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The influence of geopolitics on research activity and international collaboration in science: the case of Russia

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Abstract
We study the possible influences of the Russia-Ukraine War on Russia's research productivity and international collaboration in science. For this purpose, we introduce and apply two recently developed indicators of relative intensity and balance in international collaboration. To see whether longitudinal trends have changed recently, we combine a long-term perspective based on annual updates since the year 2000 with a short-term perspective based on monthly updates since the beginning of 2022. The clearest change is that the productivity of Russian science, as measured within Web of Science, has dramatically decreased after several years of growth. There is also a clear decline in the degree of international collaboration in fields of research that heavily rely on large multinational infrastructures established through state agreements. In other fields, however, the degree of international collaboration is more stable. The general decline in Russian science seems to be more driven by internal factors than by loss of partnerships abroad.

Keywords Geopolitics · Russia-Ukraine war · Research activity · International collaboration

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Introduction

Recent years have seen increasing tensions between science policies advocating openness and globalization on the one hand, and foreign policies much more focused on competition, trade sanctions, self-containment, and security and defence on the other. Taking the latter perspective of foreign policies, the present pattern of global collaboration in science represents a paradox. It does not follow the borders of defence alliances. The highest relative collaboration intensity of the United States (hereafter "the US") is with Canada, South Korea, and China according to the bibliometric indicator of "Relative international collaboration specialization" in the *Science & Engineering Indicators* report published by the US' National Science Foundation (2021). Of these three countries, only Canada is an ally of the US. China remains by far the largest collaboration partner of the US in terms of the total of co-authored papers despite the political tensions between the two countries in recent years. According to a study of global collaboration intensities in science (Sivertsen, 2023), the intensity in the relations of member countries of NATO in northern Europe has been higher with Russia than with the US.

The Russia-Ukraine War[1] presents us with a possible case of geopolitical influence on research activity and international collaboration. Russia quickly became the most sanctioned nation in the world after February 2022 (Zandt, 2022) with no exception for governmental agreements and investments in science and technology. To take two countries as examples, the US' White House Office of Science and Technology Policy has decided to "wind down" government-to-government research collaboration with Russia and no longer start new projects (The White House, 2022). The German government has officially suspended all governmental cooperation with Russia in science and asked other European countries to follow suit (Plackett, 2022). As a typical example, the publicly funded German Electron Synchrotron Center (DESY) has suspended all organizational-level collaboration, including visits, conferences, and co-publishing, with similar institutions in Russia and Belarus.

The scientific communities themselves, however, have been more hesitant to stop collaboration, and most countries have decided not to intervene in contacts and collaboration between scientists on an individual basis, thereby reflecting the long-standing consensus in scientific communities worldwide that science should have no borders. This combination of political condemnation and continued support of scientific collaboration have occurred in the *Nature* and *Science* magazines. An editorial published on March 4, 2022 (Nature, 2022) expressed a strong condemnation of Russia and an explicit sympathy with Ukraine while at the same time supporting the plea of the InterAcademy Partnership (IAP, the main global alliance of academies of science) to "leave no one behind" in global science collaboration. *Nature* would "continue to consider manuscripts from researchers anywhere in the world". According to an article in *Science* a few days later on March 10, 2022, editors and publishers of scientific journals had largely refused the call of Ukrainian scientists to decline publishing manuscripts from Russian scientists (Brainard, 2022). The resistance of the global scientific communities towards being steered by geopolitical conflicts seems to prevail even under high pressure.

[1] In the official announcement of Russian Federation, the Russia-Ukraine War is termed as "a special military operation in Ukraine".

There are other recent cases where geopolitics have been demonstrated to influence international collaboration patterns to some degree. The relative intensity of collaboration between the US and China has been declining since it peaked in 2016 while the opposite is the case for the relation between the UK and China (Rousseau et al., 2023). The decrease in relative collaboration intensity between the US and China is therefore not explained by the COVID-19 travel restrictions, but most probably by the deteriorating relations between the two countries since 2018 (Tang et al., 2021; Zweig, 2021). However, we have not observed dramatic changes so far.

Based on the general picture presented above with global collaboration patterns that might seem paradoxical from a geopolitical point of view, our hypothesis is that the Russia-Ukraine War has not considerably affected the long-term patterns and trends in international scientific collaboration. We will test this hypothesis by using partly new methods. For the analysis of international collaboration, we apply a recently developed refinement of the measurement of collaboration intensity (Fuchs et al., 2021) along with a new indicator that measures the balance in the collaboration profile of a country over time (Rousseau et al., 2023). We extend the general collaboration analysis with an analysis of long-term trends and recent month-by-month changes in four different fields of research.

To interpret the influence of geopolitics on Russia's international relations in science, we need to consider the perspective of other countries as well as Russia's own policy changes in its research and higher education system. We present a short account of the system here in the introduction and will provide more information below as we interpret our empirical findings.

According to the monitoring of educational organizations of higher education for 2022, there are 1208 universities in Russia, of which 896 are public (including municipal) and 312 are private (Chief Information and Computing Center of the Ministry of Science and Higher Education of the Russian Federation, 2022). The relative role of the universities in the Russian science system has changed over time (Markusova et al., 2014). Another important actor is the Russian Academy of Sciences (RAS), which celebrates its 300th anniversary in 2024. RAS received its greatest development during the Soviet period. This is explained by the fact that the regime needed "old" specialists but did not trust them and was afraid to allow them into universities to communicate with the youth. Therefore, they were mainly concentrated in the RAS' research institutes. Gradually, a "research triad" emerged: the Academy of Sciences, the industry design bureaus,[2] and the research institutes.[3] The universities and the industry institutes[4] were mainly engaged in training personnel with public funding (Lazar, 2019). Therefore, historically, both fundamental and applied research largely moved "outside" universities.

[2] In the USSR, industrial design bureaus played a key role in the development of various industries. They were involved in the development and improvement of technologies, equipment, and materials necessary to ensure the competitiveness and sustainable development of enterprises. In general, they are similar to modern corporate R&D departments but centralized at the level of entire industries.

[3] Research institutes in the USSR were the main centers for conducting fundamental and applied research in various fields of science and technology. This group of research institutions mainly included institutes of the Academy of Sciences and industry research institutes. Most of industry research institutes were closed in the 1990s, except mainly the gas and nuclear industries.

[4] In 1990, there were 911 HEIs in the USSR, including only 71 universities (Tomskikh, 2010). The remaining HEIs were aimed at meeting the HR needs of certain industries; they were usually called institutes.

RAS was negatively affected by the reforms that were carried out in Russia in the 1990's. The meager wages, which were also not paid on time, forced people to go to universities, to go abroad, or to simply leave science. The next blow was the separation of the network of academic institutes (over 600 organizations) from RAS and their transfer to the direct subordination of the Ministry of Science and Higher Education. Formally, RAS remains the country's main expert body, but the regulatory mechanism for conducting this function largely remains on paper. As we shall see below, in the last two decades, the universities have received the main investments and incentives to improve Russia's science and make it more internationally influential.

Data and methods

To test our hypothesis about the relative stability in Russia's collaboration and publication patterns, we combine a long-term perspective with an analysis of annual changes and a short-term perspective with an analysis of monthly changes. Our data sources include Web of Science™ Core Collection (hereinafter "WoS") and InCites Benchmarking & Analytics™ (hereinafter "InCites"), a platform launched by Clarivate, offering indicators built upon the publications metadata in the WoS.[5] We downloaded a total of 461,366 international collaborative publications involving authors from the 20 most productive countries worldwide to calculate two indicators for our analysis of international collaboration patterns (see details in the following paragraphs). This data spans from January 2022 to April 2023. Additionally, we supplemented our analysis with data retrieved from either WoS or InCites online, which was last updated in February 2024. This supplementary data covers the period from 2000 to 2023. Note that the document type adopted in our study is *Article* (except for Fig. 2, in which the trend regarding proceeding papers is analysed for comparison).

For the collaboration analysis, we introduced two newly proposed indicators in our study. One is an indicator of the relative intensity of collaboration (*RIC*). It was introduced by Fuchs et al. (2021) as a mathematically consistent alternative to a similar and widely used indicator (e.g., the "Relative international collaboration specialization" used by US' authorities as mentioned in our introduction) to measure the activity in bilateral relations relative to all other collaboration activities within a network. The RIC indicator compares the share of country Y within the collaboration profile of country X to the share of Y within all collaborations in the whole network. It is calculated as:

$$RIC(X,Y) := \frac{\frac{C_{XY}}{C_X}}{\frac{C_Y - C_{XY}}{T - C_X}} = \frac{C_{XY} \cdot \left(T - C_X\right)}{C_X \cdot \left(C_Y - C_{XY}\right)}$$

where C_{XY} denotes the number of collaborations between countries X and Y; C_X (C_Y) denotes the total number of collaborations country X (Y) has with all other countries; and T denotes the total number of pairwise country collaborations in the set of publications under study.

The other new indicator, balance in collaboration (*BIC*), was developed by Rousseau et al. (2023) to measure the degree of balance in a country's collaboration profile and

[5] https://clarivate.com/webofsciencegroup/solutions/incites/

Fig. 1 Annual trend of the number of Russia's articles and its share in Web of Science (WoS)

possible changes of time. We use this indicator to study whether the balance in Russia's international collaboration is influenced by geopolitics. The *BIC* indicator is based on the Gini evenness index for a weighted Lorenz curve, represented as:

$$BIC(X,Y) = \sum_{j=k+1}^{N} \left(b_j + b_{j-1}\right) w_j, where b_j = 1 - \sum_{m=1}^{j} a_m, j = 1, \ldots, N and b_0 = 1$$

In the formula, $w_j = \frac{C_Y - C_{XY}}{2(\mathrm{T} - C_X)}$ and $a_m = \frac{C_{XY}}{C_X}$. *BIC* can be regarded as an extension for the use of *RIC*.

The calculation of the two indicators is further explained in Fuchs et al. (2021) and in Rousseau et al. (2023). It should be noted that when calculating these two indicators, we only consider the 20 most productive countries in terms of scientific articles according to the 2021 ranking of InCites. Articles with contributions by researchers from these countries represented 88.3% of all international collaborative articles published in that year.

Results and discussion

Trends in Russia's contribution to international scientific journals

Figure 1 provides an overview of the trends in Russia's contribution of articles indexed by Web of Science over the past two decades. There is a remarkable decrease in Russia's relative contribution (as percentage) to world science until ten years ago followed by a clear increase and then a continuous decline in recent years.

We will firstly provide possible explanations for the initial phase of decrease and the following phase of increase.

Between the years 2000 and 2014, there was a decline in the share of articles in WoS for several well-established scientific countries, including the US (from 32.5 to 26.5 percent) and Germany (from 8.3 to 7.0 percent). This was mainly due to the rapidly increasing contributions from other parts of the world, such as China (from 3.7 to 16.9 percent) and India (from 2.1 to 3.9 percent). However, the share of Russia (from 3.3 to 2.0 percent) decreased relatively more than for all other countries except Japan. After 2014, the shares continued to decrease for most countries, including Germany, Japan, and the US, while Russia uniquely increased its share for a while. It is possible to explain the trends in the two first phases with changes in Russia's own science policy.

Historically, the two oldest universities, Moscow State University and St. Petersburg State University, have been prioritized financially and enjoyed slightly more autonomy than others. However, since 2008, the Russian government has attempted to expand the group of "national champions". The status of "federal university" was normatively established by a Presidential Decree for nine universities, a number indicating an attempt to create something similar to China's League of Nine (C9), an official alliance of prestigious universities. Another Presidential Decree established "national research universities" with the aim at developing the national priorities in science and technology. Two universities were awarded the status without competition and 27 more universities were selected on a competitive basis.

In 2013, the Russian government launched the academic excellence initiative Project 5top100 with the aim of having five Russian universities included in the top 100 of the world university rankings (THE, QS, or ARWU). The goal of the project was not achieved; however, project participants significantly increased the number of publications indexed in Web of Science. The same effect was achieved by the so-called flagship (pillar) universities program (Lisitskaya et al., 2023). The 5top100 project implied financial support of activities aimed at developing international academic mobility and cooperation. Therefore, its influence on the creation and development of international collaborations was very significant. After February 2022, most of the project's gains were lost. The successor to the project was the Priority 2030 program launched in 2021 (Kochetkov, 2022), which declared a move away from university rankings as an assessment tool but retained quantitative publication indicators. There are no indicators of international collaborations in the program targets.

The science policy initiatives and priorities described above obviously explain how Russia could succeed in turning a relative decline into a remarkable increase in the proportion of articles indexed by Web of Science in the last decade until 2022.

Figure 2 shows that the changes have been even more dramatic for conference proceedings. They became one of the tools to increase the number of publications from Russian universities (Guskov et al., 2018). However, within the framework of the more recent Priority 2030 program, only journal publications are considered. Combined with the problems with paying conference fees and visa difficulties after February 2022, this led to a dramatic drop in the interest of Russian scientists to participate in international conferences.

In the following, we will investigate to what extent the recent dramatic decrease in Russia's contribution to international scientific journals is due to reduced international collaboration.

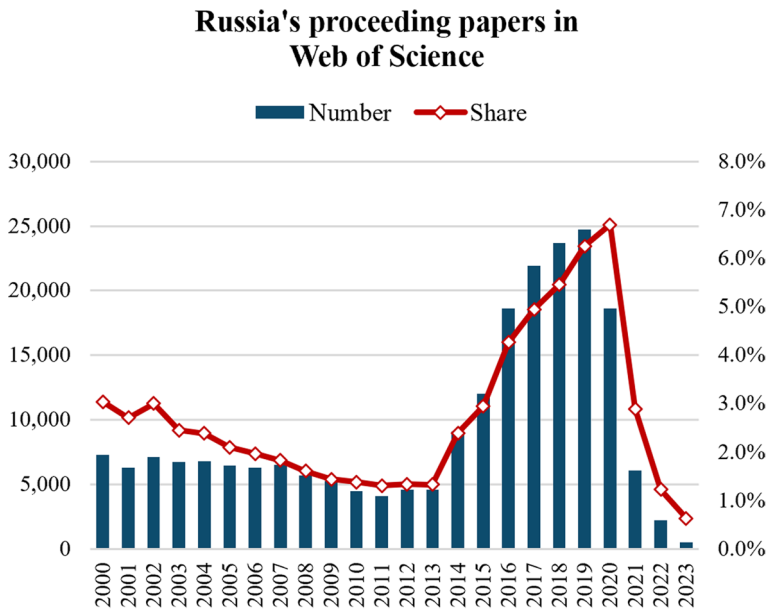

Fig. 2 Annual trend of the number of Russia's proceeding papers and its share in Web of Science (WoS)

Russia's international collaboration pattern

Our analysis of trends in Russia's international collaboration, as measured by Russian articles with co-authors abroad, is more directly related to our hypothesis that the Russia-Ukraine War has not considerably affected the long-term patterns and recent trends in this aspect of scientific practice. As observed in Fig. 3a1, the long-term international collaboration rate gradually increased as Russia invested in internationalization and global influence (see above) with decrease since 2022. However, as shown in Fig. 3a2, a month-by-month measurement since January 2022 reveals the total production has been dramatically affected while the international collaboration rate has been relatively stable. The decline of Russia's science is not explained by an indication that scientists abroad are turning their back on Russian colleagues.

Focusing on four specific large countries representing different parts of the geopolitical world, China, Germany, India, and the US, we use the relative intensity of collaboration (*RIC*) in their relations to Russia to study the long-term patterns (Fig. 3b1) and the most recent months (Fig. 3b2). Over the years, the *RIC* between Russia and Germany, and Russia and the US, has continuously declined while it has increased in relation to China and India. These long-term trends have not changed much in the past few months. The collaboration intensity in the relations to China and India continues to increase whereas it is clearly decreasing in the relation to Germany. The differences between the four countries are as expected given that mainly Europe and North America has reacted by withdrawing from state-funded collaboration with Russia.

We also calculated Russia's balance in collaboration (*BIC*) (see Fig. 3c). It seems to be stable and then affected negatively in the most recent months, but this change may also be due to the dramatically decreased scientific production.

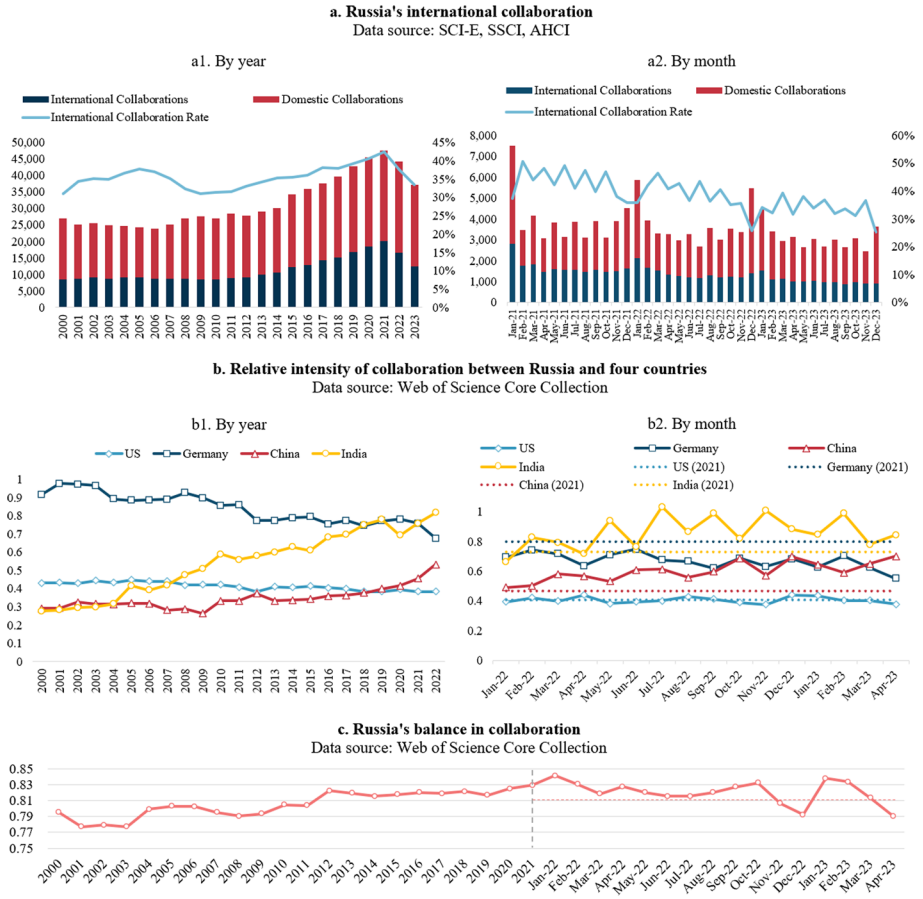

Fig. 3 Evolution of Russia's international collaboration pattern

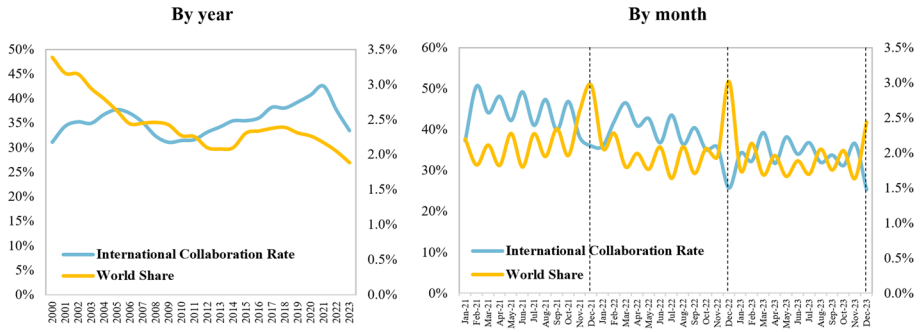

Fig. 4 Comparison between trends of the international collaboration rate and the world share

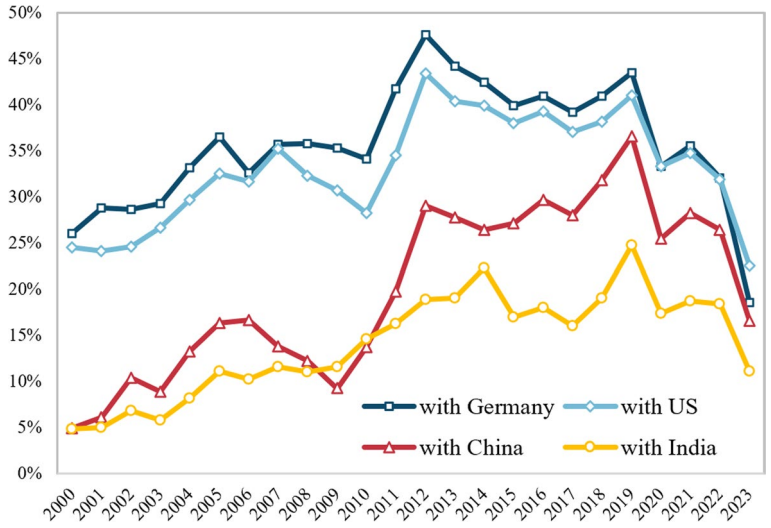

Fig. 5 Shares of Russia's articles in *Particles and Fields* that were collaborated with four countries

Figure 4 compares the trend of Russia's international collaboration rate to the trend in the world share of Russia's publications. In the long-term perspective, until 2020, we see that the world share goes down as the international collaboration rate goes up and vice versa. Then both rates decrease. However, in the most recent months, we observe that the international collaboration rate remains high as the world share is drastically reduced. These observations reinforce our hypothesis that the Russia-Ukraine War has not affected international scientific collaboration with the country to a high degree. On the contrary, the dramatic decrease in international publishing needs to be explained by internal factors. It is noteworthy that there is an unusual fluctuation in the month of December in 2022 and 2023. We checked and observed the same phenomenon in 2021: The number of publications from Russia increases in this month, leading to a temporary increase in the world share and a temporary decrease in the degree of international collaboration. It seems that the indexing of Russian journals in Web of Science is intensified by the end of the year. A similar anomaly can be observed in Fig. 3a2 in terms of the publications with domestic collaboration during the same period.

Russia's decreasing international collaboration in *Particles & Fields*

We conducted a closer analysis to examine whether the long-term and short-term evolution of Russia's international collaboration patterns differ among various research fields. A noteworthy discovery in this section is that our hypothesis is not applicable to the field of *Particles & Fields* in physics. This field of research heavily relies on large multinational infrastructures established through state agreements and is sensitive from the viewpoint of state security as well. In this field of research, Fig. 5 clearly shows that Russia's collaboration with Germany, the US, China and India has been seriously impaired recently.

To investigate possible explanations for the observation in Fig. 5, we focused on the organizational level and compared Russia's international collaboration in *Particles & Fields* and three other fields—*Soil Science*, *Astronomy & Astrophysics* and *Pure Maths.*

Table 1 Top 10 foreign institutions collaborated with Russia in four fields

3.45 Soil science		5.20 Astronomy & astrophysics	
University of Gottingen	Germany	Max Planck Society	Germany
Chinese Academy of Sciences	China	Centre National de la Recherche Scientifique (CNRS)	France
Centre National de la Recherche Scientifique (CNRS)	France	Istituto Nazionale Astrofisica (INAF)	Italy
Helmholtz Association	Germany	University of California System	US
University of Alaska System	US	National Aeronautics & Space Administration (NASA)	US
University of Alaska Fairbanks	US	Consejo Superior de Investigaciones Cientificas (CSIC)	Spain
Institut de Recherche pour le Developpement (IRD)	France	Universite PSL	France
Universite de Toulouse	France	Observatoire de Paris	France
Universite Toulouse III—Paul Sabatier	France	Smithsonian Institution	US
Alfred Wegener Institute, Helmholtz Centre for Polar & Marine Research	Germany	Universite Paris Cite	France
5.9 Particles & fields		**9.28 Pure maths**	
Istituto Nazionale di Fisica Nucleare (INFN)	Italy	Centre National de la Recherche Scientifique (CNRS)	France
United States Department of Energy (DOE)	US	Universidade de Sao Paulo	Brazil
Centre National de la Recherche Scientifique (CNRS)	France	CNRS—National Institute for Mathematical Sciences (INSMI)	France
Helmholtz Association	Germany	University of Ljubljana	Slovenia
CNRS—National Institute of Nuclear and Particle Physics (IN2P3)	France	University of California System	US
Universite Paris Saclay	France	Leibniz University Hannover	Germany
University System of Ohio	US	Aix-Marseille Universite	France
University of California System	US	Pennsylvania Commonwealth System of Higher Education (PCSHE)	US
Chinese Academy of Sciences	China	Max Planck Society	Germany
Sapienza University Rome	Italy	University of Palermo	Italy

Data source: InCites platform

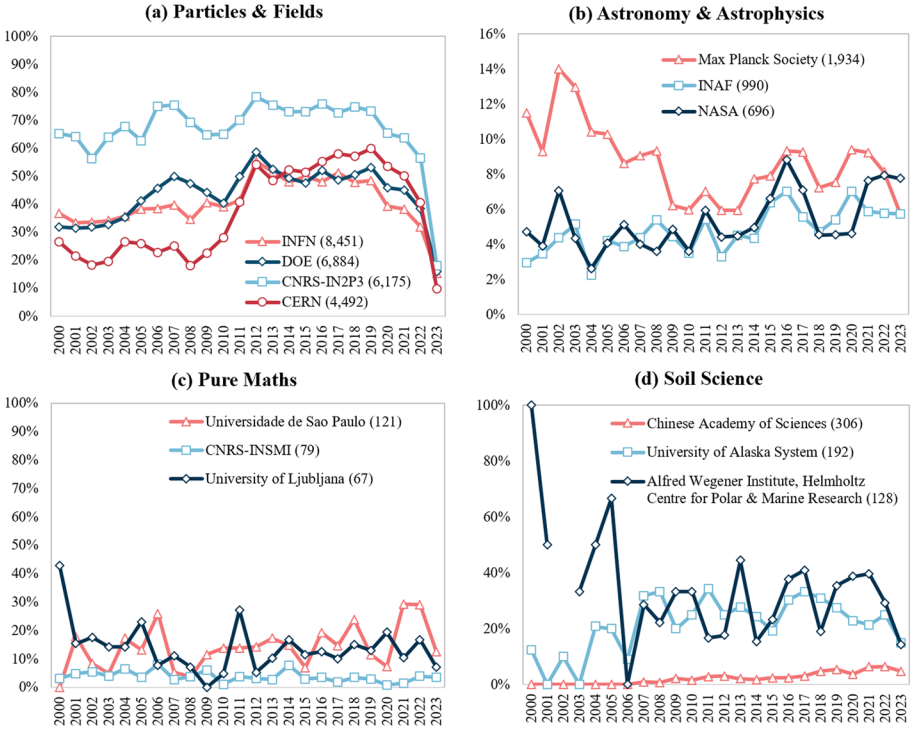

Fig. 6 Share of articles collaborated with Russia in each institution's total international collaborative articles under each meso-topic

Table 1 shows the ten foreign institutions that Russian institutions collaborated with most frequently in 2000–2023 in the four fields. We find large national research organizations such as the Centre National de la Recherche Scientifique (CNRS) in France and the Helmholtz Association in Germany as well as specialized organizations such as Istituto Nazionale di Fisica Nucleare (INFN) in Italy and the United States Department of Energy (DOE). Some universities appear as well. Among the organizations in Table 1 we select three or four in each field to see whether there are distinctive patterns in the annual trends in collaboration with Russia in the four fields of research.

As observed in the Fig. 6, *Particles & Fields* stands out with significantly declined collaboration in the past two years. In other fields, Russia's collaboration with selected institutions continued the long-term trends. For example, according to the news released by Chinese Academy of Sciences (CAS) (2023), Russia's collaboration with CAS on permafrost-related research is in a normal status. Statistics also suggest that their collaboration in the field of *Soil Science* has not been impaired.

Our results may break a stereotype that international collaboration is mainly determined by the relationship between countries. Beyond geopolitical factors, the field where they collaborate might be more essential. A typical comparison is Russia's collaboration with NASA in *Astronomy & Astrophysics* and that with DOE in *Particles & Fields*. Whereas the former has kept a generally upward trend, the latter has dropped sharply. In fact, NASA official has stated that Russia's role in the International Space Station partnership is hard to

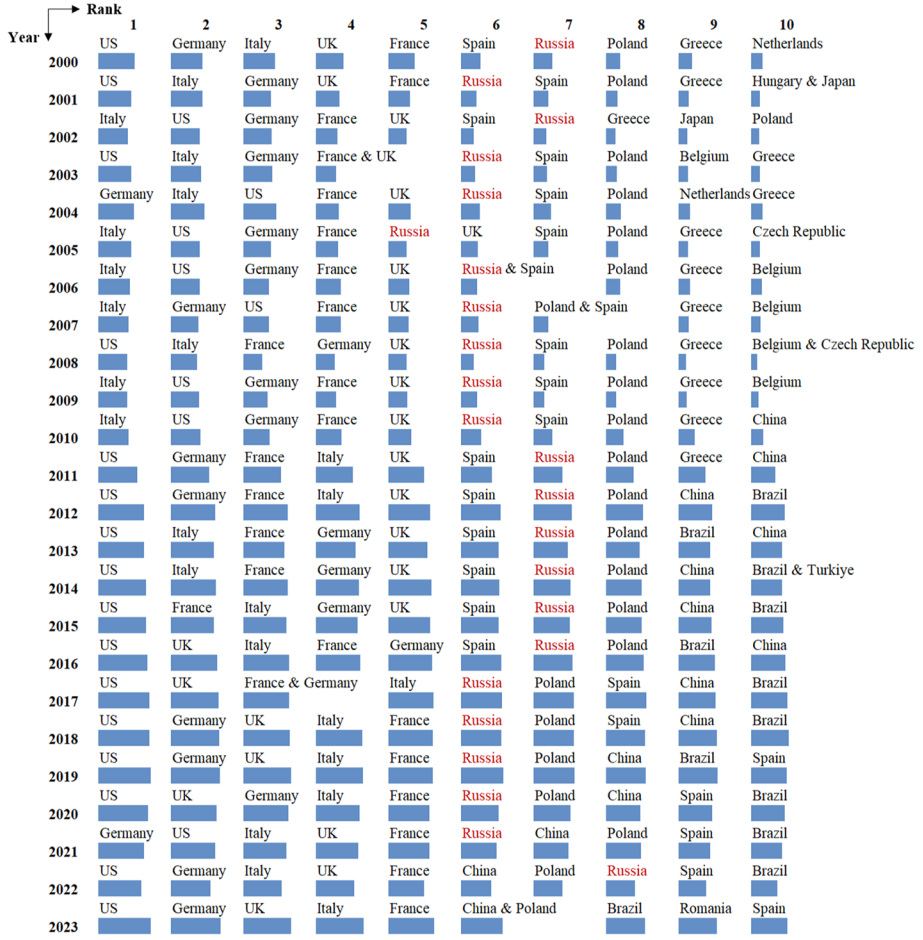

Fig. 7 Top 10 countries collaborating with CERN within years 2000–2023 according to the number of articles they contributed. Note: Bars in each cell indicate the share of articles collaborated by CERN and the corresponding country (column) in the corresponding year (row)

replace (Sheetz, 2022). Russia's previous exploration in space has accumulated sufficient technical advantages, which will cost other countries much if excluding Russia from collaboration. On the contrary, Russia's research foundation in elementary particle physics is not solid enough, which relies heavily on costly multinational infrastructures. In this way, it is easier for other countries to cut ties with Russia. Institutions including CNRS, INFN and CERN Council have expressed their intention to suspend new scientific collaboration with Russia and provide more opportunities for Ukrainian scholars (Catanzaro, 2022; CERN Council, 2022; CNRS, 2022). It seems that under geopolitical tensions, strategic considerations may apply differently across various fields of research of different political interest.

From the perspective presented above, the European Organization for Nuclear Research (CERN) in Switzerland represents an interesting case related to our main hypothesis that a geopolitical conflict will not seriously affect international scientific collaboration.

Although CERN operates within the field of *Particles & Fields*, its reaction to the Russian conflict has been ambiguous. The CERN Council in June 2022 declared its intention to terminate their international cooperation agreements with the Russian Federation, but not before their expiration dates in 2024, hoping to see an end to the conflict at that time. However, behind this official statement is a detectable harsher reality. Figure 7 shows the 10 countries that collaborated with CERN the most from 2000 to 2023. Russia always ranked in the range from 5th to 7th before 2022, dropped to 8th in 2022 and vanished from the top 10 by being 16th so far in 2023. Contrary to this declining trend, there are other countries newly entering the Top 10 list, such as China and Brazil since 2010. Another finding is that the bars in the past 10 years are generally higher than those in the first ten years in the twentieth century, which may imply that multilateral collaboration has become more prevalent.

Conclusion

Our results confirm our hypothesis that geopolitical conflicts only marginally affect long-term patterns and trends in international scientific collaboration. Russian science is to a high degree integrated in global science, and the relative intensity of collaboration in bilateral relations remains relatively stable. This stability is mainly provided by the relations to the two largest science-producing countries, the US and China. However, there are signs that collaboration becomes less intense with Germany and is increasing in the relations to China and India. We also see an exception from the general confirmation of our hypothesis: Scientific collaboration may be negatively affected in fields of research demanding large international infrastructures and where the exchange of new knowledge is sensitive from a security and defence perspective.

While our general hypothesis about continuing international collaboration is confirmed, we find an almost dramatic recent decrease in Russia's contributions to international scientific journals. This change may instead be explained by internal factors such as repression of academic freedom and academic diaspora, which have become a cause for concern in Russia (see, e.g., Yudkevich, 2023). A recent example that may illustrate this problem, is the Institute of the USA and Canada of the Russian Academy of Sciences (ISCRAN). On August 29, 2023, the director of the institute, Valery Garbuzov, published an article about the "imperial complexes" of Russia (Garbuzov, 2023). Already on September 1, the Ministry issued an order on his dismissal with the wording "at the initiative of the founder" (Plamenev, 2023). This case is not unique: the dismissal of a director without taking into account the opinions of employees also occurred at the Scientific and Technological Centre for Unique Instrumentation (STC UI RAS), Institute for Information Transmission Problems, and most recently at the Institute of Ethnology and Anthropology of the Russian Academy of Sciences. However, it is a topic for a separate study.

A limitation of this study is that Web of Science mainly covers international journals and that most of these journals are edited and published outside of Russia. However, some Russian journals are included. Among these, we checked the 30 Russian journals with the most significant share articles from Russia and found a 25 percent decline in Russian productivity in these journals between 2022 and 2023. The general decline is thereby also visible within Russia. We also checked the main publishers of Russian science within Web of Science in recent years. They remain the same as for the rest of the world: Springer

Nature, Elsevier, and MDPI. As indicated in our introduction, the main scientific journals and publishers in the world do not seem to refrain from publishing Russian science.

Another limitation of using Web of Science in this study is that it is based on bibliographic data covering published research only. Industrial scientific collaborations are not covered. However, a strength of bibliographic data is that it covers research that individual researchers in different countries choose themselves to perform together independently of agreements between states. We can thereby acknowledge the fact that international scientific collaboration is not solely based on government and institutional agreements, but also shaped by human interactions and direct contacts.

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Declarations

Conflict of interest Dmitry Kochetkov is a former employee of the Russian Ministry of Science and Higher Education. Dmitry also has a significant record at universities participating in the 5top100 and Priority-2030 Projects. Lin Zhang is Editor-in-Chief of *Scientometrics*.

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