ISSN: 2755-0168

Journal of Biotechnology & Bioinformatics Research

SCIENTIFIC Research and Community

Review Article

Open Access

Science, Technology and Innovation in Latin America, the Caribbean and Ibero-America in 2024

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ABSTRACT

This document presents the main economic and context indicators on Science, Technology and Innovation in Latin America, the Caribbean and Ibero-America through 2024, taken mainly from RICYT, The World Bank, and The World Economic Forum. Brief concepts on the Knowledge Society and statistical data on Science and Innovation from the World Intellectual Property Organization "Global Innovation Tracker 2024" are added. The ten-year ScTi investment, the yearly drug launches by therapeutic area, the human resources dedicated to ScTi and the impact of the COVID-19 pandemic in Ibero-America and Latin America and the Caribbean -LAC- are analyzed in detail.

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Received: May 22, 2025; **Accepted:** May 26, 2025; **Published:** June 05, 2025

Keywords: Science, Technology, Innovation, Research and Development, The Knowledge Society, Context Indicators, Economic Indicators

Introduction

The Knowledge Society

Currently, it is widely accepted that Education, Science, Technology and Innovation are the axes to advance the well-being of countries and their societies, since they generate sustainable development.

This acquires relevance in developing countries such as Guatemala, in the face of the challenges presented by the Knowledge Society. In Central America, Guatemala is the country with the lowest percentage of investment in science, technology, and innovation-ScT*i*-, with an average of 0.03% in relation to the Grow Domestic Product -GDP-.

It is important to recognize that to achieve the solution of national problems and the integral development of the country, the mastery of scientific and technological skills is required, for this reason investment ScT*i* should be ensured, considering that this is a fundamental for the nation development.

The development of science, technology and innovation (-Sc, T, *i*-,) is a stratifying element of countries, their aspirations for the future and the place they occupy internationally.

The concept of the "Knowledge Society" (a society in which the creation, transmission and conversion of scientific knowledge into technology is its most precious asset), originates from the important advances of science, guided by scientific research and technology, as the main driver of the explosion of knowledge that we have been experiencing in recent years.

Knowledge has driven the socioeconomic development of "first world" and "emerging" economies, which generate scientific technological policies that allow them to adapt to the dizzying pace at which new knowledge is produced and the speed at which it will become obsolete.

Concepts such as those coined by Tilak "literate society", "learning society", "educated society", among others, are very closely related, since the knowledge society requires a highly educated society, which demands "knowledge workers" not necessarily "skilled workers" and a greater integration between knowledge, economy and society, promoting the creative capacity of the members of a society [1-5].

This is demonstrated by the generation of new knowledge, the expansion and adaptation of existing knowledge and innovative talent aimed at satisfying specific needs through the development of appropriate knowledge and transfer systems.

The generation of knowledge is then the common thread of Technological Development and Innovation, it is the fundamental ingredient to promote the knowledge society, the model based on science, which allows:

1. Fighting Poverty.
2. Strengthen Competitiveness.
3. Participate in the era of Digitalization and Emerging Sciences.
4. Strengthen Democracy, Reducing Social Inequalities, by reducing the distance between "developed" and "developing" societies.

With the concepts of the Knowledge Society, at the same time, as it is a fundamental aspect of its conception, the discussion on the way in which knowledge is currently generated is reborn.

The "Knowledge Production Mode" has recently been widely disseminated, because it allows differentiating a series of practices of an epistemological, economic, social and political nature that are vital to understand the processes of knowledge generation at different historical moments or from different perspectives and interests.

These conceptions permeate the Knowledge Society and are the basis of the theoretical foundations that currently build the National Science and Technology Policies and Plans.

Michael Gibbons, who coined this model in 1997, defines the term mode as a "form of knowledge production, a complexity of ideas, methods, values and norms that have grown to control the dissemination of the Newtonian model to more and more areas of research to ensure its conformity with what is considered to be a healthy scientific practice".

This "way" of producing knowledge includes a series of reflections on the "political economy" in the midst of which knowledge is produced in different societies and is closely linked to a series of conditions of possibility by which knowledge becomes necessary, relevant, efficient and key to the development of the same societies that generate it.

In this sense, this model has evolved from the conception that knowledge is generated exclusively by scientists via Scientific Research (Mode 1) and governed by norms and "rules" dictated exclusively by them, to its evolution to the context of application of the knowledge generated (Mode 2) as the most important of its attributes, to Mode 3, which conceptualizes that knowledge is intended to be useful to someone, whether in government or in general to society [6-11].

One of the bastions of the Knowledge Society rests on its educational system, mainly on its higher education system, since universities are primarily responsible for generating and advancing knowledge.

Concurring with Carlos Tünnermann, the University is the social institution from which the strategies to adapt to the Knowledge Society must germinate, it must teach how to think, create an attitude towards risk, uncertainty, exercise common sense, creative imagination and, more than providing information, stimulate the student to discover the place where it is. to teach him how to select and use it.

In short, a flexible education to adapt to changes, with the right balance between generality and specificity, having to transcend from a University with an ancient tradition and history dating back to the Middle Ages to a Unit of Knowledge, where the student is taught to be an "informed and professional human", who establishes contact with science through research, which should lead us not only to generate new knowledge, but also to find new ways of learning and is aware of its environment because it is linked to it.

One of the unavoidable tasks to "navigate" within the Knowledge Society, with its dizzying changes or "mutations", is the generation of public policies congruent with this reality, among which undoubtedly is that of Science, Technology and Innovation.

If, like the United Nations Educational, Scientific and Cultural Organization (UNESCO), we understand that Scientific Policy is the set of provisions (the legal system) that the State must adopt to promote scientific research, technological development and innovation, its success will depend on the better knowledge we have of the factors that condition it.

The objectives it pursues and its effective implementation, execution and control.

Its objective as a State Policy must be to contribute to the emergence of a Nation, whose economy is based on generated knowledge (scientific research) and appropriate, which has an impact on the improvement of the quality of life of the Guatemalan population.

It must have a long-term vision to become the fundamental part of the country's economic and social development strategy, which promotes the social appreciation and appropriation of science, technology, innovation and science education, which play a key role in our socioeconomic, cultural and environmental development.

The policy must be made up of the general guidelines that serve as the basis for its planning, the ordering and national consolidation of the organizational structures and what we expect from science, technology and innovation -Sc, T, *i*-, as well as all the measures that ensure the training of scientific and technical staff.

The adaptation of research to development and the application of its achievements to social practice.

Materials and Methods

Original articles published in the Red de Indicadores de Ciencia y Tecnología Interamericana e Iberoamericana -RICYT-, The World Bank, The World Economic Forum, and the World Intellectual Property Organization "Global Innovation Tracker 2024 databases, about the Science, Technology and Innovation in Latin America and Ibero-América, and specialized media in the subject, were electronically searched to accomplish the aim of the study. T**he data collected were integrated and analysed**. Articles published in any language **and traduced to English**, were included from January 1, 2023, to December 30, 2024, using a variety of keywords in combination. The studies relevant to our review were analyzed and compared.

Science and Technology in Latin America and Ibero America

A good number of countries in the world, since the beginning of the 21st century, have gradually been increasing their science and technology activities, and recently innovation, in the face of the challenges imposed by the Knowledge Society, in this way, to facilitate comparability and the global exchange of information with the purpose of deepening its knowledge and its use as a political instrument for decision-making.

Instruments are generated for the measurement and analysis of the Sc, T, and *i*.

The data presented are available on the website of the Network of Science and Technology Indicators (RICYT), whose latest report contains information on the different countries up to 2017 provided by the National Science and Technology Organizations

(ONCYTs) of each country, the data of the Gross Domestic Product of the International Monetary Fund and the populations of the last censuses in each country.

The economic context The GDP of Latin America and the Caribbean (LAC) shows a growth of 46% between 2013 and 2022, reaching more than 13,000 million PPP dollars in the last year.

Ibero-America shows a growth of similar magnitude in the same period, reaching a little more than 16,000 million PPP dollars.

In 2022, the pace of GDP growth in all geographical blocks accelerates.

Asian countries were the ones with the highest growth in the decade analyzed here, while LAC shows a more moderate evolution.

China mainly focusses on technological development, and strong government-industry collaborations, and emphasizes in the central importance of human capital in innovation.

LAC, in contrast, has prioritized scientific research over technological development and has faced challenges in promoting innovation.

Investment in R+D as is the case with the economies of the countries that make up both blocs, investment in R+D in LAC and Latin America also had a positive evolution.

In the long term, Latin American countries invested 27% more than at the beginning of the period analyzed here, while the resources allocated to R+D, also considering the countries of the Iberian Peninsula, had a growth of 42%, mainly driven by Spain.

The focus on strengthening technological innovation processes, training human resources in this and promoting the creation of new technologies and their patenting, all seeking a direct benefit to society, is notorious.

It is important not to lose sight of the fact that investment from LAC represents only 2.5% of the world total.

This region is also characterized by a phenomenon of concentration in which Brazil, Mexico and Argentina represent 83% of its total investment.

In terms of GDP, the group of Ibero-American countries made an investment that represented 0.73% of the regional gross product in 2021, while the same indicator for LAC reached 0.56%.

Portugal and Spain are the Ibero-American countries that make the most relative effort in R+D, investing 1.7% and 1.44% of their GDP respectively in these activities.

Brazil is the only Latin American country whose investment represents more than 1% of its GDP, while Uruguay manages to exceed the regional average of LAC (0.63%).

Comparatively, investment by LAC and Latin American countries continues to be lower than investment by industrialized countries.

For example, Israel is the country with the highest level of investment, allocating 6% of its GDP to R+D activities.

It is followed by Korea with an investment of close to 5%, and then the United States, Japan, Germany, Finland and Denmark, located around 3% of its GDP.

Human resources dedicated to R+D the number of full-time equivalent (FTE) researchers in Ibero-America has grown by 45% between 2013 and 2022, from 442,835 to 642,383.

If we consider the distribution of human resources according to the sector where they carry out their tasks, we see that the higher education sector is the most significant, since in 2022 46% of researchers carried out their activities in the university environment.

33% of the researchers in the region worked in companies (both public and private) and 19% did so in R+D institutions belonging to the public sector.

The total number of students in higher education in Ibero-America went from 26 million in 2013 to 34 million in 2022, which implied a growth of 30% from end to end.

The total number of graduates in Ibero-America has also grown significantly, going from almost 3.6 million in 2013 to more than 4.9 million in 2022.

Regarding the distribution by ISCED level or similar to the number of students per level, graduates from level 6 (bachelor's degree) are in the majority, representing 70% of graduates, followed by level 5 (non-university tertiary) and level 7 (master's degrees), with 15% and 14% respectively.

Finally, level 8 (PhD) graduates accounted for 1% of the total.

Publications between 2013 and 2022, the number of articles published in scientific journals registered in Scopus grew by 40%.

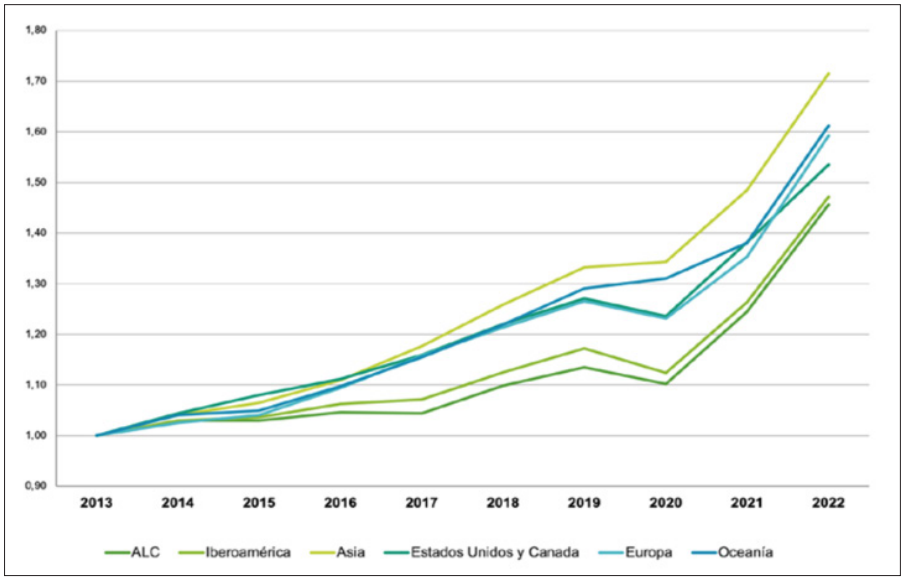
The number of articles signed by LAC authors grew at a faster rate than the total of the base, reaching a volume 64% higher in 2022 compared to 2013.

The number of international patents applied through the Patent Cooperation Treaty (PCT) shows a sharp drop in 2021 mainly due to the COVID-19 pandemic, that begins to recover in 2022 for Ibero-America and LAC.

In 2022, applications for LAC were 1,395, while for the Ibero-American countries were 3,024.

The Economic Context

Percentage Evolution of GDP in Selected Geographical Blocks Between 2013 and 2022, the GDP of all geographical blocks had a positive evolution that accelerated at the end of the period, after the economic impact of the pandemic in 2020.

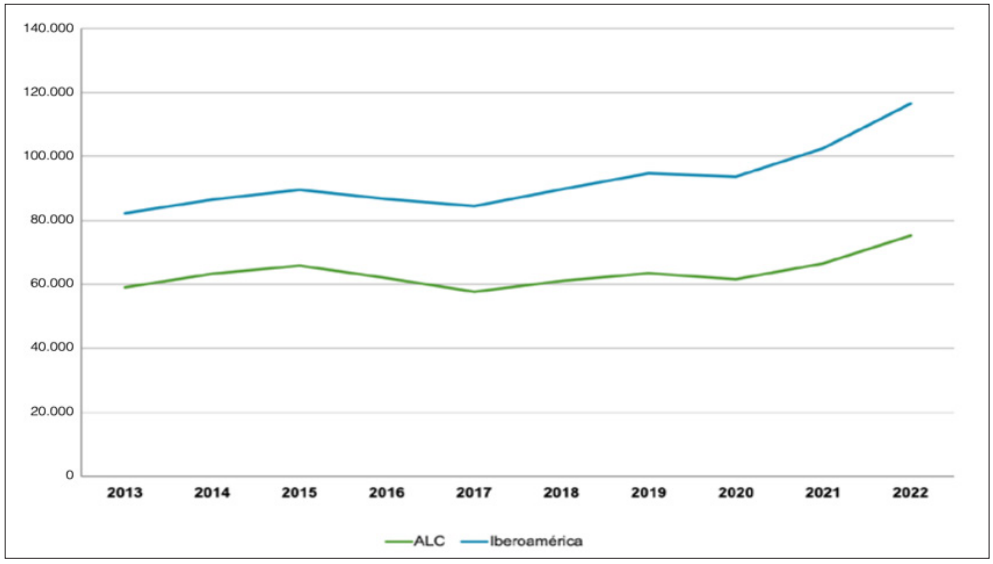


www.ricyt.org.
Asian Countries Grew the most, while Latin America and the Caribbean (LAC) howed a more Moderate Evolution.

Figure 1: Percentage Evolution of GDP in Selected Geographical Blocks

Economic Resources Dedicated to R+D
Evolution of Investment in R+D in LAC and Latin America
As with the economies of the countries that make up both blocs, investment in R+D in LAC and Latin America also had a positive evolution.

In the long term, Latin American countries invested 27% more than at the beginning of the period analyzed here, while the resources allocated to R+D – also considering the countries of the Iberian Peninsula had a growth of 42%, mainly driven by Spain.



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The growth in R+D is similar in both regions, however, the greater investment in Ibero-America than in Latin America and the Caribbean is notorious.

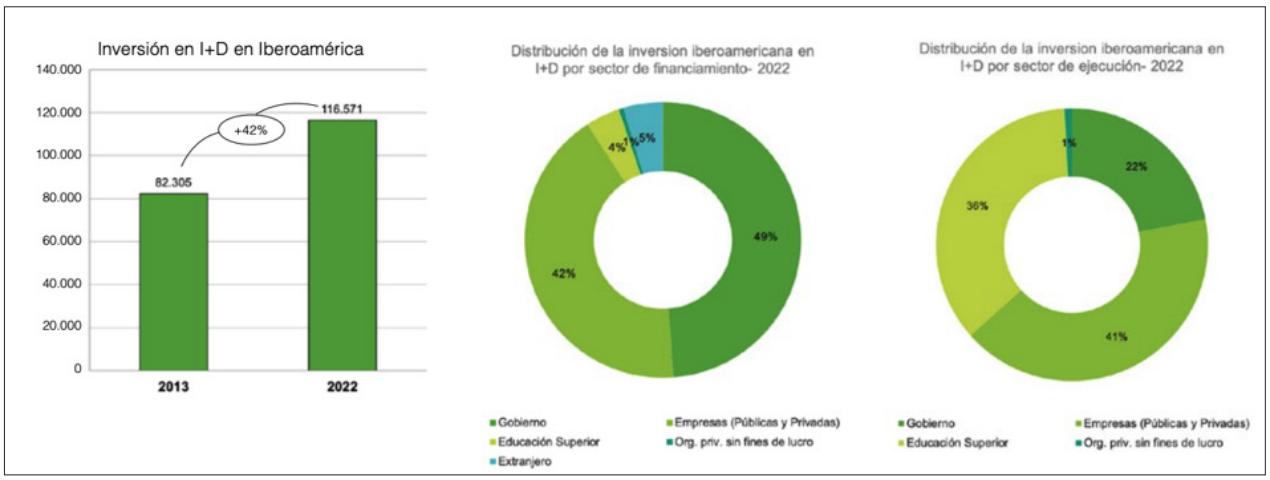
Figure 2: Evolution of Investment in R+D in LAC and Latin America (million PPP dollars)

Sectoral distribution of investment in R+D in Latin America
Investment in Ibero-American R+D went from representing 82,000 million PPP dollars in 2013 to almost 117,000 million in 2022.

49% of that amount was financed by the government and 42% by companies, while the financing of the Higher Education sector represented 5% of the total investment, the foreign sector 4% and private non-profit organizations 1%.

When analyzing how the funds allocated to R+D activities are executed by sector, we see that the distribution is different.

The government executes 22% of the investment, while higher education institutions and companies executed 36% and 41% each [12-15].



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Note the growth of investment in R+D in 10 years in Ibero-America, as well as the contributions of the different national sectors in its execution.

Figure 3: Sectoral Distribution of Investment in R+D in Latin America

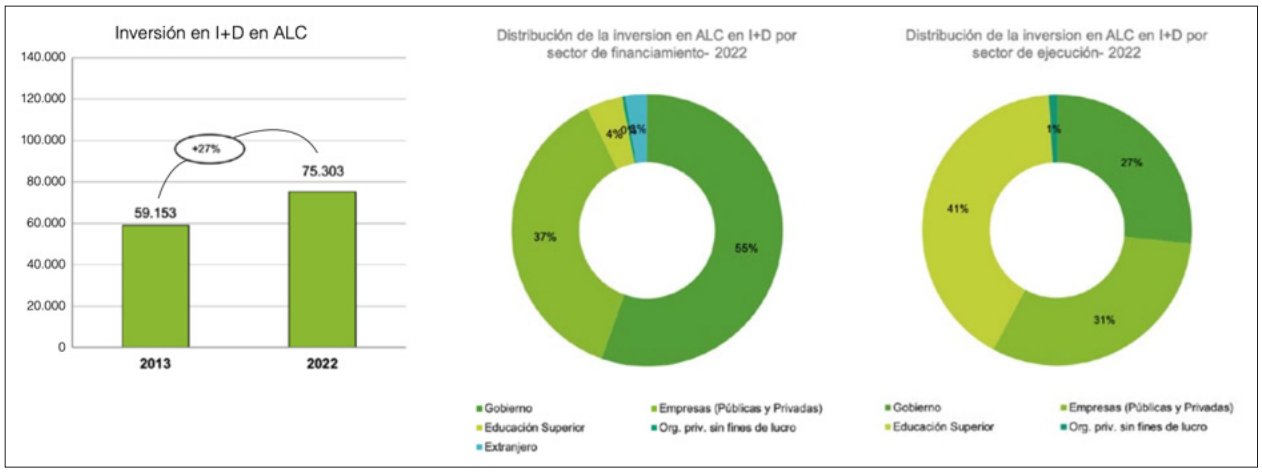
Sectoral Distribution of Investment in Research and Development -RD- in Latin America and the Caribbean -LAC-
In LAC countries, investment in R+D went from 59,000 million in 2013 to more than 75,000 million in 2021.

The weight of the government sector in the financing of R+D is greater than that of Latin America, representing 55% of the total invested.

On the other hand, the participation of companies is lower, being responsible for 37% of R+D financing.

This is a distinctive feature of countries in the region compared to more developed countries, where investment in the business sector exceeds that of the government.

As for the development sector of R+D activities, Higher Education institutions are the most relevant, representing 41% of the execution of resources, the government sector 27% and companies 31%.



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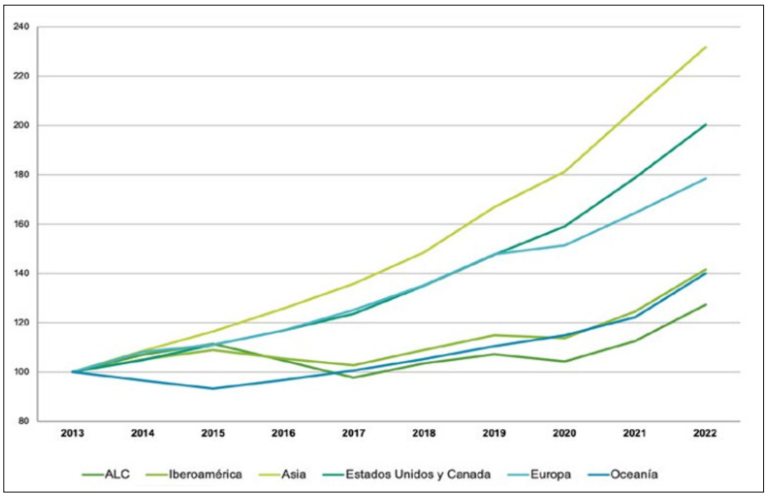
Note the Growth of Investment in R+D in 10 years in Latin America and the Caribbean, as well as the Contributions of the Different National Sectors in its Execution.

Figure 4: Sectoral Distribution of Investment in R+D in LAC

Percentage Evolution of Investment in R+D in Selected Geographical Blocks

When comparing the percentage evolution of investment in R+D in LAC with the international context as of 2015, LAC slowed down its growth rate and showed a more fluctuating evolution in the following years.

In contrast, the blocs made up of Asian countries and the United States and Canada had a sustained development throughout the decade, even with a lesser impact of the fall in investment in R+D that caused the slowdown in economic activities because of the pandemic in 2020.



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Note that LAC Slowed Down its Growth Rate and Showed a more Fluctuating Evolution, the Blocs Made up of Asian Countries and the United States and Canada had a Sustained Development.

Figure 5: Percentage Evolution of Investment in R+D in Selected Geographical Blocks (PPP dollars)

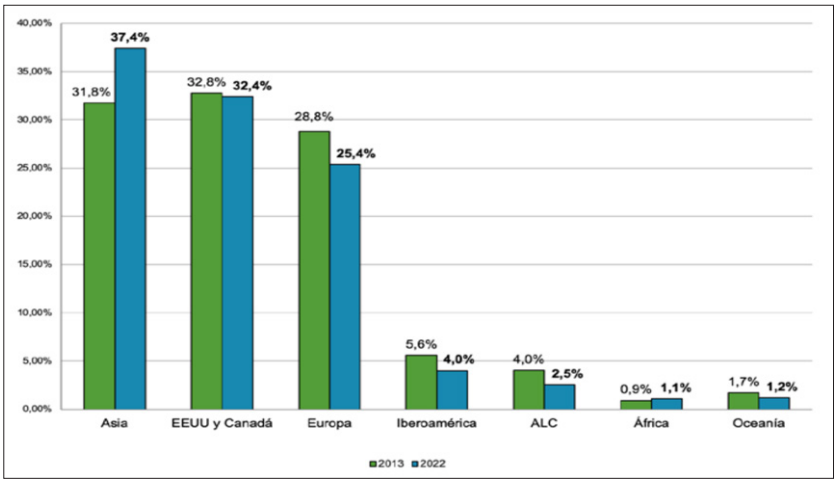
Distribution of global investment in R+D by geographical blocks (2013 and 2022)

Investment in R+D in LAC countries represented 2.5% of the total amount invested in the world in 2022, while Latin America accounted for 4%.

In both cases, their relative weight in the total resources allocated to R+D was reduced compared to 2013 levels.

Asia is the bloc that makes the largest investment in R+D, representing 37.4% of the world's investment, and managed to position itself as the bloc with the largest global participation.

It is followed by the bloc made up of the United States and Canada, which in 2022 accounted for 32.4%, and the countries of the European Union, which accounted for 25.4%.



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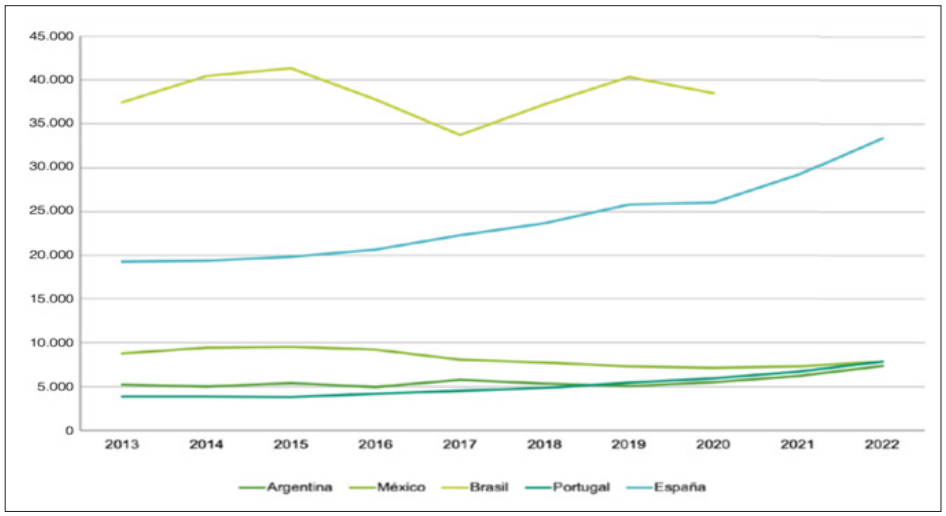
Investment in R+D in LAC countries represented 2.5% of the total amount invested in the world in 2022, Latin America accounted for 4%. Asia, EEUU-Canada and Europe show the highest investment values.

Figure 6: Distribution of Global Investment in R+D by Geographical Blocks (2013 and 2022)

Investment in R+D in Selected Countries

The countries with the highest investment in R+D in Latin America show a very different evolution in the last ten years.



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The Figure 7 shows a fluctuating evolution with falls from 2015 and 2020 in Brazil, increasing in Spain and remains stable in Mexico, Argentina and Portugal.

Figure 7: Investment in R+D in Selected Countries (million PPP dollars)

Spain shows some stability in its level of investment until 2016 and then began a period of remarkable growth that accelerates in the last two years, reaching more than 33,400 million PPP dollars in 2022.

Mexico, for its part, shows a negative trend from 2016 that it manages to reverse in the last year.

Argentina experienced a fluctuating evolution until 2017, when it contracted until 2020 and then experienced sustained growth until 2022.

Finally, Portugal shows a relatively stable evolution until 2016, after which it begins to increase its investment volume, doubling the values at the beginning of the period.

Investment in R+D in Selected Countries

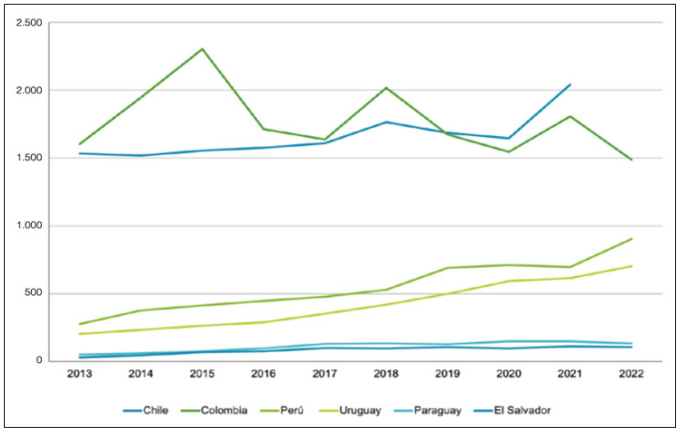
In LAC countries, with a lower volume of investment, there are also differences.

Colombia registered a very strong increase in its investment in R+D until 2015, and from then on it shows a fluctuating evolution, but with a negative trend throughout the ten years analyzed here, reaching its lowest levels in 2022.

Chile shows sustained growth until 2018, the year in which it begins to reduce its investment.

Uruguay shows constant growth throughout the decade, reaching in 2022 a value three times higher in investment compared to 2013.

Peru showed a positive evolution until 2019, a period of subsequent stagnation of two years and in 2022 it showed a strong recovery. Finally, El Salvador and Paraguay show similar levels of investment, with a positive evolution until 2017 and then with a slowdown in the pace of growth in recent years.



www.ricyt.org.

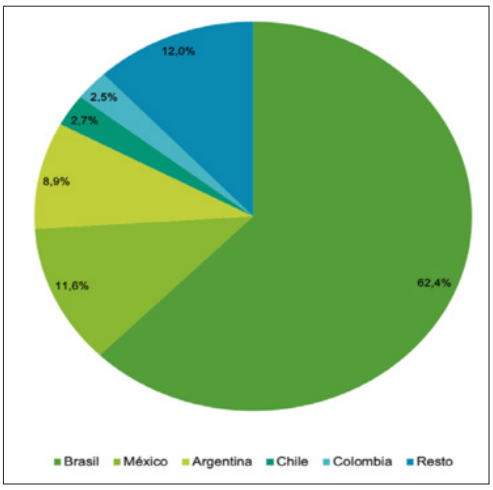
Chile shows an increased growth in R+D investment, Peru and Uruguay are growing, while Paraguay and El Salvador remains stable.

Figure 8: Investment in R+D in Selected Countries (million PPP dollars)

Distribution of R+D Investment in LAC in 2020

One of the distinctive features of LAC is the strong concentration of investment in R+D in a few countries: Brazil alone accounts for 62% of the regional effort, while Mexico accounts for 12% and Argentina for 9%.

Colombia and Chile, on the other hand, represent 3% of regional investment.



www.ricyt.org.
Brazil, Mexico and Argentina, Shows the LAC highest 2020 R+D Values in PPP Dollars.

Figure 9: Distribution of R+D Investment in LAC in 2020 (PPP dollars)

Although this concentration is somewhat related to that which occurs when comparing the size of their economies, the gap between these countries and the rest of Latin America in terms of investment in R+D is even more significant.

R+D Investment in Relation to GDP in Selected Countries and Regions (2022 or Latest available year)
Investment in R+D by Ibero-American countries represented 0.73% of the regional gross product in 2022, while the same indicator for LAC reached 0.56%.

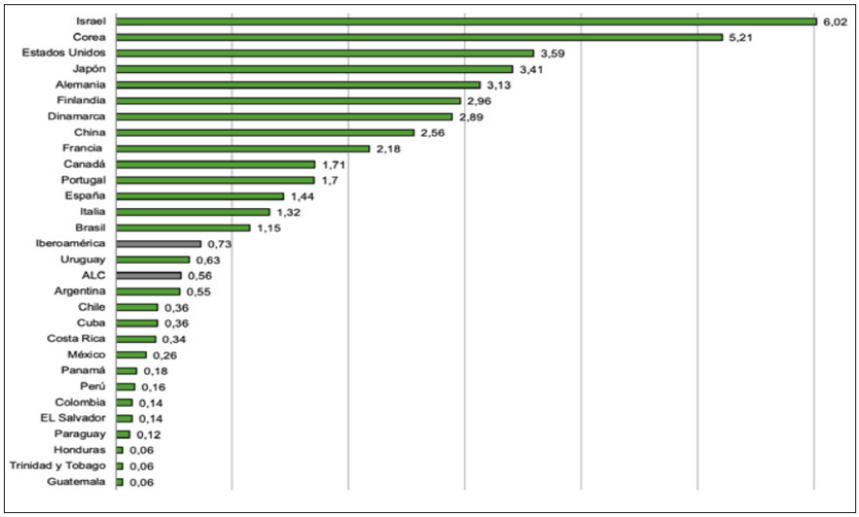
Portugal is the Ibero-American country that makes the most relative effort in R+D, investing 1.7% of its GDP in these activities.

Spain allocated 1.44% and Brazil 1.15%.

Investment in most Latin American countries did not exceed the regional average in their R+D efforts.
Comparatively, investment by LAC and Latin American countries continues to be lower than investment by industrialized countries.

Israel is the country with the highest level of investment, allocating 6% of its GDP to R+D activities.

It is followed by Korea with an investment of close to 5%, and then the United States, Japan, Germany, Finland and Denmark, located around 3% of its GDP.



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Israel, South Corea and USA show the highest R+D investment values compared to their GDP, the low percentage of investment in Ibero-America and LAC is notorious

Figure 10: R+D Investment in Relation to GDP in Selected Countries and Regions

Drug Approvals

In this edition of the Tracker, we assess the state of innovation in pharmaceuticals by examining the number of novel active substances (NASs) launched globally.

A NAS is defined as a new molecular or biologic entity or combination where at least one element is new (IQVIA, 2024).

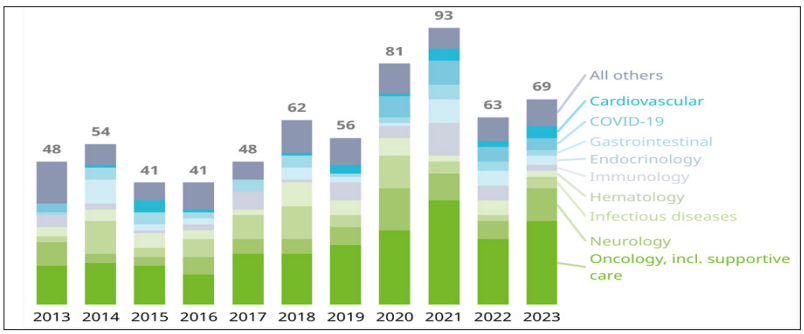
In 2023, a total of 69 NASs were introduced globally, marking a significant 9.5 percent increase on the 63 launched in 2022.

This figure surpasses the average annual growth rate of 3.7 percent observed over the decade. Still, this is lower than during 2020 and 2021, when the number of drugs introduced surged due to the COVID-19 pandemic before returning to the pre-pandemic trend.

In contrast to this year's use of IQVIA data, last year's Global Innovation Tracker relied on Food and Drug Administration (FDA) data for the monitoring of drug approvals.

FDA data confirms the positive trend in 2023, with a notable rise of 49 percent in drug approvals after a steep decline in 2022.

Figure 11 shows annual NAS launches between 2013 and 2023 disaggregated by therapeutic area.



Global Innovation Tracker

It is important to Note that Oncology, Infectious Diseases and Gastrointestinal Diseases show the highest number of drug launches in 10 years, and the increase between 2020-2023 in anti-COVID-19 drugs.

Figure 11: Number of Yearly Drug Launches, by Therapeutic Area, 2013–2023

Around 30 percent of the drugs introduced relate to oncology, 11 percent to neurology and around 10 percent to infectious diseases, together accounting for half of total launches during the period.

Human Resources Dedicated to R+D in Ibero-America

Number of Researchers (FTEs) in Ibero-America

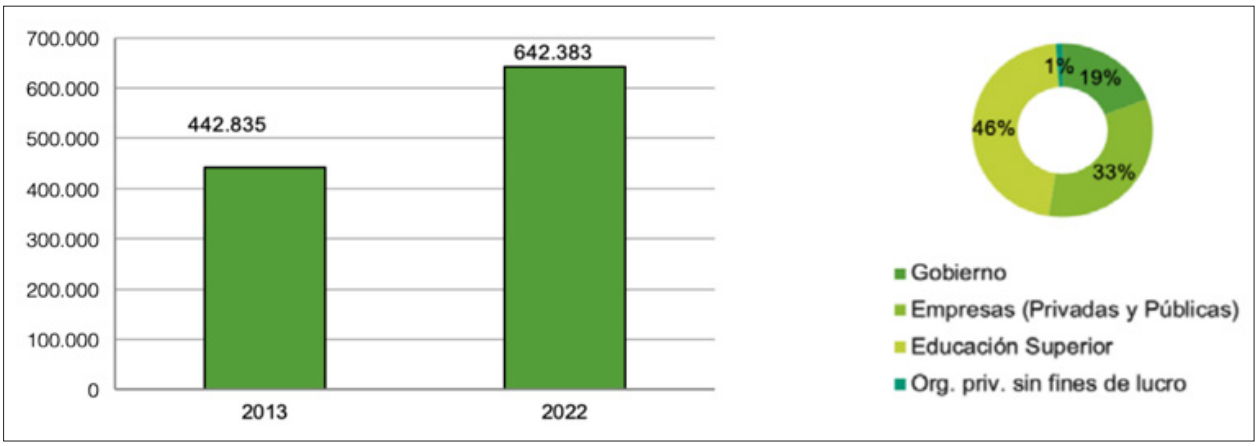
The number of full-time equivalent researchers (FTEs) in Ibero-America has grown by 45% between 2013 and 2022, from 442,835 to 642,383.

The information on the number of researchers is expressed in EJC, a measure that facilitates international comparison, since it is the sum of the partial dedications to R+D carried out by researchers during the year.

It refers more precisely to the time spent on research and is of particular importance in science and technology systems in which the university sector has a preponderant presence, as is the case in Latin American countries, where researchers distribute their time with other activities such as teaching or transfer.

If the distribution of human resources according to the sector where they perform their tasks is considered, the Higher Education sector is the most significant, since in 2022 46% of researchers carried out their activities in the university environment.

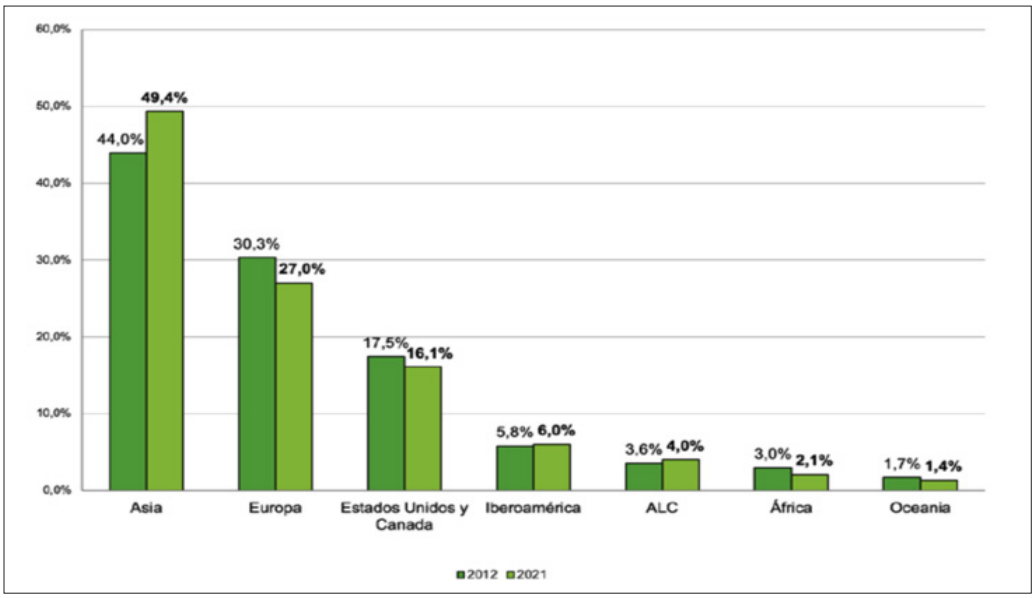
33% of the researchers in the region worked in companies (both public and private) and 19% did so in R+D institutions belonging to the public sector.



www.ricyt.org.
It is important to note the 69% Growth in the Number of Full-Time Researchers in Ibero-America in 10 years.

Figure 12: Number of Researchers (FTEs) in Ibero-America

Distribution of Researchers (FTE) by Geographical Blocks
Like what happens with respect to the financial resources allocated to R+D activities, the countries of Asia constitute the bloc with the largest representation of human resources allocated to research and their participation has grown over the last few years.



www.ricyt.org.
It is important to note the difference between Asia and Europe in relation to LAC and Africa. The Population of Each Region Must Be Taken into Account.

Figure 13: Distribution of Researchers (FTE) by Geographical Blocks

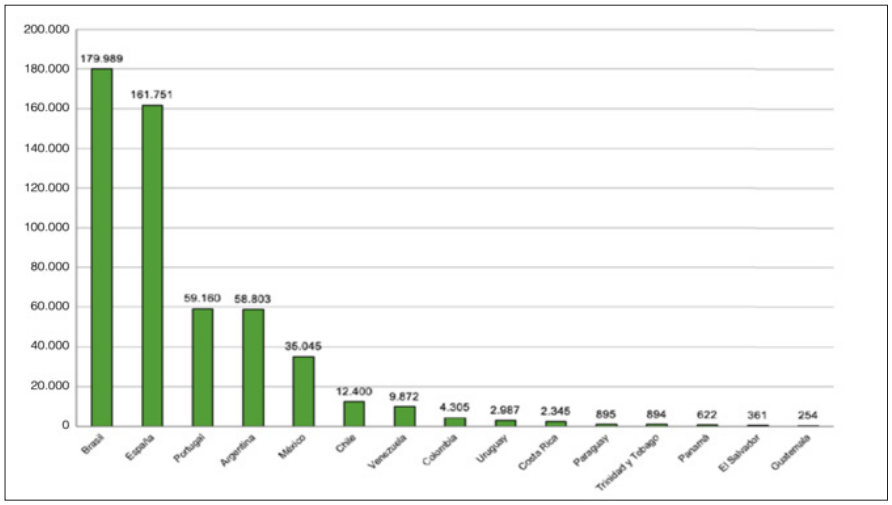
In second place are researchers from the countries of the European Union, followed by the bloc made up of Canada and the United States.

Ibero-American researchers (FTEs) accounted for 6% of the global total in 2021, surpassing the regional share of investment.

Number of Researchers (FTEs) in Selected Countries (2022 or Latest Year Available)
If the number of researchers (FTEs) in each Ibero-American country is analyzed, a picture like that indicated for R+D expenditure is obtained, with a very unequal distribution of resources among countries. Brazil and Spain concentrate the largest number of researchers.

In the case of Brazil, the country had 173,830 researchers in 2017, surpassing Spain's 154,147 in 2022 and achieving more than three times that of the Latin American country that follows it: Argentina, with 58,803 researchers [16-19].

Next is Mexico with 35,045; with a smaller scale follow Chile, Venezuela, Colombia, Uruguay and Costa Rica.



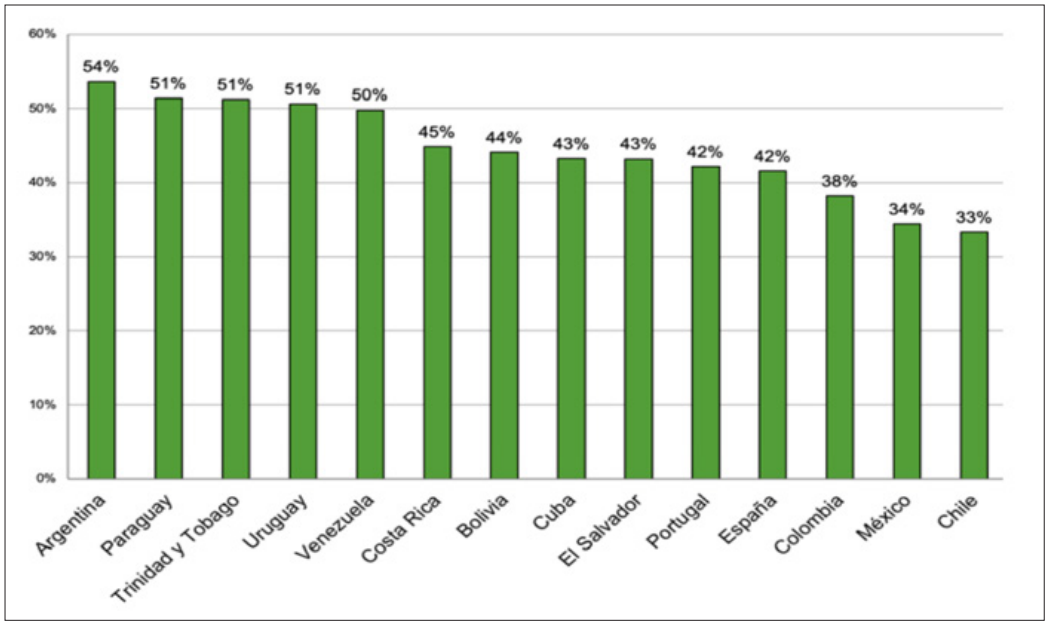
www.ricyt.org.
It is important to point out the differences between Brazil and Spain with the Central American Countries.

Figure 14: Number of Researchers (FTEs) in Selected Countries (2022 or latest year available)

Percentage of Women Researchers and/or Fellows in Selected Countries (2022 or latest available data)
It is interesting to analyze the participation of women with respect to the total number of people dedicated to research tasks.

In 2021, the number of women working as researchers is less than 50% in most countries in the region, although the gender gaps are of different magnitude.

In Chile, Mexico and Peru, women represent only a third of the people who do research.



www.ricyt.org.
The Percentage of Women Working as Researchers is Quite Similar in Latin America, with Significant values Observed in Central American Countries.

Figure 15: Number of Women Working as Researchers

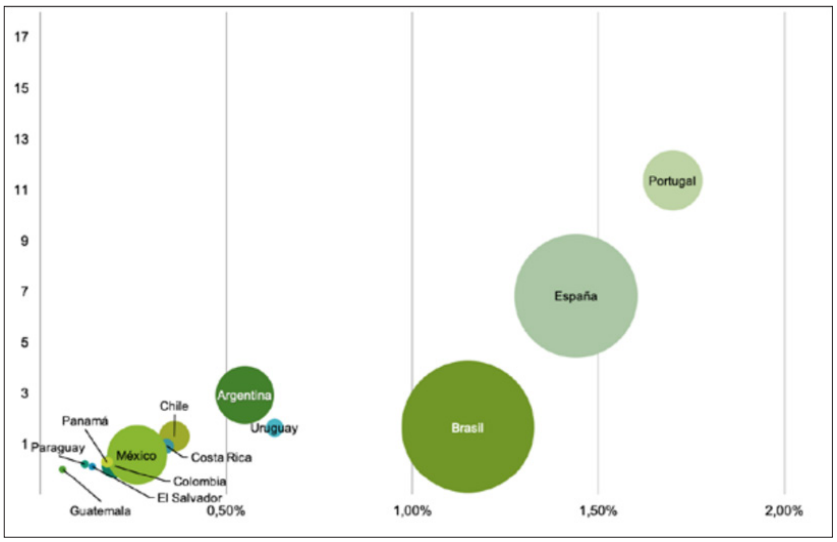
Positioning Map of Ibero-American Countries, According to Resources Dedicated to R+D
In this graph, the countries of Ibero-America are represented according to three variables that summarize the financial and human resources dedicated to R+D.

The size of the bubble is proportional to the investment in R+D made by each country; these are located according to the values adopted by investment in relation to GDP on the horizontal axis and the number of FTE researchers per 1,000 members of the economically active population (EAP) on the vertical axis.

The countries best positioned according to these analysis variables (i.e., those closest to the upper right quadrant) are Portugal, Spain and, to a lesser extent, Brazil.

In both the Brazilian and Mexican cases, the number of researchers in relation to the EAP is lower than that of some countries with relatively smaller economies.

The Argentine case is the opposite, with a significant number of researchers and a relatively low investment, while Uruguay shows a higher level of investment relative to GDP and with a number of FTE researchers in relation to the EAP, similar to that of Brazil.



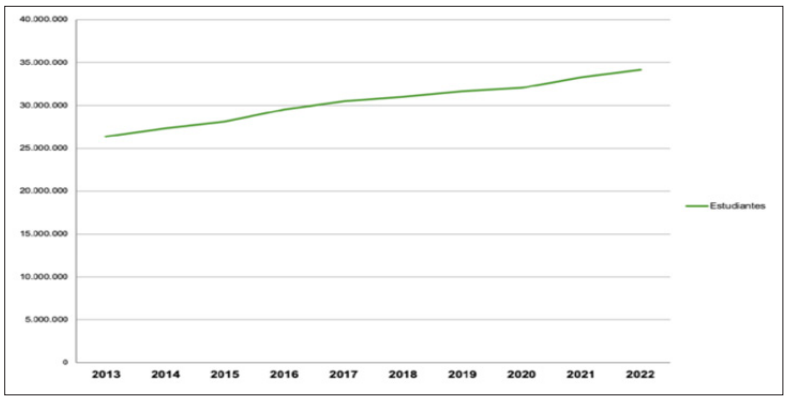
www.ricyt.org.
It is important to note the size of the Assigned Circles and their position in the Graph of the Central American Countries.

Figure 16: Financial and Human Resources Dedicated to R+D

In addition, the largest number of countries are located at values of less than 0.5% of investment in R+D in relation to GDP, and with one EJC researcher for every 1,000 members of the EAP.

Among them, Chile, Colombia and Costa Rica stand out for the volume of resources they allocate to R+D and, with much lower investment volumes, Panama, Paraguay, El Salvador and Guatemala.

Evolution of the Number of Students in Higher Education in Ibero-America
According to data from the INDICES Network (www.redindices.org), the total number of students in higher education in Ibero-America went from 26 million in 2013 to 34 million in 2022, which implied a growth of 30% from end to end.

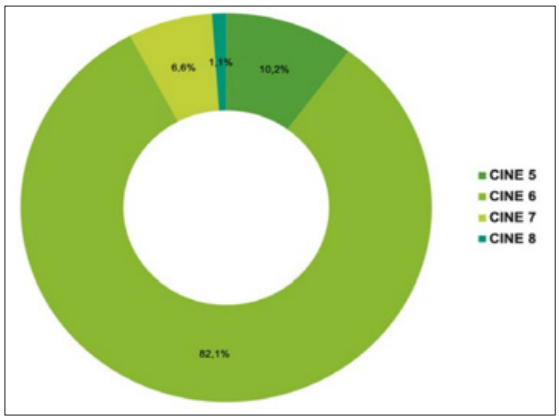


www.ricyt.org.
Note that the number of Higher Education students in Ibero-America has Grown by About 75% In 10 Years.

Figure 17: Evolution of the Number of Students in Higher Education in Ibero-America

Distribution by ISCED Level of the Number of Students in Higher Education in Ibero-America (2022)

When analyzing its composition according to the levels of the International Standard Classification of Education (ISCED), in 2022 82% of students correspond to level 6 (bachelor's degree); it is followed by level 5 (non-university tertiary) with 10%, and level 7 (master's) and level 8 (doctorate) with 6% and 1% respectively.



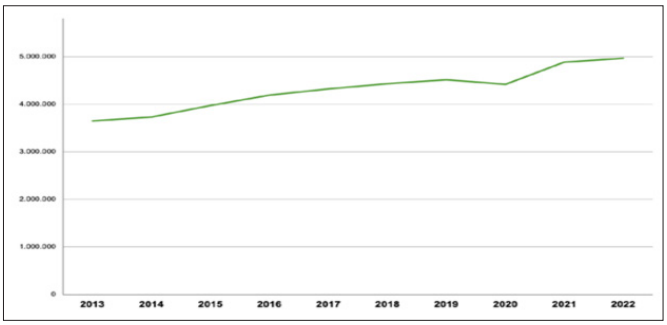
www.ricyt.org.

It is clear the difference between students At ISCED level 6 and the other ISCED levels.

Figure 18: Distribution by ISCED Level of the Number of Students in Higher Education in Ibero-America (2022)

Evolution of the Number of Graduates of Higher Education in Ibero-America

The total number of graduates in Ibero-America has also grown significantly, going from almost 3.6 million in 2013 to more than 4.9 million in 2022 and marking an accelerated recovery after 2020, a year marked by the pandemic.



www.ricyt.org.

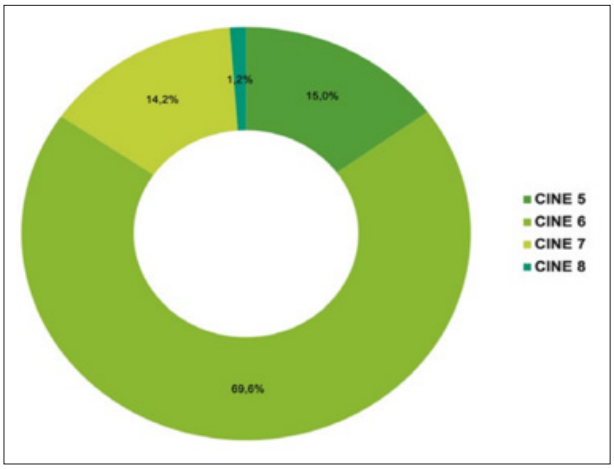
Note that the number of Higher Education graduates in Ibero-America has grown by about 74% in 10 years, Similar to the Percentage of Students involved in Higher Education.

Figure 19: Evolution of the Number of Graduates of Higher Education in Ibero-America

Distribution by ISCED Level of the Number of Higher Education Graduates in Ibero-America (2022)

Regarding the distribution by ISCED level, like the number of students per level, graduates from level 6 (bachelor's degree) are in the majority, representing 70% of graduates, followed by level 5 (non-university tertiary) and level 7 (master's degrees), with 15% and 14% respectively.

Finally, level 8 (PhD) graduates accounted for 1% of the total.



www.ricyt.org.

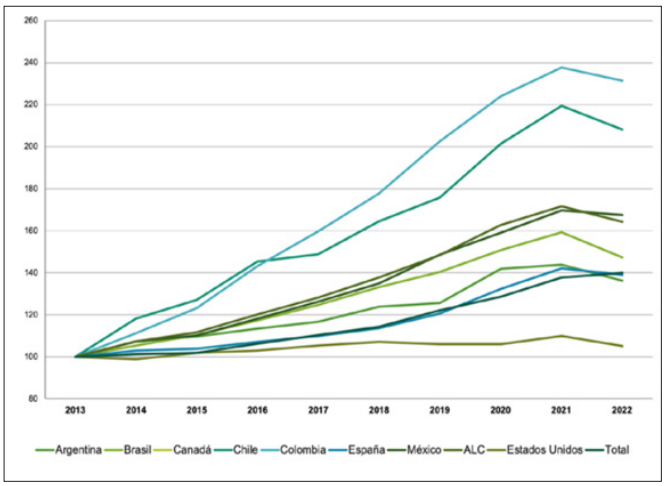
Similar to Latin America, is clear the difference between Higher Education graduates at ISCED level 6 and the other ISCED levels in Ibero-America.

Figure 20: Distribution by ISCED Level of the Number of Higher Education Graduates in Ibero-America (2022)

Product Indicators

Percentage Evolution of the Number of Publications in Scopus Database

In the years covered by this series (2013-2022), the number of articles published in scientific journals registered in Scopus grew by 40%.



www.ricyt.org.

The Evolution of Publications in the Scopus Database is Similar in the Countries Shown in the graph, with Colombia and Chile with the Highest Growth in 10 years.

Figure 21: Percentage Evolution of the Number of Publications in Scopus

The number of articles signed by LAC authors grew at a faster rate than the total of the base, reaching a volume 64% higher in 2022 compared to 2013.

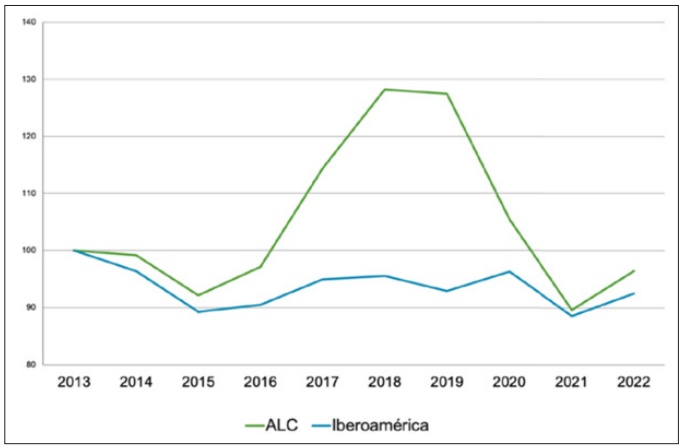
However, in the last year there has been a 4% drop in the volume of publications from the American countries.

Within the region, the growth of Colombia and Chile stands out, doubling the number of publications from end to end.

The United States, the world leader in terms of the volume of its scientific production, shows a sustained evolution over time, with a growth of 5% between 2013 and 2022.

Percentage Evolution of the Number of PCT Patent Applications

With great ups and downs, the number of international patents applied for through the Patent Cooperation Treaty (PCT) shows a sharp drop in 2021 that begins to recover the following year for Ibero-America and LAC.



www.ricyt.org.

It is important to note the Decrease in the PCT Patent Applications 2019-2021, Most Likely due to the COVID-19 Pandemic.

Figure 22: Percentage Evolution of the Number of PCT Patent Applications

In both cases, but especially for Latin American countries, there is a sharp drop in the number of patent applications during 2021 as a result of the declines in patent applications from Mexico, Spain, Brazil, Portugal and Colombia [20, 21].

The following year, the trend reversed for the cases of Brazil, Mexico and Spain.

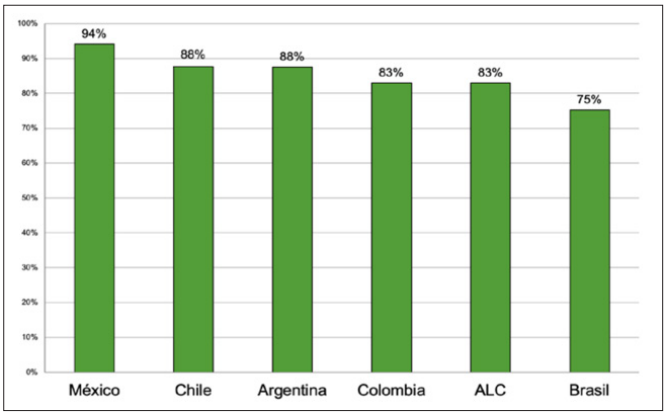
Patent Applications by Non-Residents in Relation to the Total Number of Applications in Selected Countries

In relation to patents applied for in the intellectual property offices of the countries of the region, in 2022, 83% of patent applications in LAC countries correspond to non-residents, mainly foreign companies, protecting products in the region's markets.

Mexico is the country where this phenomenon was most marked, with 94% of the total applications in the hands of non-residents.

In Chile and Argentina that value was 88%.

One of the lowest values in LAC was obtained by Brazil, where 75% of applications correspond to non-residents.



www.ricyt.org.

It is worth noting the Percentage Difference Between Patent Applications by Non-Residents and Country Residents in Ibero-America and LAC.

Figure 23: Patent Applications by Non-Residents in Relation to The Total Number of Applications in Selected Countries

The Global Innovation Tracker 2024

https://www.wipo.int/web-publications/global-innovation-index-2024/en/global-innovation-tracker.html

The Global Innovation Tracker 2024 addresses these crucial questions.

It takes the pulse of four key stages in the innovation cycle:

1. Science and Innovation Investment.
2. Technological progress.
3. Technology Adoption.
4. The Socioeconomic Impact of Innovation.

The main findings are as follows:

Science and Innovation Investment

Following a boom between 2020 and 2022, investment in science and innovation experienced a significant downturn in 2023, marking a notable reversal from previous years. Venture capital and scientific publications declined sharply back to pre-pandemic levels, the impact being most pronounced in emerging regions such as Latin America and Africa. Corporate R&D spending also slowed, mirroring stagnant revenue growth and resembling the post-2009 crisis deceleration. Despite high R&D levels and stable intensities, international patenting has decreased. Looking forward, while some central banks have started cut interest rates, the tighter conditions for innovation finance, might continue to weigh negatively on innovation investments in the near term. The outlook for 2024 and 2025 is unusually uncertain.

Technological Progress

Technological advancements remained strong in 2023, particularly in health-related fields such as genome sequencing, as well as computing power and electric batteries. However, progress in green technologies lagged behind average growth for the decade, highlighting the difficulty in reducing the energy consumed by supercomputers and a slower than previously common declines in renewable energy prices.

Technology Adoption

The adoption of technology saw positive growth across all indicators in 2023, especially in 5G, robotics, and electric vehicles. While overall penetration levels increased compared to a decade earlier, there are exceptions, such as the slower penetration rate of cancer radiotherapy equipment. The adoption of safe sanitation has also slowed significantly.

Socioeconomic Impact

Many socioeconomic indicators have returned to positive growth, representing a return to normalcy post-COVID-19. However, several metrics, such as poverty rates and life expectancy, have not yet returned to pre-pandemic levels. Productivity has increased but still lags, in terms of overcoming the structural slowdown identified in the Special theme of the GII 2022, the effective deployment of a new Digital Age and a Deep Science innovation wave is still work in progress, it would seem. Environmental impact indicators, including carbon emissions and global temperatures, continue to rise, underscoring the need for further action to combat climate change. Technological innovation plays a crucial role in addressing environmental challenges; yet, it is clear that technology is only one part of the solution.

Science and Innovation Investment

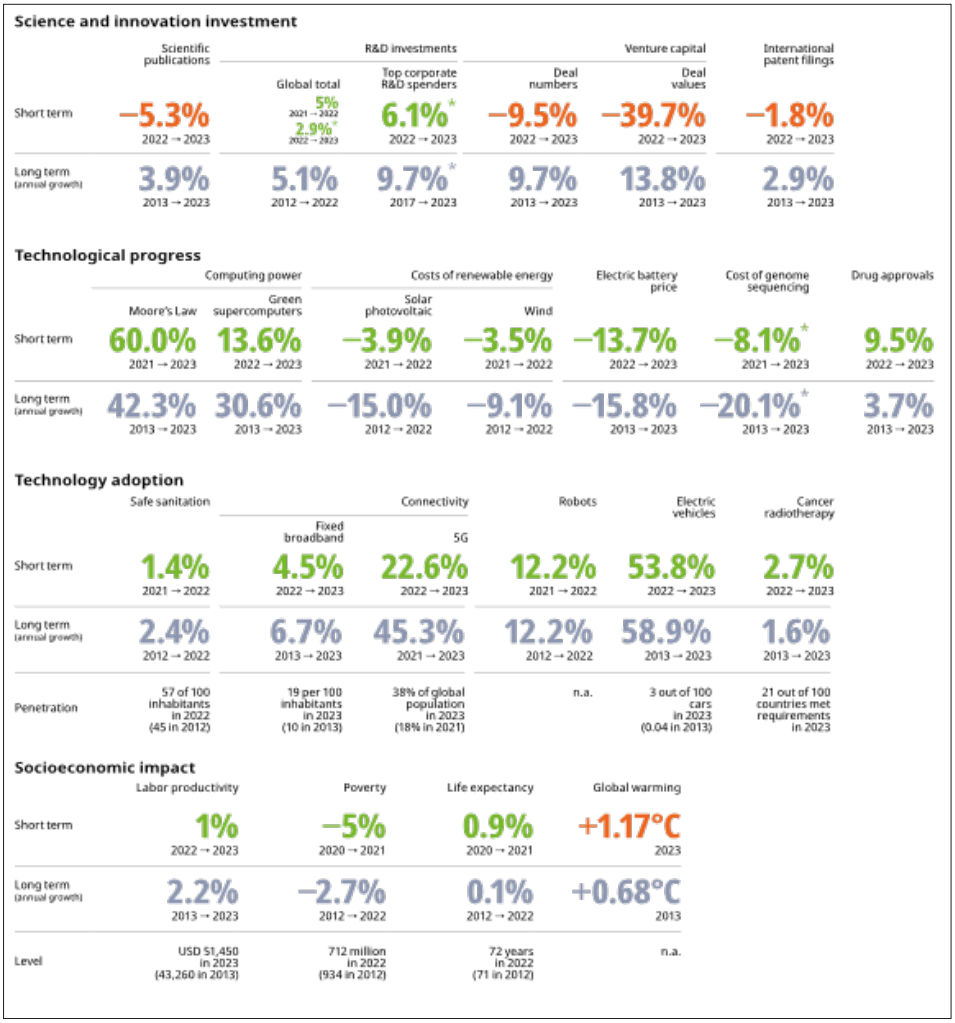
https://www.wipo.int/documents/d/global-innovation-index/images-2024-gii-2024-innovation-investment-1920.jpg

Innovation investment remained resilient throughout the 2020–2021 COVID-19 period and the associated downturn.

Indeed, many innovation investment variables, including scientific publications, R&D and venture capital boomed.

However, the first signs of weakness in innovation investment appeared in 2022, although returning from a historic high.

This slowdown intensified in 2023, making the outlook for 2024 and 2025 uncertain.



It is important to Analyze the Variables of Innovation Values with the Socio-Economic Impact they Generate.

Figure 24: Science and Innovation Investment

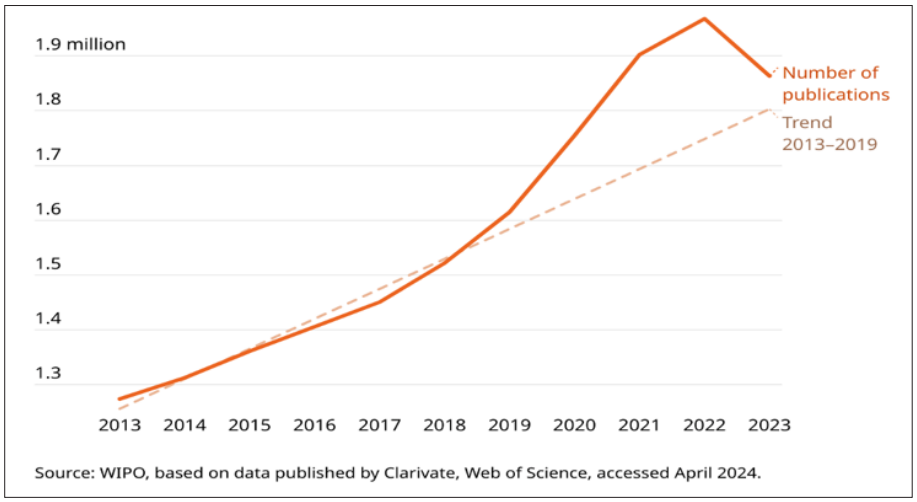
The scientific landscape experienced a significant shift, a 5 percent decrease in publications between 2022 and 2023 deviating from the decade-long average increase of around 4 percent.

However, this represents nothing other than a return to the pre-pandemic growth trend (Figure 25).

Indeed, the period between 2019 and 2021, just prior to and during the COVID-19 pandemic, witnessed an acceleration in new publications, with exceptional growth in 2020 (8.7 percent) and 2021 (8.4 percent).

This period was followed by a deceleration in 2022 (3.4 percent), linked to a decrease in research output in environmental sciences and COVID-19-related fields.

Yet, despite this decline, the number of publications in 2023 remained above the 2013–2019 trend.



It is important to observe the Impact of the Covid-19 Pandemic on the 2022-2023 in Publications Decrease.

Figure 25: Number of Scientific Publications (millions) 2013-2023

The most recently available data show that global R&D investment growth in 2022 slowed to 5 percent (in real terms).

This is down from 6.6 percent in 2021, and slightly below the pre-pandemic growth rate of 6.2 percent in 2019.

The growth of business R&D expenditure, the most significant component of total global R&D, representing 70 percent of total global R&D, likewise slowed to 6 percent in 2022 (compared to 8.5 percent growth in 2021), yet is still comparable to the pre-pandemic rate of 6.6 percent in 2019.

Estimates for 2023, based on projected GDP growth, paint a potentially unhappier scenario, with global R&D growth expected to slow again to less than 3 percent in 2023, and business R&D to 2.8 percent (1.7 percent and 1.4 percent, respectively, excluding the United States and China).

If estimates prove correct, these would be the lowest growth rates on record since 2010.

Moreover, this would mean that the growth rate for business R&D growth would be at the same level as the growth rate for total gross domestic R&D expenditure (business plus private); a situation that has been observed before, but never at such comparatively low rates (see Figure 26).

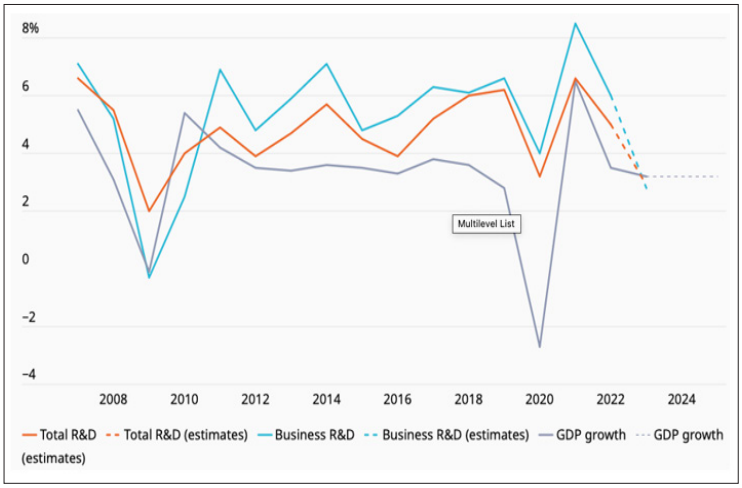
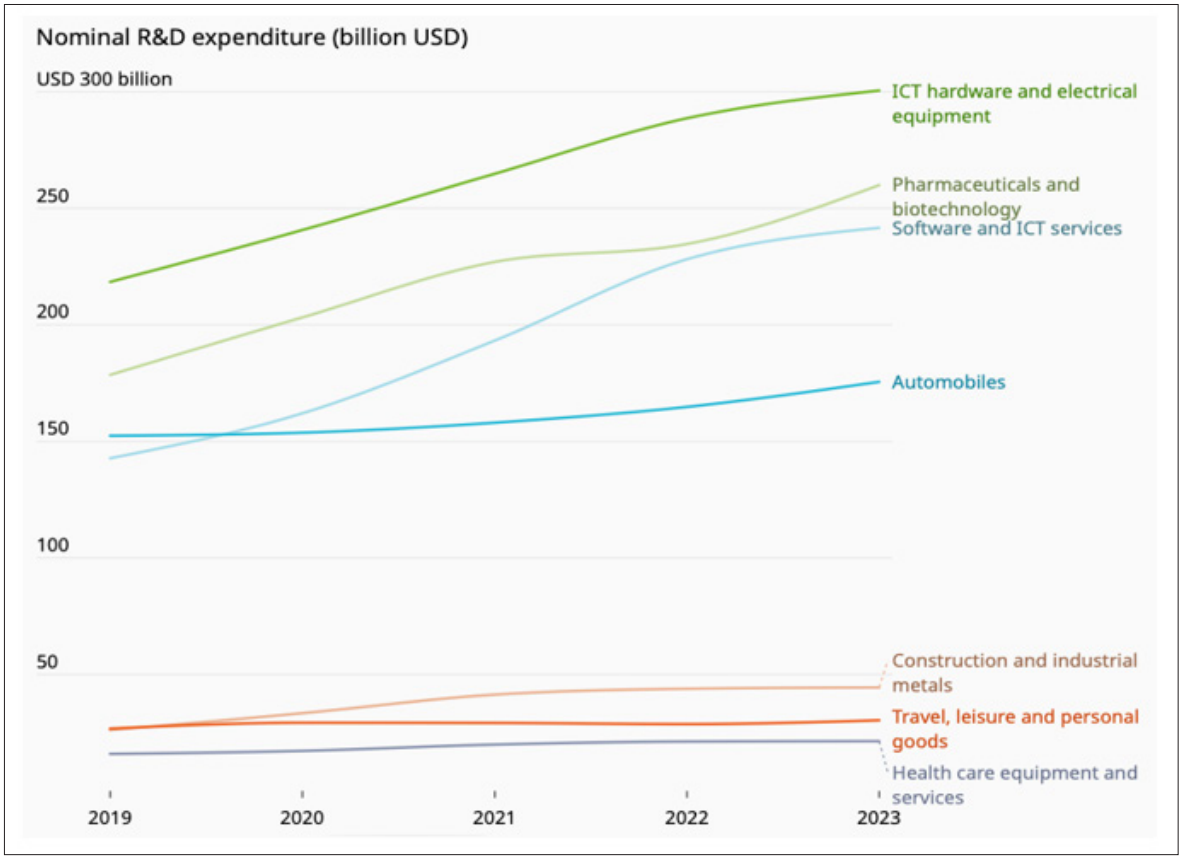


Figure 26: GDP Growth and Total and Business R&D Growth Rates, 2007-2025

Source: WIPO estimates, based on the UNESCO Institute for Statistics database, Organisation for Economic Co-operation and Development (OECD) Main Science and Technology Indicators (March 2024); Eurostat; Ibero-American and Inter-American Network of Science and Technology Indicators (RICYT); and the International Monetary Fund World Economic Outlook Update, April 2024.

In terms of unweighted nominal growth (Figure 27), the ICT hardware and electrical equipment, and the software and ICT services sector, saw their growth rates divided by two between 2022 and 2023.

In contrast, the pharmaceutical sector experienced a significant rebound in R&D expenditure, with growth increasing more than threefold, from 3 percent in 2022 to 10 percent in 2023.
In 2023, the pharmaceutical sector led in R&D intensity at 19 percent, followed by Software and ICT services with 14 percent.



Source: WIPO

Note the Increased Investment in R+D in ICT Hardware, Software and Pharmaceuticals and Technology Areas.

Figure 27: Nominal R&D Expenditure and Intensity of Top R&D Spenders by Industry and Year, 2019-2013

Science, Technology and Innovation in America
The promotion and development of Science, Technology and Innovation in the Americas is guided by the Organization of American States (OAS), through the Inter-American Council for Integral Development (CIDI), which is an OAS body made up of all member states that reports directly to the General Assembly.

Its purpose is to promote solidarity cooperation to support integral development and contribute to the elimination of poverty.

It is supported by the Executive Secretariat for Integral Development (SEDI) and its Competitiveness, Innovation and Technology Section, which coordinates and facilitates support for the process of defining and implementing decisions within the scope of CIDI.

Among the seven Inter-American Working Committees created to achieve its objectives is the Inter-American Committee on Science and Technology (COMCYT), whose mission is to contribute to the definition and implementation of OAS policies on cooperation for scientific, technological and innovation development.

It has a Technical Secretariat; the Office of Science, Technology and Innovation.

The technical arm of COMCYT is the “Meeting of Ministers and High Authorities of Science and Technology of the Americas”

(REMCYT), which is made up of the heads of the National Science and Technology Organizations (ONCYT) of the member countries.

The resolutions of the REMCYT are transferred to the "Summit of Presidents" of the OAS, for analysis and approval as a hemispheric policy in the development of science, technology and innovation in the Americas.

The objectives of the REMCYT are fundamentally:

- Make science, technology and innovation a fundamental component of the post-COVID-19 economic recovery.
- To define a framework for cooperation in science, technology, and innovation in the Americas for the period 2022-2024.

Through the VI REMCYT, co-organized with the government of Jamaica and held virtually in December 2021, under the theme "Harnessing the Power of Science and Transformative Technologies to Propel our Communities into the Future", the following topics were addressed:

1. Science and Technology to build Resilience in the framework of sustainable development and post-COVID-19 recovery.
2. Youth: Improving Skills and Preparedness for Industry 4.0.
3. Science, Technology, Innovation (STI) and Entrepreneurship to reduce the digital divide and promote the inclusion of women and girls, rural and indigenous communities, and other populations in vulnerable situations.
4. Effective public-private-academia collaboration to improve competitiveness and quality of life.
5. Equal conditions for the active participation of Micro, Small and Medium-sized Enterprises (MSMEs) in the global economy through STI.
6. Technological Foresight as an input for public policy decision-making (Prospecta Americas).
7. Science for decision-making.

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