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Sino-Norwegian collaboration in science: An analysis based on articles in Web of Science

Gunnar Sivertsen

This Policy Brief presents the results of a study commissioned by the Norwegian Ministry of Education and Research with the aim of mapping Norway's scientific collaboration with China within the context of global scientific collaboration. The main results were presented earlier on in [NIFU Working Paper 2022:1](#) and in [NIFU Working Paper 2023:1](#). They are now updated with time series based on more than 31 million articles covering the twenty-year period 2004-2023. In addition, we present a closer analysis of Sino-Norwegian collaboration in research contributing to UN's Sustainable Development Goals. We also summarize a study of how the global pattern of scientific collaboration relates to security policy which was published in Norwegian in the journal [Internasjonal Politikk, No. 1, 2024](#).

The growth of China

The growth of China is the clearest change in global science in the last two decades. China contributed to 6.4 percent of the world's scientific articles in 2004. By 2019, the share reached 25 percent, leaving the USA behind at 24 percent. In 2023, the shares were 33 percent versus 19 percent.

One factor that may explain the growth of China in science is the growth of the economy itself combined with rapidly increasing investments in science. China

Abstract

China is the world's largest nation in terms of scientific publishing and now contributes to one third of all articles in Web of Science. China and the USA are the largest and most intense collaborators in the global network of scientific collaboration. Norway's collaboration with China has increased over the years following a general European trend that reflects the growth of China in science and technology. However, Norway slightly deviates from the general trend by collaborating less with China than the other Nordic countries and the EU countries do. Nevertheless, China has become Norway's largest collaboration partner in the technological sciences and in some of the natural sciences. The most active research collaboration of mutual interest is seen in research on climate change.

has doubled its GDP every eight years since the nineties and raised its R&D share of GDP to the average of the EU countries. Other factors are the global integration of the market of scientific journals combined with strong incentives in China to publish in journals indexed by Web of Science (Zhang & Sivertsen, 2020). Nevertheless, China probably was the world's largest scientific nation for a longer time while publishing mainly in domestic Chinese journals.

The research profile of China and of Sino-Norwegian collaboration

As shown in Figure 1, the USA is still the largest contributor to scientific articles in the health sciences, the social sciences and the humanities. China's research profile is heavily skewed towards the natural sciences and, in particular, towards the technological sciences. The domination of China in the technological sciences is even visible in the originally American and now core international journals published by Institute of Electrical and Electronics Engineers (IEEE).

China's skewed research profile is present also in the Sino-Norwegian collaboration pattern, as showed in Figure 2. The general profile of Norway differs from the Chinese profile and is more similar to the American profile with relatively more activity in the health sciences and in the social sciences and humanities. There is a potential for more Sino-Norwegian collaboration in these areas of research.

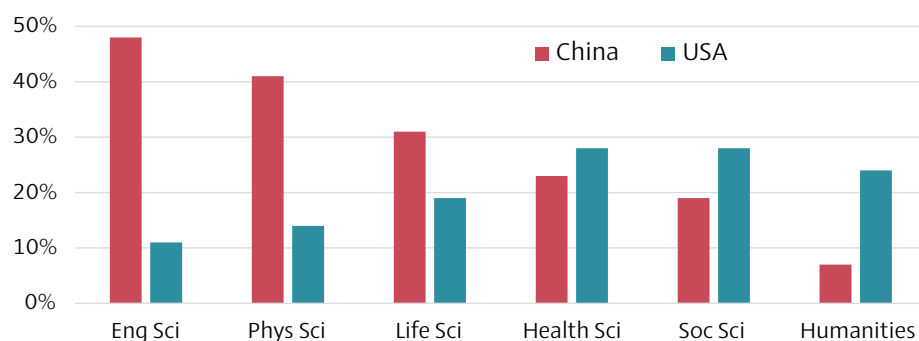


Figure 1. The percentage shares in the world's scientific articles in 2023 of China and the USA in six main areas of research.

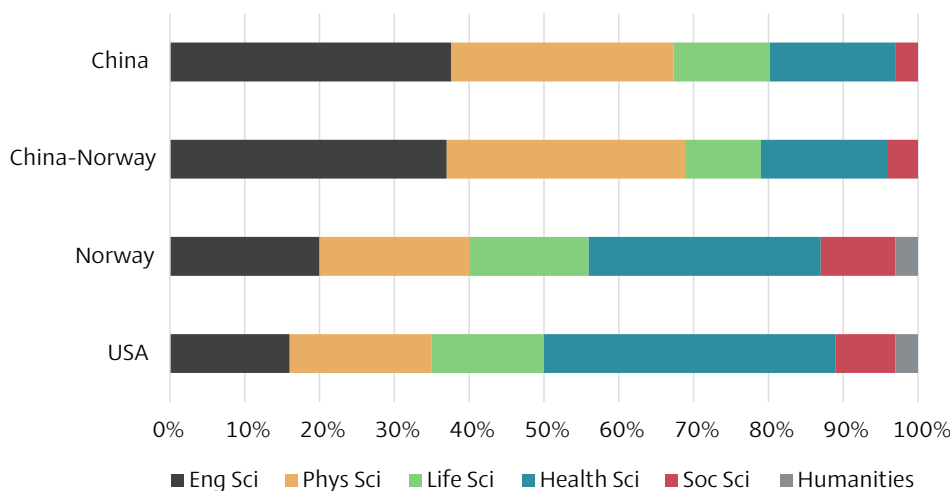


Figure 2. The research profiles of China, Norway and the USA, and for Sino-Norwegian collaboration measured in 2023 as the percentage shares among the articles in six major areas of research.

Increasing collaboration with China

Norway's scientific collaboration with China has increased over the years following a general trend that reflects the growth of China in science and technology. As shown in Figure 3 below, Sino-Norwegian collaboration increased at the same rate as for the other Nordic countries and the EU-countries in general until 2014. The increase for Norway then halted for four years until it resumed in 2017 without reaching the same level as for the other Nordic countries. Accordingly, Norway is less engaged in scientific collaboration with China than the other Nordic countries are. An explanation for the deviation from the Nordic pattern seems to be China's unilateral decision to close official relations and collaboration with Norway after the Nobel Peace Prize was awarded to Liu Xiaobo in 2010 (Sverdrup-Thygeson, 2017). The relations were restored in 2016, among them the bilateral programme for collaboration in science, which was recently renewed.

The USA deviates from the European countries with relatively more collaboration with China and a higher growth rate until five years ago, as shown in Figure 3. A similar relative decrease can also be observed on China's side. The cause cannot be the pandemic. As an example, the share of the UK in their articles with international collaboration has been stable for both countries. The decreased relative intensity of collaboration between China and the USA is more likely to be reflecting the deteriorating relations between the two countries since 2018 (Tang et al., 2021; Zweig, 2021). We will return to this observation below.

The USA remains Norway's largest collaboration partner in science in 2023 with a share of 26 percent of Norway's articles with international collaboration. Then follow the UK (22 percent), Germany (20 percent), Sweden (19 percent), Denmark and France (14 percent each). China ranks seventh together with Italy and the Netherlands (13 percent each). The shares are overlapping because of multilateral relations. As an example, authors from the USA were involved in 36 percent of the 1,821 articles indicating Sino-Norwegian collaboration in 2023.

While the overall share of the USA is 26 percent in Norway's articles with international collaboration, this share differs widely among the main areas of research. In the technological sciences, China is now Norway's largest collaboration partner with 26 percent compared to USA's 12 percent. China is also a larger partner than the USA in some of the natural sciences such as Oceanography, Condensed Matter Physics, Geology and Physical Chemistry.

The most active fields of research and institutions

NIFU Working Paper 2022:1 (Sivertsen, 2022) identified the technological sciences (including computer science) as the most active domain for Sino-Norwegian collaboration. The high activity is mainly explained by China's research profile. Almost half of the world's articles in the technological sciences have addresses in China. NIFU Working Paper 2023:1 provided a closer

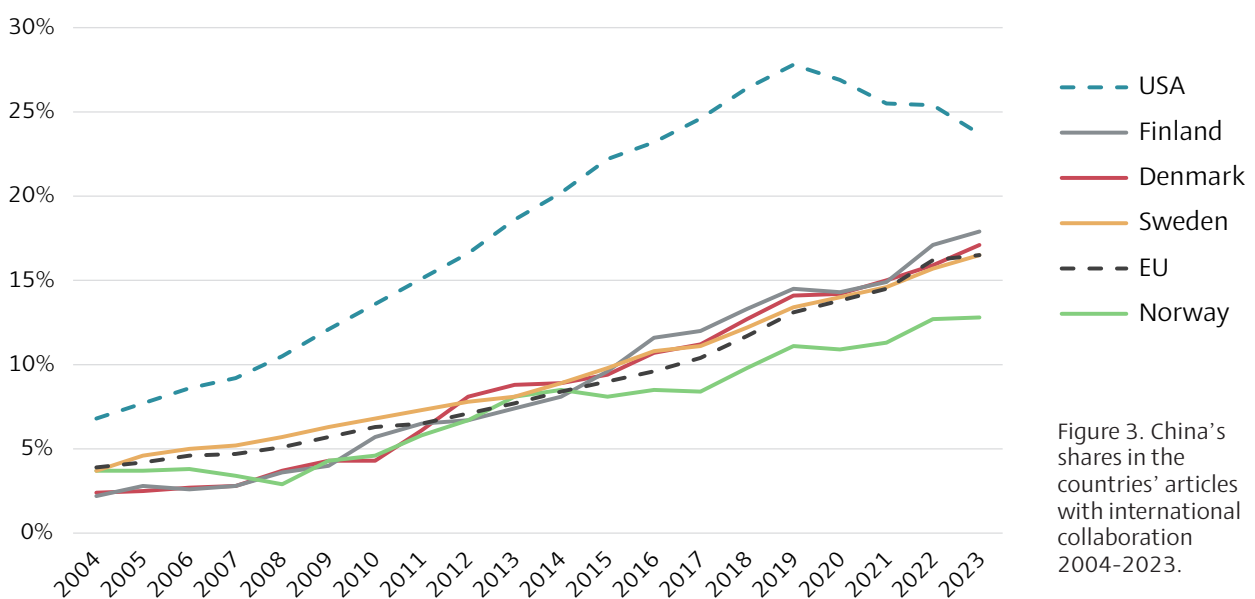


Figure 3. China's shares in the countries' articles with international collaboration 2004-2023.

look at collaboration in the technological sciences and identified the Norwegian University of Science & Technology as the clearly most active collaborating institution in Norway, followed by University of Oslo and University of Agder, Simula Research Laboratory, SINTEF, and the Norwegian Geotechnical Institute. The most active Chinese partners were Harbin Institute of Technology, Shanghai Jiao Tong University, China University of Petroleum, Wuhan University, University of Electronic Science and Technology of China, and East China University of Science and Technology.

While the high collaboration activity in the technological sciences is as expected given China's special research profile, there are two other areas of research where the Sino-Norwegian collaboration activity is higher than could be expected from the research profiles of both countries: Physics and Environmental sciences (Sivertsen, 2022). The high activity in Physics is mostly explained by the two countries' participation in major multinational consortia. In the Environmental sciences, however, Norway is relatively active compared to the world average and contributes to a clearly higher activity in China than could be expected from China's general profile.

The identified mutual interest of the two countries in collaborating within the Environmental sciences can mainly be attributed to research focused on two of UN's Sustainable Development Goals (SDG): *Climate Action and Sustainable Cities and Communities*. Articles in Web of Science can be classified by SDG. We used the same methods as in Sivertsen (2022) for identifying mutual interest compared to the two countries' general SDG profile and found the two categories as clearly prioritized for collaboration by both countries, also with the highest rates on increasing publication activity from Sino-Norwegian collaboration.

In research to support *Climate Action*, the most active partners on the Norwegian side are a group of closely related organizations in Bergen (Geophysical institute at University of Bergen, Bjerknes Centre for Climate Research, Nansen Environmental and Remote Sensing Centre), Norwegian University of Science and Technology, other departments at University of Bergen, and University of Oslo (particularly Department of Geosciences). The Norwegian Meteorological Institute is also active.

On the Chinese side in climate change research, a major partner is the Institute of Atmospheric Physics (IAP) of the Chinese Academy of Sciences. Some

of the collaboration is with two centres hosted by IAP, the Climate Change Research Center (CCRC) and the Nansen-Zhu International Research Center (NZC). The latter was founded in collaboration with the above-mentioned partners in Bergen. Other active partners are the Department of Earth System Science at Tsinghua University, the State Key Laboratory of Water Resources and Hydropower Engineering Science at Wuhan University, and the State Key Laboratory of Ocean Engineering at Shanghai Jiao Tong University.

The main collaborating institutions on the Chinese side are the same as above in research to support *Sustainable Cities and Communities*. Norway also has the same main actors but with relatively more contributions from the Norwegian University of Science and Technology and from SINTEF and CICERO.

Research collaboration and security policy

Based on similar publication data and with a special method for measuring a size-independent indicator of relative collaboration intensity in a global network of countries (Fuchs, Rousseau & Sivertsen, 2021), the relation between a map of defence alliances and a map of global collaboration in science are discussed in Sivertsen (2024). These maps so far largely diverge. While the European countries (NATO members) collaborate relatively intensively with each other, China and the USA continue as close collaborators even after the relative decrease in the last five years. Apart from collaborating mainly with the USA and other English-speaking countries, China collaborates closely with neighbours such as Singapore, South-Korea and Japan among which South-Korea and Japan are official *Partners across the globe* of NATO.

So far, global research collaboration remains a paradox from the perspective of security policy. This is possible because most production of new knowledge does not take place within a country and is then exported or withheld from sharing. Scientists depend on each other across countries. This is evidenced in how scientists cite each other in their lists of references.

Still, global research collaboration now seems to be affected by a deterioration of the relation between the USA and China which is clearly visible in our data. Geopolitical influences on scientific collaboration are visible in the relations to Russia as well (Zhang et al., 2024). Research policy in the Nordic region is increasingly affected by security policy as a response to the geopolitical situation (Gåsemeyr, 2024).

Data and methods

Web of Science is a searchable bibliographic database with a broad global coverage of the sciences and a more limited coverage of the social sciences and humanities (Aksnes & Sivertsen, 2019). It covers the published literature only. Hence, the coverage of research in the corporate sector is limited. On the other hand, it has a strength compared to economic statistics in covering both self-initiated and state-funded collaborative research among scientists.

This study is based on searches and downloads in Web of Science that were performed in March 2024. The searches covered more than 31 million articles published in the years 2004-2023 that were indexed for the three core indices Science Citation Index Expanded, Social Science Citation Index and Arts & Humanities Citation Index. Included are only original research articles and review articles with authors' addresses that can be linked to countries, but they represent almost all contributions to new knowledge.

The main indicator in the study is the percentage share a country has in another country's articles with international collaboration. As an example, 2.2 million scientific articles were indexed in Web of Science in 2023. Of these, 19,496 articles (0.9 percent) had addresses in Norway. Within Norway's contributions, 14,152 articles (72.6 percent) had addresses in other countries as well. These are categorized as articles with international collaboration in this study. Among these, 1,821 articles (12.9 percent) had a combination of Norwegian and Chinese addresses. On the other side, China contributed to 33.5 percent of the world's articles in 2023. Of these, 20 percent were articles with international collaboration. The share of articles with international collaboration tends to be lower for large countries (Aksnes & Sivertsen, 2023). Another asymmetry is that the 1,821 articles indicating collaboration with Norway only represented 1.2 percent of China's articles with international collaboration.

Articles with international collaboration can also be studied at the institutional level. As examples, University of Oslo is present in 33 percent of the 1,821 articles with Chinese collaboration in 2023 while the Chinese Academy of Sciences is present in 23 percent of them. Other institutions, not only in the two countries, may be present in the articles as well. The articles with international collaboration can also be analysed according to the area of research. As an example, 79 percent of the 1,821 articles indicating Sino-Norwegian collaboration are in the natural sciences and the technological sciences.

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PB 2815 Tøyen, NO-0608 Oslo
www.nifu.no | post@nifu.no

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