Using OpenAlex to Assess Canadian Research Outputs: An Exploratory Analysis

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Key messages:

- Analysis of Canadian research outputs using the relatively inclusive OpenAlex database provides new insights into Canadian research performance.
- OpenAlex includes more non-English publications relative to Web of Science and Scopus, providing a more accurate positioning of Canada's performance within the global research system
- Declining relative performance of Canadian research is attributable to large growth in research outputs from China, India, Brazil, and Turkey
- The quality and impact of Canadian research remain high
- Canada performs particularly well in health sciences and social sciences

November 2025

This paper was commissioned by the CCA using funding provided by the Social Sciences and Humanities Research Council (SSHRC) under the Strategic Initiatives Fund.

This paper is one of eight commissioned to support the CCA's 2025 assessment on the State of Science, Technology, and Innovation in Canada by synthesizing evidence and providing new insights into the assessment charge. The expert panel considered each paper alongside many other sources of evidence. These papers are the work of the authors alone and were not approved or endorsed by the expert panel.

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Report comissioned by the Council of Canadian
Academies 11th July 2025

Introduction

Scientific production has historically been compiled using exclusive bibliographic data sources which indexed the subset journals that considered to be the most cited of their subfields (Garfield, 1972; Sugimoto and Larivière, 2018). These exclusive databases—of which the Science Citation Index (SCI) was the first iteration in 1963 and Scopus the first real competition in 2004—rely on Bradford's Law (1934) to select journals for indexing. Bradford's *Law of Scattering* states that, for any field, most relevant papers are published in a small subset of journals and, conversely, most journals publish papers that are of limited impact.

Given such indexing rules, these databases, which have been the standard in bibliometric analysis for decades, have provided a partial view of countries, institutions, and researchers' scientific activities (Mongeon and Paul-Hus, 2016). More specifically, many studies have shown how these exclusive databases overestimate the research outputs of specific disciplines, such as those published in the natural and medical sciences, as researchers rely largely on international journals published in English and, conversely, underestimated literature published in the social sciences and humanities (Archambault et al. 2006; Sen and Lakshmi. 1992). Along those lines, these databases have been shown to provide an incomplete portrait of the literature published in languages other than English (Céspedes et al., 2025), and of countries whose main language is not English (Mongeon and Paul-Hus, 2016). Those databases also provide a limited view of outputs published outside scholarly journals, such as books, book chapters, and conference proceedings (Larivière et al., 2006; Lisée et al., 2007).

While the launch of Google Scholar, with its large (but imprecise) coverage, democratized bibliometric analyses and provided a first glimpse at what inclusive data might look like (Falagas, 2008; Giustini and Barsky, 2005), the fact that its raw data remains unavailable made its use for bibliometric analysis limited. Therefore, it is only with the advent of databases such as dimensions.ai and Microsoft Academic Graph—both relying on the Crossref infrastructure—that inclusive bibliometric data could be compiled at scale. Those results showed that despite the more extensive coverage of these databases in terms of journals and papers, the missing metadata—especially of citations—leads to a sizeable overlap between the data sources when considering only available metadata (Basson et al., 2022; Singh et al., 2021; Martín-Martín et al., 2021; Visser et al., 2021).

From Microsoft Academic Graph to OpenAlex

Despite widespread use, Microsoft Academic Graph was discontinued at the end of 2021 (Singh Chawla, 2021), and the organisation *OurResearch* stepped in to fill this void by creating the OpenAlex database (Priem, Piwowar, & Orr, 2022). Launched in 2022, OpenAlex is an open bibliometric source—both in terms of code and access—available via a web interface, API, and database snapshots. Indexing 268,000,000 research documents as of July 2025, it

currently stands as one of the largest bibliometric databases[1]. Its selection criteria are inclusive: the database aims at indexing all scholarly research published, irrespective of its citation rates or the Impact Factor of the journal in which it is published.

Given this inclusivity, OpenAlex has several advantages compared with traditional, exclusive, bibliometric databases. First, its coverage is more extensive and aims at providing an *exhaustive* portrait of research papers published at the world level. Compared with the Web of Science, OpenAlex indexed 21% more papers over the 2000-2022 period (Larivière et al., 2024). Given that journals indexed in OpenAlex are not selected based on citations, bibliometric indicators obtained using this data source should not underestimate—or underestimate to a smaller extent—literature published in the Global South or in languages other than English. Previous research on the topic has shown that OpenAlex has a much better coverage of non-English language (Alperin et al., 2024; Céspedes et al; 2025): while more than 96% of the entire content of the Web of Science is in English, that percentage is slightly less than 68% for OpenAlex.

Second, as the linguistic coverage suggests, the database does cover a larger share of papers from outside North America and Western Europe. More specifically, 29 out of the 30 most active countries in science have a higher number of papers indexed in OpenAlex than in Web of Science over the 2000-2022 period. As one may expect, gains in OpenAlex are higher for South America and Southeast Asia. Gains in terms of papers' coverage are not limited to those parts of the world, with countries such as the US and Canada gaining by 55% and 33%, respectively. European countries are also increasing, with higher numbers for Eastern European countries. However, China gains only lightly in terms of papers, with a mere 8% over the 2015-2022 period, while India increases by 58%.

However, inclusivity comes at a cost. Given that OpenAlex draws a large proportion of the papers it indexes—and of their metadata—from the Crossref platform[2], the quality of its metadata will be a function of the quality of the data that is provided by publishers. While publishers must provide a certain core set of information on their papers in order to obtain a digital object identifier from Crossref—such as titles, authors, journal, pages—information on affiliations and cited references are recommended, but not mandatory[3]. Therefore, despite having a higher number of cited references than Scopus or Web of Science, Open Alex has a much lower percentage of records with cited references (Alperin et al., 2024), and has lower references per paper (Culbert et al., 2025). Along those lines, our own analysis shows that a high percentage of papers are missing affiliations—both at the levels of institutions and countries. This has an influence on the number of papers which can be retrieved for Canada and comparable countries. Therefore,

[1] Descriptive stats on the database are available here: https://openalex.org/stats
[2] https://www.crossref.org/
[3] https://www.crossref.org/documentation/schema-library/required-recommended-elements/

the results obtained here can be considered as a lower bound in terms of papers. There are more papers from Canadian and foreign authors in the database; however, those cannot be retrieved—and therefore included in the analysis—because of a lack of affiliation information.

What this report provides

This report provides an analysis of the Canadian and comparable countries' scientific production using the inclusive and non-proprietary database OpenAlex. It is divided into two parts. The first part provides a macro-level analysis of the scientific production of Canada and comparable countries, over time, and across broad domains (health, life, social and physical sciences). It also provides comparisons between the Scopus data compiled in the main CCA report and the OpenAlex data. The second part provides a more fine-grained analysis of the areas of strength of Canada, focusing on those in which the country has higher scholarly impact and specialization. Along with this section, an online interactive tool that allows for the analysis of the data for Canada and comparable countries is provided.[4] The report concludes with a summary of findings.

Methods

OpenAlex data was obtained from the InSySpo infrastructure at the University of Campinas (Brazil), which has developed an in-house version of OpenAlex that allows for the compilation of advanced bibliometric indicators. Data on publications by domain were compiled for the top 20 most productive countries at the world level (Australia, Brazil, Canada, China, France, Germany, India, Iran, Italy, Japan, Poland, Russia, South Korea, Spain, Switzerland, Taiwan, The Netherlands, Turkey, United Kingdom, and United States). Those are presented in Figures 1-6. Topic-normalized citations and specialization were compiled for Canada as well as 14 countries of comparison: Australia, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Norway, South Korea, Sweden, United Kingdom, United States[5]. Figure 8 provides scholarly impact for this set of countries. While only data for Canada are presented in Figures 9-13, equivalent figures for each of the comparable countries are available in the online interactive tool. Affiliation in OpenAlex mainly relies on ROR_ID, which standardises institutions' names and groups them under their current name and location.[6]

Contrary to traditional bibliometric databases, OpenAlex does not use a journal classification to assign a discipline or specialty to research papers. Instead, it relies on an algorithm to assign a topic to each paper, based on journal

[4] https://vlab.ebsi.umontreal.ca/cca_app/
[5] In some cases, we added other countries to provide more context on the relative decline of Canadian research papers.
[6] According to the OpenAlex documentation, 100% of institution names have ROR_IDs. As of June 2025, OpenAlex indexes about 109,000 institutions. See: https://docs.openalex.org/api-entities/institutions

name, title and abstract of paper, and citations.[7] Research papers indexed in the database are divided into 4516 topics, which are then grouped into 252 subfields, 26 fields and 4 domains.[8]

Data compiled in the report is based on the journal article document type in OpenAlex and excluding paratext.[9] This document type is not as precise as those found in traditional bibliometric databases: it does not divide documents published in journals into various document types (such as articles, reviews, editorials, etc.) but, rather, considers all documents published in journals as journal articles, as opposed to books, book chapters, theses, etc. Most of the analyses presented in the report are based on full counting method—that is, a full paper is attributed to any country contributing to it. Some analyses are based on fractional counting—that is, each country obtains a fraction of a paper that is representative of their share of affiliations within a paper—while others are based on first affiliation, which puts emphasis on the country that was leading the research. Comparisons of counting methods are provided in the first part of the report.

Citations were normalized using the average citations received by publications on the same topic during the same period. When the score is above 1, it means that the mean impact of those papers in that topic is beyond the world average. Specialization index was compiled at the level of topics, with 0 being the middle point (i.e. no specialization.) Both indicators are compiled for two time periods (2012-2017 and 2018-2023), which match those used in the main CCA report.

Results

Macro-level comparison with Scopus data

Figure 1 presents the total number of papers of Canada and selected comparable countries using OpenAlex and Scopus over the 2012-2023 period. For most countries—except Italy and China—OpenAlex indexes more papers than Scopus over the same period. For Canada, about 13% more papers are added by including OpenAlex. Surprisingly, the United States has a much higher percentage of added papers, which suggests that OpenAlex *also* covers a higher number of English language journals. Countries with the highest gains are Brazil (123%), Turkey (65%), and Poland (53%) and, to a lesser extent, Russia (33%). Those added papers have consequences on the ranking of countries. While the rank of Canada is 9th using Scopus and full counting, it drops to the 11th rank using OpenAlex and the same counting method, as it gets surpassed by Brazil, Russia, and Spain, but gains a rank ahead of Italy.

[7] https://docs.openalex.org/api-entities/topics
[8] https://docs.google.com/document/d/1bDopkhuGieQ4F8gGNj7sEc8WSE8mvLZS/edit?tab=t.0#heading=h.5w2tb5fcg77r
[9] https://docs.openalex.org/api-entities/works/work-object

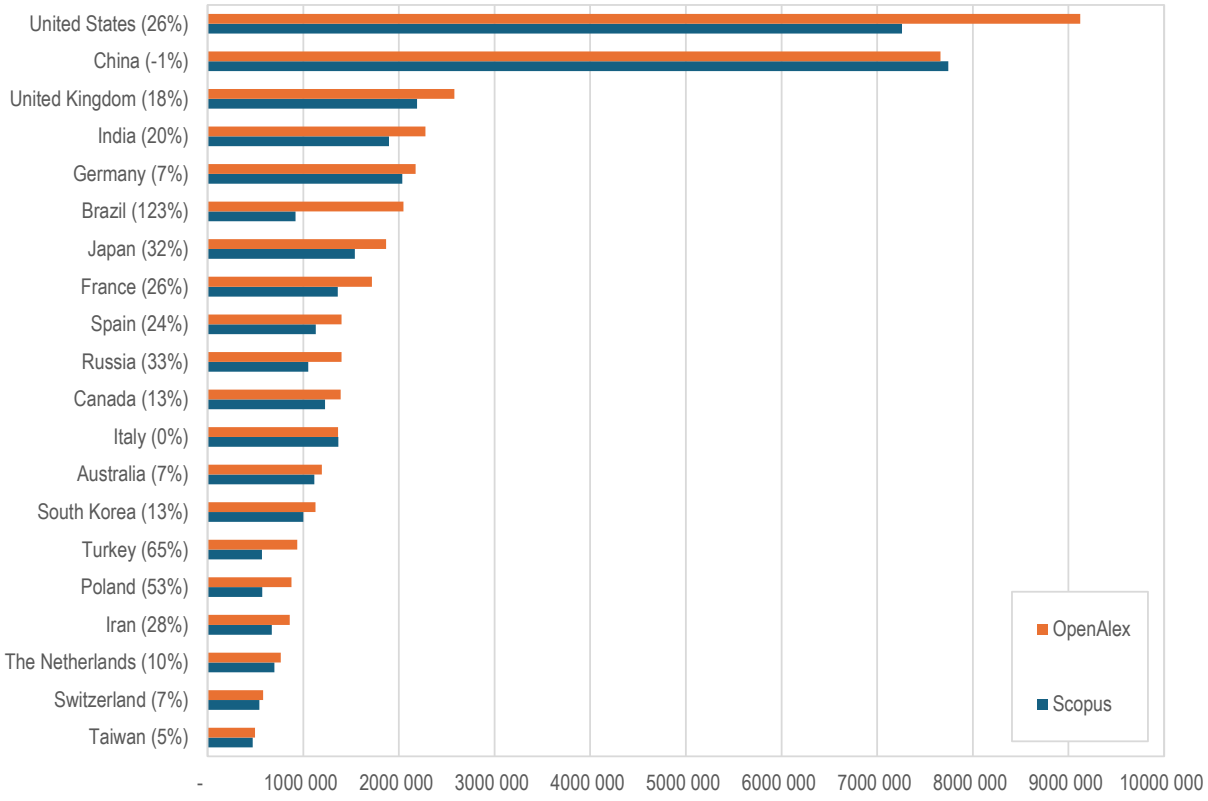

Figure 1. Number of papers in OpenAlex and Scopus for selected countries, 2012-2023. Countries' papers are attributed based on full counting, any authorship.

Figure 2 presents the ranking of countries using various counting methods in OpenAlex. While most countries' ranks are the same using each counting method, some important differences are observed. For instance, with first authorship, China surpasses the US as the lead producer of knowledge at the world level over the 12-year period under study. A similar phenomenon is observed with France—this suggests that those two countries are generally leaders of their papers in international collaborations. In the case of Canada, the three different counting methods do not change the ranking of the country (11th).

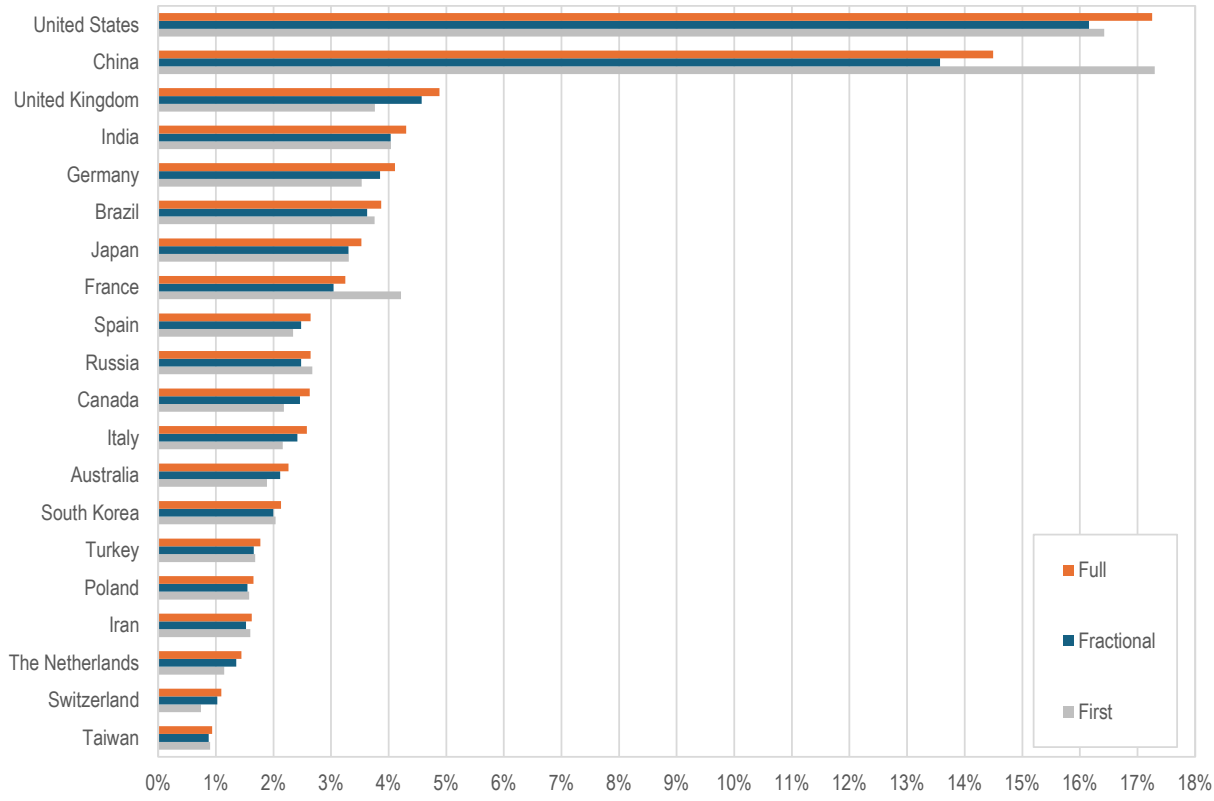

Figure 2. Percentage of world papers in OpenAlex for selected countries, by counting method (full, fractional, first), 2012-2023.

The ranks of countries changes quite drastically when research outputs are normalized by their size (here measured by their population). Figure 3 shows that Switzerland has a clear lead, with almost twice the number of papers per capita than Canada (which stands at the 5th rank at the world level). Ranks 2nd to 4th are occupied by Australia, the Netherlands, and the United Kingdom. It is worth noting that Canada is above most comparable European countries (Spain, Germany, France, and Italy).

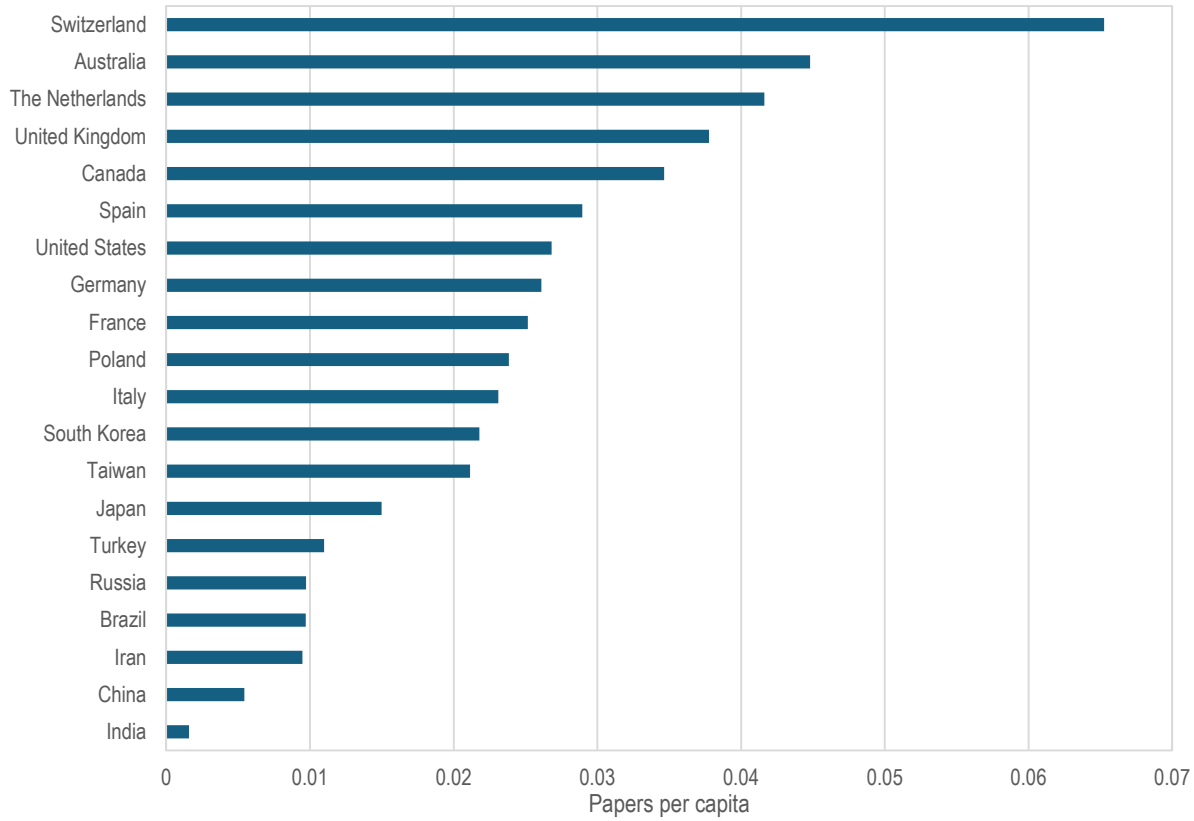

Figure 3. Per capita scientific output of selected countries, full counting, any authorship, 2012-2023.

Growth in scientific production varies drastically by country and, therefore, the ranks of countries have changed over the last decades. The case of China is striking: it grows, decreases, and then grows again, which is due to indexing issues of OpenAlex (Zheng et al., 2025)[10]. The growth of China, India and Brazil (Figure 4), as well as Russia and Turkey (Figure 5) are remarkable. Most North American and Western European countries are growing in a more stable manner, with little changes in ranks within those. The growth of several emerging countries influences the rank of Canada in the most recent years: over the three decades analyzed, the country drops from 5th at the world level to 13th.

[10] OpenAlex has issues with the indexing of Chinese papers from 2010 onwards. This likely explains why China gains very little papers with the use of the database compared with Scopus or Web of Science.

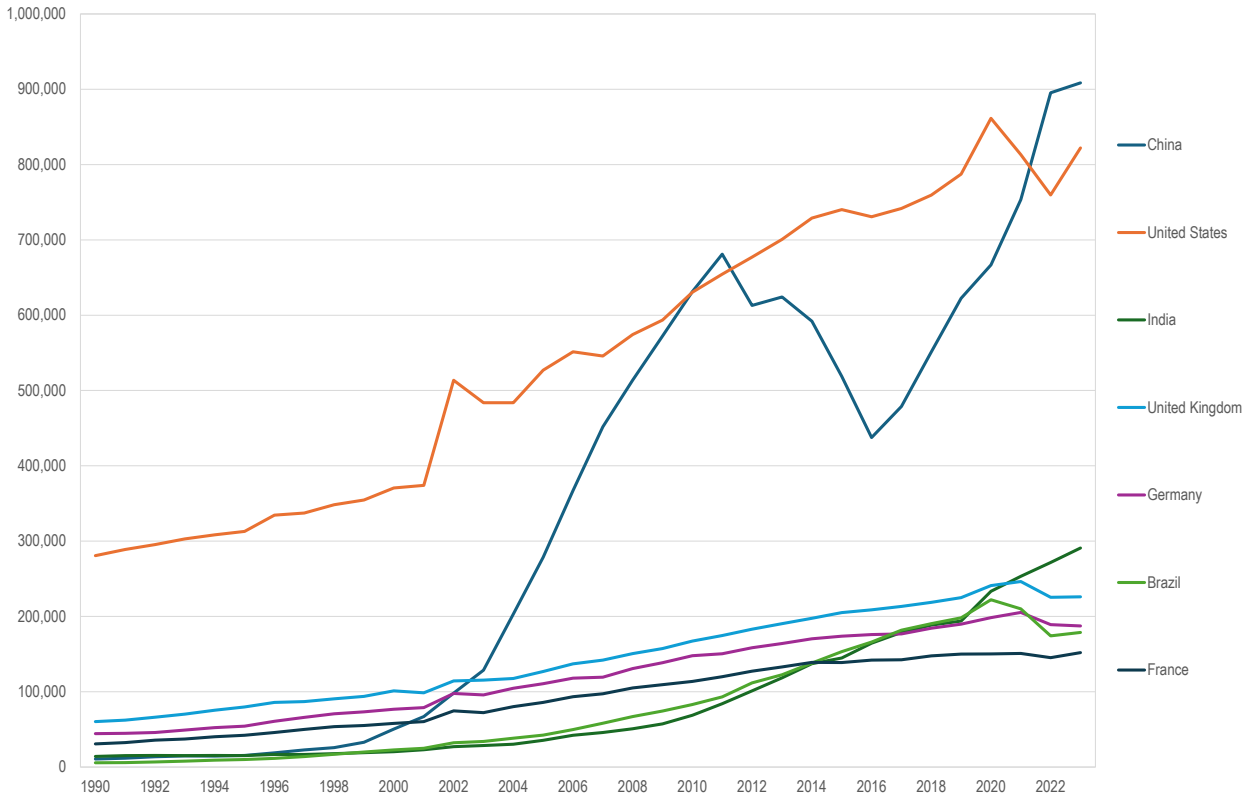

Figure 4. Annual number of papers of the top 7 most productive countries in 2023 (> 150,000 papers), 1990-2023. Countries' papers are attributed based on full counting, any authorship.

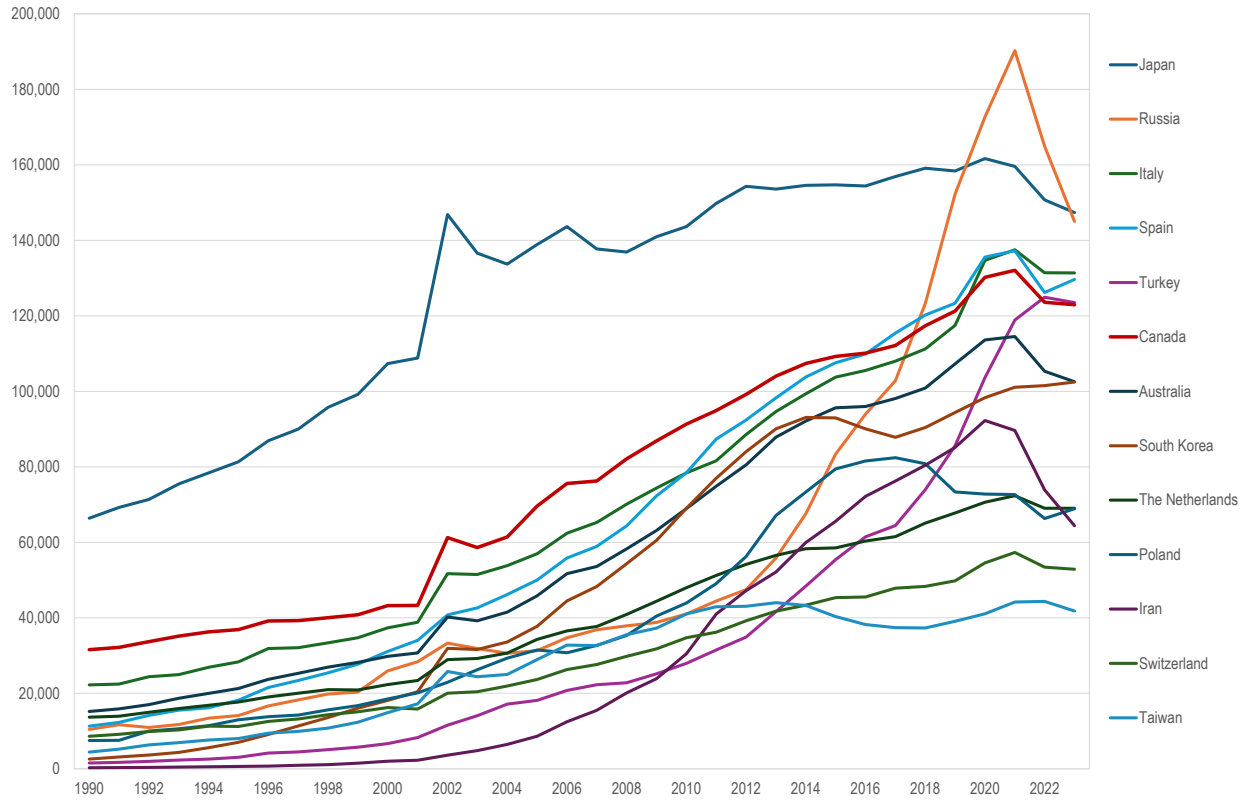

Figure 5. Annual number of papers of the next 8 most productive countries in 2023 (< 150,000 papers), 1990-2023. Countries' papers are attributed based on full counting, any authorship.

Countries research activities are focused on different research domains. Compared to the global distribution, Canada has a higher percentage of papers in health sciences (10% more) and social sciences (4% more), and relatively less research activities in life sciences and physical sciences (Figure 6). This pattern matches that of most Western countries; Asian countries (and Brazil) have a higher relative focus on Life sciences and physical sciences.

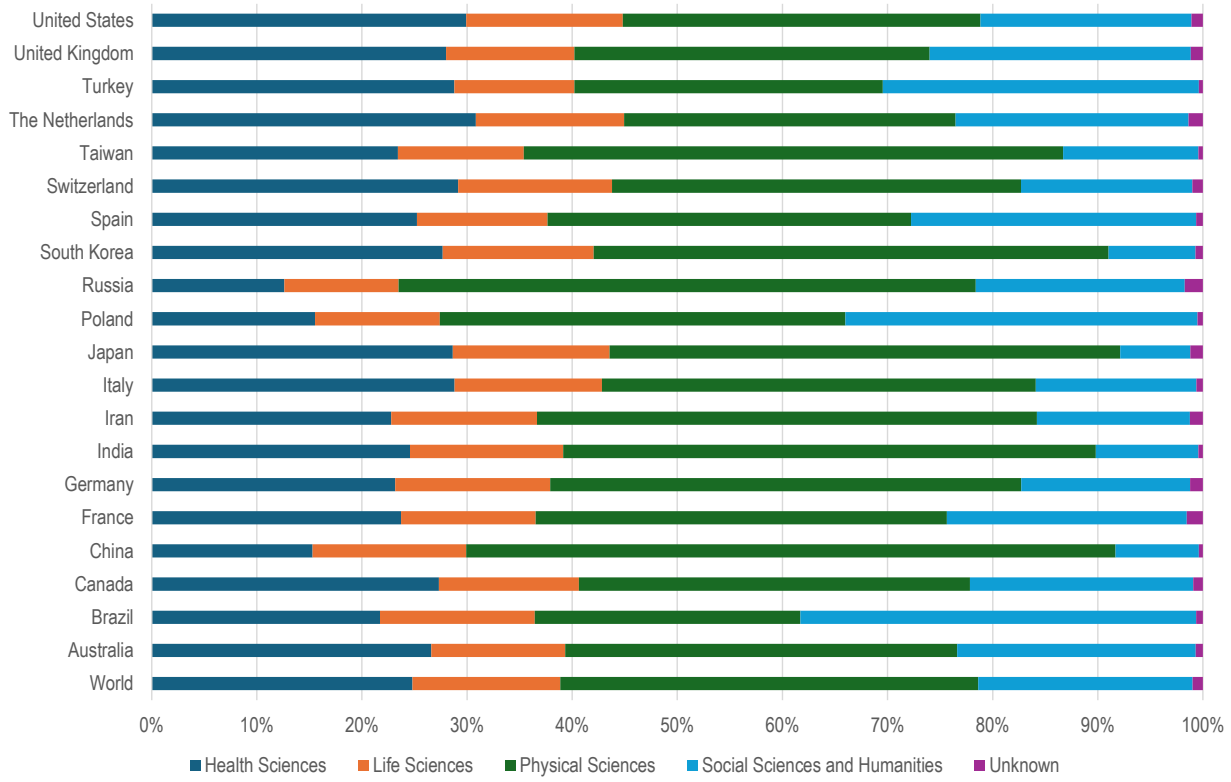

Figure 6. Percentage of papers by domain and country, OpenAlex, 2012-2023. Countries' papers are attributed based on full counting, any authorship.

Given the growth of the scientific contribution of Asian countries, such as China and India, over the last decades, the relative contribution of Canada across various domains has been decreasing. Figure 7 presents the percentage of World's papers contributed by the country over the last 3 decades. Across all domains, the share of Canadian papers across world papers has decreased by 46%, from 4.2% to 2.3%. This decrease is more important in social sciences, where it decreased from 6.3% to 2.3%, and in life sciences, where it decreased from 4.2% to 2.1% of all papers. The decrease is less important in health sciences: Canadian papers accounted for 3.3% of all papers in 1990; this percentage dropped to 2.6% in 2023.

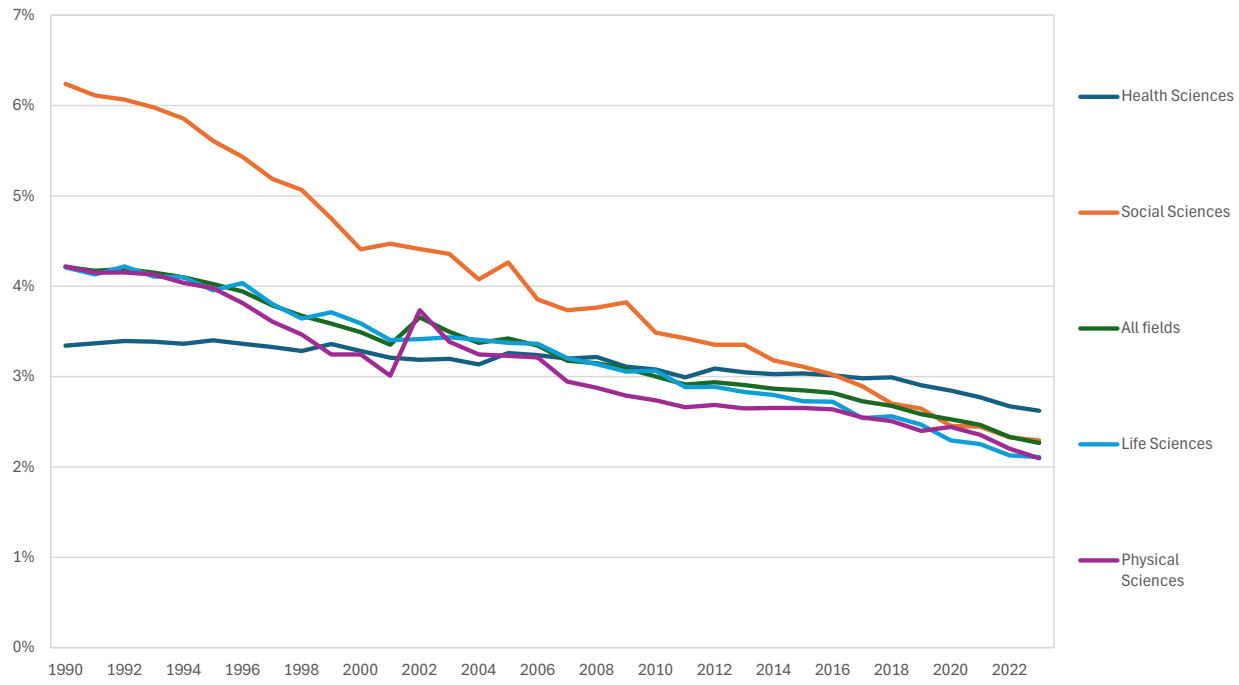

Figure 7. Percentage of papers by domain and country, OpenAlex, 1990-2023. Countries' papers are attributed based on full counting, any authorship.

Figure 8 presents the average of relative citations of papers of papers, by domain and country. The figure presents a striking feature, associated with the massive growth of China (and other Asian countries) over the two time periods analysed. Given that field normalized citations are a zero-sum game—if some countries increase in relative citations, others should decrease—the results show that between the two periods, all countries decreased in terms of relative citations, except for China, that increased across domains. Previous research has shown the strong national preference in citations—i.e. countries are more likely to cite research from their national colleagues (Larivière, Gong and Sugimoto, 2018). Therefore, the growth of Chinese papers also increased citations to their papers, leading to a major shift in countries relative citation rates.

Despite decreasing—like that of all Western countries in the figure—Canada's mean research impact remains above average and, all fields combined, above that of Germany, Italy, and France, among others. Its relative impact is higher in health sciences, where it ranks 7th among countries present in the figure.

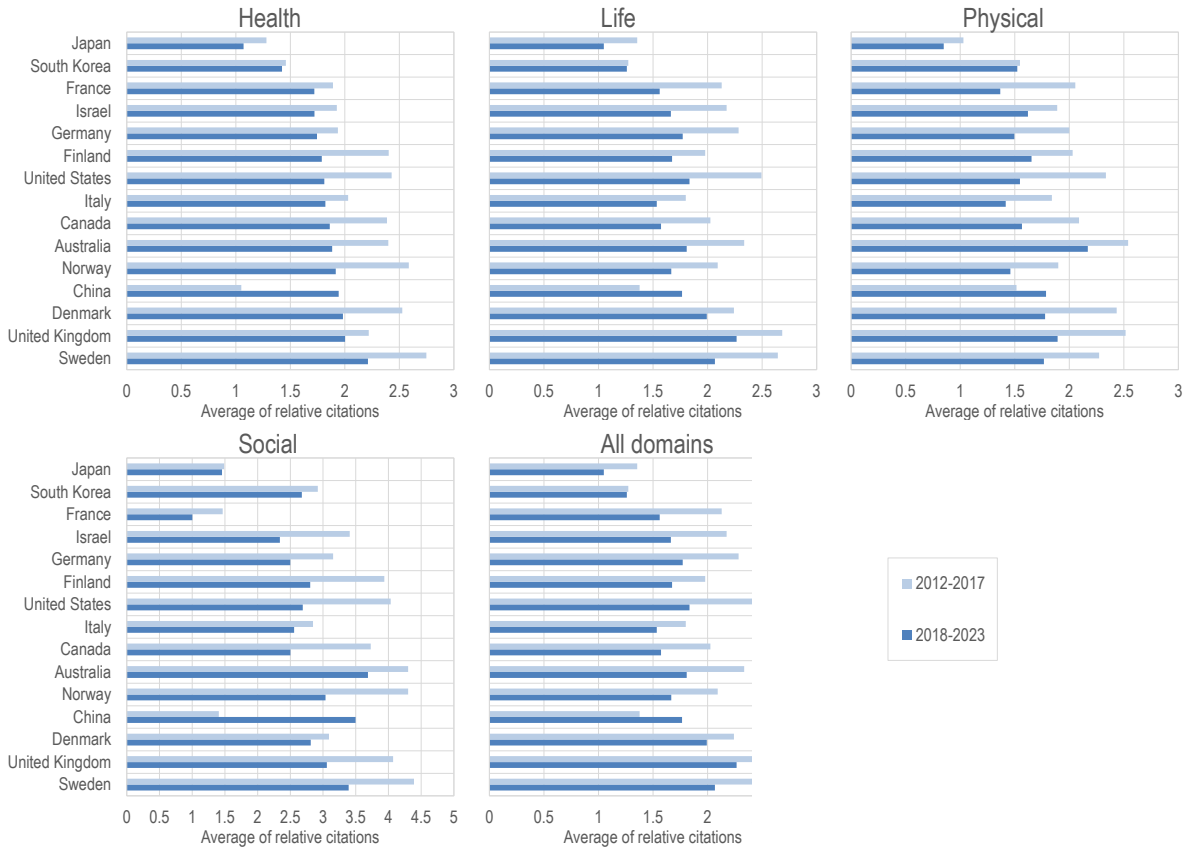

Figure 8. Average of relative citations of countries' papers, by domain (and for all domains), 2012-2017 and 2018-2023.

Topic analysis

To provide more details on the areas of strength of Canadian research over the last 6 years, we extracted papers per topics from the OpenAlex database to draw comprehensive maps on the areas of strength of Canadian science in each domain. Figures 9-13 provide the relative scientific impact (x-axis), specialization (y-axis), growth (color coded, 1=lowest growth; 10=highest growth), and absolute number of papers (size of bubble) of Canadian papers across health sciences (Figure 9), life sciences (Figure 10), natural sciences (Figure 11), social sciences (Figure 12), and artificial intelligence (Figure 13). Each dot represents a topic; those that are above 0 on the y-axis are topics where Canada is specialized—performs more research on that topic than the global average. Dots that are above 1 in the x-axis are those where Canada has an impact that is above world average. Those figures are static versions of interactive visualizations found in the online tool, which contain much more information.

Given their large amount, we cannot highlight all the research topics in which Canadian research performs well. Therefore, for this report, we provide the top 10 topics with the highest impact where Canadian researchers are 1) specialized and 2) published at least 500 papers.

In health sciences, those topics are:

- Obesity and Health Practices (N=1112, ARC=4.93)
- Biomedical Ethics and Regulation (N=558, ARC=3.4)
- Cardiovascular Syncope and Autonomic Disorders (N=660, ARC=3.11)
- Health, Medicine and Society (N=1345, ARC=2.79)
- Clinical practice guidelines implementation (N=1701, ARC=2.72)
- Ethical Considerations in Pediatric Medical Decision-Making (N=782, ARC=2.67)
- Management of metastatic bone disease (N=632, ARC=2.65)
- Hip and Femur Fractures (N=1232, ARC=2.64)
- Atrial Fibrillation Management and Outcomes (N=2002, ARC=2.61)
- Diabetes Treatment and Management (N=1430, ARC=2.6)

In life sciences, those topics are:

- Metabolism, Diabetes, and Cancer (N=824, ARC=2.39)
- Bioinformatics and Genomic Networks (N=757, ARC=2.26)
- Metabolomics and Mass Spectrometry Studies (N=1136, ARC=2.03)
- Metabolism and Genetic Disorders (N=830, ARC=1.92)
- Bacterial Identification and Susceptibility Testing (N=759, ARC=1.85)
- Forensic Toxicology and Drug Analysis (N=600, ARC=1.84)
- Microbial infections and disease research (N=583, ARC=1.78)
- Reproductive Physiology in Livestock (N=705, ARC=1.77)
- Neuroscience and Music Perception (N=1279, ARC=1.76)
- Muscle metabolism and nutrition (N=766, ARC=1.73)

In physical sciences, those topics are:

- Planetary Science and Exploration (N=589, ARC=2.42)
- BIM[11] and Construction Integration (N=701, ARC=2.42)
- Quantum Mechanics and Applications (N=801, ARC=2.29)
- Ultrasound and Hyperthermia Applications (N=882, ARC=2.26)
- Robotics and Sensor-Based Localization (N=934, ARC=2.23)
- Network Security and Intrusion Detection (N=1265, ARC=2.21)

[11] Building Information Modeling.

- Advanced Techniques in Reservoir Management (N=1055, ARC=2.17)
- Autonomous Vehicle Technology and Safety (N=667, ARC=2.16)
- Internet Traffic Analysis and Secure E-voting (N=549, ARC=2.04)
- Quantum Computing Algorithms and Architecture (N=1035, ARC=2.03)

In social sciences, those topics are:

- Arctic and Russian Policy Studies (N=783, ARC=4.4)
- Delphi Technique in Research (N=1135, ARC=4.26)
- French Language Learning Methods (N=787, ARC=3.64)
- Cultural Industries and Urban Development (N=541, ARC=3.02)
- Social Sciences and Governance (N=2685, ARC=2.95)
- Social Policies and Family (N=566, ARC=2.86)
- Global Public Health Policies and Epidemiology (N=1048, ARC=2.74)
- Meta-analysis and systematic reviews (N=1391, ARC=2.67)
- Health Systems, Economic Evaluations, Quality of Life (N=5954, ARC=2.63)
- scientometrics and bibliometrics research (N=626, ARC=2.48)

In artificial intelligence research, Canadian research has higher impact than the world average in most areas. However it remains under-specialized in most areas, which is not surprising given the high number of papers in those topics published by other countries, among others China, India and the United States. There are, however, a certain number of AI topics where Canadian research is both specialized and has higher impact than expected. Those topics are:

- Artificial Intelligence in Games (N=379, ARC=1.81)
- Computability, Logic, AI Algorithms (N=260, ARC=1.8)
- AI in cancer detection (N=876, ARC=1.76)
- Hydrological Forecasting Using AI (N=411, ARC=1.75)
- Artificial Intelligence in Healthcare and Education (N=891, ARC=1.74)
- AI in Service Interactions (N=265, ARC=1.21)
- Artificial Intelligence in Law (N=181, ARC=1.1)
- Ethics and Social Impacts of AI (N=551, ARC=1.08)

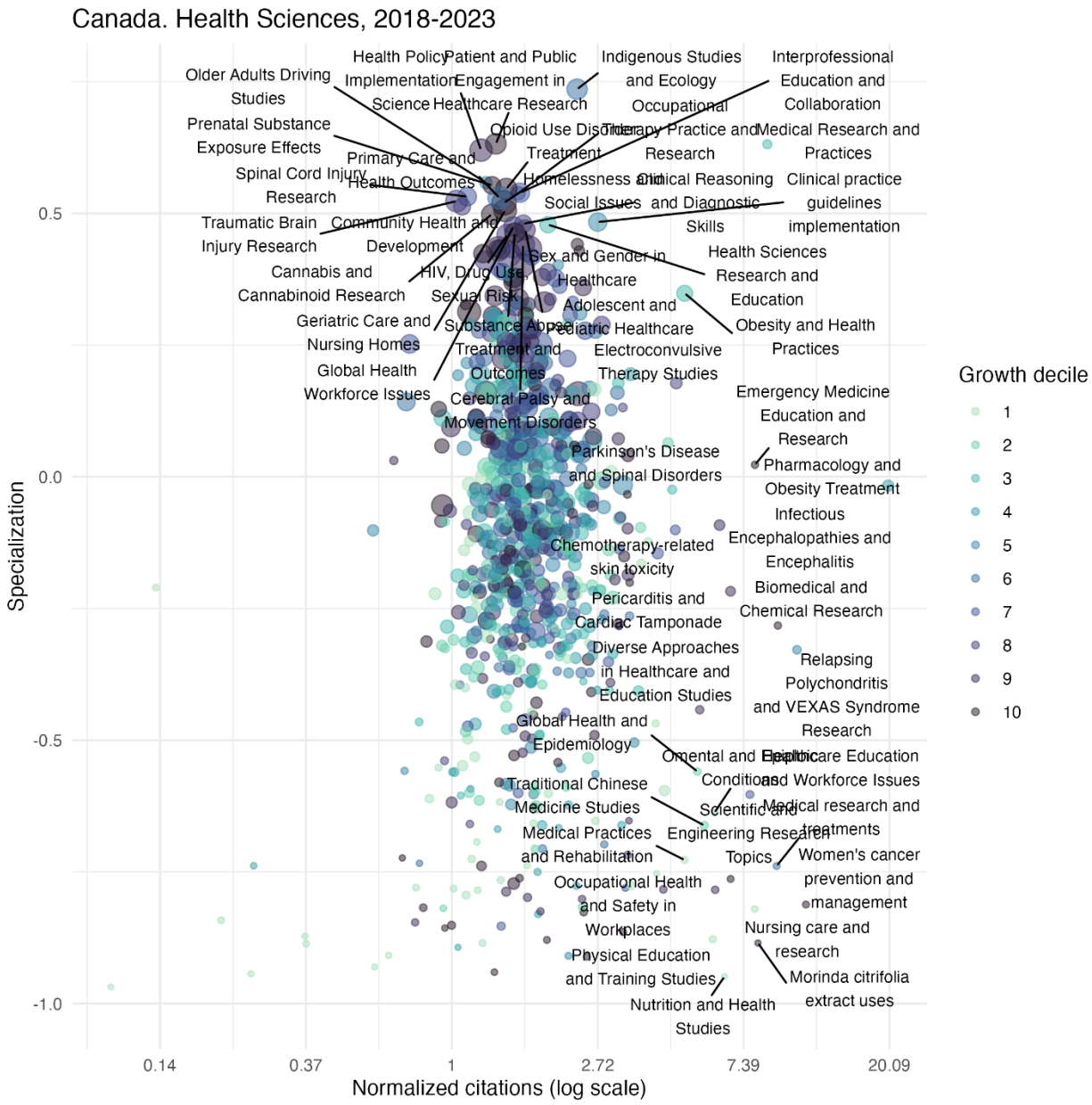

Figure 9. Scatterplot of normalized citations and specialization index of Canadian research papers in health sciences, by topic, 2018-2023.

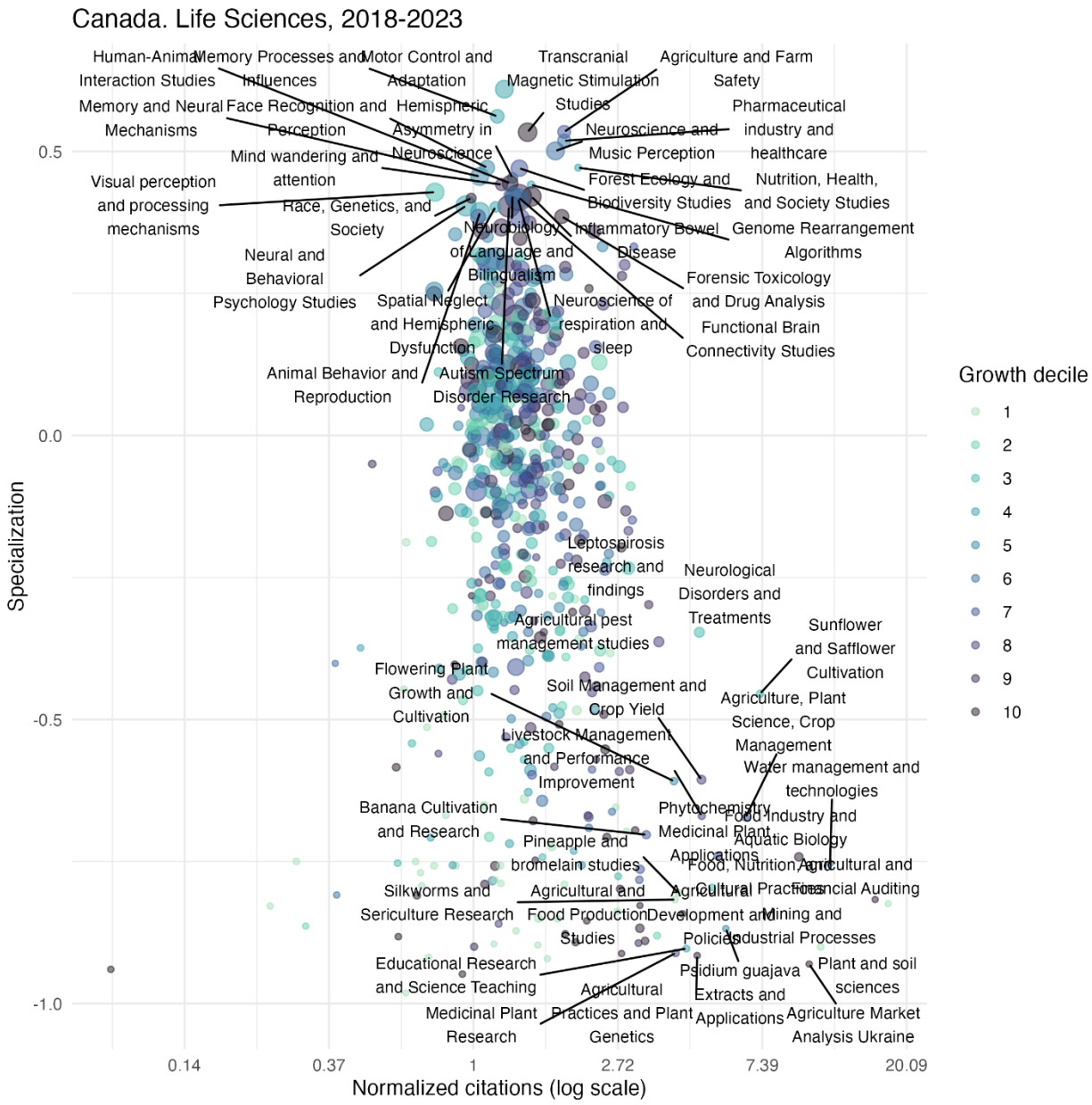

Figure 10. Scatterplot of normalized citations and specialization index of Canadian research papers in life sciences, by topic, 2018-2023.

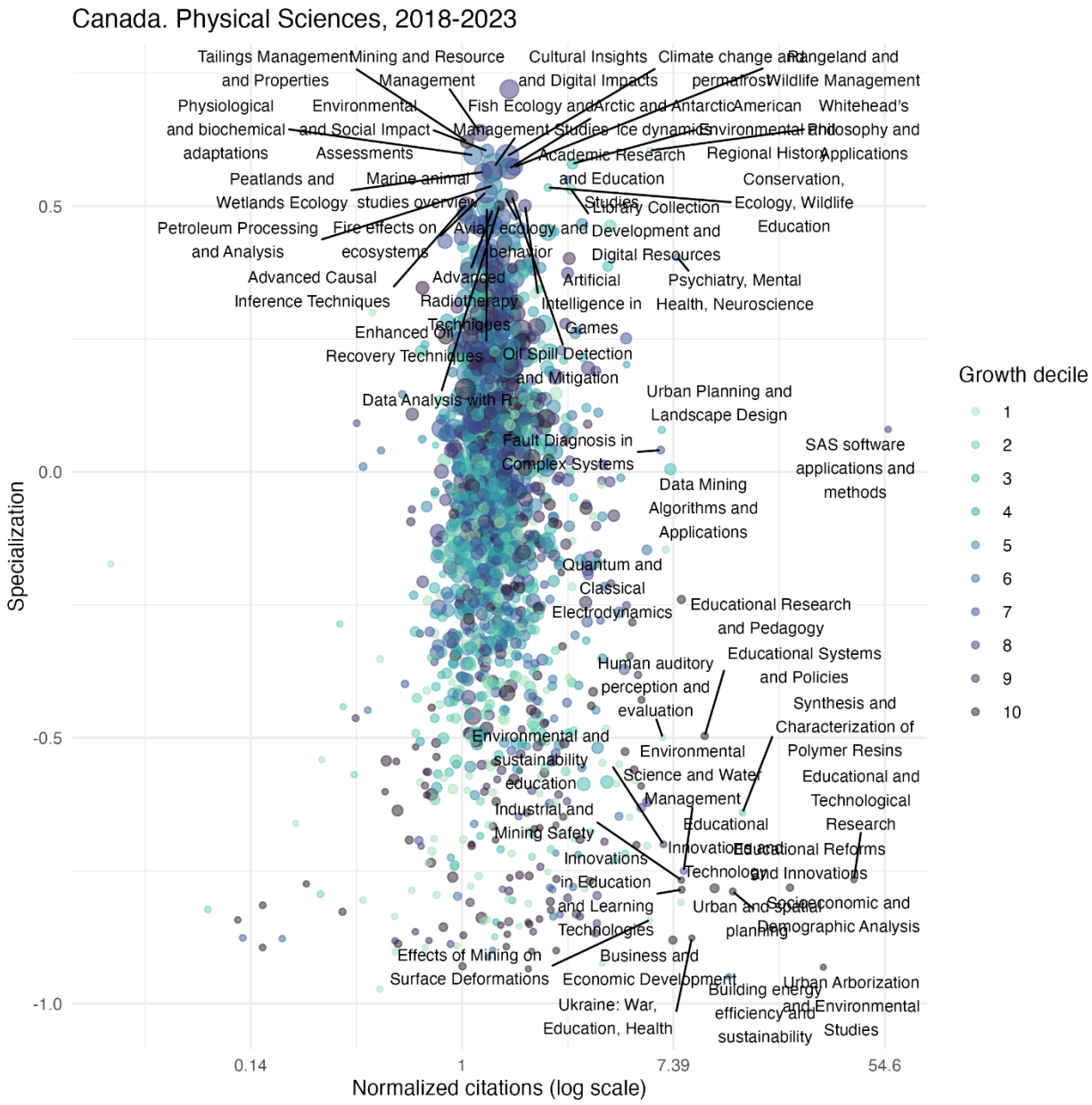

Figure 11. Scatterplot of normalized citations and specialization index of Canadian research papers in physical sciences, by topic, 2018-2023.

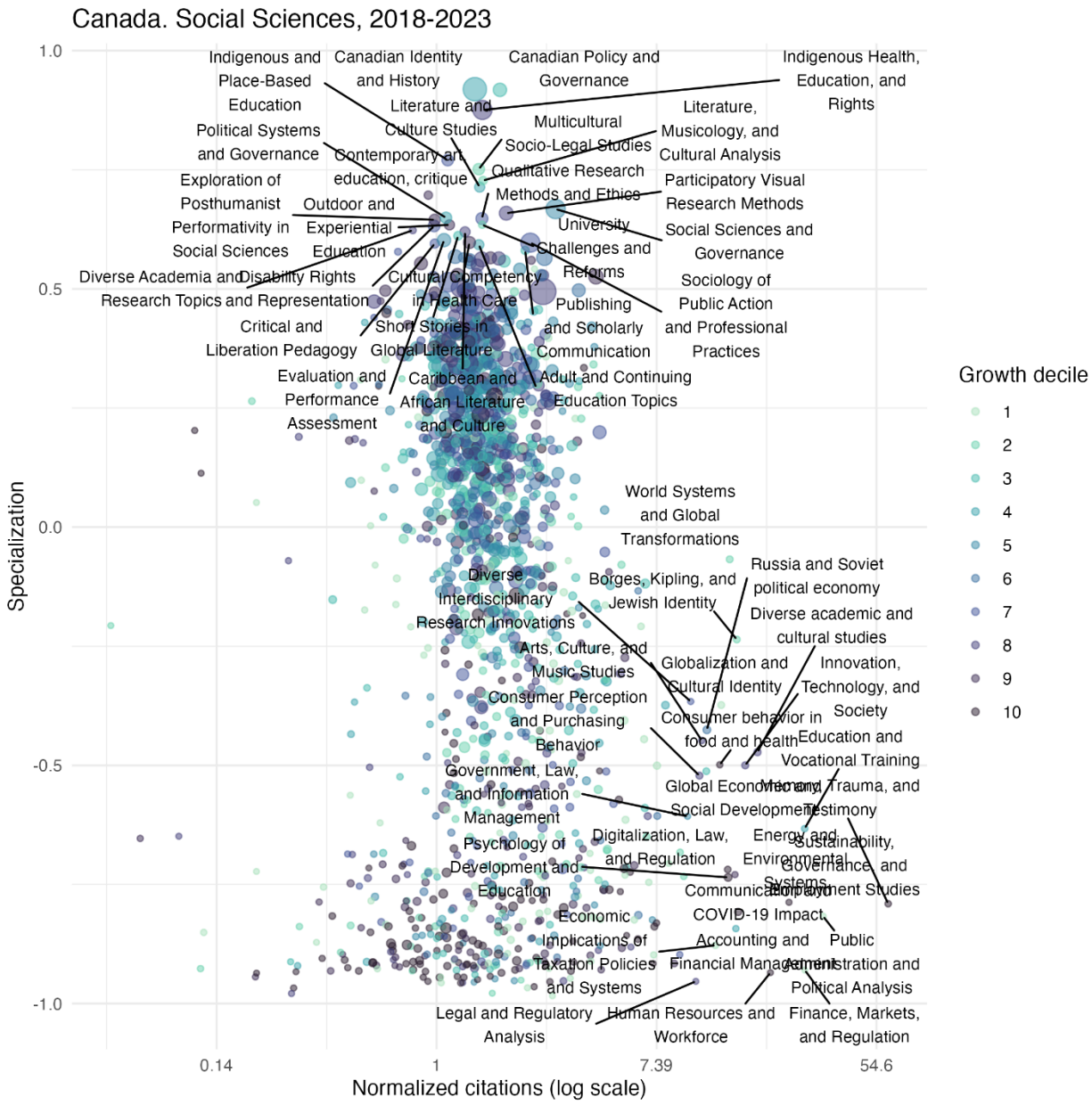

Figure 12. Scatterplot of normalized citations and specialization index of Canadian research papers in social sciences, by topic, 2018-2023.

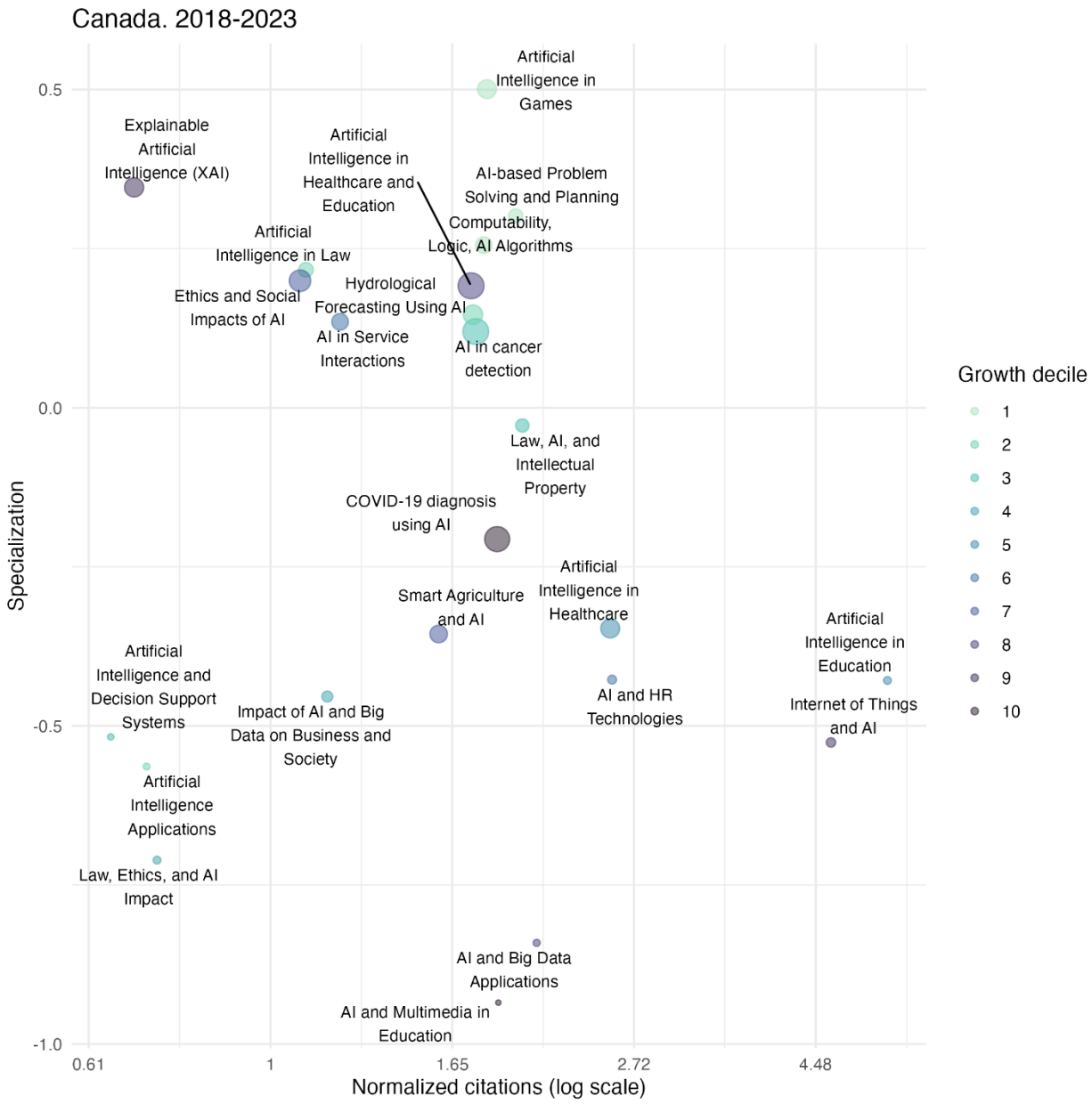

Figure 13. Scatterplot of normalized citations and specialization index of Canadian research papers in artificial intelligence, by topic, 2018-2023.

Conclusion

This report provided a first empirical analysis of Canadian and comparable countries' research activities based on the OpenAlex database. Compared with traditional bibliometric databases, such as Web of Science or Scopus, OpenAlex is more inclusive: it covers more papers globally, as well as for most countries. The use of this source represents a fundamental shift in how we understand and measure scientific output, offering a more complete picture of global research activities while highlighting the evolving dynamics of international scientific collaboration. For Canada, OpenAlex indexes approximately 13% more papers than Scopus, suggesting that previous assessments may have underestimated Canada's research output. More importantly, its greater coverage of non-English publications and research from the Global South provides a more accurate representation of global scientific activity, contextualizing Canada's position within a truly global research ecosystem rather than one dominated by English-language publications.

Our analysis reveals that Canada's relative position in the global scientific ecosystem has changed drastically over the last 30 years. While Canada maintains its status as a significant contributor, its relative share has declined substantially, dropping from 4.2% to 2.3% of global papers since 1990. This decline is not indicative of Canadian research weakness but rather reflects the remarkable growth—and improved indexation—of China and India and, to a lesser extent Brazil and Turkey. Despite this relative decline, Canada's scientific output demonstrates remarkable quality and impact. The country consistently produces research with above-average citation rates across multiple domains, ranking particularly well in health sciences where it maintains the 7th position globally. This pattern suggests that, while Canada may be producing a smaller percentage of the world's total research output, its influence in research remains high.

In terms of research impact, OpenAlex citation data shows how the emergence of China as the world's most productive country has led to a major shift in countries' relative citation impact. Given that relative citation rates are a zero-sum game, the huge increase in citations received by Chinese papers has led to a relative decrease in citations received by Western countries.

At the disciplinary level, our analysis reveals that Canada exhibits higher-than-average activity in health sciences and social sciences, while maintaining strong performance across an array of topics. Although the analysis of topics of excellence remains relatively superficial—given the large number of topics—the strong performance in health sciences aligns with Canada's public healthcare system and aging population, while the excellence in Arctic research leverages Canada's unique geographic position and Indigenous knowledge systems. Topic-level data suggests that the country's specialization areas are coherent with its history, culture and geography. More research is needed,

however, to assess whether such alignment is observed across the entire set of topics, and whether specialization in those could lead to distinctive contributions to global knowledge.

Many of the countries that have emerged in the last decades have not reached the per capita level of activities that of Canada—let alone of Switzerland or Australia. That suggests that those countries still have room to grow, and that Canada's position in the research ecosystem may continue to decline. Therefore, science policy intervention should leverage the country's established strengths in specific research domains, its high-quality, and accessible public university system, and its position as a bridge between American and European research traditions. Moreover, in a context where government investments in research of its main scientific partner—the United States—are declining, Canada's scientific success will depend on its ability to strengthen collaborative relationships with European partners, and to find new Asian and South American partners.

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