consensus, with a collective process creating this structural consensus.

In the Brazilian case, findings seem to point to the following comparative institutional advantages, whereas the Chinese trajectory's cautionary warnings, challenges, and eventual hindrances or snags are recommended for consideration.

1. The Brazilian innovative system has a mature institutional architecture that has evolved over decades. It is complex and, apparently, suitable for decision-making, taking into account the interests of the different shareholders represented by the various institutional arrangements comprising the SNCTI.
2. Although relatively distant from the decision-making core, universities and research institutes, especially those closely connected to the ministries most relevant for innovation, have contributed to increase the production

of science, technology and innovation, which is perceivable through an evaluation of Brazilian scientific production.[29]

3. The Brazilian system's funding is rooted in its very institutional architecture – in principle, in a manner suitable for the adequate functioning of the system. The existence of excessive controls and bureaucracy, however, may be in effect hindering any institutional advantage in the Brazilian innovation funding system. There is a recurring complaint at institutions such as the BNDES and Finep about a shortage of innovative companies seeking funding for technological change.
4. In theory, the Brazilian legal framework is suitable for the needs of its innovation system. Nevertheless, its details and practical application are still subject to pitfalls and setbacks that hinder any institutional competitive advantage to perform effectively. In particular, far less requirements and red tape are required.
5. The governance system includes the representation and the representatively of several stakeholders in the innovation process. However, decisions seem to be taken in closed, limited spheres – which do not necessarily take into account stakeholder interests, even of the latter would apparently be properly represented.

In comparison with the Chinese system, the most significant Brazilian disadvantages seem to be the following:

1. In spite of the existence, complexity and, above all, recognized excellence from the point of view of scientific production, the second tier of the system – the advising structure for strategic decision-making such as research institutes, think tanks and universities – often do not participate in the strategic choices during the definition of Brazilian innovation policy.

29 Not only scientific paper indices (Citation Index, H-index) place Brazil in a prominent position, but successive National Innovation Conferences such as the fourth, held in 2010, point to Brazilian science's leading position in several fields of knowledge: 'Brazil, given the historical moment it underwent until 2015, the characteristics of its territory, energy matrix, regional and cultural diversity, size, population, and scientific level attained, has a unique opportunity to build a new model of sustainable development that respects nature and society. A model that shall, necessarily, rely on science, technology and quality education for all Brazilians' (CGEE, 2010, p. 5).

2. Technology foresight exercises, if any, are performed in a sporadic manner – and not systematically, as in the Chinese system – this being one of the main recommendations for a Brazil-China cooperation platform.
3. The process of structured consensus building, regarding priorities in innovation policy, such as which specific industries to support or even protect, could be the 'Achilles' heel' of Brazilian science, technology and innovation policy.[30] Shared beliefs and the ability to make the right strategic choices when formulating innovation policies have proved essential in other historical examples of countries that have proven capable of crossing the threshold of development.

30 The Argentine case did not involve enough research material to allow drawing similar conclusions, thus contributing a minor counterpoint to the conclusions.

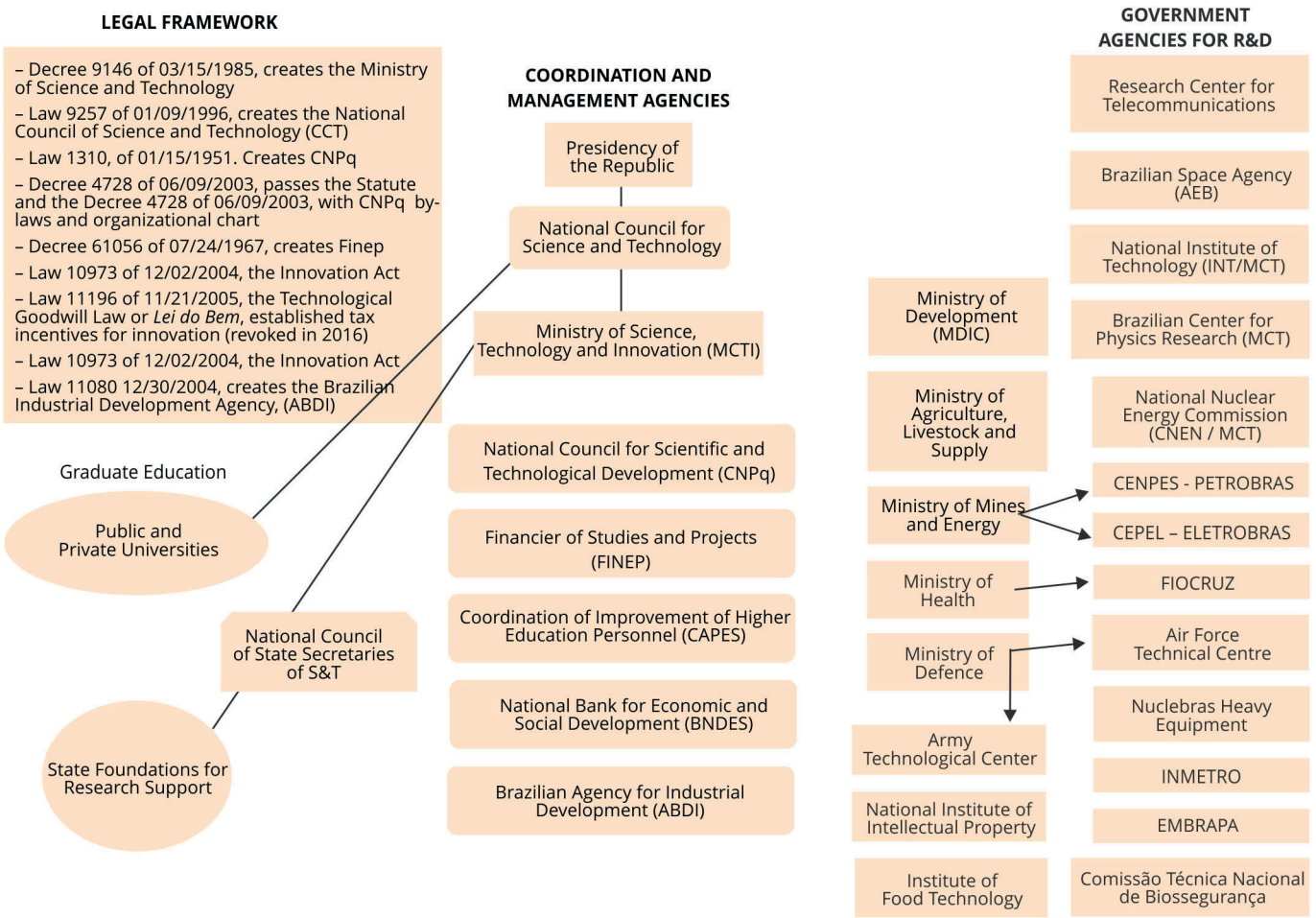


Figure A.1 Brazilian National System for Science, Technology and Innovation SNCTI (Sistema Nacional de Ciência, Tecnologia e Inovação)

Source: Red de Indicadores de Ciencia y Tecnología (RICYT).

Legend.: CNPq – National Council for Scientific and Technological Development – Conselho Nacional de Desenvolvimento Científico e Tecnológico

Finep – Financier of Studies and Projects – Financiadora de Estudos e Projetos

CAPES – Higher Education Personnel Improvement Coordination – Coordenação de Aperfeiçoamento de Pessoal de Nível Superior

BNDES – National Bank for Economic and Social Development – Banco Nacional de Desenvolvimento Econômico e Social

ABDI – Brazilian Agency for Industrial Development – Agência Brasileira de Desenvolvimento Industrial

MDIC – Ministry of Development, Industry and Foreign Trade – Ministério do Desenvolvimento, Indústria e Comércio Exterior

INPI – National Institute of Industrial Property – Instituto Nacional de Propriedade Industrial

AEB – Brazilian Space Agency – Agência Espacial Brasileira

INT – National Institute of Technology – Instituto Nacional de Tecnologia

CBPF – Brazilian Center for Physics Research – Centro Brasileiro de Pesquisas Físicas

CNEN – National Nuclear Energy Commission – Comissão Nacional de Energia Nuclear

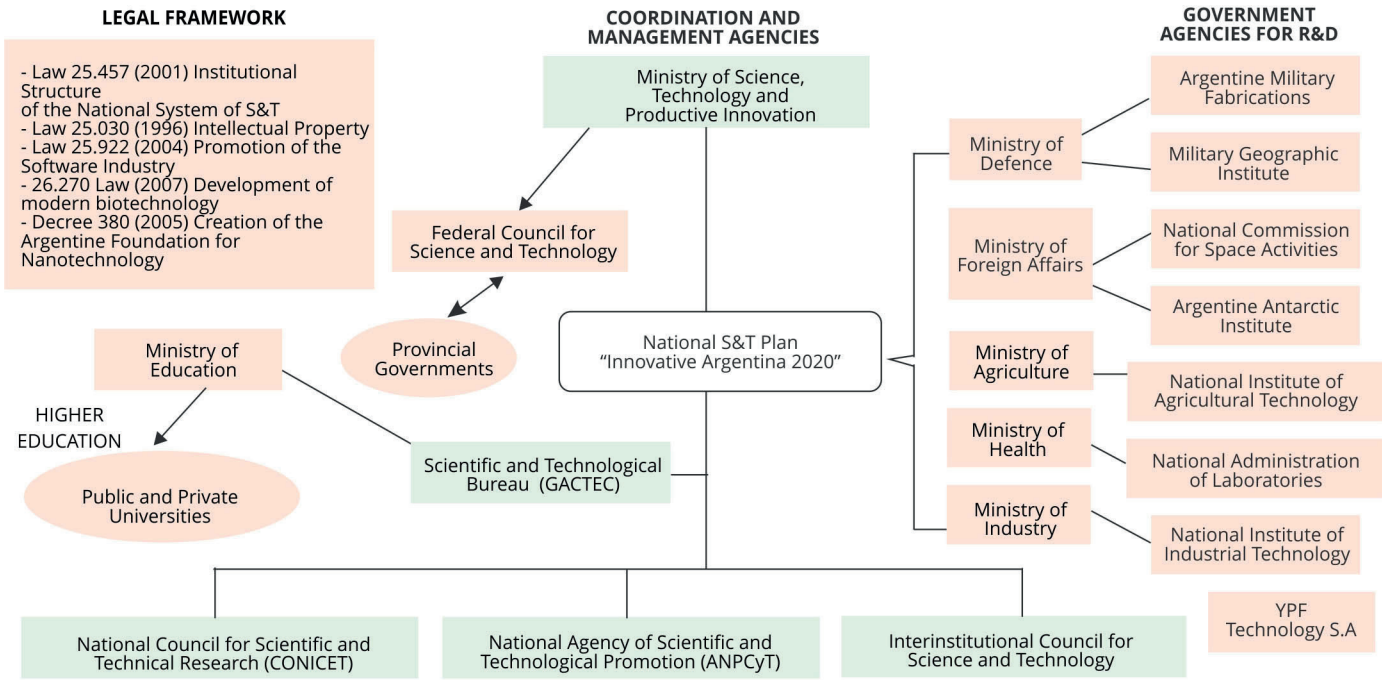
Cenpes – Research Center Leopoldo Américo Miguez de Mello – Centro de Pesquisas Leopoldo Américo Miguez de Mello

Cepel – Electric Energy Research Center – Centro de Pesquisas de Energia Elétrica

Fiocruz – Oswaldo Cruz Foundation – Fundação Oswaldo Cruz

Inmetro – National Institute of Metrology, Standardization and Industrial Quality – Instituto Nacional de Metrologia, Normalização e Qualidade Industrial

Embrapa – Brazilian Agricultural Research Corporation – Empresa Brasileira de Pesquisa Agropecuária



Source: Red de Indicadores de Ciencia y Tecnología (RICYT).

Legend: Gactec – Office for Science and Technology - Gabinete Científico e Tecnológico

Conicet – National Council for Scientific and Technical Research – Conselho Nacional de Pesquisas Científicas e Técnicas

ANPCYT – National Agency for Scientific and Technical Promotion – Agência Nacional de Promoção Científica e Tecnológica

Figure A.2
Argentine SNCTI

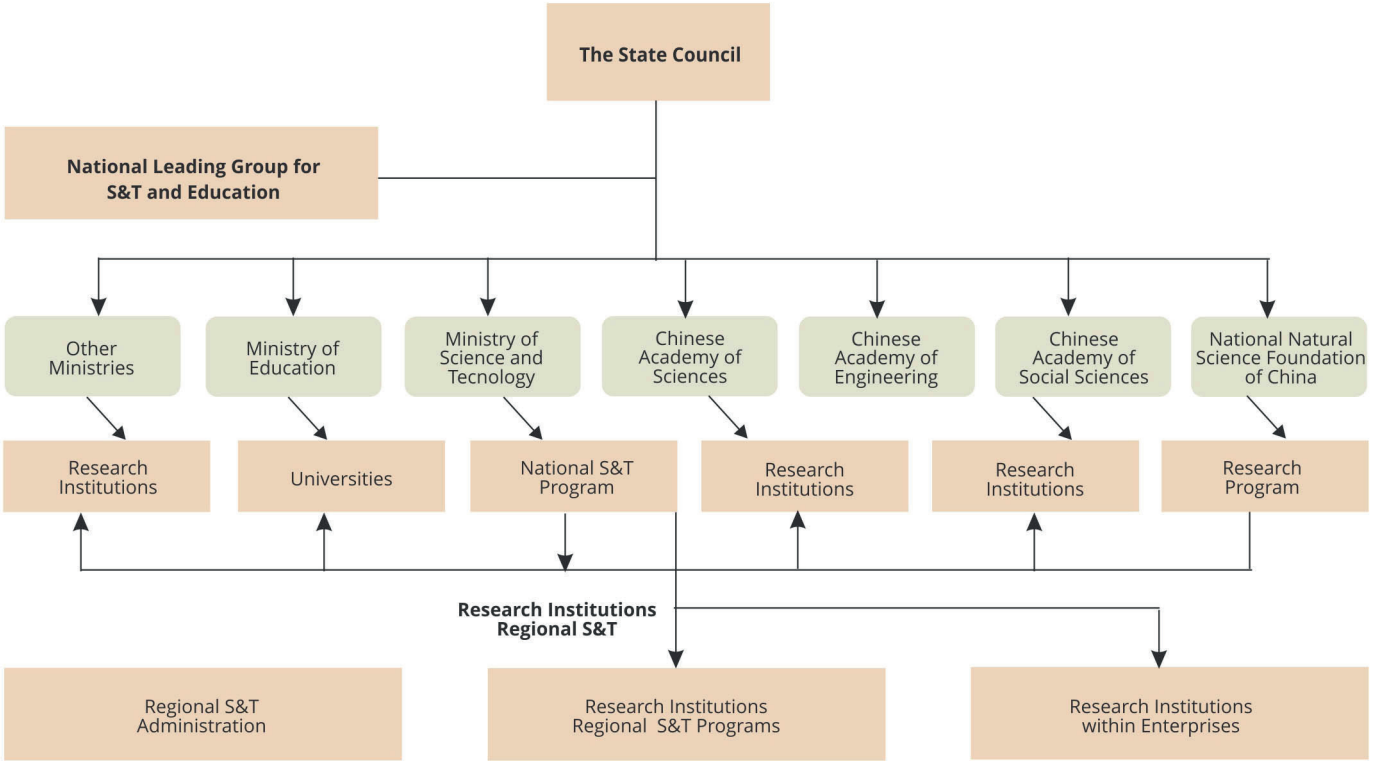
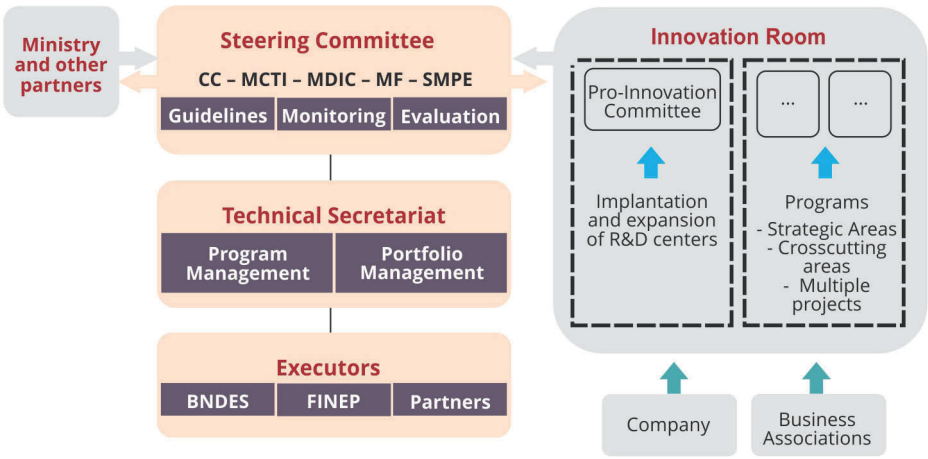


Figure A.3
Chinese SNCTI

Source: Rongping, Mu. *Development of science and techonology policy in China*. Tokyo: Nistep, 2004 <http://www.nistep.go.jp/IC/ic040913/pdf/30_04ftx.pdf>.

Legend: Governance structure of the Chinese science and technology system
MOE - Ministry of Education
MOST - Ministry of Science and Technology
CAS - Chinese Academy of Science
CAE – Chinese Academy of Engineering
CASS - Chinese Academy of Social Sciences
NSFC - National Natural Science Foundation of China.

Figure A.4
Brazil: Governance of the Company Innovation Plan (Plano Inova Empresa)



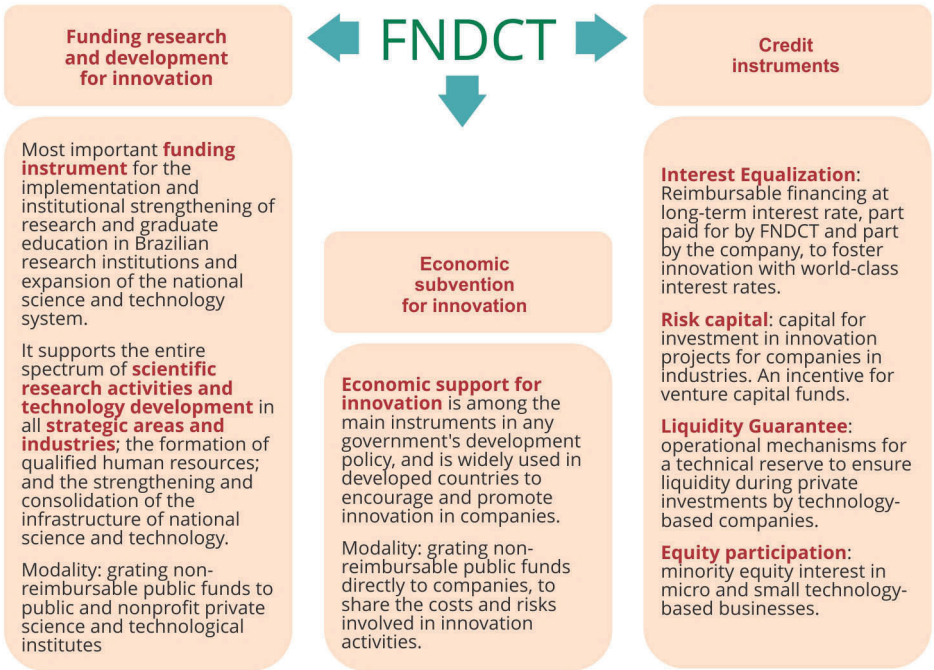
Source: MCTI. – Ministry of Science and Terchnology – Ministério da Ciência, Tecnologia e Inovação

Legend: CC – Chief of Staff – Casa Civil

MDIC – Ministry of Development, Industry and Foreign Trade – Ministério do Desenvolvimento, Indústria e Comércio Exterior

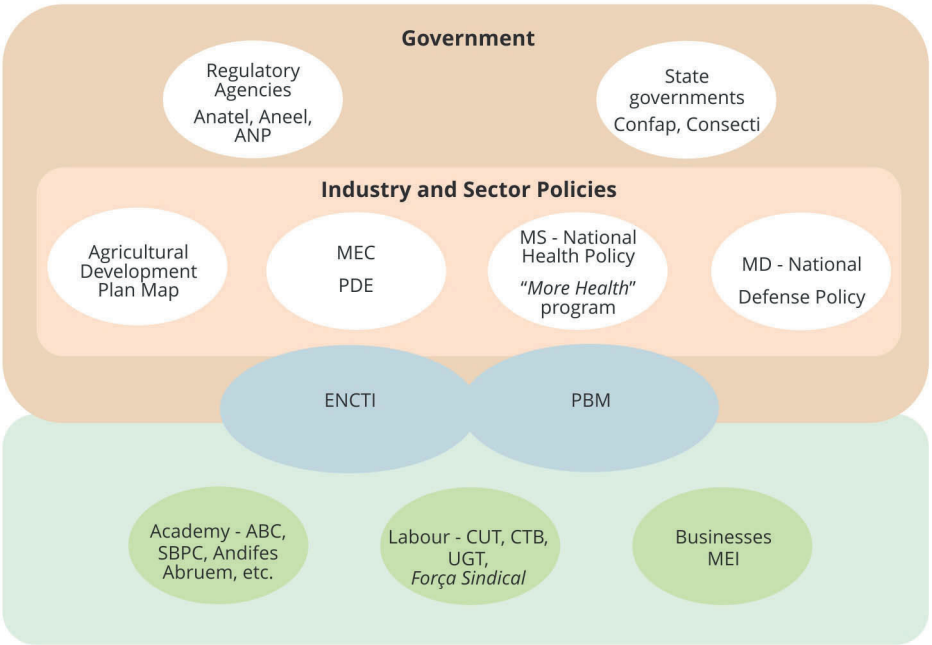
MF – Ministry of Finance – Ministério da Fazenda

Figure A.5
Brazil: Funding/credit lines in the FNDCT



Source: MCTI.

Figure A.6
Brazil: SNCTI consolidation



Source: MCTI.

Legend: Anatel – National Telecommunications Agency
ANEEL – Brazilian Electricity Regulatory Agency
ANP – National Agency of Petroleum, Natural Gas and Biofuels
Confap – National Council of State Foundations for Research
Consecti – National Council of Secretaries for Science Affairs, Technology and Innovation
MEC – Ministry of Education
PDE – Education Development Plan
ENCTI – National Strategy for Science, Technology and Innovation
ABC – Brazilian Academy of Sciences
SBPC – Brazilian Society for the Advancement of Science
Andifes National Association of Directors of Federal Institutions of Higher Education
Abruem – Brazilian Association of Rectors of State and Municipal Universities
CUT – Workers' Unitary Central
CTB – Workers Central and Workers of Brazil
UGT – General Union of Workers
MEI – Businesses Mobilization for Innovation

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