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SCIENCE AND TECHNOLOGY FOR DEVELOPMENT: THEORETICAL REVIEW OF PROPOSALS FROM THE GLOBAL SOUTH[1]

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Abstract

Autonomous development, also called self-determination of development, is a proposal originating in the Global South that offers a development model that differs from the idea that maintains that underdevelopment is a prior stage to development and that by reproducing successful models it automatically will access this. Thus, autonomous development maintains that countries must stop imitating models and strategies designed and implemented by industrialized countries and, instead, try to create their models according to their particularities,

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establishing goals that satisfy social needs and address national problems. This article reviews how scientific and technological self-determination is related to the construction of a self-development model that guarantees national autonomy in all areas (economic, political, social, etc.) and that is oriented towards the resolution of national problems, especially of majority social groups.

***Keywords**: Development; Science and Technology; Technological Styles; Technological Self-determination.*

***JEL Codes**: O21, O25; O30, O54.*

1. Introduction

During World War II, the Manhattan Project and the dropping of the atomic bombs changed the way science and technology (S&T) policy was conceived and linked to society. The conception of science as neutral and with the sole purpose of the search for knowledge disappeared and, in its place, different political, military, economic, social, etc. interests could be identified more clearly - both by those who finance S&T and by those who generate it -, which was consolidated in what is known as techno-science, since its ultimate goal is no longer knowledge per se, but the ability to generate innovations (Echeverría, 2003, 2015). With this linear conception between S&T and development, scientific and innovation policies took a leading place on the agenda of the main governments, who had the firm belief that these could be aimed at encouraging economic development by creating competitive advantages. In this way, public policymakers around the world included the idea of S&T for development in their agendas (De Angelis, 2013), and later they would add innovation.

At first, the idea of using S&T as an engine for development was applied only in the most industrialized countries. However, upon noticing that the war not only left considerable human and social losses in its wake but also caused an economic debacle that had repercussions throughout the world, it forced economies to design strategies that would allow them to accelerate their economic and social recovery. In this way, based on the experience of developed countries regarding the use of science, technology, and innovation (ST&I), as a tool to encourage economic and social progress, various international organizations recommended that less advanced countries promote the area to access development, preserving the idea that underdevelopment was a previous stage and that its transition could be expedited by increasing investment in this area.

In Latin America, the postwar period was characterized by the incremental emergence of technologies and innovations, a result of the needs of the economic strategy implemented at that time, the Import Substitution Industrialization Model (ISI). The Latin American countries aimed to expand and modernize local industry, in such a way that they began to import technology from industrialized countries, adapting it to the characteristics of each region. In this regard, De Angelis, (2013, p. 1) points out that:

> *The first policy relationship models were based on conceptions designed in the most advanced countries, mainly in the form of the linear model of innovation, which supposes an automated linear process where basic research is followed by applied research and technological development, which in turn leads to industrial technological innovation.*

In the beginning, the transfer of technologies via imports resulted in an important technological learning process, however, the almost exclusive research activity of the State prevented the generation of technology and innovations endogenously (Dagnino et al., 1996). The Latin American region was dependent on the scientific-technological advances that emerged in other countries, which controlled the lines and research agendas following their interests, which in most cases did not match the productive and much fewer social needs of the people in Latin America.

This situation began to be studied by academics from around the world, who proposed different alternatives for less advanced nations to improve their socioeconomic condition. Latin America was no exception, the situation of dependency and inequality in which the region found itself was placed at the center of the discussion, carrying out studies on different sectors, including S&T. Most of the works proposed the creation of national industries directed by the State, the protection of the internal market and strategic activities, as well as the promotion of science, technology, and education as necessary instruments to meet all the proposed objectives.

Concerning S&T, its link with development processes was analyzed, and academics emerged - mainly from applied sciences - who carried out different perspectives and proposals for public policies on the matter. These efforts from the region formed what was called Latin American Thought on Science, Technology, Society, and Development. According to Dagnino et al., (1996), the discussion was oriented firstly towards making diagnoses and criticisms of the prevailing model, considering the economic and political aspects that defined the direction the area was taking; and secondly, proposals for social change were made emphasizing the need for national projects and policies aligned with the needs of the local S&T platform.

Between 1950 and 1960, the work of the science-technology-society triad multiplied. It was thought that S&T could function as a tool for underdeveloped or semi-industrialized countries to access development, leave dependency behind, and reduce the asymmetries that prevailed. However, starting in the 70's, because of the poor administration of the States, an increase in economic problems became visible that led to crises, political and financial instability, and an increase in social problems, with this the model ISI collapsed. Faced with this situation, the main international organizations made a series of recommendations to replace the development model that had failed with the neoclassical economic model and even conditioned financial aid to its implementation.

The S&T platform necessarily required a transformation that would allow its objectives to match those of the new development model. In this context, emerges the proposal of Bengt-Ake Lundvall in 1992 on the functioning, connections, and interactions between the actors participating in the innovation of the National Innovation System (NIS) (Freeman, 2005). According to Foladori (2012), the main goal of the NIS was to link research with the productive sector, where the main integration mechanism is the triple helix. In this way, the word innovation began to be added to the policies, plans, programs, and the names of the institutions in charge of the area, which placed innovation as an indispensable element for economic growth.

Regarding the analysis framework called the triple helix, this was designed by Henry Etzkowitz & Loet Leydesdorff in the nineties and states that the agencies that promote the advancement of ST&I are the university, industry, and the government; therefore, are dedicated to studying their interactions. Specifically, Etzkowitz (2002, p. 2) points out that "the triple helix is a spiral model of innovation that captures the multiple and reciprocal relationships at different points in the knowledge capitalization process."

Broadly speaking, the model considers it necessary to encourage interaction and cooperation between academia, industry, and government to generate mechanisms for the creation of innovative environments to face the knowledge society. The main objective, according to Záyago (2011), has been to link S&T with production and consumption, that is, the market has been used to transfer possible technological benefits to society. Currently, the triple helix model has incorporated more actors, such as society and the environment, in such a way that we speak of the penta-helix model.

The objective of this chapter is to review some proposals from the 1970s made by scholars who generated Latin American Thought on Science, Technology, Society, and Development, to determine to what extent these are viable for the Latin American region today. In the first section, the idea of self-determination for development is developed, specifically for the area of S&T, which supports the importance of countries designing their development model aligned with their characteristics, resources, needs, and social problems. In the second section, the technological styles, studied in the work of Oscar Varsavsky, town-centric and business-centric, are reviewed; the first of them is directed by the State and aimed at satisfying social needs, and the second is focused on the company that controls the area. Subsequently, the issue of scientific and technological capabilities is addressed as a necessary condition to achieve autonomous development; and finally, some final reflections are presented about the current validity of this analytical framework in the countries of the region.

2. Technological Self-Determination for Development

Autonomous development, also called self-determination of development, is an idea that originated in the Global South and offers a development model that differs from the linear one - which maintains that underdevelopment is a prior stage to development and that by reproducing models' successful ones will automatically access it-. In this framework, countries must stop imitating the models designed and implemented by industrialized countries and, instead, try to create their development models, establishing goals that satisfy needs and address national problems. Two exponents of this conceptual proposal were

Oscar Varsavsky and Fernando Fanjzylber, it has a socialist overtone, but not in the sense that the State controls the means of production, but that it is the one who directs capital investments and promotes industrialization with the objective that they meet social needs of most of the population, that is, they do not respond to the interests of elites.

Additionally, in the case of Fanjzylber (1973) he also starts from the idea that some of the strategies of the ISI Model should serve as a basis to overcome the failures that it had in the past. For example, in Latin America protectionism, far from strengthening the national capital industry, benefited transnational companies with foreign capital, whose headquarters were in developed countries, hindering: i) reinvestment in research on the profit rate of transnational companies in the country; ii) effective technology transfer, given that there was no appropriation and improvement of imported technology; iii) the promotion of product exports making use of the marketing networks of transnational companies; iv) the growth of the national capital industry, given that transnational companies absorbed local companies and iv) that the imported technology, both processes and products, was of the latest generation.

O'Brien (1976) refers to the self-determination of economic and social development as the mobilization of resources planned by the State that is accompanied by aspects such as: i) collective political resistance; ii) rupture of the vertical structure, where the international mobility of resources is defined by transnational companies; iii) establishment of a commercial diversification policy; and iv) the emergence of social resistance and awareness that a development strategy must be based not only on general economic conditions but must also consider the distribution of its fruits. Furthermore, he adds that:

> *The key point that brings together the essential aspects can be expressed as follows: each social unit must be its center in the sense of having effective defense mechanisms against pressures of any nature. The "social unit" can be different depending on the context - in particular, we can talk about self-determination at the level of the individual, of a community or region in a country, of an entire country, or of a group of countries. I propose the hypothesis that these levels reinforce each other and that a development strategy can consist of the elaboration of a society in which each unit has a certain degree of control over its interests, without prejudice to other units controlling, in turn, their interests.*

> *The hypothesis implies that society must provide broad participation to each group in political and economic decisions (O'Brien, 1976, p. 758).*

Broadly speaking, O'Brien (1976) points out that the idea and practice of self-determination is a dialectical phenomenon, the result of a reaction against the vertical system that has been imposed and whose expressions cover various areas: political, economic, social, and cultural. According to this author, this approach proposes social control of production, that is, one that is oriented towards the fulfillment of social objectives. In particular, the approach has a totalizing vision of the problems, contrary to the division of parts that facilitates control. A representative example of this situation would be health, which must be conceived as both a collective and individual state, instead of giving an individualistic orientation to medicine, whose production easily lends itself to private appropriation.

For his part, Fanjzylber (1983a) analyzes the precariousness of self-determination in the economic and industrial sphere of a country and assures that to recover it, it is necessary to strengthen the endogenous core defined as: "the articulation of a certain alliance of social forces endowed with historical memory, a proposal for the transformation of the economy and society, the will for national affirmation, and effective leadership over the majority sectors of society" (1983a, p. 309); and adds that this strengthening must be projected to the industrial sector in a way that promotes what he calls new industrialization, as an alternative to the implementation of the neoliberal neoclassical model in the 80's (1983a, 1983b, p. 274).

The construction of this new industrialization implies: i) recovering efficiency to generate the necessary conditions that allow access to high and sustained growth, creativity being a central component for this, since it translates into new modalities of industrialization, and is also expressed in different areas such as cultural, artistic, political and scientific; ii) that, based on a planning scheme, market actions are defined, articulated and guided, based on the needs and potential of the country; and iii) the expansion of social alliances with movements and strategic actors that guide the objectives of industrialization to address the social deficiencies of majority groups, encourage the creative potential of the population and ensure sovereignty in the use and exploitation of their natural resources, That is, autonomy in the area must be promoted (Fanjzylber, 1983a, 1983b).

In this sense, Metzger's (1970) analysis of self-determination and its connection with the political sphere is relevant. It maintains that countries that have achieved political independence promote economic growth through the implementation of new international economic arrangements and the opening of commercial fields and sources of financing and investment. Metzger (1970) explains that the challenge of development is to transform a traditional economy based on the exploitation of raw materials and the export of primary products into a modern one. To achieve this, a socioeconomic transformation must be promoted that includes the organization of the productive process, a qualified workforce, adequate allocation of resources, changes in land ownership, income distribution, and improvements in the quality of life and education.

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In general, the authors agree that self-determination is related to the construction of a self-development model that guarantees national autonomy in all areas (economic, political, social, etc.) and that is oriented toward solving problems. national, especially, of majority social groups. Likewise, a nodal point of autonomous development is to achieve scientific and technological self-determination to eliminate scientific-technological dependence, since this contributes to accentuating the gap between developed and underdeveloped countries.

Sagasti (1981) agrees that the hegemonic scientific and technological model has served as a tool to promote an unfair and unequal distribution of work between developed and underdeveloped countries, which increases the gap by accentuating inequalities. This occurs because highly industrialized countries make use of their superiority in scientific and technological matters to exercise domination over those at a disadvantage; this through the direct exploration of its natural resources, the establishment and administration of industrial activity, as well as the control and conditioning of financing.

In this way, considering the use and possession of S&T, Sagasti (1981, pp. 16–21) identifies two types of countries:

I. Those who have an endogenous scientific-technological heritage, that is, who do not depend on the outside to transform their knowledge into products. This happens because they went through an internal cumulative process or because the transferred technology was organically linked to their productive processes and the generation of scientific and technological knowledge.

II. Those that have an exogenous scientific-technological heritage, that is, that have not managed to establish a base of productive technologies derived from their own scientific and technological discoveries. Because there was no link between knowledge generation and production

In this sense, under this analytical framework, it is believed that the best way to ensure that scientific-technological progress serves as a lever for development is for countries to achieve technological self-determination. In this regard, Sagasti (1976, pp. 779–780) explains that self-determination in the sphere of S&T can be understood in three ways:

I. The ability to make autonomous decisions in technology matters. It refers to having decision-making autonomy as a precondition for the development of scientific and technological capacity. Decision autonomy refers to the ability to define technological needs, identify existing options in other countries, and determine the best way to acquire, incorporate, and absorb said technology.

II. The ability to independently generate the critical elements of technical knowledge that are necessary to obtain a specific product or process. This capacity is closely related to the development of design engineering; It does not imply that the entire critical element must be produced within the country, but rather the ability to design the process or product (and its critical elements), to define standards and specifications for the components to be manufactured, and to assemble these components until integrating the total design.

III. The autonomous potential capacity to produce, within the country, the goods and services that are considered essential in the development strategy. This entails both the possession of knowledge and technical skills as well as the ability to convert them into goods and services. In this sense, a country could depend on its means if it were forced to do so.

For his part, Contreras (1979) says that technological self-determination refers to the construction of a platform in the area based on the definition of policies aimed at the development of national scientific and technological capabilities. It is about countries acquiring autonomy to decide the type of technologies they need to acquire, assimilate, and develop according to their priorities; furthermore, the use of natural and human resources is optimized, and indigenous technology is created to increase productivity. To achieve scientific-technological self-determination, certain conditions must be met:

I. Consider the historical, natural, cultural, and social structure of a country when defining the S&T policy, since this will allow the most pressing needs to be considered and will determine whether its application is possible.

II. Create an institutional scaffolding structure that can be a council or ministry that oversees developing a national plan to encourage the development of S&T, which of course must follow the objectives of the development strategy.

III. Develop strategies for harmonious and self-sustained economic and social development, which contemplate the satisfaction of the needs of the entire society and not just the elites.

IV. Scientific and technological policy must be in perfect synchronization with economic, administrative, cultural, demographic, and social policies and those that influence the physical and ecological environment.

V. Allocate sufficient financial resources, which must be provided in part by the State, but mechanisms must also be sought for companies to allocate a percentage of their profits to research and development (R&D) activities within the country.

VI. Encourage the training of specialized human resources and provide them with the ideal conditions to carry out research activities: jobs with decent working conditions, scholarships, sabbaticals, etc.

VII. Encourage research activities through infrastructure and equipment, access to programs and sources of information, etc.

However, it is important to clarify that the concept of self-determination does not apply to scientific research as such. This is because science is an international activity, therefore, its methodology and discoveries are universal, in this sense no country can depend only on the scientific knowledge that has emerged within it. For this reason, when talking about science, reference is made to the development of scientific capabilities that provide a basis for technological self-determination (Sagasti, 1976). Therefore, it is important to review scientific and technological capabilities in detail since they are a fundamental part of technological self-determination. However, before this, Oscar Varsavsky's (1971, 2013) proposal on technological styles will be analyzed.

3. Technological Styles

As already mentioned, in the postwar stage, development was a widely discussed topic due to the interest in accelerating socioeconomic recovery in the world. According to Veltmeyer (2010), development was understood as economic growth and was associated with industrialization and modernization, therefore, it is measured with indicators such as national production and per capita income. In addition to this, underdevelopment was considered a prior stage through which countries had to go to access development.

Precisely the work of Oscar Varsavsky (1971) begins with a criticism of the role attributed to S&T under this hegemonic conception of development. Consider that these ideas are linear and fallacious since being supported only by quantitative measurements, they do not consider the social aspect and leave aside the structural reasons for dependency.

Varsavsky (2013) observes two styles of development: the first, with a people-centric orientation, that is, focused on the satisfaction of social needs, where companies must produce what is necessary to meet them and the State oversees monitoring the distribution of production to the population. Furthermore, under this scheme, the State serves as a provider of physical and institutional infrastructure and is responsible for remedying inequity in the distribution of income. The second, focused on the company - business-centric -, who decides what and when to produce; and, therefore, is the one who distributes the income.[2]

On the other hand, the dominant scientific-technological model - business-centric - is linked mostly to productive modernization and the creation of profit-generating products, which are not necessarily those that serve to address the most pressing social needs. Furthermore, the progress of S&T is concentrated in highly industrialized countries since they are the ones who finance R&D and, therefore, direct the direction of the area. For their part, poor, underdeveloped, or semi-industrialized countries constantly seek strategies to reduce the scientific and technological gap and, to do so they choose to replicate successful models or request technology transfer, given that these are the recommendations of the main public policymakers. in the world.

> *Its history is presented to us as a unilinear development, without desirable or possible alternatives, with stages that occurred in a natural and spontaneous order and necessarily led to current science, the indisputable heir of everything done, whose future evolution is unpredictable, but surely grandiose, as long as no one interferes with its fundamental driving force: freedom of research (this last said in a very solemn tone) (Varsavsky, 1969, p. 7).*

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2 It is important to note that Varsavsky, O (1969, p. 43) points out that: "There is undoubtedly a correspondence between technology and its supporting sciences; Each technological style that we have briefly described requires a certain scientific style".

Varsavsky criticizes this hegemonic model of science and technology management that conceives them as neutral although in the periphery the dominant, hegemonic, and global technological response even conditions the development of science in terms of the dictate of its questions; Contrary to this, it encourages the construction of a national project that changes the form of management where technology contributes to the well-being of society (Ochoa, 2016).

> *The classic response is that these are not scientific problems: science provides neutral instruments, and it is the political forces who must use them fairly. If they don't, it's not science's fault. This answer is false: current science does not create all kinds of instruments, but only those that the system encourages it to create. For the individual well-being of some or many, refrigerators, and artificial hearts, and to ensure order, that is, the permanence of the system, propaganda, the readaptation of the alienated individual or the dissatisfied group. However, it has not been so concerned with creating instruments to eliminate these underlying problems of the system: methods of education, participation, and distribution that are as efficient, practical, and attractive as a car. Even the most flexible instruments of use, such as computers, are made with other purposes in mind more than others. Even if political power were to suddenly pass into well-inspired hands, they would lack the adequate technology to transform socially and culturally – not just industrially – the people, without incalculable and useless sacrifices (Varsavsky, 1969, p. 8).*

In this sense, Varsavsky (2013) states that the technological style (TS) of the dominant countries is not the only one for the construction of a new and better society, since sometimes it does not have the answer to the needs and problems that arise. In each region. In this sense, it raises the need to build technological styles that are aligned with the objectives pursued by its development project and, of course, under the particularities of each country.

That is, the author proposes that the most backward countries design their style of scientific and technological development, which must be presented in a hierarchical and structured manner. First, they must design a National Project that includes general short, medium, and long-term plans and objectives aimed at addressing national needs and problems. More specifically, Varsavsky (2013, p. 57) points out the following:

> *It is practically a long-term plan, that attempts to repeat these objectives in terms that can be translated without major difficulties or ambiguities to specific projects and determined deadlines, that is, to medium and short-term plans. The National Project (NP hereinafter forward) does not deal only with the final objectives of society, but with the intermediate stages, starting from the current situation, including its political aspects; therefore, it must be permanently updated.*

Of course, in this project you must define the direction and type of S&T platform that you are trying to implement; In addition, consider the evaluation and selection criteria of technologies, all the above under the major development objectives. Then, the NP will derive what it calls the Great Technological Strategy in which the guidelines that the country will follow in terms of technological development will be defined.

> *The answer sought is what we call Grand Technological Strategy: it defines major lines of technological decision, respecting at the same time the TS and the limitation of resources. Like the TS, it proposes general characteristics of the technologies, without even dealing with specific projects, except when they are of such volume that they include much more than the rest (Varsavsky, 2013, p. 143).*

Finally, derived from the Great Technological Strategy, the TS to follow is defined. In this regard, Varsavsky (2013, p. 76) points out the following:

> *We will call "technological style" – "TS", from now on – a set of general qualitative characteristics, common to all branches of technology (and science), desirable because they are directly deducible from national objectives, and practical, in the sense that they help make decisions since they are not compatible with any proposal.*

The TS must set out specific objectives, the investment that will be allocated to each area, the qualified personnel needed and their working conditions, the social impact, the scales of production, and the characteristics of the scientific-technological research that must be carried out. promote (Giri, 2019). Furthermore, it is important to point out that everything contained in the TS must be aimed at meeting the major development objectives set out in the NP.

All those characteristics of technology that obey the objectives of the National Project form what we call technological "style", and our law of technological relativism affirms that each National Project corresponds to an optimal technological style (ET from now on). This law does not aspire to quantitative validity: it only says, in summary, that of the different ways of doing technology, some adapt better than others to national objectives (when these have been defined with minimal clarity)" (Varsavsky, 2013, p. 35).

To create your own technological style, proposals that are not compatible with the chosen style are filtered and rejected. Also, it is necessary to take stock of available resources (human, natural, installed capacity, import capacity, etc.) for all projects. In this way, it is possible to identify the "major technological lines" - which together form the Grand Technological Strategy - in each sector, as well as the type of materials, equipment, labor, and processes necessary to ensure that resources are sufficient to comply with national objectives (Varsavsky, 2013).

As a summary, Varsavsky's thesis on technological styles highlights the need for countries to achieve autonomy in S&T, based on the design and implementation of their development style that adjusts to their characteristics - economic, political, social, etc.-, resources, needs, and problems; instead, applying models from other places that are generally not compatible with reality and the objectives to be achieved.

4. Scientific and Technological Capabilities

The promotion of science and technology as a strategy for development has been present in public discourse for almost half a century in Latin America. In the last fifty years, explanations, models, agendas, and policy instruments have been formulated that state the importance of building scientific and technological capabilities to help semi-industrialized or underdeveloped countries transform into modern and developed societies (Gómez, 2005).

The construction of self-determination or one's technological style is closely related to the creation and increase of a country's scientific and technological capabilities, as they are necessary resources for the progress of S&T. In addition to this, Corona (1990) points out that these capabilities must support participatory social processes, and equal opportunities, be compatible with the environment and, of course, satisfy the most pressing needs of society.

Technological ability was defined in the eighties by Westphal, Kim & Dahlman (1984, p. 5) as "the ability to make effective use of technological knowledge[...]; This does not lie in the knowledge that is possessed but in the use of knowledge and the capacity to be used in production, investment, and innovation." Furthermore, they point out that due to the existence of different technological capabilities, they can be classified in numerous ways, depending on the technological knowledge used and its applications.

> *Technological capabilities are separable into three broad areas: production, investment, and innovation. The first capability is for operating productive facilities, the second is for expanding capacity and establishing new productive facilities, and the third is for developing technologies. Proficiency in production capability is reflected in technical efficiency and in the ability to adapt operations to changing market circumstances. Proficiency in investment capability is reflected in project cost and in the ability to tailor project designs to suit the circumstances of the investment. Proficiency in innovation capability is reflected in the ability to develop technologies that are less costly and more effective (Westphal, Kim y Dahlman, 1984, p. 6)*

For their part, Bell & Pavitt (1995) pointed out that efficiency does not automatically follow from the acquisition of new technologies and the accumulation of knowledge, but rather depends on national capabilities to generate and manage change in the technologies used in production. For its part, the *Foro Científico y Tecnológico A. C.* (2012) defines them as specialized resources of an organization that serves to generate and manage technological change and make effective use of knowledge. In the same sense, Tapias (2005) indicates that technological capabilities are essential for the development of competitiveness; considers that its accumulation is necessary to improve a company's processes and products, as well as to increase productivity via an increase in innovation flows. This author takes up the concept of technological capabilities of Katz, Dahlman, and Lall, among others, and points out that they are:

> *A set of knowledge required to plan, organize, direct, execute, and control the acquisition, adaptation, improvement, creation, and effective use of technology. That is, knowledge to manage technological change and to produce goods and services with the quality, differentiation, flexibility, and opportunity with which the market demands them. They allow productive facilities to be operated*

> *efficiently, but also to adapt, optimize, improve, recreate, and generate new ones (Tapias, 2005, p. 105).*

While Bell & Pavitt (1992, p. 261) state that:

> *Technological capability incorporates the additional and distinct resources needed to generate and manage technical change, including skills, knowledge and experience, and institutional structures and linkages. This distinction is important because we are interested in the dynamics of industrialization, and hence in the resources necessary to generate and manage that dynamism.*

It should be noted that the work of Bell & Pavitt (1995) is considered an important framework within the literature on the study and classification of technological capabilities. These authors used work by Lall (1992) to develop a taxonomy of technological capabilities using a production function (primary and supporting techniques), in which they distinguish the different levels of innovation (basic, basic innovative, intermediate innovative, and advanced innovative); they explain the characteristics and aspects that must be considered at each level.

Regarding scientific capabilities, the Frascati Manual (2015) points out that R&D includes "the creative and systematic work carried out to increase the volume of knowledge (including knowledge of humanity, culture, and society). and conceive new applications based on available knowledge" (OECD, 2015, p. 47). Furthermore, this manual indicates that R&D includes three types of activities:

I. Basic research: experimental or theoretical work that is undertaken primarily to obtain new knowledge about the foundations of observable phenomena and facts, without the intention of granting them any specific application or use.

II. Applied research: original work carried out to acquire new knowledge, but it is fundamentally directed towards a specific practical objective.

III. Experimental development: systematic work based on existing knowledge obtained from research or practical experience that is aimed at producing new products or processes or improving existing products or processes.

In this sense, it can be said that scientific and technological capabilities constitute the accumulation of tangible and intangible resources necessary to generate knowledge and technological applications. Reyes (2016, par. 3) points out that these capabilities include:

> *On the one hand, they refer to physical or tangible elements such as specialized human capital, scientific and technological infrastructure, basic research, applied research, scientific and technological development projects; and on the other hand, they include intangible but highly valuable elements such as the link between strategic actors such as Higher Education Institutions, Research Centers, companies, society and the public sector, the consolidation of collaboration agreements, the generation of promotion programs to science and technology activities and of course, the promotion and consolidation of a regulatory framework consistent with the environment of a society that applies new or existing knowledge to the generation of wealth.*

The generation of knowledge is considered essential for the development of successful technological innovation processes, given that it is necessary for the construction of technological capabilities (Morales & Villavicencio, 2015) that can be transformed into new processes and products (Amaro & Robles, 2013).

Due to the importance of these capacities for economic and social development, strategies are constantly sought to increase and improve them, such as the implementation of legislative tools (plans, laws, programs) and the creation of institutions that are responsible for their promotion. Some authors such as Flores & Cárdenas, (2017, p. 292) point out that the importance of promoting S&T lies in the fact that "the ability of a nation to solve problems, reduce poverty and generate sustainable development depends on its scientific, technological and innovation capabilities."

5. Final Reflections on these Proposals

The analytical framework of self-determination for development in its broad sense and, specifically, for the area of S&T becomes relevant in the current context where more than three decades of implementation of the neoliberal economic model show its inability to reduce the gap. between developed and underdeveloped countries. Contrary to this, as mentioned by Fanjzylber (1983b), social deficiencies have increased and potentialities that were developed inefficiently and insufficiently in the past have been suppressed.

In this context, imitating the development recipes (economic, political, social, scientific-technological, among others) of the most developed countries is not the best solution to address the problems of the region, given that they are not designed considering the characteristics of these countries. Contrary to this, own development models must be sought according to their conditions, resources, and strengths, defining goals that are oriented towards the resolution of national problems, in this way, autonomous development turns out to be a current analytical framework.

Currently, academics, researchers, and public policymakers in the world agree that S&T is a central area for development, however, scientific-technological progress between developed and underdeveloped countries is unequal and the dependence of the latter is increasingly greater, that is, the gap is widening more and more. For example, the World Intellectual Property Organization (2023) in its report on the World Innovation Index 2023 places Switzerland, Sweden, and the United States of America as the three most innovative countries in the world, while the countries in the region with the best rating Brazil, Chile, and Mexico were ranked 49, 52 and 58 respectively; that is, very far from the top positions.

In this way, it is essential that the countries of the region build a strategy of technological self-determination that allows them to achieve their autonomy and leave behind technological dependence, and that in turn they distance themselves from the research agendas of other countries that have little to do. do with the national problems of each country. As an example, we can mention the Cuban case where their technological style was created, which allowed them to promote and place one of their most important strategic biotechnological sectors as a leader in the region. Likewise, the objective was not only to make efficient use of resources but also to solve national problems. Broadly speaking, Cuba chose a people-centric national plan aimed at meeting the needs of its population and, at the same time, a business-centric plan towards the outside was implemented. In this way, once they were able to cover internal needs, the research centers and marketing companies followed the logic of the capitalist market, selling their products abroad, complying with international regulations on intellectual property rights, and configuring themselves as globally competitive companies (Cuevas & Chávez, 2021).

Finally, it is important to note that for the construction of one's technological style, it is necessary to build public policy agendas that need to be overseeded by the State through i) defining the sectors, programs, and strategic plans for the country; ii) promoting national industries, iii) identifying the scientific and technological capabilities available and those that need to be acquired or encouraged; and iv) establishing technology transfer mechanisms that incorporate, internalize and improve it to encourage R&D. Many of these actions can be seen as characteristics that Southeast Asian countries implemented in the 1970s, mostly known as Developmental States.

References

Amaro R., M., & Robles B., E. (2013). Producción de conocimiento científico y patrones de colaboración en la biotecnología mexicana. *Entreciencias. Diálogos en la sociedad del conocimiento*, *1*(2), 183–195.

Bell, M., & Pavitt, K. (1992). Accumulating Technological Capability in Developing Countries. *The World Bank Economic Review*, *6*(suppl_1), 257–281. https://doi.org/10.1093/wber/6.suppl_1.257

Bell, M., & Pavitt, K. (1995). The development of technological capabilities. In *Trade, technology, and international competitiveness*. Economic Development Institute of the World Bank.

Contreras, C. (1979). Una ciencia y tecnología para el desarrollo económico y social del Tercer Mundo. *Nueva Sociedad*, *42*, 5–14.

Corona, L. (1990). Elementos para una estrategia latinoamericana de desarrollo científico y tecnológico. *Comercio Exterior*, *40* (2), 150–155.

Cuevas M., N. A., & Chávez E., M. G. (2021). Desarrollo de vacunas biotecnológicas en Cuba y Argentina. *Ciencia, Tecnología y Política*. DOI: https://doi.org/10.24215/26183188e065

Dagnino, R., Thomas, H., & Davyt, A. (1996). El pensamiento en ciencia, tecnología y sociedad en Latinoamérica: Una interpretación política de su trayectoria. *Redes*, *3* (7), 13–51.

De Angelis, I. (2013). Desafíos para el desarrollo en América Latina: La política científica y tecnológica en el siglo XXI. Parte I. *Comercio y economía internacional*, *168* (7), 1–4.

Echeverría, J. (2003). *La revolución tecnocientífica* (Vol. 7). Madrid: Fondo de Cultura Económica de España.

Echeverría, J. (2015). De la filosofía de la ciencia a la filosofía de las tecno-ciencias e innovaciones. *Revista iberoamericana de ciencia tecnología y sociedad*, 10(28), 105-114.

Etzkowitz, H. (2002). La triple hélice: Universidad, industria y gobierno. Implicaciones para las políticas y la evaluación. *Science Policy Institute*. http://www.sivu.edu.mx/portal/noticias/2009/VinculacionLatriplehelice.pdf

Fanjzylber, F. (1983a). Intervención, autodeterminación e industrialización en América Latina. *Trimestre económico*, *50*(197), 302–328.

Fanjzylber, F. (1983b). *La industrialización trunca de América Latina.* Centro de Economía Transnacional.

Fanjzylber, F. (1973). "La empresa internacional en la industrialización de América Latina" (pp. 16-63). In Fajnzylber, F.; Bitar, S.; Chapoy, A.; Ffrench-Davis, R. & Jonas, S. Corporaciones Multinacionales en América Latina. Ediciones Periferia.

Flores, U. M., & Cárdenas, M. R. (2017). Desarrollo de capacidades científicas en estudios medioambientales en América Latina y el Caribe. *Opción*, *33*(83), 278–304.

Foladori, G. (2012). Riesgos a la salud y al medio ambiente en las políticas de nanotecnología en América Latina. *Sociológica*, *27*(77), 143–180.

Foro Consultivo Científico y Tecnológico A.C. (2012). *Glosario de términos relacionados con la innovación*.

http://www.foroconsultivo.org.mx/asuntos/temas_innovacion/glosario_innovacion.pdf

Freeman, C. (1995). The 'National System of Innovation' in historical perspective. *Cambridge Journal of Economics,* 19(1), 5-24. http://www.jstor.org/stable/23599563

Giri, L. A. (2019). Oscar Varsavsky, Estilos tecnológicos: Propuestas para la selección de tecnologías bajo racionalidad socialista. *Tecnología y sociedad*, *3*, 99–105.

Gómez, Y. J. (2005). Política científica colombiana y bibliometría: Usos. *Nómadas*, *22*, 241–254.

Metzger, S. D. (1970). La autodeterminación y el desarrollo económico. *Foro Internacional*, *11*(2), 245–253.

Morales, A., & Villavicencio, D. (2015). Convergencia de capacidades científicas y tecnológicas en el sector de la biotecnología farmacéutica en México. En *Convergencia del conocimiento para el beneficio de la sociedad: Tendencias, perspectivas, debates y desafíos.* (Primera Edición, p. 304). Consejo Nacional de Ciencia y Tecnología (CONACYT).

O'Brien, P. (1976). La autodeterminación como estrategia de desarrollo. *Comercio Exterior*, *26*(7), 757–761.

OECD. (2015). *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development*. OECD. https://doi.org/10.1787/9789264239012-en

Ochoa, A. (2016). Paradigmas de la tecnología desde una dimensión política. Una lectura desde el presente de los Estilos Tecnológicos de Varsavsky. *Conocimiento Libre y Licenciamiento(CLIC)*, *12*, 83–88.

Sagasti, F. (1981). *Ciencia, tecnología y desarrollo latinoamericano* (Primera edición). Fondo de Cultura Económica.

Sagasti, F. R. (1976). Autodeterminación tecnológica y cooperación entre países del Tercer Mundo. *Comercio Exterior*, *26*(7), 779–784.

Tapias G., H. (2005). Capacidades tecnológicas: Elemento estratégico de la competitividad. *Revista Facultad de Ingeniería Universidad de Antioquia*, *33*, 97–119.

Varsavsky, O. (2013). *Estilos tecnológicos: Propuestas para la selección de tecnologías bajo racionalidad socialista* (1a Ed). Ministerio de Ciencia, Tecnología e Innovación Productiva.

Varsavsky, O. (1971). *Proyectos nacionales. Planteo y estudios de viabilidad.* Ediciones Periferia S. R. L. https://repositorio.esocite.la/896/

Varsavsky, O. (1969). Ciencia, política y cientificismo. *Centro Editor de América Latina*, 1–32.

Veltmeyer, H. (2010). Una sinopsis de la idea de desarrollo. *Migración y Desarrollo*, *14*, 9–34.

Westphal, L. E., Kim, L., & Dahlman, C. J. (1984). *Reflections on The Republic of Korea's Acquisition of Technological Capability* (World Bank Group, 1–no. DRD 77, pp. 1–62). https://documents.worldbank.org/en/publication/documents-reports/documentdetail/771951468273590388/reflections-on-koreas-acquisition-of-technological-capability

World Intellectual Property Organization. (2023). The Global Innovation Index 2023 captures the innovation ecosystem performance of 132 economies and tracks the most recent global innovation trends. https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2023-section1-en-gii-2023-at-a-glance-global-innovation-index-2023.pdf

Záyago L., E. (2011). Clúster nanotecnológico en Nuevo León, México. *Reflexiones de pertinencia social*, 319–333.