

French Science Diplomacy and International Science: A Scientometric Analysis

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ABSTRACT

Objective: Scientific diplomacy involves the use of scientific and technical collaborations to foster international relations and to address global challenges. It promotes collaboration between nations through joint research and innovation projects, knowledge-sharing, and the application of scientific advancements to tackle shared issues and challenges in national and international contexts like climate change, public health crises, and technological innovation. France is a key player in international scientific organizations and agreements, emphasizing the importance of scientific and technological collaboration in addressing global issues.

Materials and Methods: The primary source of data utilized in this scientometric study was the Web of Science citation database. The extracted data were recorded and analyzed using Excel software.

Results: This study shows the state of French scientific collaborations separately from each of the five continents. On the continent of America, France collaborated with 32 countries, with most scientific collaborations taking place with the United States, Canada, Brazil, Mexico, Chile, and Argentina. In Europe continent, France engaged in scientific collaborations with 49 countries, including Germany, the United Kingdom, Italy, Spain, Switzerland, Belgium, the Netherlands, etc. Similarly, in Asia continent, France fostered scientific relationships with 36 countries, consisting of China, Japan, India, and South Korea emerging as its most prominent partners. On the African continent, France also established scientific collaborations with 49 countries, especially with Tunisia, Algeria, Morocco, and South Africa. Finally, in the Oceania continent, France maintained scientific ties with 8 countries, especially with Australia, New Zealand, New Caledonia, Fiji, and Vanuatu.

Conclusion: The current research shows that France has a rich tradition of engaging in science diplomacy and international collaboration, emphasizing on multilateralism and cultural influence.

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Introduction

Science diplomacy involves using scientific or academic collaborations, exchange of expertise, evidence-based decision-making, and knowledge-sharing as a tool for building and maintaining international relations and foreign policy (EUTOPIA, 2023). It aims to address global challenges, opportunities and threats by fostering collaboration in scientific research, technological innovation, and academic education to promote mutual understanding and resolve issues on a global scale. Science diplomacy has three dimensions, including:

1. *Science in diplomacy* refers to the scientific expertise that guides diplomatic efforts such as climate change negotiations and global health.
2. *Science for diplomacy* refers to the process by which scientific collaboration pave the way for better diplomatic and international relations.
3. *Diplomacy for science*. The opposite of the former, diplomatic means of promoting greater scientific collaboration (The Royal Society/AAAS, 2010, EUTOPIA, 2023).

In the current study we address the “*Science for diplomacy*”, analyzing the scientific collaboration between France and other nations as a sign of the diplomatic and international relations.

France actively engages in science diplomacy, leveraging its scientific expertise and scientific collaboration to address global challenges, build international partnerships, and promote diplomatic relations. France often engages in various joint research projects, academic exchange programs, partnerships, and collaborative initiatives to foster international collaboration and address global challenges and shared scientific priorities with other countries. This approach helps strengthen diplomatic ties and contributes to global scientific advancements.

French institutions like CNRS (National Center for Scientific Research), IRD (Research Institute for Development), and INSERM (Institut national de la santé et de la recherche médicale) play key roles in France’s science diplomacy. Scientific initiatives involve joint research projects, international academic exchanges, international research partnerships, and scientific exchanges, contributing to diplomacy through shared knowledge and addressing common issues like climate change and health.

France has a rich tradition of engaging in science diplomacy. French diplomacy has a rich history, known for its emphasis on multilateralism and cultural influence. It plays a prominent role in international organizations like the United Nations (UN), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Pasteur Institute, the Organisation for Economic Co-operation and Development (OECD), the International Science Council (ISC), the International Energy Agency (IEA), the European Space Agency (ESA), European Science Foundation (ESF), the European Organization for Nuclear Research (CERN), the European

Molecular Biology Laboratory (EMBL), the European Southern Observatory (ESO), and the International Federation for Human Rights (FIDH), and prioritizes dialogue and collaboration among civilizations. Key principles of France include human rights, democracy, and sustainable development. In addition, France's proactive involvement in science diplomacy contributes to its soft power, solidifying its position as a global leader in research, innovation, and technology. The country's emphasis on scientific collaboration not only benefits the international community but also serves its own interests by promoting French expertise and fostering goodwill with partner nations. France's engagement in research and science diplomacy underscores the value of using science as a diplomatic tool to promote mutual understanding, build trust, and tackle shared challenges through scientific collaboration on a global scale.

Scientometric studies analyze scientific publications and international collaboration patterns. These studies provide valuable information on international trends, international research collaborations, emerging research fields, influential researchers, institutions, countries, and journals, and the overall dissemination of knowledge in specific scientific fields (Gholampour et al., 2023). Yamashita and Okubo (2006) examined international collaborative patterns, domestic collaborative patterns and multilateral relationships established within the French-Japanese collaboration. Previous studies examined scientific fields, institutions, and countries from different angles (e.g., Carayol & Carpentier, 2019; Gholampour et al., 2022). Several studies have been conducted at the level of journals investigating the impact factor and quality of scientific journals (e.g., Elahi et al., 2020), and others examined the authors to identify the influential authors in a scientific field (Nawaz et al., 2023).

Materials and Methods

The current research was conducted based on the Web of Science (WoS) citation database, due to its rigorous evaluations and exact criteria for indexing publications, as well as the accurate and reliable search results and data of this database (Gholampour et al. 2022).

In the advanced search section of Web of Science, a search with the name of the country of France with CU=France was performed without document type, year, or special citation index restrictions in December 2023. The data was extracted in Excel and the figures and graphs were drawn with Excel. In fact, Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), Conference Proceedings Citation Index – Science (CPCI-S), Conference Proceedings Citation Index – Social Science & Humanities (CPCI-SSH), Book Citation Index – Science (BKCI-S), Book Citation Index – Social Sciences & Humanities (BKCI-SSH), Emerging Sources Citation Index (ESCI) Current Chemical Reactions (CCR-EXPANDED) and Index Chemicus (IC) indexes were searched in the Web of Science Core Collection (WoSCC). Based on the above search 3,411,418 documents

were retrieved. Then, all information about these documents was depicted in tables and figures format.

Results

Figure 1 indicates the number of publications conducted by French researchers and scientists per decade in the Web of Science (WoS). It is evident that the French publications have been on a steady upward trend. The data suggests that French scientific publications has experienced a lot of fluctuations throughout history, in the years 1900-1964 where the number of publications was less than 100 documents, but from the 1966 until 1971, the number of documents increased to 800 documents. However, a significant turning point occurred in the year 1972 (3,264 documents), marking the beginning of a drastic increase in scientific output. Overall, the increased funding, international collaborations, and emphasis on scientific education has fueled the rising trend in French scientific publications since 1972. The culmination of publications in 2021 with 131,627 scientific publications reflects the progress made in the field of scientific research in France and demonstrating the highest level of scientific productivity in French scientific research.

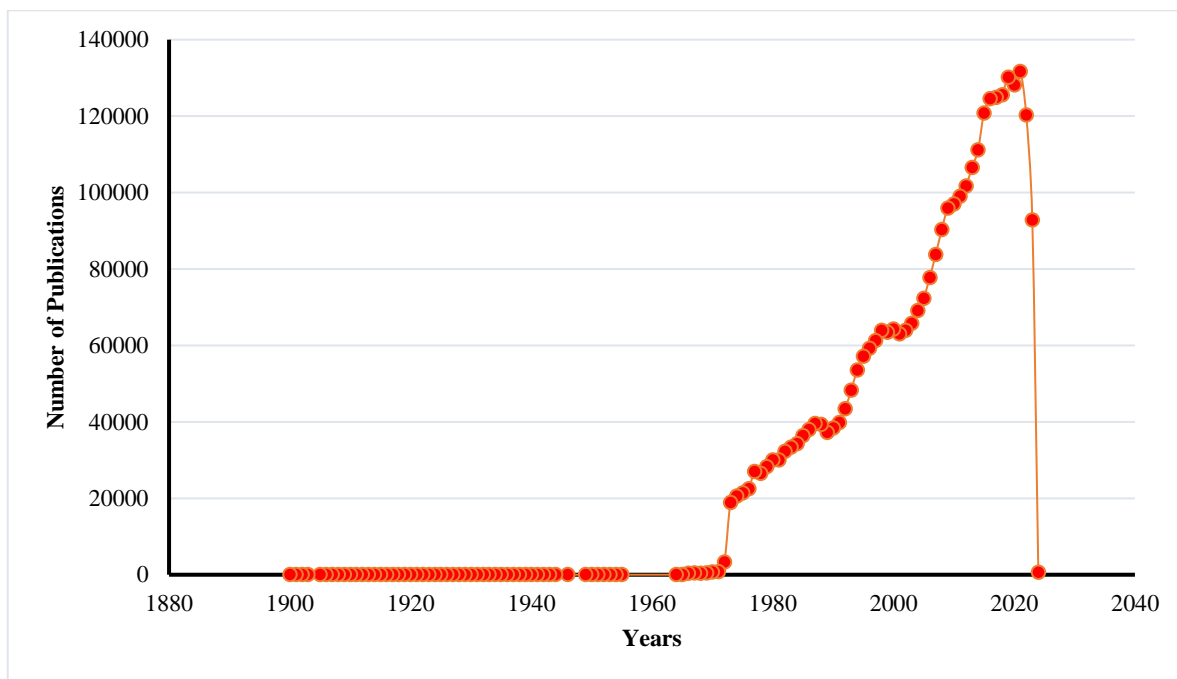


Figure 1. The number of publications per decade in Web of Science

Table 1 presents valuable information regarding the scientific collaboration between France and various partner countries. France has a rich history of collaboration with several nations, including the United States, Germany, and the United Kingdom. Moreover, France has actively engaged in scientific partnerships with Italy, Spain, Switzerland, Canada, Belgium, and the Netherlands. Table 1 also highlights that French scientific collaboration with these countries has

exceeded 10,000 collaborations, indicating a robust network of collaborative research projects. It is interesting to note that a significant portion of France's scientific collaborations are formed with European countries. This underscores the strong ties and collaboration within the European scientific community. The collective efforts between France and these nations (countries) have made substantial contributions to the advancement and growth of French research.

Table 1. The number of publications conducted by French researchers in collaboration with 20 countries

#	Countries	No. Publications
1	USA	385,546
2	Germany	243,197
3	England	221,386
4	Italy	194,535
5	Spain	145,902
6	Switzerland	122,982
7	Canada	116,875
8	Belgium	109,990
9	Netherlands	103,866
10	China	83,202
11	Australia	68,342
12	Japan	66,522
13	Sweden	61,860
14	Russia	55,709
15	Brazil	51,968
16	Poland	50,941
17	Austria	43,387
18	Denmark	42,617
19	Scotland	37,422
20	Portugal	34,954

From an interpretive standpoint, Figure 2 showcases France's influential position in the international scientific landscape. This geographical distribution highlights the varying degrees of partnerships, with the bold blue color representing a high number of collaborations, the low blue color indicating limited collaborations, and the gray color denoting non-collaborations (Gholampour et al., 2022). Upon examining the geographical map of scientific collaboration in this domain, it becomes evident that France has fostered scientific relationships with more than two-thirds of the world. This suggests that France plays a significant role in global scientific collaboration and maintains ties with many of the leading countries worldwide. Also, by establishing partnerships with a wide array of nations, France demonstrates its dedication to the advancement of scientific research and promoting cross-cultural scientific engagement. This

collaborative approach not only benefits France, but also contributes to the progress and development of the global scientific community as a whole.

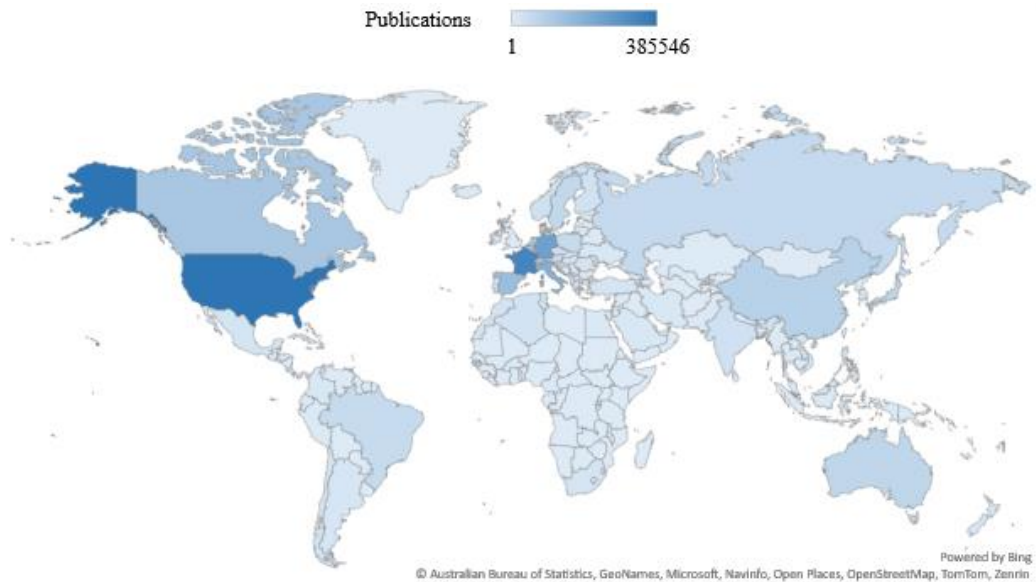


Figure 2. Geographic distribution and scientific collaboration of France in WoS

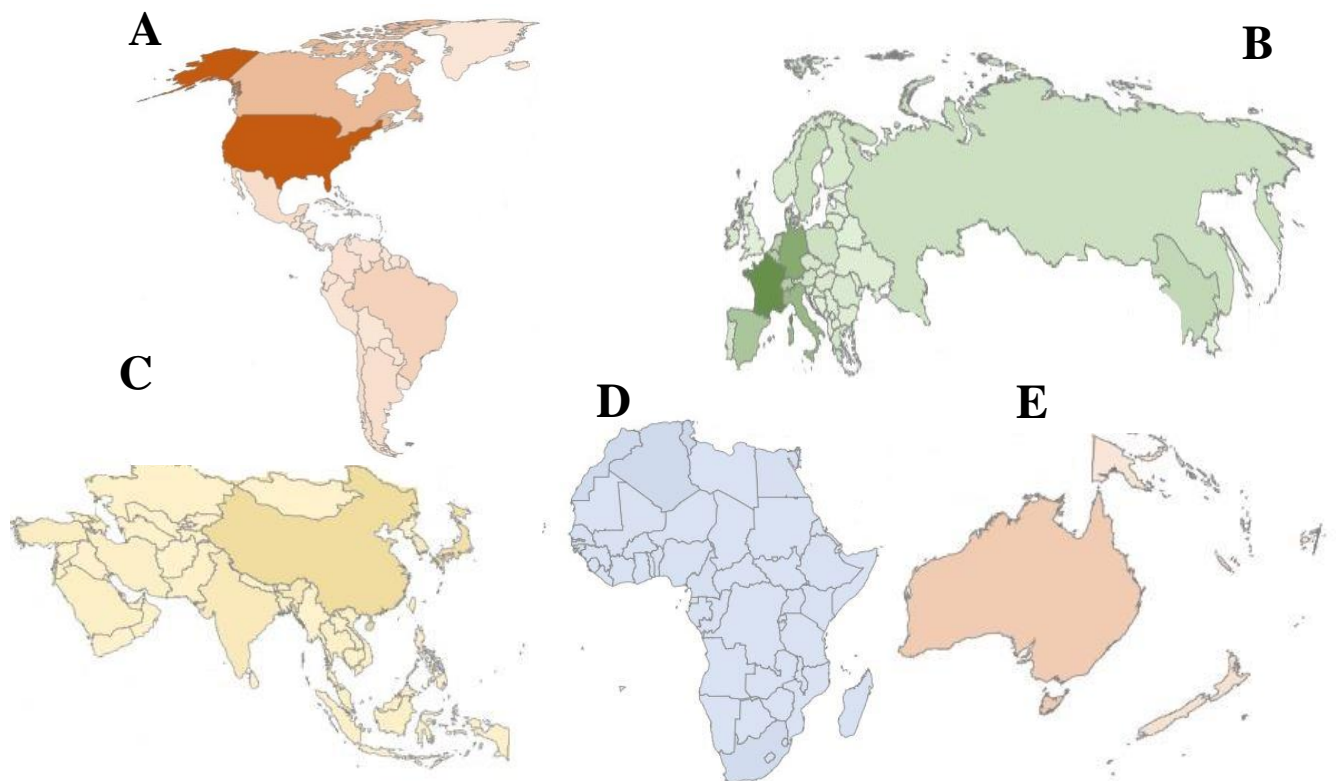


Figure 3. The growth of scientific collaboration conducted by French researchers in collaboration with the five continents in WoS

Figure 3 shows the state of French scientific collaborations separately from each of the five continents in WoS. On the continent of America, France collaborated with 32 countries, with the majority of scientific collaborations taking place with the United States, Canada, Brazil, Mexico, Chile, and Argentina (Fig 3A). In Europe continent, France engaged in scientific collaborations with 49 countries, including Germany, the United Kingdom, Italy, Spain, Switzerland, Belgium, the Netherlands, etc. (Fig 3B). Similarly, in Asia continent, France fostered scientific relationships with 36 countries, consisting of China, Japan, India, and South Korea emerging as its most prominent partners (Fig 3C). On the African continent, France also established scientific collaborations with 49 countries, especially with Tunisia, Algeria, Morocco, and South Africa (Fig 3D). Finally, in the Oceania continent, France maintained scientific ties with 8 countries, especially with Australia, New Zealand, New Caledonia, Fiji, and Vanuatu (Fig 3E).

Based on the provided information in the Figure 4, it is evident that French scientific activity has experienced significant growth and collaboration with researchers from various continents over the years. Collaboration between French researchers and their Asian counterparts commenced in 1970, and since then, it has steadily increased and reached its highest point in 2021 with 22,491 documents. This signifies a strong and productive scientific relationship between France and Asian countries. Similarly, French scientific collaboration with European countries began as early as 1906. Over the years, this collaboration has flourished, with the highest level of scientific collaboration recorded in 2021 with 52,224 documents. This demonstrates the extensive exchange of knowledge and collaboration between France and European nations in the scientific field. Since 1979, French scientists have actively communicated and collaborated with researchers from the American continent. This scientific relationship reached its peak in 2021 with 31,375 documents, highlighting the substantial contributions and partnerships between France and scientists from the American continent. It is also worth noting that a significant number of documents (528,672 documents), involved at least one researcher from the American continent, highlighting the extensive involvement of American researchers in French scientific publications.

French scientific collaboration with researchers from the African continent began in 1969. In recent years, this collaboration has shown remarkable growth, with the highest level of scientific collaboration observed in 2021, amounting to 8,534 documents. In total, at least one researcher from Africa was involved in 130,461 publications, indicating a strong partnership between France and African scientists. Furthermore, French scientific activity has also engaged researchers from the Oceania continent. This collaboration started in 1972 and reached its pinnacle in 2021 with 6,507 documents. A significant proportion of the overall scientific production, totaling 78,859 documents, involved at least one researcher from Oceania. In conclusion, French scientific activity has experienced substantial collaboration with researchers

from Asia, Europe, America, Africa, and Oceania. These collaborations have resulted in a remarkable number of publications and signify the global reach and impact of French scientific research. The diverse partnerships formed by French researchers with scientists from different continents contribute to the advancement of knowledge and promote international scientific collaboration.

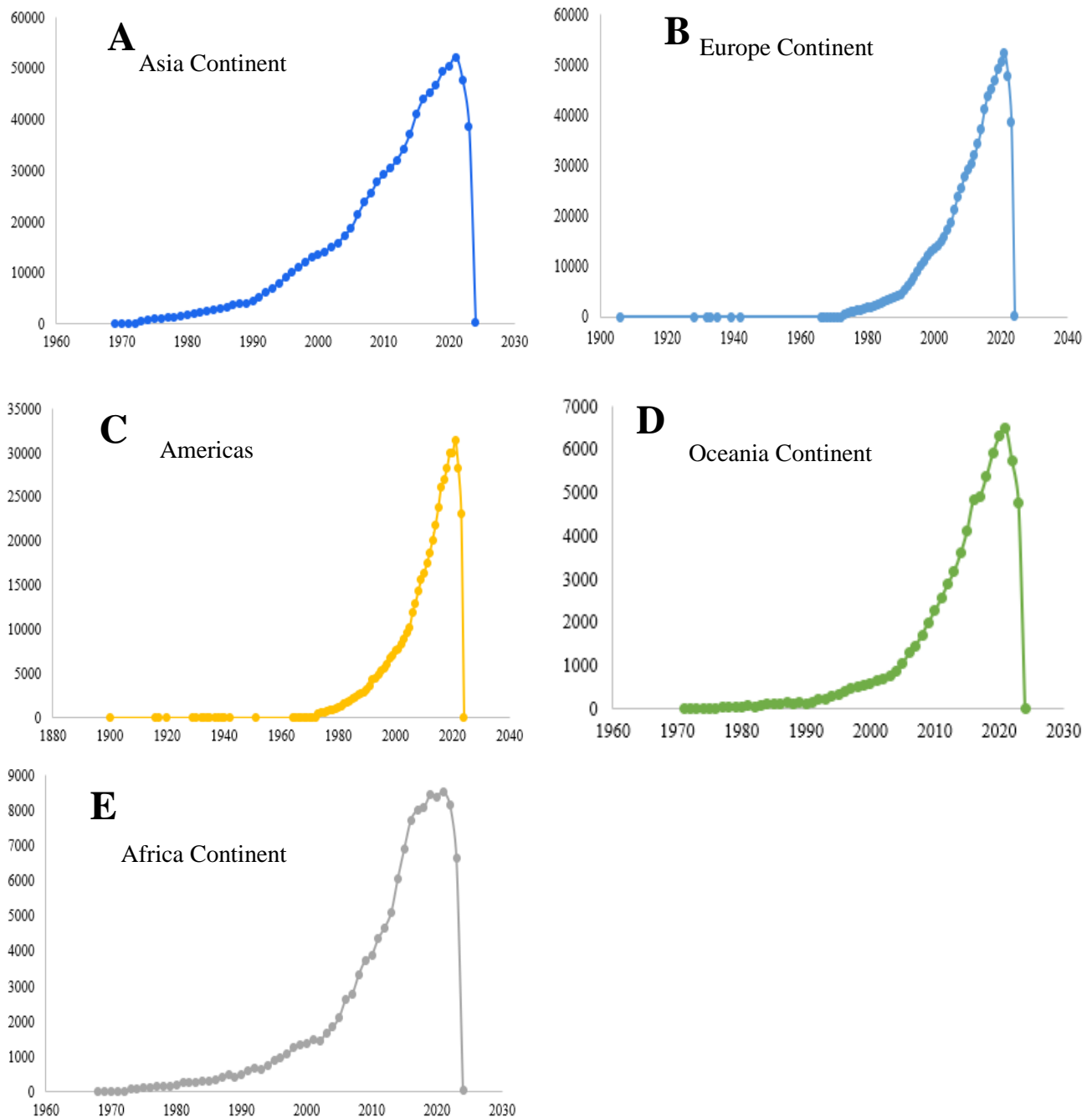


Figure 4. The growth of collaboration between France and the five continents in WoS

Table 2 shows valuable insights about the French scientific publishing landscape. In the meantime, Elsevier appears as the leader by publishing a significant number of articles from France, and with a significant difference compared to other publishers. Elsevier is the most popular publisher among the other publishers in Table 2. According to Table 2, the wide influence of Elsevier as an academic publishing giant cannot be ignored. The numbers presented in the table are staggering and show the immense popularity of Elsevier among French researchers. By publishing 964,560 articles from France, Elsevier has introduced itself as a suitable platform for the scientific publications of researchers in this country. After Elsevier, Springer stands as the second largest publisher in the table. While the number of articles published by Springer is less compared to Elsevier, but with the publication of 332,717 articles from France, it played an influential role in the publication of articles by French researchers and was able to achieve a significant position compared to its peers in Table 2. Although Springer and Wiley are far behind Elsevier in terms of number of publications, Wiley occupies the third place among the top publishers. This American publishing giant has a significant contribution to the collection of French scientific literature with the publication of 262,598 articles. These three publishing giants published nearly 65% of French researchers' articles.

Table 2. The most popular publishers in French scientific diplomacy based on WoS

Publisher	No. Publication
Elsevier	964,560
Springer Nature	332,717
Wiley	262,598
IEEE	153,262
Taylor & Francis	77,482
Oxford Univ Press	75,432
Amer Chemical Soc	70,433
Lippincott Williams & Wilkins	57,391
IOP Publishing Ltd	52,387
Amer Physical Soc	50,032
MDPI	39,587

According to Table 3, it seems that French researchers have explored and focused on a wide range of scientific fields in their publications. The goal of French scientific diplomacy is to promote international collaboration in various scientific fields. Therefore, in their scientific publications, French researchers especially focused on the scientific fields of engineering electrical electronic (with 162,968 documents), biochemistry molecular biology, materials science multidisciplinary, physics applied, chemistry physical, and oncology. In addition to the mentioned scientific fields, French scientific diplomacy has also paid attention to the scientific fields of chemistry multidisciplinary, multidisciplinary sciences, medicine general internal and

pharmacology pharmacy. This reflects France researchers' commitment to promoting scientific diplomacy (international collaboration and knowledge exchange) across various disciplines.

Table 3. The most active scientific fields in French scientific diplomacy based on WoS

Category	No. Publications
Engineering Electrical Electronic	162,968
Biochemistry Molecular Biology	158,276
Materials Science Multidisciplinary	154,926
Physics Applied	132,547
Chemistry Physical	115,228
Oncology	105,651
Chemistry Multidisciplinary	96,951
Multidisciplinary Sciences	93,719
Medicine General Internal	92,550
Pharmacology Pharmacy	89,240

Conclusion

Science diplomacy bridges the gap between the domains of science and diplomacy by bringing together scientific experts, policymakers, and diplomats to address issues and challenges in national and international contexts like climate change, public health crises, and technological innovation (EUTOPIA, 2023). Science diplomacy is a hot topic at the intersection of science, international relations, and policy. Scientific research diplomacy typically involves the use of scientific or academic collaboration as a means to foster international relations and solve global challenges. It focuses on building partnerships and exchanging knowledge across borders to address shared issues like health, environment, and technology. This approach emphasizes the role of research and academia in promoting understanding and collaboration between nations.

The current study shows that France has a rich tradition of engaging in science diplomacy and international collaboration, emphasizing on multilateralism, cultural influence, and partnerships in research and education. France has a strong tradition of scientific excellence and often uses science diplomacy to enhance its global influence. One of the prime examples of France's commitment to science diplomacy is through its various scientific and cultural exchange programs, which aim to strengthen ties with other nations through collaborative research, joint projects, and academic exchanges. France has a strong history of scientific achievement and innovation, and it leverages this expertise to build relationships and form partnerships on the global stage. The French government, along with its research institutions and universities, actively promotes scientific collaboration with other countries as a means of fostering international collaboration, addressing global challenges, and building international relationships.

France often combines scientific expertise with diplomatic efforts to promote collaboration on international issues.

Data Availability Statement

Not applicable.

Ethical considerations

The author avoided from data fabrication and falsification.

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Not applicable.

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