

Expanding Scientific and Technological Cooperation with Latin America in the New Era: A Case Study of Chinese Academy of Sciences' Cooperation with Latin America (Postprint)

Authors: Tong Ting, Sun Hui

Date: 2023-03-19T00:00:00+00:00

Abstract

Latin America, by virtue of its unique geopolitical position, abundant natural resources, and relatively open and flexible policy environment, is emerging as a significant region for international scientific and technological innovation. In recent years, China-Latin America cooperation has gained increasing momentum. This study employs a bibliometric approach to analyze the current state of scientific and technological development in Latin America, the global landscape of international scientific and technological cooperation with the region, and the collaborative activities between the Chinese Academy of Sciences and Latin American countries. Building upon existing cooperative foundations, it further explores prospective recommendations and strategic measures for future cooperation with Latin America.

Full Text

Abstract

In recent years, China has achieved remarkable progress in scientific and technological innovation, establishing itself as an important component of the global S&T landscape with growing international influence. The 19th Party Congress report identified innovation as the primary driving force for development and strategic support for building a modern economic system, setting ambitious goals for China to become a leading innovative nation by 2035 and a world S&T powerhouse by 2050. The Chinese Academy of Sciences (CAS), as a national strategic S&T force, is building world-class research institutions and establishing a global open cooperation and collaborative innovation network[1]. In this context, cooperation between China and Latin America and Caribbean

countries (hereinafter referred to as “Latin America”) has gained significant momentum. In July 2014, during his visit to Latin America, President Xi Jinping officially proposed establishing the “China-Latin America Science and Technology Partnership Program,” announcing the building of a comprehensive cooperative partnership based on equality, mutual benefit, and common development, with S&T innovation as one of six key cooperation areas. On November 24, 2016, the Chinese government released “China’s Policy Paper on Latin America and the Caribbean,” ushering in a new phase of bilateral relations and creating unprecedented historical opportunities for China-Latin America S&T cooperation[2]. The document explicitly called for strengthening S&T innovation cooperation, encouraging dialogue between scientific talents, and supporting more outstanding young scientists from Latin America and Caribbean countries to conduct short-term research in China. On January 22, 2018, President Xi Jinping proposed building a “Pacific Maritime Silk Road” with Latin American and Caribbean countries.

Author Information

TONG Ting SUN Hui*

Bureau of International Cooperation, Chinese Academy of Sciences, Beijing 100864, China

TONG Ting is a program officer in the Division of American and Oceanian Affairs, Bureau of International Cooperation, Chinese Academy of Sciences (CAS). Her primary responsibilities include planning, organizing, coordinating, and managing S&T exchange activities and projects between CAS and American countries, as well as investigating S&T cooperation policies and trends in the region. E-mail: tongting@cashq.ac.cn

SUN Hui is Director of the Division of American and Oceanian Affairs, Bureau of International Cooperation, Chinese Academy of Sciences (CAS). He is responsible for managing and coordinating bilateral S&T cooperation between CAS and its counterparts in American and Oceanian countries, investigating international cooperation policies, and coordinating major international cooperation projects and activities in this region. E-mail: sunhui@cashq.ac.cn

Introduction

Latin America refers to the region of the Americas south of the United States, comprising 34 countries and territories including Brazil, Mexico, Chile, and Argentina. Nine countries in the region have not established diplomatic relations with China, and more than ten remain colonies. The total population is approximately 640 million. According to World Bank indicators, Latin America’s economic development stage is generally comparable to China’s, but its S&T development lags behind (Table 1).

Economic and Social Development

Latin America's economic development stage is roughly equivalent to China's, while its social development exceeds China's. The region's per capita GDP rose from \$4,310 at the turn of the 21st century to approximately \$10,000 during 2011–2014. Influenced by regional economic contraction and US dollar exchange rates, it declined to \$8,493 in 2015, slightly higher than China's \$8,069 in the same year, placing the region in the upper-middle-income development stage. Social development indicators show that Latin America's gross enrollment ratio in higher education increased significantly from 22.6% at the turn of the century to 44.7% in 2014, surpassing China's 40%. The overall urbanization rate stands between 75% and 80%, reaching developed-country levels and far exceeding China's 56.1% in 2015.

Innovation Capacity

Latin America's S&T innovation capacity remains relatively underdeveloped. The region's investment in S&T innovation resources has been chronically insufficient, with overall R&D intensity (R&D as a percentage of GDP) below 1% and growing slowly—from approximately 0.6% at the turn of the century to around 0.8% in recent years, far below China's 2.06% in 2015. Latin American countries demonstrate weak S&T innovation output, with patent applications by nationals far lower than those by foreigners, reflecting that high-tech industries are primarily controlled by foreigners and foreign capital. The proportion of high-tech industry exports in manufacturing exports has continuously declined from 15.7% in 2000 to 11.2% in 2015, indicating decreasing international competitiveness of the region's high-tech industries.

Natural Resources

Latin America is richly endowed with resources, particularly mineral and biological resources. Mexico and Venezuela possess abundant oil reserves, while Mexico, Chile, and Peru rank among the world's top countries in copper reserves and production. The region is home to the world's largest tropical rainforest—the Amazon—60% of which lies within Brazil. The Amazon rainforest contains rich biodiversity resources, with plant species alone numbering between 86,000 and 90,000, offering immense scientific research value and potential. The Americas collectively host 124,993 vascular plant species, accounting for one-third of the global total, with most growing in Latin America. Latin American countries feature not only abundant species but also high levels of endemism: Brazil has 33,161/18,316 species (total/endemic), Peru 19,147/7,590, Ecuador 17,548/5,480, Colombia 23,104/6,739, Bolivia 14,431/2,923, Central America 16,335/5,624, and Mexico 22,969/12,069[3]. Tropical rainforests also represent a treasure trove of biological genes and human medicine, intimately connected with global climate change and ecological balance. However, economic development has led to massive deforestation, threatening biological diversity. According to the Intergovernmental Panel on Climate Change, Latin America faces the

greatest biodiversity impacts from climate change, with predictions indicating the region will lose 14%–23% of its species during the 21st century.

Geographic Advantages

Geographically, Latin America comprises a continent located between 32°42 N and 56°54 S, surrounded by oceans and vast in territory. Brazil and other Latin American countries are geographically conjugate with China, compensating significantly for China's gaps in space observation data. Notably, the desert regions of northern Chile, with high altitude, numerous clear nights, excellent seeing conditions, and dry air, are recognized by the astronomical community as optimal sites for ground-based astronomical observation. Chile has become the world's largest optical astronomy observational base, where the United States, European Union, and Japan have long conducted astronomical research.

International Cooperation Patterns in Latin American Research

Historically, S&T innovation development in Latin America has long been neglected. Weak connections between government, industry, and academia, coupled with low investment in intangible assets and human resources, have resulted in the region's S&T innovation level remaining below the world average for an extended period[4]. Simultaneously, Latin America serves as a global treasure trove of biological resources, space physics, and earth geology, possessing unique research assets that make it an important component of the global scientific landscape[5].

In recent years, Latin America's S&T development has regained momentum. In terms of research output, the region's scientific publications have maintained steady growth, increasing from 46,000 in 2007 to 84,000 in 2016—a growth of 82.6%. Latin America's share of global scientific papers remains around 5%, slightly higher than its R&D investment share of approximately 3% of the world total (Figure 1[Figure 1: see original paper]).

Significant disparities exist in research output among Latin American countries. As shown in Figure 2[Figure 2: see original paper], Brazil leads by a substantial margin, accounting for approximately half of the region's total publications. Mexico, Argentina, Chile, and Colombia constitute the second tier, collectively contributing about 40% of regional output. Other countries produce relatively fewer papers, with Peru, Ecuador, Uruguay, Venezuela, and Cuba forming the third tier.

Analysis of national disciplinary strengths (Table 2) reveals that the region has solid foundations in clinical medicine, environmental/ecology, and physics. The prominence of highly cited papers in physics is directly linked to collaboration using international large-scale scientific facilities. Highly cited papers in space science (including astronomy) are primarily distributed in Brazil, Chile, and

Mexico.

Influenced by history, geography, and S&T development levels, Latin America's international research collaboration partners are primarily the United States and European developed countries, similar to global patterns. Figure 3[Figure 3: see original paper] shows that among collaborative partners for Latin American international co-authored papers, the United States occupies the leading position by a large margin, followed by traditional European S&T powers such as Spain, the United Kingdom, France, Germany, and Italy in the second tier. In contrast, collaboration with Asian countries including China, Japan, and South Korea remains relatively small in scale. This indicates that Latin American S&T activities are closely linked with Europe and the United States, while China-Latin America research cooperation remains limited, offering enormous potential for expansion.

CAS Cooperation with Latin America

As China's comprehensive academic institution for natural sciences and technology, CAS represents the main force in China-Latin America research cooperation. CAS-Latin America co-authored papers increased from just 77 in 2007 to 555 in 2016—a 6.2-fold increase with an average annual growth rate of 24.5%. During 2007–2016, CAS-Latin America cooperation accounted for approximately one-third of China's total cooperation with the region, demonstrating continuously expanding S&T collaboration (Figure 4[Figure 4: see original paper]).

In terms of partner countries, Brazil has consistently been CAS's largest collaborator in Latin America (Figure 5[Figure 5: see original paper]). In 2016, China-Brazil co-authored papers represented approximately 60% of CAS's total cooperation with the region. Collaboration with Colombia and Chile has also developed rapidly.

In recent years, CAS has achieved notable progress in Latin America through overseas S&T education bases, cooperative projects, and technology exports.

Overseas S&T Education Bases

CAS established the South American Astronomical Center in Chile in 2013 and the South American Space Weather Laboratory in Brazil in 2014, conducting space and astronomical research cooperation in the region in collaboration with local universities and research institutions. The South American Astronomical Center has been approved by the Chilean government as an international organization enjoying the same status as the European Southern Observatory, securing approximately \$4 million worth of large telescope observation time and establishing postdoctoral programs supporting China-Chile joint projects. It has published 65 SCI academic papers, including in top-tier journals such as *Nature*. The South American Space Weather Laboratory has completed its

first-phase construction, establishing four monitoring devices capable of detecting ionospheric and middle-upper atmospheric parameters in South America, filling the gap in China's independent observational data for space environment research in the region. The second-phase plan will incorporate atmospheric science and space debris, gradually developing into a comprehensive space environment monitoring and research platform for South America.

Cooperative Projects

In recent years, the CAS Bureau of International Cooperation has supported the South China Botanical Garden in conducting biodiversity-related research cooperation in upstream Amazonian countries. In 2016, the South China Botanical Garden and San Marcos University in Peru established a joint molecular laboratory. Through the construction and collaboration of molecular systematics and evolution laboratories, they jointly research, develop, explore, and screen useful plant resources, collecting and introducing a number of economically valuable species. Additionally, they have invited researchers from Peru, Colombia, Ecuador, Bolivia, and other countries to China multiple times for training and workshops to enhance their capacity building.

Technology Export

The Shanghai Institute of Applied Physics, Chinese Academy of Sciences, and the Brazilian Center for Research in Energy and Materials have conducted close cooperation focusing on high-energy particle accelerators and synchrotron radiation applications. In 2013, the institute undertook the entire linear accelerator project for Brazil's SIRIUS light source. In July 2017, a 150 MeV electron linear accelerator developed by China was shipped to Brazil. This cooperation represents the first case of CAS exporting high-tech products in the synchrotron radiation field and holds significant meaning. As emerging nations in S&T, China and Brazil can greatly enhance their collective S&T strength through strengthened cooperation on large scientific facilities.

Recommendations for Future Cooperation

In summary, Latin America's overall S&T level is in a stage of accelerated development, with unique advantages and abundant resources in certain fields. China-Latin America S&T cooperation started relatively late with a weak foundation but is currently in a rising development stage. Strengthening cooperation with Latin America not only responds actively to national strategic deployment but also represents an internal need for CAS to optimize global resource allocation and enhance innovation capacity. As a national strategic S&T force, CAS faces new opportunities for international cooperation with Latin America.

First, China should actively formulate a national-level S&T cooperation strategy for Latin America. The strategy should focus on Latin American countries' characteristic resources, consider their strategic significance comprehensively, and

strengthen overall planning for China-Latin America S&T cooperation from the national level. Building on existing cooperation, China should develop tiered cooperation with Latin America. For countries with established cooperation foundations, China should enhance exchanges with key research institutions, create bilateral cooperation mechanisms, and actively conduct cooperative research in priority areas. For countries with weaker cooperation foundations, China should actively explore cooperation channels, encourage and support researcher exchanges, strengthen cooperation platform construction, enhance mutual understanding and trust, and gradually accumulate strength for long-term in-depth cooperation.

Second, China should select priority countries and disciplines to develop cooperation systematically and build a regional research cooperation network. Based on China's overall Latin America strategy and each country's resources and disciplinary strengths, China should identify key partner countries and priority areas in the region. Major Latin American countries such as Brazil, Mexico, Chile, Argentina, and Colombia should be cooperation priorities, with efforts to gradually establish bilateral cooperation mechanisms with their research institutions in complementary strength areas. From a disciplinary perspective, biodiversity, space and atmospheric science, energy and environment, and ecological agriculture represent relative resource advantages and needs in Latin American countries. Cooperation and exchanges should focus on these key areas with appropriate resource allocation. Notably, the Amazon basin possesses the world's richest biodiversity resources. Considering the characteristics of biodiversity research and the challenges of cooperating with Latin America, China should establish relatively stable and long-term funding channels to provide guarantees for long-term in-depth cooperation in this field, accumulating strength for breakthrough achievements. China should actively promote cooperation with research institutions in these key countries, cultivate long-term partners, and build a Latin American research cooperation network around priority areas, gradually achieving a transnational multilateral exchange and cooperation system.

Third, China should consolidate and develop overseas S&T education centers to further enhance CAS's influence in Latin America. As China's national research team, CAS has already made certain deployments in some Latin American countries. China should use the two existing overseas S&T education bases as cooperation platforms and bridgeheads, fully leveraging their leading and coordinating roles to build them into comprehensive S&T education cooperation and observation platforms for CAS in Latin America, continuously enhancing CAS's influence in the region. In the long term, based on thorough investigation and overall planning, China should strengthen top-level design and study the feasibility of building a Chinese space observation base in Latin America relying on large astronomical observation facilities. Considering Latin America's unique political, economic, and cultural environment, China should proceed steadily and orderly in combination with existing cooperation foundations and internal S&T development needs.

Fourth, China should strengthen two-way talent exchanges and encourage dialogue with Latin American think tanks. S&T cooperation originates from and centers on people. Talent work with Latin America can be divided into three levels: students and young researchers, senior scientists, and government officials engaged in research management. Under the CAS International Talent Program (PIFI), CAS should establish a CAS Latin America Talent Exchange Program focusing on supporting in-depth exchanges among young researchers, encouraging Latin American students to study in China, and cultivating a new force for CAS's Latin America cooperation. Through enhanced think tank dialogue, China can improve overall S&T strategic planning capacity in Latin America and provide more win-win S&T development and cooperation policies for respective countries.

Latin America, with its unique research resource advantages, represents an important arena for CAS to serve scientific innovation and national diplomatic priorities through international cooperation. The importance of China-Latin America S&T cooperation in the new era is increasingly prominent. Cooperation with Latin America remains a relative weakness in China's and CAS's international cooperation portfolio. China should further clarify and refine cooperation objectives, adopt a long-term perspective in planning, innovate cooperation models and mechanisms, optimize resource allocation, and build China-Latin America S&T partnerships from the perspectives of talent, projects, and platforms based on priority areas, thereby better serving CAS's international development layout and national S&T innovation.

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Note: Figure translations are in progress. See original paper for figures.

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