

The systemic nature of technological development: similarities between the neo-Schumpeterian school and Fernando Fajnzylber's approach

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Abstract

This article seeks to draw connections between Fernando Fajnzylber's approach and certain elements of the neo-Schumpeterian systemic approach to innovation, to show that there is longstanding discussion of many of the ideas underlying the development of both approaches in a variety of contexts. The results of the analysis revealed six similar features: the historical determinants of technological development; the similarity between the elements that sustain long-term technical progress; the relationship between technological development and the "non-economic spheres"; the relationship between technological development and the idiosyncrasies of each sociopolitical context; the proactive nature of government action; and the sector-level aspects of technical progress.

Keywords

Economic development, technological change, macroeconomics, industrial development, history, Fajnzylber, Fernando, economic analysis, industrialization, technological innovations, Latin America

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I. Introduction

Technological development is a prominent issue in the historical analysis of societal development and is addressed in the works of great economists who are renowned for their writing on production and distribution phenomena and how they are manifested in specific sociopolitical contexts.¹ It was Joseph Schumpeter who placed technological development at the centre of the analysis. “New combinations” of materials and forces were seen as the drivers of dynamic and structural economic system transformation, and hence of all qualitative transformations that occur over time (Schumpeter, 1934).

Technological development also takes centre stage in the contributions made by the Economic Commission for Latin America and the Caribbean (ECLAC) and associated theorists,² who hold that the incorporation of technology through capital accumulation — seen as stemming from a process of industrialization led by nation States— will enhance labour and capital productivity and ultimately improve social welfare (Welters, 2004). This is the basis of the importance of studying the specific ways in which technological progress is manifested and developed in each nation.

This article focuses on two approaches, one derived directly from Schumpeter’s writings and the other from the ECLAC theoretical framework. To some extent, the first of these approaches is synthesized in the concept of national innovation systems, which establishes a frame of reference for analysing the modality and characteristics of (historically determined) innovation processes in each country. It emphasizes the way in which countries absorb, use and generate economically useful knowledge, taking into account the set of actors specific to each sociopolitical structure. The second approach is related to the writings of Chilean researcher Fernando Fajnzylber, who — based on ECLAC’s “classical” structuralism— studied the Latin American industrialization process from a historical perspective. His analysis highlights elements that are clearly aligned with a systemic perspective (although this perspective did not yet exist formally at that time), which led to a normative agenda based on overcoming weaknesses to thus generate technical progress endogenously.

Both approaches emerged in the 1980s, a period characterized by the rise of neoliberal ideology and support for short-term recessionary macroeconomic adjustments. This formed the backdrop for the debate on long-term development policies, the focus of both Fajnzylber and the neo-Schumpeterian systemic perspective. The apparent simultaneous emergence of these two approaches shows Fajnzylber’s affinity with Schumpeterian ideas in his analysis of the Latin American industrialization process. This article thus seeks to identify points of convergence between the two approaches that reveal Fajnzylber’s systemic vision of innovation. To that end, sections II and III, respectively, address the positive and normative aspects of the concept of national innovation systems, while section IV provides a comparative synthesis of the points of convergence and divergence between this perspective and Fajnzylber’s analysis. The fifth and final section presents the conclusions of the study.

II. The national innovation systems approach

In brief, the national innovation systems approach falls within the scope of neo-Schumpeterian economics and consists of a “means to learn about the impact of organizations and institutions on national innovative activity, understood as the result of interactive processes determined by various actors and framework conditions” (Balzat, 2002, p. 10).³ The analytical and normative treatment of the concept is described below.

¹ Examples include Smith (1776), Ricardo (1996) and Marx (1973).

² These writings form the paradigm known in the literature as “Latin American structuralism” (Rodríguez, 2006).

³ Neo-Schumpeterian economics is concerned with the dynamic processes that generate qualitative transformation in economies, driven by innovation in its diverse and multifaceted forms and the related coevolutionary processes (Hanusch and Pyka, 2007, p. 280).

1. Origin of the concept and brief theoretical review

The concept of national innovation systems dates back to the 1980s, which saw the publication of seminal studies on technological development that diverged from conventional views. According to Sharif (2006), “The concept arose simultaneously in academia and policymaking spheres (with regard to the latter, specifically in the Organisation for Economic Co-operation and Development (OECD)), largely because its main proponents held positions in both universities and organizations that promoted economic policies.⁴ At the time, the concept was a reaction to the minor role assigned to knowledge, technology and technological progress by the predominant neoclassical paradigm of the period. This “equilibrant” approach to economic growth ignores several factors that are considered determinants of technical progress or reduces them to excessively simplistic schemas. These include the formation and historical evolution of each country’s specific socioeconomic structures; the role of government and institutions; the uncertainty inherent in the innovation process; interactive learning; and, mainly, the role of innovation as a driver of economic growth (Sharif, 2006; Cassiolato, de Matos and Lastres, 2014).

The systemic interpretation of technological development is the analytical cornerstone of the concept of national innovation systems. The first element of this interpretation is that technological progress, rather than being a linear process with stages determined and constructed sequentially through isolated research activities, is viewed in terms of the manner in which economic agents interact with each other in their innovation processes. From this perspective, the central factor is the manner in which interactions take place among the vast range of existing societal actors (researchers, firms, consumers and educational institutions, among others), from which new and economically useful knowledge emerges. In these processes, “formal” knowledge (through research and development (R&D), research centres and universities) is not the only determinant of technological development. Other knowledge, of a tacit and complex nature, may arise, for example, from professional and personal experiences and relationships, from organizational routines and in production lines (Balzat, 2002; Cassiolato, de Matos and Lastres, 2014).

The second element of this interpretation is that interactive processes of innovation are shaped by the institutional environment in which social actors are immersed.⁵ As these interactions occur between a wide range of actors in a particular sociopolitical setting, technological development is likely to be influenced not only by interactions related directly to formal learning but also by the broad set of institutional domains present in that environment. These include the education system (which promotes creative capacity-building and formal learning); the legal system (which defines issues such as intellectual property rights and technology transfer); the financial system (which funds the development of new technologies); and the agencies that formulate economic policy (which define the development strategy and its parameters as embodied in the policies to be implemented). The national character of technological development is worth noting, since, as Lundvall (2016) notes, the geographical, cultural and linguistic features common to a nation, the actions of national governments, and the technological capacities developed over time in each country all have a positive effect on interactions between the agents present in a given system.

Three contributions to the concept of national innovation systems should be noted. The first is Christopher Freeman’s “historical” approach to technological development.⁶ Freeman argues that,

⁴ For example, Christopher Freeman worked as a consultant at the Organisation for Economic Co-operation and Development (OECD) in the 1980s, and Bengt-Åke Lundvall served as Deputy Director of that organization’s Directorate for Science, Technology and Industry (Sharif, 2006).

⁵ The term “system”, within the concept proposed by Nelson (2006, p. 40), consists of a group of institutional actors that jointly play the important role of influencing innovative performance.

⁶ Christopher Freeman’s analysis is directly influenced by List (1986), his research on German economic development in the nineteenth century and his studies on the “Japanese success” observable from the 1950s onwards (Freeman and Soete, 2008).

throughout history, the incentives that nation States deliberately promoted for technology assimilation and production, as well as technological learning and factors beyond formal R&D (such as incremental innovations in production lines and interactions between firms and the market) were fundamental for the technological and economic development of the countries analysed (Freeman and Soete, 2008; Bittencourt and Cário, 2017). The second contribution is the “narrow” approach of Richard Nelson (1993).⁷ In this case, the emphasis is on the “explicit” factors that stimulate innovation in firms, represented by national science and technology policies. The elements that comprise each country’s national innovation system include public research laboratories and the provision of funds for R&D in private firms and universities, for example (Nelson, 2006; Cassiolato, de Matos and Lastres, 2014; Bittencourt and Cário, 2017). The third and last contribution would be the “broad” approach, resulting from the writings of Bengt-Åke Lundvall. This approach sees the core of the national innovation system as the environment in which producers and users interact with knowledge infrastructure, through which information circulates beyond mere price and quantity.⁸ This environment extends beyond the “narrow” dimension and encompasses the vast range of institutional spheres that exist (Lundvall, 2016; Bittencourt and Cário, 2017).

The national innovation system concept can thus be seen as an analytical construct for understanding the determinants of technological development. It transcends determinants directly related to the promotion of science and technology and encompasses all of the institutional spheres present in a given sociopolitical context and the relationships between the actors in that environment. According to Lundvall (2007), the concept becomes a “focusing device” for analysing the dynamics of contemporary production and innovation; in other words, a historically rooted analytical frame of reference that is capable of capturing how socioeconomic phenomena and the institutional framework present in each national context influence innovation and learning processes. These, in turn, help to explain a country’s economic development.

2. Policies to promote technological development based on the systemic approach

The foregoing clearly shows the importance of the State as a promoter of policies aimed at stimulating a country’s technological development.

More broadly, according to the typology proposed by Ferraz, de Paula and Kupfer (2013), from the standpoint of competency to innovate, industrial policy is closely aligned with the systemic perspective of innovation.⁹ Government action involves fostering a competitive environment for firms, developing capacities (which encompasses the development of new technologies and the acquisition of formal and tacit knowledge), and stimulating interaction between firms through selective instruments targeting specific groups and general instruments affecting economic agents as a whole.

In terms of the characterization of a “technological agenda”, Erber and Cassiolato (1997), authors who are aligned with the systemic perspective, define the neo-developmental agenda as one that

⁷ The “narrow” approach is based on his work for *National Innovation Systems: A Comparative Analysis* (Nelson, 1993), which analyses the national innovation systems of 15 countries. These are classified into large industrialized high-income countries, small high-income countries with a strong natural resource matrix, and low-income newly industrialized countries.

⁸ This information flow is related to the emergence of non-scientific knowledge and elements such as cooperation, loyalty, coordination, trust, power and codes of mutual respect, which are considered essential for overcoming the uncertainty inherent in the innovation process. Thus, in addition to “formal” learning (through R&D, research centres and universities), consideration is given to learning derived from the use of innovations that require long periods of use, or learning-by-using; learning through improvements implemented in production environments, or learning-by-doing; and product innovations that arise from interaction between users and producers, or learning-by-interacting (Lundvall, 2016; Bittencourt and Cário, 2017).

⁹ On a preliminary basis, industrial policy is defined as the set of incentives and regulations associated with public actions, which can affect the inter- and intraindustry allocation of resources, influencing the production and capital structure, and the conduct and performance of economic agents in a given national space (Ferraz, de Paula and Kupfer, 2013, p. 313).

proposes the structural transformation of production matrices in favour of higher-tech sectors. Such agendas are government-directed, with actions that take into account the systemic nature of innovation, the set of agents involved and the strategic partnerships that exist between the state and civil society. To defend the efficacy of this agenda, these authors cited international examples and pointed out that the policies implemented by the key OECD countries (Germany, Japan, the United Kingdom and the United States), which were considered as advanced in terms of technology and manufacturing capabilities, were aligned with this neo-developmental agenda,¹⁰ even though that was not the prevailing view in the 1980s and 1990s.¹¹

Regarding the scope of more contemporary innovation policies, the following extract shows that this approach gained strength in the next decade, with emphasis on:

[...] the tendency for policies to target sets of actors and their environments, in order to enhance, disseminate and increase the effectiveness of their results. The different contexts, cognitive and regulatory systems, and forms of articulation, cooperation and interactive learning among actors are recognized as fundamental for the generation, acquisition and dissemination of knowledge, particularly of the tacit kind. At the same time, instruments are being developed that encompass these collective actors, complementing the traditional emphasis on individuals (Cassiolato and Lastres, 2005, p. 39).

Under a neo-Schumpeterian approach, Suzigan and Furtado (2006) argue that industrial policy would be responsible for the following:¹²

- (i) Setting targets for new technologies to become internationally competitive, ensuring that they attain the necessary levels of economies of scale and industrial efficiency;
- (ii) Organizing instruments, rules and regulations (tax incentives, protecting competition, financing) in a synchronized and unambiguous manner, in line with the strategy to promote competitiveness and development;
- (iii) Building and providing economic infrastructure services and developing education, science, technology and innovation systems, always in harmony with businesses, to enable them to benefit from the technological advances developed;
- (iv) Coordinating actions, a very important issue given that coordination of industrial policy under this approach takes place before the fact rather than afterwards, as a reaction to market failures.¹³

The neo-Schumpeterian approach becomes more robust as an analytical framework for formulating technological development policy when the (supposed) contradiction between vertical and horizontal policies is placed at the centre of the debate over government actions aimed at improving and upgrading

¹⁰ This shows the major influence of the historical analysis of the neo-developmental agenda. Examples include the following: the general reorientation of German industrial policy towards improving the national productive matrix, through stimulus measures targeting R&D investments in segments related to the “microelectronics paradigm”; the measures adopted in the United States to transfer the findings of military research to civil society (which in turn had a positive and direct influence on the development of higher-tech sectors, such as the semiconductor industry); and the work of the Japanese Ministry of Economy, Trade and Industry in formulating long-term technological and industrial policies on the basis of technology foresight systems, in which the main goal was to identify new technologies that could transform existing patterns of economic growth, such as recognition of the importance of information technology (Erber and Cassiolato, 1997, p. 56).

¹¹ Even during the heyday of neoliberalism, governments constantly intervened heavily to promote productive and technological development and the expansion of sectors that were strategic for the structural dynamic, even if these policies were camouflaged by strategic-military imperatives (Erber and Cassiolato, cited in Cassiolato and Lastres, 2005, p. 39).

¹² “According to this theory, industrial policy should be active and wide-ranging and should be aimed at industrial sectors or activities which foment technological change and at the economic and institutional environment as a whole, which conditions the evolution of business and industrial structures and the organization of institutions, including the establishment of a national innovation system” (Suzigan and Furtado, 2006, p. 77).

¹³ As Ferraz, de Paula and Kupfer (2013) note, industrial policy from a market failure perspective would apply only when market mechanisms function suboptimally, where “market failures” (such as externalities and public goods) would be operating. Industrial policy would minimize the adverse effects of such phenomena.

production structure technology.¹⁴ Based on this premise, Gadelha (2001) argues that government action should be both systemic and structural. The basis of this proposal is the interpretation that enterprises are immersed in a system, in other words, a locus of interactions between existing actors which also includes productive sectors undergoing structural and dynamic transformations in different ways. This implies a heterogeneous and idiosyncratic production structure, with nationally delineated characteristics. Its systemic nature is manifested in transformations of the business environment, and government actions should be structured to target sectors that “radiate” the effects of technological progress to the production structure as a whole; in other words, sectors that have a systemic impact. This gives rise to a new definition of industrial policy, which consists of targeting:

[...] public intervention on the dynamic of industrial innovations, with the aim of promoting qualitative transformations in the production structure and the development of national economies, through systemic actions that selectively modify the competitive environments in which business strategies are formed (Gadelha, 2001, p. 161).

Thus, the formulation and implementation of policies aligned with a national innovation systems approach can promote national technological development, to the extent that they focus on the following: fostering the harmonized application of instruments to establish and regulate the competitive environment in which national enterprises operate; stimulating interaction and cooperation between social actors from the most varied institutional spheres, which in turn implies a symbiotic relationship between government and the private sector, focused on expanding technological capacity; creating innovative capacity by stimulating formal and informal learning, which in turn is directly related to building a knowledge infrastructure that is interconnected with the business environment (including science, technology and innovation systems and the education system, but also other elements, such as infrastructure, and even informal institutions based on relationships of trust between agents); and promoting dynamic sectors whose technological progress can have a ripple effect throughout production systems.

That said, what Fajnzylber has called “the truncated industrialization” of Latin America is described briefly below, in order to highlight elements that are aligned with the systemic perspective.

III. Truncated industrialization

Fernando Fajnzylber’s writings are situated within the ECLAC theoretical framework, more precisely in “Latin American neo-structuralism”, and they both criticize and complement the original contributions to this theoretical framework.¹⁵ The basics of structuralist thought and its considerations and limitations with respect to technological progress are described below, followed by the positive and normative aspects developed by Fajnzylber.

1. Fundamentals of Latin American structuralism: the issue of technology at the centre of the debate

The industrialization process and its characteristics have always been a central part of the conception of Latin American structuralism. Based on the structural characteristics of the region’s economies and

¹⁴ Horizontal industrial policies seek to improve the performance of the economy as a whole, without favouring any industry specifically. In contrast, vertical industrial policies deliberately favour a specific industry. In other words, on the basis of strategic decisions, the government mobilizes part of the instruments described above, to benefit a targeted set of firms, industries or production chains (Ferraz, de Paula and Kupfer, 2013, p. 320).

¹⁵ In short, neo-structuralism can be understood as the most recent phase in the evolution of Latin American structuralism, which originated in the 1990s and “regains the development analysis and policy agenda, by adapting it to the new era of openness and globalization” (Bielschowsky, 2016, p. 35).

the implications thereof, industrialization was seen as “the principal means at the disposal of those countries to obtain a share of the benefits of technical progress and progressively raise the standard of living of the masses” (Prebisch, 1950, p. 2).

From this standpoint, industrialization can be approached in two ways: as a historically determined process leading to the rise and leadership of the industrial sector in Latin American nations, which unfolded throughout the twentieth century and was known as the “import substitution process”; and as a model (import-substitution), in other words, an abstraction from the characteristics of materiality, which seeks to capture the essence and development rationale of the process, where improvement in the population’s standard of living is based on productivity gains derived from an increase in the capital-labour endowment (through the adoption and efficient use of indirect production methods) and capital density (with accumulation driven by technical progress) (Fonseca, 2003; Rodríguez, 2006; Prebisch, 1950).¹⁶ In short, the key feature of the import substitution model is its dynamic, characterized by a contradiction between the increase in substitutive production and the limits of import capacity. The continuity of substitutive production is constrained by external bottlenecks and the available technology (which is related to the structural characteristics of peripheral countries) (Tavares, 2011).¹⁷

The problem of technology in the import-substitution model stems from its limitations, which are manifested in the historical development of Latin American economies. Unlike the developed countries, which developed and then continued to dominate modern production techniques, peripheral countries were forced to use production techniques in their production systems that they had not developed or even adopted in the initial stages of development, when they were less distant from the technological frontier.¹⁸ Moreover, the increasing complexity of production made it harder to level the production and technology playing field by scaling up production in key capital accumulation sectors, increasing the need for capital investment for those sectors to continue operating. In fact, they were considered as key sectors for both capital accumulation and for the generation and dissemination of technical progress.

In time, it became increasingly clear that merely introducing the most capital-intensive sectors into the production mix —as occurred in Brazil between 1956 and 1961 through the “*Plano de Metas*” [Targets Plan], later reinforced to some extent by the Second National Development Plan (II PND)— could not generate and propagate technical progress as hoped, and that major obstacles would remain. This was the main focus of Fajnzylber’s vision, as described below.

2. Latin America’s “truncated” industrialization: Schumpeterian elements in Fajnzylber’s analysis

The economic development that Latin America enjoyed between the 1940s and 1970s collapsed for all intents and purposes in the wake of the Bretton Woods system crisis and the oil crises of the last quarter of the twentieth century. The global economic crisis worsened in the 1980s; its effects in Latin America were expressed through a sharp contraction in regional economic activity. Fernando Fajnzylber, Chilean economist and ECLAC researcher, contributed to the debate on the crisis through the diagnostic lens

¹⁶ “Import substitution” can be defined as a domestic development process steered by external constraints and manifested mainly through the expansion and diversification of industrial production capacity (Tavares, 2011, p. 72).

¹⁷ Given an initial external bottleneck situation, substitutive production starts with final consumption goods, given their lower technological content. From this, a derived demand for intermediate and capital goods is created, given the positive effect on the income multiplier and the fact that only part of the production value-added is fully internalized, considering the results of the initial stage.

¹⁸ Viewed from a historical perspective, the development of these countries shows that the creation and mastery of modern techniques facilitated an increase in capital density and its standardization by the existing sectors. This was due to the mutual determination of innovations and incomes and also to the substitution of labour by capital, which was made possible by labour absorption in the newly created production processes. This reveals the harmonious relationship between accumulation, technical progress, wages and employment in the countries in which modern production techniques were developed (Rodríguez, 2006).

of a historical analysis of Latin American industrialization that focused on the distorted and “truncated” nature of the industrialization process, which departed from the neoliberal argument (and its claim that the economic crisis in the region had been caused by the fiscal irresponsibility of national governments).

Fajnzylber’s analysis begins by noting the similarities and differences between the industrialization process in Latin America and in developed countries, as well as with respect to the productive restructuring that took place in those countries and in the “newly industrialized countries” of Asia during the twentieth century.

In short, major industrial powers and countries that experienced rapid and substantial industrial growth from the mid-twentieth century onwards (especially Japan) took steps to reorganize their production structures in response to the exhaustion of the prevailing industrial matrix, which was dominated by the capital goods and chemical sectors and whose consumption patterns centred around durable goods (including, in particular, the automotive sector). The reorganization was targeted towards new and emerging technologies, such as microelectronics, and, according to the neo-Schumpeterian perspective, it represented a shift from the “era of oil, automobiles and mass production” to the “era of information and telecommunications” (observable from the 1970s onwards) (Pérez, 2009).¹⁹

Broadly speaking, Fajnzylber’s conclusion is that Latin American industrialization, framed by the import-substitution model, lacked creativity (a concept that will be discussed below), in contrast to the industrialization of the countries that served as comparators for his analysis.

It should be noted that Latin American industrialization reproduced the sectoral patterns of the developed countries; and, although the growth of manufacturing gross domestic product (GDP) and its share in the region’s total GDP increased in most countries between 1940 and 1980 (both variables were drastically reduced thereafter), this replication was unsuited to the reality of these countries, both in “economic” terms (the production domain) and in “non-economic” terms (the social, political and cultural spheres). Its objective, rather than understanding the processes with a view to improving them, was to reproduce what already existed. Despite the industrial growth achieved, Fajnzylber argues that the socioeconomic structures of Latin American countries continued to be characterized above all by an abundance of labour and the predominance of natural-resource-intensive sectors. In contrast, external engagement through manufactured products was limited, since exports of industrialized products failed to keep pace with industrial GDP growth (Fajnzylber, 1983; Paiva, 2006).

In this context, Fajnzylber argues that industrialization should take into account each country’s specific characteristics, and that results should be evaluated according to the “degree of functionality in responding to majority social needs, and creativity in developing the varied range of regional potentialities” (Fajnzylber, 1983, p. 163). On this basis, the author lists several unique features of the Latin American industrialization process that contrast its results with those of developed countries and newly industrialized countries (mainly observable between the 1950s and 1970s). These features are detailed below:

- (i) The prevalence of transnational firms in the dynamic sectors of the economy, rather than the national public and private business sector; this makes the region’s industrial future precarious, with no rules to guarantee the strengthening of the national technological innovation process;
- (ii) The predominance of “frivolous protectionism”, which can be defined as protecting both national and transnational firms, with few incentives for technological development and international competitiveness, and prioritizing final goods sectors over intermediate and capital goods sectors;²⁰

¹⁹ The emergence of a new technological pattern is known in the neo-Schumpeterian literature as a “technological revolution”. It consists of a set of interrelated radical innovations that form a large constellation of interdependent technologies (Pérez, 2009, p. 8).

²⁰ The antithesis of this concept would be “protectionism for learning”, which characterized Japanese industrial development in the post-war period (Fajnzylber, 1983).

- (iii) The backwardness of the capital goods sector, considered to be the “bearer of technical progress” (given its positive effects on labour productivity and wages, and also on the manufacture and productivity of capital goods themselves); this is reflected in this sector’s negligible participation in the region’s manufacturing production. It should also be noted that the more complex capital goods were produced by transnational firms, while national firms were oriented towards less complex capital goods;
- (iv) The external fragility of the region and of the industrial sector, which accounted for most of the structural deficit in Latin America’s trade balance and revealed the “truncated” nature of its industrialization pattern. This reflects the weak technological development observed in those countries, owing to their inability to assimilate and create innovative capacities; and
- (v) External engagement mainly through natural resources, which also contributed to the region’s trade deficit, since the modernization of agriculture occurred mainly in the commodity-export sectors (the effects of which included the deterioration of relative prices), compounded by an increase in demand for food products driven by greater urbanization resulting from industrialization.

The specific features listed by Fajnzylber lead him to conclude that the Latin American industrialization pattern arose from the fact that the region’s countries had been unable to build a production matrix that could promote technological development internally. This characterized the “truncated industrialization” observed between the 1930s and 1980s (an industrialization pattern that proved unable to overcome the contradiction in the import-substitution model with respect to technology). The factors that prevented the region’s countries from assimilating the technologies of the major centres, given each one’s internal shortcomings and potentialities (in other words their individual and specific characteristics), ultimately rendered them unable to form an “endogenous technology-energizing nucleus”, which would foster the generation and assimilation of technical progress suited to the specificities of each nation.²¹ This “endogenous technology-energizing nucleus” can be understood as an organized production structure in which creativity and learning provide mutual feedback, driving technological development in strategic sectors that propagates throughout the production structure through continuous waves of innovation (Paiva, 2006; Rodríguez, 2006). To form this endogenous nucleus, Fajnzylber proposes a “new industrialization” for Latin America, based on some of the fundamental categories of his analysis.

Fajnzylber argued that productive restructuring had to be “efficient” if it was to foster the long-term, sustained economic development of Latin America by overcoming each country’s economic and social weaknesses. Fajnzylber’s concept of “efficiency” was related to industrial development combining growth and creativity. Since “growth” is easy to quantify, his views on the concept of “creativity” need to be explored further.

Embedded in the concept of efficiency, creativity would basically entail overcoming social weaknesses and constructing a new technological pattern in the major centres, transcending the “strictly economic” domain to manifest in the political, cultural, artistic, scientific and productive spheres, which would ultimately drive the development of individual and collective capacities specific to each sociopolitical structure, thus evidencing the endogenous nature of creativity (Fajnzylber, 1983; Paiva, 2006). The link between creativity and industrial development can be examined in Fajnzylber’s words:

Creativity can therefore be associated with the establishment of social goals; with the deepening of understanding of man and social relations, as well as of the natural environment and the processes by which it is transformed. However, in the limited scope of these reflections on industrialization, attention is focused on discussion of some of the economic-institutional requirements of creativity and their link with the growth process (Fajnzylber, 1983, pp. 348-349).

²¹ For Fajnzylber, the concept of technical progress consists in the accumulation of knowledge about a set of goods and how to produce them, and on existing production techniques.

Creativity is therefore viewed as the attitude that underlies learning and makes it effective, conditioned by the various actors that constitute the spheres of socio-materiality, taking into account each country's "economic" and "non-economic" idiosyncrasies so that individual and collective capacities can be developed (Rodríguez, 2006).²² Growth alone would not be sufficient to stimulate creativity. The other factors needed for the development of domestic creativity include the organization of the relationship between economic agents and the degree of decentralization of economic life, which fosters greater autonomy for creativity to be unleashed through interaction between economic agents, both among those responsible for technological development and among those situated in the domain of production (Fajnzylber, 1983; Paiva, 2006).

It follows that Fajnzylber's "new industrialization" should promote creativity, which in turn would allow for both the domestic generation and external incorporation of modern production techniques, in addition to promoting external engagement through greater "real" competitiveness.²³ The main objective of development is to solve domestic shortcomings and promote each nation's potential (Paiva, 2006). Although Fajnzylber does not define a complete strategy for productive restructuring, he suggests prioritizing four sectors to form a productive and harmonized industrial matrix: the automotive industry, the capital goods sector, agriculture and the energy sector.

The government would play a strategic role in the new industrialization by setting targets based on social demands. This could include defining investment programmes to be implemented in specific sectors, along with the required conditions of "macroeconomic equilibrium". In addition, the social bases for sustaining this agenda would stem from the "new alliance", composed of the various agents of materiality and their convergence to enhance national value (Paiva, 2006; Rodríguez, 2006). In short:

[...] according to Fajnzylber, it is the constitution of an "endogenous technology-energizing nucleus" that will determine the creation and harmonization of an industrial and productive matrix capable of generating technical progress, both by adapting technology acquired internationally and through innovation (Paiva, 2006, p. 195). Through this nucleus, the generation, adaptation and incorporation of technical progress is transformed into productivity; and it ultimately leads to enhanced competitiveness in international markets (Paiva, 2006, p. 195).

IV. Preliminary synthesis: convergent and divergent aspects between national innovation systems and Fajnzylber's contributions

The foregoing shows that there are similarities between Fajnzylber's analysis and the national innovation systems approach, in terms of both analytical categories and normative agendas. These similarities are elaborated further in this section.

Nonetheless, it should first be noted that analytical affinities are usually explained by their (at least partial) adherence to the same frame of reference. In this case, the reference is Joseph Schumpeter. Torres Olivos (2006) highlights that author's influence on the formation of Fajnzylber's thinking, emphasizing the role of the firm as an innovative economic agent. This influence was present throughout his writings beginning in the 1970s.

²² Fajnzylber defines learning as the acquisition of new knowledge related to production techniques, arising from the activity of production itself and through R&D (Rodríguez, 2006).

²³ In other words, competitiveness strengthening through the generation and dissemination of technical progress and the consequent productivity increase. Such strengthening would be achieved through structural transformations in the various existing institutional domains, consciously employed through industrial policies, which would aim to form a solid basis for international engagement (Suzigan and Fernandes, 2004).

This helps to explain part of the process of analytically refining ECLAC's contributions in the fields of productive and technological development and international integration in the 1990s. The approximation of neo-Schumpeterian authors to Fajnzylber resulted in what Bielschowsky (2009) called a merger of neo-Schumpeterian and structuralist thought. In his words:

The merger of the Schumpeterian and structuralist approaches is not surprising, given the priority both assign to the analysis of historical trends in the productive domain. The neo-Schumpeterian accent on knowledge formation and accumulation through the enterprise learning process, the effect of past decisions on the present (path-dependency), and changes in techno-economic paradigms enhance the historical-structural approach used by ECLAC in its attempt to understand changes in productive structures under conditions of underdevelopment and structural heterogeneity (Bielschowsky, 2009, p. 181).

With respect to Fajnzylber's diagnostic assessment of the weaknesses of Latin American industrialization, it is possible to view the specifics of this process from a neo-Schumpeterian perspective as described in the previous section. Thus, through the lens of national innovation systems, factors i and ii can be analysed as the inability to form an institutional framework that would enable the generation of economically useful knowledge, either by assimilating techniques originating in the central countries or by developing domestic innovation capabilities through learning-oriented activities. This would include the adoption of laws guaranteeing the transfer and appropriation by national enterprises of the technologies deployed by transnational firms, and the creation of a science, technology and innovation system aligned with production sectors to strengthen external competitiveness.

Factors iii, iv and v are related to the neo-Schumpeterian literature through the concept of "Schumpeterian efficiency" (Martins, 2008), a concept grounded in the prescription of a format for productive specialization and international engagement based on opportunity and the appropriable and cumulative nature of technology. Thus, international trade patterns should be defined on the basis of "innovative opportunities" (the possibility of improving and expanding the technological apparatus) in a technological paradigm; on expectations of extraordinary returns from investments in possible technological opportunities; and on the belief that existing patterns of productive specialization and trade mediate technological change through positive or negative externalities, and also, to a greater or lesser extent, mediate opportunities for the generation of technological learning. On this basis, the backwardness of the capital goods sector, which is considered strategic for the region's industrialization, and the repercussions of this backwardness on the fragile international integration of Latin American countries show that the industrialization pattern applied in the region was far from efficient in Schumpeterian terms.

In their analytical and normative aspects, both Fajnzylber's analysis and the systemic perspective actually emphasize the value of the presence of a broad set of social actors in the most varied institutional spheres of each specific sociopolitical context, together with their interactions, as key factors for technological progress. Moreover, this understanding serves as a basis for formulating specific policies to promote technological development. Points of convergence between the two perspectives include the following:

- (i) *Historical determinants of technological development.* Both in Fajnzylber's analytical perspective and in that of national innovation systems, technological development is determined by the particular way in which the production and institutional structures of the different countries were articulated over time. Fajnzylber highlights a major difference between Latin American and central countries, noting that the way the industrialization process unfolded among the former restricted technical progress. After nearly half a century of substitutive production, not even the internalization of technology-intensive sectors (sectors in which leading companies were replaced, particularly after the last quarter of the twentieth century) was sufficient to promote a form of production that would generate continuous innovation. In other words,

the way technical progress was promoted basically reproduced the contradictions existing in the import-substitution model. The contrast with developed countries is clear: throughout their history, they adopted regulatory agendas aimed at strengthening innovation capacity and policies aligned with the systemic approach to innovation. Their approaches were aimed at shifting production structures towards more technologically advanced sectors (in other words, facilitating participation in the technological revolution that has been under way since the 1970s). From the national innovation systems standpoint, the shortcomings of the production structure in implementing “sophisticated” innovation processes are analysed in Viotti (2002), for example. In analytical terms, these shortcomings stem from an inability to assimilate scientific and non-scientific knowledge by strengthening the interactions between the agents involved in production and innovation processes. This is a structural characteristic, stemming from the inability of the production structure to participate in technological revolutions.

- (ii) *Elements that sustain technological development and technical progress over the long term.* For Fajnzylber, the generation and dissemination of technical progress goes beyond mere quantitative growth and involves stimulating creativity. Technological development would therefore involve the stimulation of individual and collective capacities related to each specific sociopolitical context, taking into account its shortcomings and potentialities. This, in turn, would enable learning or, in other words, the acquisition of knowledge of production techniques. In the national innovation systems approach, learning, both formal and informal, is seen as the key variable for promoting technological development. The creation of scientific and non-scientific knowledge streams, from processes such as learning by searching, learning by doing, learning by using and learning by interaction, which in turn are closely entwined with the interrelationships between actors in the social fabric, makes technological development not only possible but also effective.
- (iii) *The “non-economic spheres” and technological development.* Fajnzylber emphasizes that technological development transcends the “strictly economic” domain. He argues that the cultural, artistic, political, scientific and productive spheres, as well as the interfaces between them, are factors that affect the stimulation of creativity, along with others such as the degree to which economic life is decentralized and the nature of the relationship between agents. The analysis of national innovation systems also encompasses a diverse set of non-economic elements capable of explaining technological development. This is revealed in specific studies on various countries, including Christensen and others (2008), who highlight the significance of the trust relationship between producers and users for the rapid dissemination of innovation in the Danish national innovation system; or Kim (2005), who considers the particular characteristics of the mindset of a country’s workers.
- (iv) *Technological development and the idiosyncrasies of each sociopolitical context.* Fajnzylber’s analysis departs from the domestic shortcomings and potentialities of Latin American countries and the region as a whole, which are evident in specific aspects of the Latin American industrialization process, considering the whole set of specific actors and their characteristics. Fajnzylber posits that creativity and, ultimately, technological development, are directly related to each country’s idiosyncrasies, which reveals the endogenous nature of the scope of his analysis of the determinants of technical progress. In addition, authors aligned with the national innovation systems perspective stress that some aspects defined at the “national” level have a positive influence on interactions between agents, and hence on technological development. These include a nation’s shared geographical, cultural and linguistic features, and the development of technological capacities that are accumulated historically.
- (v) *The proactive nature of government action.* For Fajnzylber, the role of the State is defined mainly in his “new industrialization” proposal. According to this view, government action entails

construction of the national development strategy as a whole, for example by promoting investments in sectors considered strategic and maintaining “macroeconomic equilibrium” to implement that strategy. The “new alliance” would constitute the basis for sustaining that normative proposal, in which the defined strategy would be pursued on the basis of a connection between the agents of socio-materiality, such as business groups, government bureaucracy and the working class. Government action in the national innovation systems approach would consist, in short, of constructing a propitious habitat for interaction between agents (in other words, an environment conducive to learning) and for the creation of innovative capacities, both in terms of the assimilation and generation of new technologies and in terms of learning itself. In national innovation systems with numerous shortcomings, such as those of Latin America, government action would consequently need to be more prominent. Mazzucato (2014) discusses proactive action in the neo-Schumpeterian perspective. Based on the historical experience of technologically developed countries, she posits that it is the symbiotic relationship between the government and the private production sector that drives capitalism and development. This contradicts the commonly disseminated dichotomous view of the relationship between these two societal actors.

- (vi) *Preferential treatment of a set of products and sectors, according to their technical-progress absorption and generation properties.* In this sense, Fajnzylber aligns with the Schumpeterian notion of efficiency, both in pointing out that external engagement continued to be based excessively on natural resource-intensive products, that is, products with little capacity to generate long-term productivity gains; and also in identifying a group of sectors that could constitute a productive and harmonized industrial matrix, which, by having relatively better conditions for inducing creative production processes, would receive government incentives. From the systemic standpoint, such conditions would include the possibility of appropriating the benefits of innovation, the cumulative nature of the technical knowledge base, and opportunities for improving and propagating existing technologies. They would also promote Schumpeterian efficiency. It is worth noting that, in terms of the policy agenda, the promotion of policies aimed at strengthening innovation capacity would be targeted at sectors that have potential systemic impact, in keeping with Schumpeterian efficiency.

Several observations regarding the similarity between Fajnzylber’s analysis and the national innovation systems perspective have been presented above. Although these approaches have different subjects of study (Fajnzylber deals with development in Latin American countries, while the systemic perspective considers technologically developed countries), the article has revealed clear similarities between the two. The importance of technological progress in historically constructed processes of economic development, and the fact that both arguments invoke the influence of non-economic factors and the centrality of the role of the state are clearly points of convergence. Affinities were also noted between Fajnzylber’s “creativity” and neo-Schumpeterian “learning”, with respect to their causes and specifics, especially the influence of non-economic factors. These, in turn, can be summarized as the institutional architectures constructed and delineated by the idiosyncrasies of each system (especially in terms of the “national” character of these institutional structures). Lastly, the “endogenous technology-energizing nucleus” synthesizes the existing similarities, by advocating symbiotic interaction between the production structure and the institutional environment, as does the national innovation systems perspective. These considerations are summarized in table 1.

Table 1
Synthesis of the points of convergence between the Fajnzylber
and national innovation system approaches

	Analytical and normative aspects in Fajnzylber's thinking	Analytical and normative aspects in national innovation systems
Historical determinants of technological development	The historical diagnosis of the Latin American industrialization process evidences an inability to assimilate and generate technical progress, owing to the characteristics acquired by the industrial structure as a result of the import substitution process. Hence the need to promote creativity.	The cumulative nature of the knowledge acquired by the national innovation system is a decisive element in understanding its future potential. Development is path-dependent. Hence the desirability of strengthening interactions between agents over time, which can be seen in the agendas for promoting technological development in the most developed national innovation systems.
Elements underpinning technological development and technical progress in the long run	Creativity: related to the development of individual and collective capacities, which are reflected in a degree of mastery of the technologies deployed, so that the implementation of significant modifications is endogenously determined.	Capacity to innovate: related to the development of individual and collective capacities, which are reflected in a degree of mastery of the technologies deployed, so that the implementation of significant modifications is endogenously determined. The creation of scientific and non-scientific knowledge flows, derived from "formal" and "informal" learning processes, is decisive for developing the capacity to innovate.
Relationship between technological development and the "non-economic spheres"	Creativity is manifested in the cultural, political, artistic, scientific and production domains.	Set of institutions that directly or indirectly affect technological development and are closely related to knowledge creation (previous point).
Technological development and idiosyncrasies of each sociopolitical context	Endogenous aspect: based on domestic shortcomings for the development of the potential of each nation.	National aspect: a nation's shared geographical, cultural and linguistic features, and the action of nation States have a direct impact on technological development. The latter is necessary because systems have weaknesses.
Proactive nature of government action	Promote investment programmes in sectors considered strategic, preserve macroeconomic equilibrium. The theme of the "new alliance" is highlighted.	Provide a propitious environment for interaction between agents and the creation of innovative capacities. Instruments, standards and regulations are used in a coordinated manner.
Preferential treatment of a set of products and sectors, according to their technical-progress absorption and generation properties	Government action in the restructuring of key sectors (defined by their capacity to radiate technical progress), to constitute a productive and articulated industrial matrix: the automotive, capital goods, agriculture and energy sectors.	Government action aimed at promoting Schumpeterian efficiency, those sectors with the potential to "radiate" their technological progress throughout the production structure.

Source: Prepared by the authors.

V. Final thoughts

This article set out to conduct a theoretical review and comparative analysis of Fernando Fajnzylber's writings on the Latin American economic development process, and of the neo-Schumpeterian analytical perspective represented by the concept of national innovation systems. Without creating a theoretical summary, the study was confined to highlighting similarities in the scopes of these analyses, while suggesting points of convergence and divergence which, in turn, reveal the systemic vision of innovation in Fajnzylber's contributions.

The innovation systems approach considers the development of innovative capacities as cumulative and historically constructed, determined by the broad set of actors existing in socio-materiality. It thus seeks to understand the influence of these actors and their interactions in the development of the capacities in question. Fajnzylber's analysis focuses on the specifics of the industrialization process, expressed through the concept of "truncated industrialization". Identification of the weaknesses of this process brought the neo-Schumpeterian authors closer to Fajnzylber and, consequently, to the systemic approach, although the term "national innovation systems" would only be coined at the end of the 1980s.

The article has shown this influence to have been decisive in defining the meaning of Fajnzylber's normative "new industrialization" agenda, especially the emphasis on "creativity" (limited in Latin America) as a key variable for assimilating and generating technical progress. The alignment between the two

approaches was also seen by relating the causes of weakness to the historical aspects of the region's economic and institutional formation. It can also be seen that the new industrialization agenda aligns implicitly with the Schumpeterian concept of efficiency, by promoting production activities that offer a high degree of technological opportunity. Lastly, reflections on the role of government in promoting productive and technological development also suggest an alignment between the two approaches.

Bibliography

- Balzat, M. (2002), "The theoretical basis and the empirical treatment of national innovation systems", *Volkswirtschaftliche Diskussionsreihe*, No. 232, Augsburg, University of Augsburg.
- Bielschowsky, R. (2009), "Sixty years of ECLAC: structuralism and neo-structuralism", *CEPAL Review*, No. 97 (LC/G. 2400-P), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC).
- (2016), "Fifty years of ECLAC thought: a review", *ECLAC thinking: selected texts (1948-1998)* (LC/G.2699), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC).
- Bittencourt, P. F. and S. A. F. Cário (2017), "Sistemas de inovação: das raízes no século XIX à análise global contemporânea", *Economia da ciência, tecnologia e inovação: fundamentos teóricos e a economia global*, M. S. Rapini, L. A. Silva and E. M. Albuquerque (coords.), Curitiba, Prismas.
- Cassiolato, J. E. and H. M. Lastres (2005), "Sistemas de inovação e desenvolvimento: as implicações de política", *São Paulo em Perspectiva*, São Paulo, vol. 19, No. 1, March.
- Cassiolato, J. E., M. P. de Matos and H. M. Lastres (2014), "Innovation systems and development", *International Development: Ideas, Experiences and Prospects*, Currie-Alder and others (eds.), Oxford, Oxford University Press.
- Christensen, J. L. and others (2008), "An NSI in transition? Denmark", *Small Country Innovation Systems: Globalization, Change and Policy in Asia and Europe*, C. Edquist and L. Hommen (eds.), Northampton, Edward Elgar.
- Erber, F. S. and J. E. Cassiolato (1997), "Política industrial: teoria e prática no Brasil e na OCDE", *Revista de Economia Política*, vol. 17, No. 2, April-June.
- Fajnzylber, F. (1983), *La industrialización trunca de América Latina*, Mexico City, Editorial Nueva Imagen.
- Ferraz, J. C., G. M. de Paula and D. Kupfer (2013), "Política industrial", *Economia industrial: fundamentos teóricos e práticas no Brasil*, 2nd ed., D. Kupfer and L. Hasenclever (coords.), Rio de Janeiro, Elsevier.
- Fonseca, P. C. D. (2003), "O processo de substituição de importações", *Formação Econômica do Brasil*, J. M. Rego and R. M. Marques (coords.), São Paulo, Saraiva.
- Freeman, C. and L. Soete (2008), *A Economia da Inovação Industrial*, Campinas, Editora da Unicamp.
- Gadelha, C. A. G. (2001), "Política industrial: uma visão neo-schumpeteriana sistêmica e estrutural", *Revista de Economia Política*, vol. 21, No. 4, December.
- Hanusch, H. and A. Pyka (2007), "Principles of neo-Schumpeterian economics", *Cambridge Journal of Economics*, vol. 31, No. 2, March.
- Kim, L. (2005), *Da imitação à inovação: a dinâmica do aprendizado tecnológico da Coreia*, Campinas, Editora da Unicamp.
- List, G. F. (1986), *Sistema Nacional de Economia Política*, São Paulo, Nova Cultural.
- Lundvall, B. (2007), "National innovation systems: analytical concept and development tool", *Industry and Innovation*, vol. 14, No. 1, February.
- (2016), "Innovation as an interactive process: from user-producer interaction to the national systems of innovation", *The Learning Economy and the Economics of Hope*, B. Lundvall (coord.), London, Anthem Press.
- Martins, M. (2008), "Padrões de eficiência no comércio: definições e implicações normativas", *Nova Economia*, vol. 18, No. 2, August.
- Marx, K. (1973), *Grundrisse: Foundations of the Critique of Political Economy*, London, Penguin.
- Mazzucato, M. (2013), *The Entrepreneurial State: Debunking Public vs. Private Sector*, New York Anthem Press.
- Nelson, R. (ed.) (2006), *As Fontes do Crescimento Econômico*, Campinas, Editora Unicamp.
- (1993), *National Innovation Systems: A Comparative Analysis*, New York, Oxford University Press.
- Paiva, S. C. F. (2006), "Estratégias de política industrial e desenvolvimento econômico: idéias e ideais de Fernando Fajnzylber para a América Latina", doctorate thesis, Postgraduate Programme in Applied Economics, State University at Campinas.

- Pérez, C. (2009), "Technological revolutions and techno-economic paradigms", *Working Papers in Technology Governance and Economic Dynamics*, No. 20, Tallin, Tallinn University of Technology.
- Prebisch, R. (1950), *The economic development of Latin America and its principal problems* (E/CN.12/89/Rev.I), New York, United Nations.
- Rodríguez, O. (2006), *El estructuralismo latinoamericano*, Mexico City, Siglo XXI/Economic Commission for Latin America and the Caribbean (ECLAC).
- Schumpeter, J. A. (1934), *The Theory of Economic Development: An Inquiry Into Profits, Capital, Credit, Interest, and the Business Cycle*, Cambridge, Harvard University Press.
- Sharif, N. (2006), "Emergence and development of the National Innovation Systems concept", *Research Policy*, vol. 35, No. 5, June.
- Smith, A. (1776), *An Inquiry into the Nature and Causes of the Wealth of Nations*, Chicago, Chicago University Press.
- Suzigan, W. and S. C. Fernandes (2004), "Competitividade sistêmica: a contribuição de Fernando Fajnzylber", *História Econômica & História de Empresas*, vol. 7, No. 2, July.
- Suzigan, W. and J. Furtado (2006), "Industrial policy and development", *CEPAL Review*, No. 89 (LC/G.2312-P), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC), August.
- Tavares, M. C. (2011), "O processo de substituição de importações como modelo de desenvolvimento na América Latina: o caso do Brasil", *Desenvolvimento e igualdade: homenagem aos 80 anos de Maria da Conceição Tavares*, V. P. Corrêa and M. Simioni (coords.), Rio de Janeiro, Institute for Applied Economic Research (IPEA).
- Torres Olivos, M. (comp.) (2006), *Fernando Fajnzylber: una visión renovadora del desarrollo de América Latina*, ECLAC Books, No. 92 (LC/G.2322-P), Santiago, Economic Commission for Latin America and the Caribbean (ECLAC)/Institute for the Integration of Latin America and the Caribbean (INTAL).
- Viotti, E. B. (2002), "National learning systems: a new approach on technological change in late industrializing economies and evidences from the cases of Brazil and South Korea", *Technological Forecasting and Social Change*, vol. 69, No. 7, September.
- Welters, A. (2004), "Tecnologia, distribuição de renda e implicações para o crescimento: algumas notas sobre a visão da Cepal nas décadas de 1970 e 80", *Nova Economia*, vol. 14, No. 2.