A Study on the Demographic Characteristics of Foreign Members of the Chinese Academy of Sciences (Postprint)

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Abstract

The foreign academician system of the Chinese Academy of Sciences (CAS) was formally established in 1994 and has since spanned more than two decades. This article takes the cohort of CAS foreign academicians as its research subject, conducting a quantitative analysis of their characteristics. From a historical perspective, it examines their contributions to China' s scientific and technological development, and proposes policy recommendations for further leveraging their role to advance China' s scientific and technological endeavors.

Full Text

Quantitative Research on the Characteristics of Foreign Members of the Chinese Academy of Sciences

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Abstract

The foreign membership system of the Chinese Academy of Sciences (CAS) was formally established in 1994 and has since undergone more than two decades of development. This study examines the community of CAS foreign members through quantitative analysis of their characteristics. From a historical perspective, it explores the contributions of foreign members to China' s scientific and technological endeavors, and proposes policy recommendations for further

leveraging their role in advancing the development of science and technology in China.

Keywords: CAS foreign members, community characteristics, quantitative analysis, scientific and technological contributions
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Historical Background

On September 5, 1963, Premier Zhou Enlai presented a certificate to D.N. Aidit, then Chairman of the Communist Party of Indonesia, conferring upon him the honorary title of CAS Member. Aidit became the only foreign political figure to receive this honorary designation. Following the end of the Cultural Revolution, the CAS Party Group repeatedly discussed the establishment of "foreign members" during meetings of the Standing Committee of the Academic Division in May 1979. On July 4, 1983, in the "Request for Instructions on Convening the Fifth General Assembly of Academic Division Members" submitted to the Central Committee, CAS explicitly noted: "Comrade Xiaoping proposed in a recent speech that, to better unite foreign scholars of Chinese descent in contributing to national construction, 'foreign academic division members' may be established. We fully agree with these opinions and will make specific provisions in the supplementary measures for academic division members to be formulated this time." On January 17, 1985, the five executive chairmen of the CAS Academic Division Presidium submitted a letter to the Central Committee regarding the establishment of an academician system, which again proposed the establishment of a "foreign academician" title.

In April 1992, the "CAS Academic Division Member Charter (Trial)" adopted at the Sixth General Assembly of Academic Division Members stipulated the election criteria and requirements for foreign academic division members. In December of the same year, the Academic Division Presidium approved the election methods for foreign academic division members. In 1993, academic division members were renamed academicians, and the divisions began recommending and pre-evaluating candidates for foreign academicians. In June 1994, the Seventh General Assembly of Academicians elected the first batch of foreign academicians, marking the formal establishment of the CAS foreign membership system. As then CAS President Zhou Guangzhao pointed out: "Electing foreign academicians is an important measure consistent with international scientific community practices and a sign that China' s scientific and technological community is further opening up to the world and that CAS is further developing and maturing."

1. Overall Characteristics

1.1 General Profile

By the end of 2015, CAS had elected a total of 100 foreign academicians. The number of foreign academicians elected in each session is shown in [Figure 1: see original paper]. The foreign academician community exhibits a "three mores" phenomenon: a high proportion of American scientists (59 individuals), ethnic Chinese (41 individuals), and Nobel laureates (23 individuals). This "three mores" phenomenon reflects to some extent the characteristics of China' s international exchange and cooperation: the United States, as a world science and technology powerhouse, exerts significant influence on China' s scientific community; overseas Chinese scholars have always been valuable assets for China' s international exchanges due to their linguistic, ancestral, and emotional ties to China; and Nobel laureates represent internationally recognized scientific elites. However, the foreign academician community also demonstrates a "three lesses" phenomenon: few were working in China at the time of election (6 individuals), few come from developing countries (5 individuals), and few have held important positions in foreign academies (6 individuals).

1.2 National and Regional Distribution

Foreign academicians primarily originate from North America and Europe [Figure 2: see original paper], representing 17 countries and regions: United States (59), United Kingdom (9), France (7), Russia (3), Germany (3), Japan (3), Australia (2), Denmark (2), Sweden (2), India (2), Israel (2), Austria (1), Finland (1), Canada (1), Singapore (1), Pakistan (1), and Brazil (1). Comparing CAS foreign academicians with those of the Royal Society of the UK and the US National Academy of Sciences reveals that Royal Society foreign members mainly come from the United States and Europe, accounting for approximately 65% and 28% respectively—a distribution structure similar to that of CAS foreign academicians, reflecting the overall global landscape of scientific resources and strength. However, US National Academy of Sciences foreign members are distributed worldwide, including scientists from scientifically less-developed countries such as Tanzania.

Examining the evolution of national and regional distribution of CAS foreign academicians over the years shows a continuous expansion trend in their national origins. The number of represented countries has gradually increased, with new countries added in different election years, including Australia, Austria, Germany, Sweden, Japan, Denmark, India, Russia, Singapore, Israel, Brazil, Finland, and Pakistan.

1.3 Age Distribution at Election

Data show that the age of elected CAS foreign academicians at the time of election is concentrated primarily between 65 and 70 years [Figure 3: see original paper]. The oldest elected foreign academician was Joseph Needham, who was

94 years old when elected in 1994, while the youngest was Xiaowei Zhuang, elected at age 43 in 2015. Overall, CAS foreign academicians have shown a trend toward younger ages over time.

1.4 Disciplinary Distribution

Statistics on the disciplinary fields of elected foreign academicians show that mathematical and physical sciences account for 26%, technological sciences for 21%, life sciences for 18%, chemistry for 17%, earth sciences for 12%, and information sciences for 6% [Figure 4: see original paper]. Mathematical and physical sciences and technological sciences are traditional fields of international cooperation, with relatively more foreign academicians, particularly ethnic Chinese scientists—ethnic Chinese account for 53.8% in mathematical and physical sciences and 71.4% in technological sciences. Notably, the information sciences field was first added in 2007, and the number of foreign academicians in this field has grown rapidly. The number of elected foreign academicians in chemistry has also increased rapidly in recent years, with a high proportion of Nobel laureates (41.2%). This aligns with chemistry being a dominant discipline in China's international scientific exchanges and consistent with the trend of China' s chemistry ranking among the top in the world in recent years. However, despite active international exchange and cooperation in earth sciences in recent years, the number of foreign academicians in this field remains relatively small.

2. The Contribution of Foreign Academicians to Chinese Science and Technology

Foreign academicians have played positive roles in enhancing China' s scientific and technological innovation capacity through various means. Overall, collaborative research and talent cultivation constitute the primary modes of contribution. These contributions exhibit distinct characteristics of different eras and can be roughly divided into three stages.

2.1 Late 1970s and 1980s

In the early period of reform and opening up, Chinese science and technology urgently needed to broaden international horizons, fill gaps in various fields, and keep pace with the latest developments. In the early 1980s, China signed intergovernmental bilateral science and technology cooperation agreements with major developed countries in Europe and America. However, Sino-foreign scientific and technological exchange and cooperation during this period were relatively simple in form, and foreign academicians'contributions mainly manifested as one-way assistance: helping China develop weak fields, assisting Chinese scientists and technicians in learning advanced technologies, and using their influence to promote Chinese scientific and technological achievements internationally while offering advice for China' s scientific and technological endeavors. These contributions made them the first batch of CAS foreign academicians.

During this period, a group of influential foreign experts enthusiastically promoted the establishment of scientific and technological exchanges with China, laying the foundation for the comprehensive development of China-foreign relations. For example, shortly after the restoration of diplomatic relations between China and the United States in 1978, American professor Peter Raven organized mutual visits between Chinese and American botanists and established the "Sino-American Botanical Exchange Committee," laying the foundation for botanical exchanges between the two countries. Similarly, to cultivate physics talent, Professor Tsung-Dao Lee initiated and established the China-U.S. Physics Examination and Application (CUSPEA) program, which sent 915 Chinese graduate students to the United States for study between 1979 and 1989, writing an important chapter in China's educational development history. Some foreign academicians helped secure international conferences in China, enabling international colleagues to fully understand China's scientific and technological development and accumulating valuable experience for China's participation in international scientific organizations. For instance, Indian professor Gurdev S. Khush facilitated the 1979 International Rice Research Conference in Guangzhou, which also introduced China's scientific and technological development to the international scientific community. Additionally, British professor Joseph Terence Montgomery Needham devoted the latter half of his life to studying the history of science and technology, introducing the great achievements of ancient Chinese science and technology to the West. His book "Science and Civilisation in China" won China's National Natural Science Award First Prize in 1983, and the famous "Needham Question" has continued to attract sustained attention and reflection in academic circles.

2.2 The 1990s

During this period, China's scientific and technological endeavors developed rapidly. While still primarily focused on tracking, learning, and catching up, the breadth and depth of international exchanges expanded significantly. Foreign academicians' contributions were mainly manifested in promoting cooperation with China in science and education, including advancing strategic cooperation in science and education, promoting equal exchanges and cooperation between Chinese and world scientific communities, and recommending or supporting Chinese scientists' entry into international scientific organizations.

First, foreign academicians actively promoted strategic cooperation with China in science and education. For example, during his tenure as Advisor to the French Minister of Education, Research and Technology and Director of the Research Agency (1997-2001), French professor Vincent Courtillot participated in proposing to then Prime Minister Jospin that China be listed as one of the four main countries for French foreign cooperation, a suggestion that was adopted. Subsequently, he signed a science and technology and education cooperation agreement with China and proposed the establishment of Sino-French joint laboratories to promote scientific research cooperation between the two countries.

Second, foreign academicians promoted equal exchanges and cooperation between Chinese and world scientific communities. For example, American professor Burrell Clark Burchfiel has conducted cooperative research with Chinese geological colleagues since the 1990s and co-authored research papers, making positive contributions to the development of earth sciences in China. In 1997, Professor Richard Zare, then Chairman of the U.S. National Science Board, facilitated online access to *Science* magazine in China during his visit.

Third, some foreign academicians, such as British professor Brian John Hoskins, actively recommended and supported Chinese scientists' participation in international scientific organizations, which was crucial for building China' s capacity to engage in international scientific and technological cooperation.

2.3 The 21st Century

Since the beginning of the 21st century, as China' s scientific and technological strength and R&D capabilities have rapidly improved, Chinese scientists have played increasingly important roles in major international scientific and technological cooperation. International scientific and technological cooperation has shifted toward "China-led, equal and mutually beneficial" models, and the Chinese scientific community has begun to focus on its voice in the international scientific community. Against this background, foreign academicians' contributions have mainly been reflected in promoting deep strategic cooperation with Chinese science and technology, jointly establishing laboratories, and piloting reforms of the scientific and technological system.

Foreign academicians have strengthened deep strategic cooperation with Chinese science and technology. For example, Indian professor C.N.R. Rao, during his tenure as President of The World Academy of Sciences (TWAS), vigorously promoted the establishment of a regional office at CAS and advocated for and facilitated the 14th TWAS General Conference to be held in China. Foreign academicians have promoted the establishment of Sino-foreign joint research institutions in China, creating opportunities for domestic scholars to cooperate and exchange with world-class scientists while participating in the exploration of establishing world-class scientific research institutions on Chinese soil. For example, American professor Ferid Murad established the "Murad Center for Modernization of Traditional Chinese Medicine"with Shanghai University of Traditional Chinese Medicine in 2003 to conduct research on traditional Chinese medicine using modern scientific methods, promoting exchange and complementarity between Chinese and Western medicine. Similarly, Professor Mu-ming Poo was invited to establish the Institute of Neuroscience at CAS, aiming to create an internationally recognized research institution.

3. Case Studies of Foreign Academicians' Contributions

3.1 Construction of the Beijing Electron-Positron Collider

The construction of the Beijing Electron-Positron Collider (BEPC) represents a successful case of international cooperation in China' s major scientific projects. The ability to overcome shortages of manpower, material resources, and technical experience in design, development, and construction in a short period was significantly advanced by foreign academicians such as Tsung-Dao Lee, Wolfgang K.H. Panofsky, Samuel C.C. Ting, and Chien-Shiung Wu.

China proposed a plan to build a synchrotron accelerator in the early period of the People' s Republic, but the project could not be implemented due to funding and talent constraints. After the end of the Cultural Revolution, China formulated a plan for a high-energy physics experimental center (the "Eight-Seven" Project), which was halted in 1980. In January 1981, the proposal to build an electron-positron collider in Beijing was placed on the agenda. Professors Tsung-Dao Lee and Chien-Shiung Wu made several calls to inquire about the situation and participated in the evaluation of adjusted plans for China' s high-energy accelerator construction. During discussions on high-energy accelerator plans, Professor Panofsky first proposed building a 2.2 GeV electron-positron collider with simultaneous synchrotron radiation applications and conducted preliminary estimates of its physics and application characteristics, playing an important role in promoting the launch of BEPC research and development. Based on extensive consultation with domestic and overseas experts, China essentially agreed with the proposal by Professors Panofsky, Lee, and Wu to first build a 2.2 GeV electron-positron collider in China and designated the BEPC project as a national key construction project on December 15, 1983. During construction, Professors Tsung-Dao Lee, Panofsky, Samuel Ting, and Chien-Shiung Wu provided technical guidance. For example, at Professor Lee' s suggestion, Professor Panofsky served as scientific advisor to the project leadership group, visiting Beijing twice annually to guide project construction without compensation, beginning work the day after his arrival each time. The collider was completed on schedule, becoming the world' s only large-scale electron-positron collider experimental facility for studying -charm physics near the lepton and charm particle production threshold, and remains the highest-luminosity collider in this energy region to date, producing important physical results.

Furthermore, at the suggestion and arrangement of Professors Samuel Ting and Tsung-Dao Lee, China sent dozens of physicists to Europe and the United States for high-energy physics experiments and training in 1978. In 1982, China also sent 21 scientific and technical personnel to the Stanford Linear Accelerator Center in the United States for in-depth BEPC design work. Panofsky, then director of the center, assigned counterpart experts to guide each specialty of the investigation team and assisted in resolving issues related to the embargo of advanced equipment and components. These scholars sent to the United States later became the scientific and technological backbone of BEPC development.

The China-U.S. high-energy physics cooperation project for BEPC construction, promoted by CAS foreign academicians, introduced high-tech equipment, cultivated high-energy physics research talent, and brought advanced scientific management methods and concepts to China, promoting the development of Chinese science.

3.2 Hosting the International Congress of Mathematicians

The International Congress of Mathematicians (ICM), organized by the International Mathematical Union (IMU), is the world' s highest-level mathematics academic conference, with a history of over 100 years. Invited presentations at the conference are generally considered to reflect the most important achievements and advances in mathematics in recent years.

China' s representation in IMU was once a thorny issue. Chinese mathematicians such as Hua Luogeng, Wu Wenjun, Chen Jingrun, and Feng Kang were invited to present at ICM but were unable to attend for various reasons. After reform and opening up, IMU strongly urged China to join. Due to the "One China" issue, the Chinese Mathematical Society negotiated with IMU. In the early 1980s, then IMU Secretary-General J.L. Lions of France personally visited China to consult with leaders of the Chinese Mathematical Society. Chinese-American professors such as Shing-Shen Chern also did much important work. In 1986, during Ludwig D. Faddeev' s presidency of IMU (1986-1990), the Chinese Mathematical Society and the Mathematical Society located in Chinese Taipei joined the organization as a single entity.

In April 1993, Professor Shing-Tung Yau discussed with Academician Le Yang, then President of the Chinese Mathematical Society, the matter of bidding for the 2002 ICM. In May, Professors Chern and Yau were received by Chinese national leaders and formally made their proposal. With support from the Chinese government and joint efforts from mathematicians at home and abroad, the Chinese Mathematical Society won the bid to host the 2002 ICM on August 15, 1998. This was the first time the conference was held in a developing country. Brazilian mathematician Jacob Palis, then President of IMU (1999-2002), actively supported the Chinese Mathematical Society' s hosting of the conference and personally visited China to invite Chinese national leaders to attend the opening ceremony. German mathematician Martin Groetschel specially traveled to Beijing to introduce Germany' s experience hosting the 1998 ICM. The ICM was held in Beijing from August 20-28, 2002, showcasing China' s mathematical achievements and mathematicians to the world. Following the conference, Academician Zhiming Ma was elected to the IMU Executive Committee and later served as Vice President from 2007-2010.

China' s joining of IMU, hosting of ICM, and Chinese scientists holding important positions in IMU reflect the significant progress of Chinese mathematics toward the world stage and the substantial improvement in China' s international mathematical influence, which would not have been possible without the

initial proposals and active participation of CAS foreign academicians.

4. Reflections and Recommendations

Foreign academicians' contributions to Chinese science and technology have distinct characteristics of different eras, reflecting the course of China' s international scientific and technological exchange and cooperation. In response to the "three lesses" phenomenon—few working in China at election, few from developing countries, and few with important positions in foreign academies—and to better leverage the role of foreign academicians, this paper proposes the following three reflections and recommendations by drawing on beneficial international experience.

First, based on considerations of talent attraction, CAS should emphasize the inclusion of foreign experts working in China who have made outstanding contributions. Some developed countries' academies attach great importance to recommending foreign experts working in their countries as foreign members. For example, among the 21 foreign members elected annually by the US National Academy of Sciences in recent years, three were working in the United States at the time of election. In China, as scientific and technological strength has increased and international exchanges have expanded, more and more foreign scientists are working in China and making important contributions. The CAS academician title represents the highest academic honor in science and technology established by the state. Granting the CAS foreign academician title to foreign scientists working in China who have made outstanding contributions would recognize and reward their achievements, help attract more foreign experts to work in China, and promote the development of Chinese science and technology.

Second, based on considerations of science diplomacy, the selection of foreign academicians should emphasize global distribution. Although the selection of foreign academicians has begun to focus on attracting outstanding scientists from developing countries in recent years, the numbers remain small and global distribution remains unbalanced. This is clearly inadequate for the new era of science diplomacy and inconsistent with the strategic position of China's science diplomacy. Electing foreign academicians is an important window for international scientific and technological exchange and cooperation, reflecting national science and technology strategy to some extent. As Lord and Turekian wrote in *Science* in 2007: "Science and technology diplomacy has played an important role in U.S. foreign policy over the past 50 years" and "science and technology diplomacy has entered a new era; the U.S. government should strengthen the strategic position of science and technology diplomacy." Dr. Norman Neureiter, a senior U.S. science diplomat, also stated in his March 24, 2009 testimony before the U.S. House Committee on Science and Technology that "scientific cooperation can be win-win, as it both solves problems and improves relationships." Foreign members of the US National Academy of Sciences are distributed worldwide, including in some scientifically less-developed African countries. In

contrast, CAS foreign academicians are concentrated in a few developed countries, with few from developing countries. Balancing the global distribution of CAS foreign academicians would facilitate the strategic deployment of China' s science diplomacy.

Third, from the perspective of international influence, CAS should attach importance to foreign scientists who have made contributions at the strategic level for China. Foreign academician recommendations exhibit a somewhat divergent characteristic to some extent, reflecting the close connection between recommenders and recommended individuals (or their teams) in scientific and technological cooperation and contributions. Among CAS foreign academicians, Nobel laureates account for 23%, which is related to the Nobel Prize being an internationally recognized standard of peer recognition. However, there are relatively few scientists holding important positions in internationally influential academic organizations, which may be related to the election criteria emphasizing contributions to China. This raises the question of how to understand the standard of contributions to Chinese science and technology. Clearly, the standard should not be limited to co-training students, joint research projects, and co-authored papers, but should also recognize those who have made outstanding contributions to China' s scientific and technological development at the strategic level. Including such foreign scientists as CAS foreign academicians would help enhance China' s international scientific influence and improve the "soft power" and international discourse power of China' s scientific community.

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