

SCIENCE, TECHNOLOGY AND INNOVATION POLICIES LOOKING  
BACKWARDS, FORWARDS AND BEYOND: DEVELOPMENTAL  
CHALLENGES AND OPPORTUNITIES FOR IBERO-AMERICA  
IN THE ERA OF COVID-19

*POLÍTICAS DE CIENCIA, TECNOLOGÍA E INNOVACIÓN HACIA ATRÁS,  
HACIA ADELANTE Y MÁS ALLÁ: RETOS Y OPORTUNIDADES DE  
DESARROLLO PARA IBEROAMÉRICA EN LA  
ERA DE COVID-19*

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ABSTRACT

This article explores challenges and opportunities for science, technology and innovation (STI) policy in Ibero-America related to the COVID-19 pandemic, claiming a new multidirectional approach that combines two key dimensions: (i) transversality, for national innovation systems (NIS) integration with other subsystems; and (ii) coordination of STI across national and international spaces. Departing from the situation of the region, the sanitary and economic crisis, and the evolution of NIS and policy rationale, we propose some guidelines for a new STI policy agenda based on the region's challenges ahead and the need for mechanisms of coordination.

*Keywords:* Science; technology and Innovation policy; National innovation systems; Ibero-America; development, COVID-19.

## RESUMEN

Este artículo explora los desafíos y oportunidades para la política de ciencia, tecnología e innovación (CTI) en Iberoamérica en relación con la pandemia COVID-19, reivindicando un nuevo enfoque multidireccional que combina dos dimensiones clave: i) la transversalidad, para la integración de los sistemas nacionales de innovación (SNI) con otros subsistemas; y ii) la coordinación de la CTI en los espacios nacionales e internacionales. A partir de la situación de la región, la crisis sanitaria y económica, la evolución de los SNI, y la lógica de las políticas, proponemos algunas pautas para una nueva agenda de política de CTI basada en los desafíos de la región en el futuro y en la necesidad de mecanismos de coordinación.

*Palabras clave:* política de ciencia; tecnología e innovación; Sistemas nacionales de innovación; Iberoamérica; desarrollo; COVID-19.

*Clasificación JEL / JEL Classification:* O29; O3; O54.

## INTRODUCTION<sup>1</sup>

The COVID-19 pandemic has explicitly shown the relevance of incorporating science, technology and innovation (STI) as a suitable tool for achieving higher living standards and advancing toward a path of sustainable development. This implies reflecting on the nature of STI policies, evolution, and current opportunities to collaborate with social resilience for facing local and global challenges. The issue is that although biomedical scientific research occupies a central place in the short-term solutions for producing vaccines and treatments, and research and development (R&D) assets have been mobilized in the international context, and also in the Ibero-American countries, the pandemic has shown how a multifaceted health crisis requires a multi-faceted systemic response and involves addressing multiple socio-economic impacts.

The original contribution of this article is to explore STI policy challenges and opportunities for Ibero-America as a result of the COVID-19 pandemic considering a multidirectional approach that combines: (i) transversality, for national innovation systems (NIS) integration with the rest of the national subsystems; and (ii) coordination of STI across national and international spaces, following the 2030 Agenda for Sustainable Development Goals (SDG). We claim that a new approach to STI policy is required that would be based on specific aspects of building capabilities processes that would combine a short-term view related to fighting the pandemic and a more long-term view based on the systems' resilience. This approach must also be based on a democratic construction of the STI agenda which demands to attend several present obstacles such as the rigid borders across disciplines, the still scarce bottom-up approach in the definition of STI policies, and the lack of dialogue among the implied communities. Our proposal here is a multi-actor and multi-disciplinary approach in order to define the developmental problems and the strategies needed to tackle them. It must also incorporate the specificities of the region in terms of the NIS and the heterogeneous levels of development.

More than two decades after Freeman (1995) pointed out the importance of scientific and technological institutions, education and health systems, government policies and cultural traditions, we will discuss how NIS remains

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crucial to facing short term shocks and long-term challenges. The response of the different NIS from Ibero-America has proved their ability to offer ready-to-use solutions for the disease, supporting economic recovery, and to generate and strengthen capabilities in a sustainable way, so we can count on mature systems to better face new crises. The challenge is to look beyond the current one and move forward into a new STI policy that is more articulated with a development agenda that combines national and international solutions.

After this introduction, section two reflects on the situation of Ibero-American countries prior to the COVID-19 crisis in order to understand how it shocked them in terms of the healthcare and economic crisis, the evolution of NIS and the STI policy rationale in Ibero-American countries. Section three proposes some guidelines for a new STI policy agenda that reflects on the developmental challenges ahead in relation to STI policy and the need to coordinate mechanisms at different levels of policy action including a specific reference to the SDGs and Agenda 2030. Finally, in section four, some conclusions are presented.

## 2. THE PAST DEPENDENCE LEADING TO THE 2020 COVID-19 CRISIS

### 2.1. THE CONTEXT: EVOLUTION OF COVID-19 AND ECONOMIC CONTRACTION

Within Ibero-American countries, the first confirmed case of COVID-19 appeared in Brazil at the end of February 2020, and as of October<sup>2</sup>, 2020 there were nearly 5.38 million confirmed cases (approximately 157,000 deaths). Brazil is followed by Spain, with more than 1.1 million infections, Argentina and Perú (1 million) and Mexico (0.8 million) follow. Nonetheless, these figures may be inaccurate because of the general lack of massive tests. The number of cases has grown exponentially and very quickly since the WHO's declaration of a pandemic on March 11, 2020. The situation is aggravated by respiratory problems, which are the 3rd cause of death in the regional context, together with the added risk of "synergy of epidemics" -outbreaks of measles and dengue fever, diseases that are not completely controlled and affect the most vulnerable population. Furthermore, chronic non-communicable degenerative diseases (hypertension and other cardiovascular diseases, cancer and diabetes) that increase the COVID-19 mortality rate are highly correlated with social determinants, an unfavorable scenario for the region (IDB, 2020).

Another dimension of the crisis is the economic impact of COVID-19. The International Monetary Fund (IMF, 2020) estimates a 3% contraction in the world economy while the World Bank's prediction is -5.2% for 2020 (WB, 2020a), with different magnitudes across regions. Projections for Ibero-American countries underline severe slowdowns or outright contractions in

<sup>2</sup> The original version of this paper was submitted in June 2020 and available data corresponded to April. Authors acknowledge the Editor for the possibility of updating data to October 2020 before resubmission.

economic activity, where the fall is expected to be 7%, with higher rates for Peru -12%, Brazil -8%, and Mexico -7.5%. The Inter-American Development Bank (IDB) forecasts a drop in GDP in Latin America and the Caribbean (LAC) of between 1.8% and 5.5% in 2020 (IDB, 2020). On the other side, Spain and Portugal are among the most affected economies in the European Union (EU): the IMF forecasts more than a -8% rate in 2020, above the -7.1% in the EU (IMF, 2020). Elevation in unemployment rates and inequality are at stake, further deepening the negative social consequences that the 2008 crisis generated. Although economic crises will be a global phenomenon, we can expect greater impact in the region: internal and external shocks accentuated by the contraction of global demand; the reduced margins of maneuverability for fiscal and monetary policy to lessen the impact of the crisis and self-reinforcing inequality being among the worst negative consequences (Lustig and Tommasi, 2020).

This situation forces the adoption and implementation of substantial social and economic measures to help affected households and businesses. Some social emergency responses have already been adopted in many countries (i.e. Spain and Argentina). However, this pandemic calls for coordinated international responses and actions -such as the program approved by the EU (European Parliament, 2020), but its success will be directly dependent on national or sub-continental areas.

Our proposal is that going beyond existing approaches, we need coordinated actions in order to cope with the multifaceted effects of this crisis while the underlying role of STI in the alleviation of these effects is twofold. On one hand, we need to use the STI capabilities to provide effective solutions for people's health: from the provision of medical devices (such as mechanical ventilators and safety equipment) to the production of pharmaceuticals (such as antiretroviral drugs and vaccines) that would protect human life. On the other, NIS should provide resilient conditions that would help to ensure economic and social recovery, implementing short term strategies that must be aligned with long term plans for development.

## 2.2. THE EVOLUTION OF NATIONAL SYSTEMS OF INNOVATION IN IBERO-AMERICA

NIS is a concept that refers to the set of organizations, institutions and their interactions, that take part of the process of the creation and exploitation of knowledge, at the national level (Arocena and Sutz, 2020; Chaminade et al., 2018). It is a powerful conceptual and methodological tool for broaching the study of innovation, as long as it recognizes the complexity and evolving nature of technological and organizational change. Since the approach first appeared in the 1990s, academic literature and policy instruments have multiplied, especially in Ibero-America and Europe (Rakas and Rain, 2019). In the case of NIS from Ibero-America, literature agrees on some stylized facts about countries within the region.

Firstly, they are characterized by historically low levels of investments in knowledge creation and application, which results in a limited science

and technology (S&T) infrastructure (Suarez et al, 2020). On average, total investment in Research and development (R&D) is around 0.75%, with an annual growth rate of 0.71% for the last decade. These figures contrast with the 2% observed for the European Union (EU), with an average annual growth rate of 2%. In absolute values, this means the average for Ibero-America is 16% of the average investment registered in the EU (Eurostat, 2020; RICYT, 2020).

Secondly, the largest share of R&D expenditure is funded and executed by the public sector, which accounts for poor innovative dynamics among firms, with innovations concentrated on modernization by means of imported capital goods (Álvarez et al., 2013; Erbes and Suárez, 2016). Moreover, 60% of R&D investments in the region come from the public sector and institutions of higher education, while the average for the EU is 30%. Similarly, patent applications in the EU is around 106 per million inhabitants, while this ratio falls to 21 for the Ibero-American case (Eurostat, 2020; RICYT, 2020).

Thirdly, unlike other developing countries, the region has a long tradition of investment in higher education and S&T capabilities (Dutrenit & Sutz, 2014). This was evidenced in the rapid response of both education and S&T to the COVID-19 crisis in terms of virtual training and development of solutions (Pedró et al. 2020). This can also be observed in the number of papers published on the subject. Since March 2020, nearly 2,250 papers have been published in specialized journals in relation to COVID-19 (June, 11, 2020); however, general figures are still far from the values registered in the EU, China or USA, since only 7% corresponds to Ibero-American countries. Moreover, in Ibero-America there are 1,250 researchers per million inhabitants versus 12,670 for the case of the EU, that is, 10 times more personnel (Eurostat, 2020; RICYT, 2020).

Fourthly, productive systems work as an archipelago of modernity islands within an ocean of firms with low levels of productivity (Dutrenit & Katz, 2005). There are some firms competing on the international frontier, with technological and commercial problems very similar to those of firms from developed countries, but scarcely connected to the rest of the productive structure. This structure is far below the level for developed countries, and the gap expands every year. For instance, EU trade data shows that both imports from and exports to Latin America are highly concentrated in less than 10 countries and represent nearly 5% of total EU merchandise trade (Eurostat, 2020). In this context, strategic planning of STI from the public sector is not strong enough to connect knowledge supply and demand, whether in terms of searching for technological upgrade among firms or providing solutions for development challenges.

Fifthly, there is inter- and intra-national heterogeneity. Ibero-America refers to a group of countries with different levels of development, with dissimilar levels of accumulated productive and STI capabilities. There are OECD country members such as Chile, Mexico, Portugal, and Spain; Costa Rica now being in the process of accession; some emerging economies such as Brazil and high- and medium-high income countries such as Uruguay, Argentina and Colombia. But

also, medium-low- and low-income countries such as Bolivia, Haiti, Guatemala and Nicaragua. In addition, there is intra-national heterogeneity (Erbes et al., 2016). Resources, capabilities and population are concentrated around a small number of cities, mainly the capital districts and some agricultural and productive nodes. The GINI index shows that Latin America is the most unequal region; it has oscillated between 45 and 55 over the last twenty years, while for the EU it is close to 28 (WB, 2020b). Moreover, around 188 million people live under the poverty line, that is 30% of the population of the region, and the income gap is increasing, while the level of informality is also very high (ECLAC, 2020). This means not only that elementary capabilities, such as access to higher education, are very limited in some regions, but also that different problems of development demand STI solutions connected to heterogeneous levels of technological complexity that ranges from the lack of healthcare systems to environmental degradation due to the use of genetically modified seeds.

In short, NIS of Ibero-American countries are historically characterized by low investments in the creation and application of knowledge, aggravated by weak linkages between the different components of the system. However, and even in the presence of high heterogeneous situations, there are accumulated capabilities in STI which account for the potential of the NIS to contribute to development. In addition, the region shares a long history of cooperation and geographical, cultural and institutional similarities. All of this accounts for the possibility of an articulated strategy, and strengthening the linkages between the NIS and the rest of the national systems will be a key challenge for STI policy.

### 2.3. STI POLICY RATIONALE IN IBERO-AMERICA

The rationality behind STI policies in Ibero-American countries evolved hand-in-hand with changes in the general frameworks for public intervention. In a very summarized *racconto* of the history of STI policy, four moments can be identified. The origins of STI policy as a state policy go back to the model of import substitution during the 1950s. This period was led by the promotion of knowledge supply in the form of traditional S&T institutions. During the 1990s, the cycle of structural adjustment and policy reforms linked to the Washington Consensus led to market oriented STI policy, characterized by competing matching grants and the promotion of firms, defined as the knowledge demand (Katz, 2007). The diffusion of the NIS approach and the cycle of post-structural reforms initiated at the beginning of this Century led to the implementation of “systemic” policies, based on vertical and integrated schemes to promote innovation by means of generating linkages within sectorial, regional and national innovation systems (Crespi and Dutrenit, 2013). Since the 2008 financial crisis - and partially explained by the limited impact of systemic policies- a new rationale behind STI policy emerged and challenged the traditional NIS-based view of public intervention. This new approach is based

on the idea that STI must be directed towards strategic goals, defined outside the NIS but connected to it.

It would be unfair to state that STI contribution to development has been denied in past policy rationales. Many STI policy instruments have been fundamental to the development of knowledge-intensive solutions that collaborate with social welfare, particularly for health issues (Natera et al., 2019). STI policy has always been thought of as a means to development, and changes in policy rationale were in fact changes in both: the conceptualization of how to reach it and the role played by STI. During the fifties, development was defined in terms of industrialization and S&T was expected to push innovation. Despite the early recognition of the importance of articulation within the NIS (Sabato and Botana, 1968), STI policy was focused on S&T institutions and protecting national industry. During the nineties, development was assimilated into competitiveness, this reached by means of market competition. Under this scheme, innovation and technologies were assumed to promote S&T activities based on pseudo-market interactions. The systemic view of the NIS approach showed the importance of articulating both sides of the system, with a more complex definition of development that includes equality, but to some extent assuming a linear relationship between innovation and development. What we have been evidencing in recent times is an explicit emphasis on the design of STI policies targeted at collaborating with development challenges.

Hence, the fourth moment of STI policy, which began during the last decade, is still under debate without a clear conceptual framework. Three approximations are gaining consensus. Mainly based on contributions from LAC, the interest in innovation processes focused on inclusion issues and related national problems (Dutrenit and Sutz, 2014), to strengthen NIS and their capabilities and interactions in innovations meeting the needs of marginalized populations, but more widely, to close the income gap. The development of new products and services can be oriented towards solving national problems, by applying two strategies: the generation of ready-to-use solutions for marginalized populations and the co-production of solutions. In both cases, the integration of multiple agents and S&T disciplines are intended to better define the development challenge based on solutions that integrate communities in the process (Cozzens and Sutz, 2014).

Another approach is the organization of development challenges in "Mission oriented projects" (Mazzucatto and Penna, 2016). S&T capabilities must be combined with other types of capabilities -namely the State, technical-administrative, political, productive and market capabilities- to provide solutions to development challenges. They are concrete goals, set with measurable levels of achievement, which must be executed within certain deadlines. Missions are articulated in a portfolio of specific projects, usually inter-sectoral, which are geared towards meeting their goals in a timely manner; they require validation in the public agenda and by State entities.

A more recent approach is the promotion of Transformative Innovation Policies (TIP), that considers the reconfiguration of social and economic





relations, in achieving new arrangements of socio-technical systems for the solution of problems (Schot & Steinmueller, 2018). These include new structures in terms of market relations, political processes, generation of local or transnational interactions or promotion of certain lines of R&D. Furthermore, it states that innovation processes generate positive and negative externalities: innovation has effectively served as an engine for economic development in some regions but, at the same time, it is part of the structural processes that sustain problems in other parts of the world.

Unlike other dimensions of public policy, every new cycle of STI policy led to new instruments and programs but maintained previous interventions. As a result, today's STI policies are composed of layers of instruments and programs from the four historical moments of STI policy with different objectives (not always designed in a coherent way), aimed at generating, applying and exploiting knowledge to contribute to overcoming development challenges. The current scenario of COVID-19 will require the combination of all three competing approaches to STI policy. Beyond the current crisis, policy concerned with the generation of specific solutions could be part of the strategic projects defined in a long-term framework, using the immediate needs as means for achieving scientific, technological and institutional capability development. The COVID-19 crisis constitutes an opportunity to look beyond the pandemic and to think of a more long-term and integrated development strategy. In this scenario, STI policy has a role to play and some lessons to learn.

### 3. STI POLICY PERSPECTIVES: SYSTEMIC INTEGRATION AND MULTILEVEL COORDINATION

#### 3.1. STI POLICIES FOR DEVELOPMENT CHALLENGES

The duality between the efforts required and the potential benefits justify the emergence of a new STI policy framework. The potential of STI capabilities reaches its maximum when they are framed in a systemic vision, where social, cultural, political and economic dimensions are combined (Borras and Edquist, 2019). The integration of different disciplines requires an effort in the construction of a common language, interdisciplinary analytical frameworks and harmonized methodologies. This implies a problem of coordination for the multi-level (national, sub-national and international) layout for agreements and actions.

STI policy for the challenges ahead must consider the complexity of their object: it implies dealing with non-linear processes and requires the conjunction of heterogeneous agents. This implies recognizing the relationship between the knowledge generation processes and their possible use (S + T + I). Different research teams' configurations can achieve these results, however some of them make the generation of these virtuous products more likely to occur: they are multi-, inter- or transdisciplinary teams that seek capabilities integration mechanisms by being oriented

at problem-solving research. These teams work under “type 2 mode of knowledge production,” made up of heterogeneous agents, with a research process that combines academic rigor with social reflexivity (Gibbons, 2000; Nowotny et al. 2003). The COVID-19 crisis is also a call for rethinking how STI processes could collaborate in the generation of new solutions, specifically through the generation of interdisciplinary frameworks, paying special attention to the creation of analytical bridges between health studies and innovation studies. A recent proposal points out four analytical dimensions in this direction (Natera et al., 2020):

- Heterogeneous agents, including knowledge generators from the public sector, the productive sector, the scientific community and health services providers. And, as the COVID-19 crisis shows, two more types of agents are knowledge users, the medical personnel who are trained to apply possible new treatments; and knowledge beneficiaries, patients and general population that should know how to act in the face of possible infections.
- Asymmetrical interactions that could foster or inhibit knowledge flows, conditioning the relationship between different agents. The COVID-19 pandemic has boosted telemedicine services, giving a more active role to patients in self-managed healthcare treatments; this reconfigures the hierarchical nature of the doctor-patient relationship as per the implementation of an STI solution.
- Learning processes, based on specific models for healthcare activities, that include the productive activities and feedback loops in a non-linear configuration: knowledge sources are distributed in the model. New insights come on a daily basis from the observation of the COVID-19 measures, such as the massive use of masks in public spaces or the use of certain drugs to alleviate symptoms.
- Institutional framework: considering formal institutions (laws and regulations) and informal institutions (socio-cultural background). The rights to use a SARS-CoV-2 vaccine will need a legal discussion on the scope of Intellectual Property Rights. On the other hand, the effectiveness of social distancing measures is greatly determined by the possibility of changing our social interactions -and living conditions- in a sustainable way.

There is no one discipline capable of dealing with all the aspects of these four dimensions for the COVID-19 pandemic. STI Policy needs a multidisciplinary approach, in which different agents can interact. It is crucial to establish a common agenda in which STI processes are oriented towards the solution of the crisis and its effects. STI policies have to consider participation mechanisms to articulate agents’ needs, interests, visions and capabilities. Dialogues for STI policy design are a fundamental tool for this objective (Dutrénit and Natera, 2017) and its relevance can be observed at two moments. The first is the design phase because processes of dialogue must be oriented at reaching consensus on the definition of

agendas, objectives and strategies of the STI policy. The second is the implementation, monitoring and evaluation of the policy. When it comes to troubleshooting, maintaining links with relevant agents (stakeholders) throughout the process is highly recommended. Participation benefits due to the usefulness of the instruments of STI policy and the appropriation of the agenda and solutions are clear, making it a mechanism for guaranteeing the efficiency and effectiveness of the STI process. Also, it may be basic to enhancing NIS linkages and generating coordination mechanisms between national and international levels.

### 3.2. STI POLICY AND THE RECONFIGURATION OF THE NIS

The COVID-19 crisis made the scientific community aware of the imperative nature of social needs, even when it meant skipping steps of scientific methods -which explains part of the scientific uncertainty when reacting to the multiple impacts of COVID-19. The pandemic showed society the timing of scientific activity and the importance of basic knowledge ready to be applied in response to an emergency. This was a clear reminder of the false dilemma between basic and applied research or between *curiosity driven* versus *mission-oriented* research (Stokes, 1997).

The shift of STI policy towards development challenges demands a new discussion regarding the autonomy of science and how, and to what extent, basic knowledge driven by the search for general rules should be supported. S&T institutionalization in the import substitution model was built under the idea of self-regulation, as if only science were capable of regulating science. This institutionalization has predominated ever since. STI policies to development challenges are at odds with that structure of coordination by forcing scientific activity to channel efforts to specific objectives, defined outside the scientific community. The pandemic showed that these two ways of producing knowledge are two sides of the same NIS. Among Ibero-American countries, the accumulation of scientific and technological capabilities and infrastructure to create and apply knowledge, and the development of industries to transform them into innovations were a precondition for rapidly responding to a change in the environmental conditions such as the COVID-19 crisis. However, curiosity-driven S&T, based on the traditional mode of research had been developed before, so capabilities and solutions were ready to use (once again S + T + I).

Another element that emerged from this crisis and that affects the new framework for STI policy is the impact of the systematic reduction in public budgets allocated to S&T. During the last decades, S&T infrastructure had suffered from the impacts of the economic crises, but especially from the back and forth of State policies more or less aimed at supporting STI as a means of development. In some countries -Argentina, Brazil, and recently Uruguay, the return to neoliberal policies aggravated the situation, as the policy responses to 2008 financial crisis on the European side. The pandemic showed that the

accumulation of knowledge depends on a path dependence processes linked to the generation of capabilities and infrastructures in basic and applied science, which demands sustained investments. When the COVID-19 crises arrived, there was no time to train biologists, virologist and epidemiologists to search for solutions. There was no time to train sanitarians, sociologists, economists, or engineers to deal with the side-effects of COVID-19 either. All fields of S&T had to search for practical solutions in a very short time.

A third element linked to a new framework for STI policy has to do with the need for a new way of articulating the NIS. Countries better responding to the crisis are those that had accumulated capabilities - including S&T infrastructures- decades before, not just in terms of S&T resources but also in terms of the different dimensions, interactions and coherence that determine the NIS and its articulation with other national systems (Freeman, 2002). In this regard, although an increase in the articulation of the system was observed, most of the reactions were based on traditional S&T disciplines. This is a partial explanation of why the healthcare crisis is moving differently than other problems - the increase in domestic violence linked to the lockdown, or the access to basic needs within the most vulnerable sectors of societies. The impact of this crisis on small and medium-sized firms cannot be estimated yet and deserves a complete article. This lack of multidisciplinary and multi-actor approach to national problems is probably the biggest challenge to STI policy.

Finally, the permeability of digital techniques -the changes entailed in terms of production, consumption, distribution, and also in the provision of social and particularly healthcare services - puts the access to digital technology and communications at the forefront of the STI agenda (Cano-Kollman et al., 2013; Medina et al. 2020). The lockdown measures have increased the virtualization of many economic and social relationships. STI policy actions must take into account the disruptive capacity of these technologies in order to guarantee the *basics* (such as e-education or e-health services), the *essentials* (supply of food, energy, housing), and those more *advanced* functions that are equally relevant in the changing routines during the pandemic and the challenges defined by our societies (finance, computing, big data). STI policies oriented at fostering basic scientific research in experimental disciplines (i.e., contributing to vaccines or drugs) have to be accompanied by the construction of a more inclusive, transformative and resilient societies.

Hence, the constitutionality of STI activities must be rethought, in order to allow other voices to be part of the construction of the STI agenda, without losing the role of autonomy and self-coordination in the process of knowledge creation. The role of STI policy includes the promotion of a more integrated definition of research agendas, working on a more articulated NIS not only in terms of their agents and linkages but specially in terms of the NIS and development problems. The key is to look beyond the COVID19 crisis and to

understand development challenges in the context of Ibero-American countries and their relationships with the rest of the world.

### 3.3. THE INTERNATIONAL ARENA FOR STI POLICY

The long-term objective of sustainability -social, environmental and economic- is moving hand-in-hand with the digital transformation of economies and societies, empowered by artificial intelligence, big data, blockchain and quantum computing (Rubmann et al, 2015). This more advanced phase of information and communication technologies (ICT), has significant implications for worldwide production and consumption - increasingly dominated by networks and extremely dependent on data and international platforms (UNCTAD, 2019). In the horizon ahead, green and digital challenges are the main focuses targeted by the transformative capacity of the different layers in STI policy (EC, 2020) while talent becomes a key factor in policy action for development (OECD, 2019).

The pandemic also comes with effects on the potential reconfiguration of global value chains -GVC (Baldwin & Freeman, 2020). The high level of interdependence and the pivotal place of China in the evolution of globalization invites us to rethink and discuss the adequacy of greater productive diversification. The COVID-19 crisis revealed the great international interaction of agents and countries, the notable concentration in some production poles, and the rise of several protectionist measures in a few months. Among direct consequences we find the reinforcement of national industry to compensate the negative impacts generated by the high degree of dependence on GVCs, clearly in the case of strategic goods (i.e. personal protective equipment, PPE) and medical devices. This evokes a reflexive diversification strategy, reshoring phase or the idea of reintegrating supply chains inside the EU (European Parliament, 2020).

The question is what possibilities, if any, exist for regional institutions in Ibero-America, particularly for the governance of STI policy that would combine, for instance low carbon and sustainability, with the promotion of digital skills in both individuals (education shift) and businesses (industrial and innovation policies). Although in the first case governance is placed at the international level, education is an issue of national State competence. Nevertheless, international collaboration and cooperation in Europe and LAC may enhance and multiply the positive effects of the European Research Area and the Ibero-American Higher Education Space. Regarding the domain of industrial and innovation policies, a convergence of several levels of government -local, regional, subnational, national and even international- can be considered. In this regard, governance of GVC brings large multinational enterprises (Gereffi et al, 2005) and digital Giant-tech companies onto the scene. It is worth saying that they are not from Europe nor from ALC but owned by the USA and China. This deficit has been revealed as a crucial issue for future scenarios of prosperity. Realistically, it is very difficult for countries

to succeed alone. A concept based on public-private partnerships can be seen as a plausible answer for success. The challenge is how to move ahead in a coordinated international way.

### 3.4. AGENDA 2030: GLOBAL CHALLENGES TO NATIONAL SYSTEMS

The COVID-19 pandemic arrived at a time when STI had been specifically incorporated into the international development agenda. Specifically, SDG 9, addresses the process of building resilient infrastructure, promoting inclusion and sustainable industrialization and fostering innovation (United Nations, 2015). In this regard, the challenge for STI policies is to work on the broad meaning of NIS while looking simultaneously at the coordination of actions in different SDG, and dealing with the regional and national specificities at different levels of government, including the international arena.

As COVID19 has shown, a multidisciplinary and multi-actor approach is imperative because we are facing a comprehensive crisis that cannot be reduced to the purely epidemiological field, as it concerns the economy, social cohesion, and also is related to environmental implications. The biomedical angle therefore needs to be supplemented by scientific and social criteria while challenges ahead require a coordinated common action, the same for the pandemic as for combating climate change; it means to deal with global problems and international solutions.

The COVID-19 crisis also shows that going forward towards the universal digitalization of the region has to be part of any inclusiveness strategy (SDGs 1 and 10). At this point, the issue of coherence of policies á la Freeman (2002) is more important than ever, taking objectives such as infrastructure, education and training into account, and considering the international, national and local dimension of STI policies.

Following an Agenda 2030 perspective, several aspects enter the scene and coordination will only be possible if three conditions are met. Firstly, there is the availability of resources in the region, being clear that the problem is not partially reduced to the matter of sufficient investments but enters into the process of building coordinated capabilities. This means concentrating efforts on the development of institutional complementarities which, so far, are very fragile (Álvarez et al., 2019). The objective is to mobilize collective resources and skills while the target is the resilience of Ibero-American NIS. In this sense, the transversality dimension of the STI policy agenda suggested here for the post-Covid-19 era, implies reinforcing complementarities to directly address multiple SDGs such as Goal 3: Good Health and Well-being; Goal 9: Industry, Innovation and Infrastructure; and Goal 17: Partnerships to achieve the Goals.

A potential coordination strategy can be built from the generalization of a bottom up process of dialogue (Álvarez et al., 2016). This can be defined at the national level of policy as a mechanism of cohesion being applied and supervised at the subnational level of policy (subnational regions, local)

following an approach of democratization STI. The dialogue methodology mentioned in section 3.1. can be expanded to the international arena to reconcile national and local conditions with international synergies. Moreover, a coordinating body for assessment and evaluation can also be created at the international level in the heart of the international cooperation on STI within the framework of SEGIB-CYTED as it was in its origin.

Secondly, multilateralism seems to be a valid coordination mechanism across different levels of policy (international, continental, subcontinental, national) and for the provision of the *basics* and the *essentials*. In such a case, STI policies oriented at resolving undersupplied structural problems must be complementary and then coordinated to facilitate initiatives of international organizations such as the IDB on regional public goods to enhance R&D for their provision, or the efforts at the core of UNESCO to enhance universal education levels.

Third, related aspects in the present world-context such as the situation of GVC is not purely of national concern but rather it is mediated by international regulations and multinational agents. The international fragmentation of production, the lack of autonomy in national industries and also healthcare in the region and STI have been then at the expense of policies looking backwards, forward and beyond in the region. However, the green and digital challenges of the post-covid-19 era require a common and coordinated commitment to mobilize resources and actions in order to enhance a knowledge co-creation process also at the international level. In this regard, it seems to be plausible to think of the reinforcement of both collaboration with the EU and bilateral R&D cooperation in Ibero-America.

#### 4. CONCLUSIONS

The pandemic has underlined some challenges and opportunities for the world economy and also in the specific arena of STI. Shocks non-rooted in economic problems like the COVID-19, affecting public health at the global level, undoubtedly imply radical shifts moving us towards a new development path. Globalization has meant notably high levels of international flows of goods, services, capital, but also people, knowledge and ideas. International interactions and spillovers must be taken into account more than ever because we have seen that they can be more serious than we could have guessed. The COVID-19 has suddenly brought us an uncertain scenario and has shaken what many understood to be stylized and rather permanent facts. It has imbued us with some overnight certainties that in the field of STI lead to the reaffirmation of its multi and interdisciplinary nature. It has also revealed that a multi-stakeholder and multi-level policy approach are two dimensions that are needed in STI policy more than ever.

The first dimension implies the coordination of public bodies with the productive sector and with some other relevant agents such as hospitals,

universities and non-governmental organizations (NGO), as we have seen during the COVID-19 outbreak. Research activities (science-based) in much of these cases must also be combined with logistic capabilities for problem solving (innovation-oriented), that turned out to be critical in facing emergencies. This dimension implies the institutionalization of STI processes, and STI dialogues can be seen as a matching instrument that guarantee a higher level of democratization. Democratization of knowledge means empowering society to understand the nature and consequences of the way of producing and distributing income, and the strategies for approaching them are not neutral in terms of social and environmental sustainability (Arocena, 2019). The dialogue approach is just one dimension of that democratization process in which different communities must be involved throughout the process of searching for and implementing solutions, monitoring and adjusting instruments and the redefinition of the problems (Dutrénit & Natera, 2017).

The second dimension calls for proximity of government bodies to people and problems. The complex development challenges together with the decentralization trends in the region need STI policy in national governments with legitimacy for intervention when needed (especially in cases of emergency), and robustly built on some durable pillars (not subject to political cycles) that provide stability (instead of fragility) to the systems. We can learn from the three approaches to STI policy under debate such as its transformative capacity and the necessary coordination of national objectives at the level of state policies to contribute to solving real national problems, the lesson is that these can only be defined by means of the integration of the different agents and institutions involved. In addition to being persistent, the STI policy requires being suitable and matching the principle of coherence in terms of development challenges.

Finally, global challenges such as SDGs require global responses too and imply targets of great coordination in the STI field at the regional level. It is not easy to deal with the complexity of development problems nor even with the SDGs agenda. A coordinated regional definition of actions makes achieving a better place in the new geopolitical map more likely. In other words, a solid bid in favor of a sustained STI policy including (at least) mid- level scientific programs in the Ibero-American countries that looks at the development challenges through the lens of inclusion. This implies the democratization of strategies to define instruments and institutional arrangements to cope with issues such as climate change and digitalization. Low carbon-consuming and diversified industries are some elements to be born in mind on the side of technological innovation, while national strategies in favor of a sustainable development path which must be supervised and subject to regulation under more solid and democratic multilateral commitments are called for.

In a situation where all predictions have failed to foresee a global crisis and all textbooks lack lessons on courses of action, we need to look beyond the crisis and start doing things differently. Some conceptual and empirical elements that would support this shift are, on the one hand, the integration



and articulation of systems and, on the other, the transversal coordination of them in the national and international contexts. Solutions for the reappraisal of issues talked in this article imply that STI must be part of a more integrated agenda to contribute to the basics, the essentials and the advanced aspects of development challenges. More integrated and articulated national innovation systems can be used as tools for those challenges but only if we manage to make them more transversally coordinated with other equally relevant systems at the local, national, regional and international levels. STI policy has a key role to play in this agenda.

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