

Scientific publications in Switzerland, 2008–2020

A bibliometric analysis of scientific research in Switzerland

Report by the State Secretariat for Education,
Research and Innovation SERI



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Preface

Once again, Switzerland has fared very well in international comparison in terms of the number of scientific papers published and their reception. Switzerland again ranks among the top 20 publishing countries worldwide and, in fact, takes second place when measured per capita and third for the impact of its publications. This is quite a remarkable achievement.

Swiss researchers and institutions have an excellent international network, and more than four fifths of all publications (84%) are co-authored. As before, the leading country for international partnerships is the United States, followed by Italy. More details on the main countries and research fields for international collaboration can be found in this report.



A comparison of the various fields is also of interest. In some, such as Clinical Medicine and Life Sciences, Switzerland ranks above the world average for the number of publications. In terms of impact, all fields are above the world average, some quite substantially.

A comparison of Swiss regions, which has been made since 2017, reveals further developments of note. The Lake Geneva and Zurich regions produce the lion's share of published papers (62%). In terms of impact, all seven Swiss regions are above the global average. The specific profiles of the regions highlight certain clusters or thematic profiles which are of particular importance at national and also international level.

This report contains two new topics of analysis: the first is open access publishing, i.e. free online access to scientific results, an important aspect of research policy. In global comparison, Switzerland ranks 16th for open access publishing. Within Switzerland, more than 60% of all papers are now published in open access form, although considerable differences exist between research fields.

The second special topic focuses on publications in a key technology of strategic importance, quantum science. In the latest period under review, China has overtaken the United States as the world leader in quantum publications. Switzerland has seen an increase in its number of such publications (in relative terms) in recent years and is currently in 18th place. In terms of impact, Switzerland has delivered an excellent performance and currently holds the lead in international comparison. The top three Swiss institutions for quantum publications are ETH Zurich, the University of Geneva and EPFL. These leading positions are the fruit of not only strategic decisions and major investments but also the outstanding performance of researchers in their national and international networks.

Drawing on an extensive data set from 2008 to 2020, this report presents all the main developments in regard to scientific publications, their impact and international collaboration. As such, I believe it is also a solid basis for your future decision-making and strategies in R&I.

I hope you will find it a source of inspiration!

Nicole Schaad

Deputy Director of Research and Innovation

Key points in brief

Scientific publications:

Publication volume: Switzerland's world share of publications, maintained at 1.1% over many years, declined slightly in 2016–2020 to 1%. This is nonetheless a strong performance, with Switzerland still ranked among the top 20 countries for publications. It is even more remarkable when we measure publications per million inhabitants, where Switzerland takes second place in the global ranking with 8,015 publications per million inhabitants in 2016–2020.

Impact: Switzerland's publication impact (measured by number of citations) exceeds the world average of 100 by 27 points, thus ranking third after the Netherlands and the UK.

Figure 1: Switzerland's performance in scientific publications 2016–2020

Indicators	Switzerland's score	Global ranking
World share of publications	1%	20
Publications per million inhabitants	8015	2
Publication impact (relative citation indicator)	127	3

Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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International collaboration: In the 2008–2012 period, 79% of Switzerland's partnerships were international. This figure increased in the 2016–2020 period to 84%. Researchers from Switzerland collaborate primarily with researchers from the United States (15.1%), followed by Italy (9%) and Germany (7.1%).

Research fields: Over the 2016–2020 period, Switzerland published most in the field of Clinical Medicine (27% of Swiss publications), followed by Life Sciences (23%) and Physical, Chemical & Earth Sciences (22%).

Institutional sectors: Higher education institutions are the biggest producers of scientific publications (accounting for 70.8% of Switzerland's publication output), followed at some distance by research institutes (14.8%), private businesses (8.8%) and international organisations (5.6%).

Regions: The Lake Geneva and Zurich regions produced the vast majority of Switzerland's publications (62%) in 2016–2020. The regions Northwest Switzerland and Espace Mittelland together produced just over 31%, and the three remaining regions (Eastern Switzerland, Ticino and Central Switzerland) produced the remaining 7%.

Top 10% publications:

For the most cited publications worldwide (the 'Top 10%'), Switzerland takes 13th place with a share of 1.5%. As this is higher than its share of total publications (1% of scientific publications), Switzerland fares very well for publications with high international visibility. In terms of the number of Top 10% publications per million inhabitants, it holds the lead with 1,202 Top 10% publications per million inhabitants, ahead of Denmark and the Netherlands.

The share of Top 10% publications in Switzerland's publication output was 18.9%, placing it in joint 1st place with Singapore and the United States.

Figure 2: Switzerland's performance in Top 10% publications, 2016–2020

Indicators	Switzerland's score	Global ranking
World share of Top 10% publications	1.5%	13
Top 10% publications per million inhabitants	1202	1

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Open access (OA) publications:

In 2008–2012 Switzerland produced 1.4% of the world's OA publications and ranked 15th. In 2016–2020 Switzerland produced 1.3% of the world's OA publications and ranked 16th.

The share of OA publications in relation to Switzerland's total publications was 43% for 2008–2012 and already rising steadily. It exceeded the 50% mark in 2011–2015 and reached 60% in 2016–2020.

Figure 3: Switzerland's performance in OA publications, 2016–2020

Indicators	Switzerland's score	Global ranking
World share of OA publications	1.3%	16
Share of OA publications in the country's publication output	60%	8

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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The breakdown of OA publications over the seven research fields is similar to that for total publications. The three largest are Clinical Medicine (27% of Swiss OA publications) followed by Life Sciences (26%) and Physical, Chemical & Earth Sciences (24%).

In Switzerland, Life Sciences is the research field with the highest share of its output in open access form: 69% in 2016–2020. This is followed by Physical, Chemical & Earth Sciences (66%), Agriculture, Biology & Environmental Sciences (62%) and Clinical Medicine (60%).

In 2016–2020, international organisations represented the sector with the highest share of OA publications: 74%. The higher education and research institutes sectors each had a share of 60%, with private businesses at 54%.

Quantum publications

In 2008–2012 the United States was the largest producer of quantum publications (17.9% of world share) but has since then been overtaken by China with a share of 22.1% in 2016–2020. Switzerland increased its world share of quantum publications slightly from 0.9% in 2008–2012 to 1% in 2016–2020. It thus ranks 18th among the countries producing quantum publications in 2016–2020.

Switzerland has fared very well in terms of the impact of its quantum publications, taking the lead over Germany and the UK in 2016–2020, with an impact that was 33 points above the world average of 100.

Figure 4: Switzerland's performance in quantum publications, 2016–2020

Indicators	Switzerland's score	Global ranking
World share of quantum publications	1%	18
Impact of quantum publications (relative citation indicator)	133	1

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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In 2016–2020, the higher education sector produced the largest share of Switzerland's quantum publications (77.9%), followed by research institutes (12.9%), private businesses (6.6%) and international organisations (2.6%).

The Lake Geneva and Zurich regions produced the vast majority of Switzerland's quantum publications (42%) in 2016–2020.

Introduction

This report is part of the 'Bibliometric Analysis of Scientific Research in Switzerland' series, which aims to regularly monitor scientific publications in Switzerland.¹ It updates the data on the performance of Swiss publications using the best-known bibliometric indicators (volume, impact and collaborations, measured in terms of total publications and the Top 10% most cited publications).

This 2022 edition also includes an analysis of:

- open access (OA) publications and
- quantum publications.

Bibliometrics and its limitations

Bibliometrics is the statistical analysis of scientific publications. Using a series of indicators, it can be used to observe trends in research and changes over time and among countries and to rank countries and institutions globally or by research field.

Interpreting the results requires a degree of caution as bibliometrics is not without its limitations:

- The data used include only articles published in scientific journals that have an international readership, and so do not reflect other means of publicising research such as presentations at conferences (e.g. in engineering sciences), monographs and books (e.g. in the humanities), or patents or ad-hoc reports (applied research)
- English is normally the reference language in these international journals, which means that a significant number of publications in languages other than English are not included, although in recent years efforts have been made to increase the number of journals in languages other than English.

Consequently, a degree of caution must be applied when analysing the results, especially in the fields of Social & Behavioural Sciences and Arts & Humanities. For example, a study by the University of Zurich showed that only 6% of humanities publications and 27% of social sciences publications from that university are recorded in the Web of Science. (Hug, S. E. & Brändle, M. P. 2017, The coverage of Microsoft Academic: Analyzing the publication output of a university. Scientometrics).

¹ See 'Scientific publications in Switzerland, 2008–2018' (SERI 2020), 'Switzerland's performance in scientific publications, 2011–2015 - A bibliometric analysis of Switzerland's performance by research sub-field' (SERI 2018), 'Scientific publications in Switzerland, 2006–2015' (SERI 2017), 'Bibliometric analysis of scientific research in Switzerland, 1981–2013' (SERI 2016), 'Bibliometric analysis of scientific research in Switzerland, 1981–2011' (SERI 2014), 'Bibliometric analysis of scientific research in Switzerland 1981–2009' (SERI 2011).

1 Switzerland's publications

1.1 Worldwide publications

The number of worldwide publications is constantly growing, up from 17 million in 2008–2012 (with an average of 3.5 million per year), to 33 million in 2016–2020 (or 6.6 million per year: see Fig. 5). Output has therefore almost doubled in size between these two periods.

Figure 5: Evolution of the volume of world publications

Period	Worldwide publications (in millions)	Increase compared with 2008–2012 (=100)
2008–2012	17.34	100
2009–2013	18.87	109
2010–2014	20.46	118
2011–2015	22.16	128
2012–2016	23.96	138
2013–2017	25.72	148
2014–2018	27.52	159
2015–2019	29.91	172
2016–2020	32.82	189

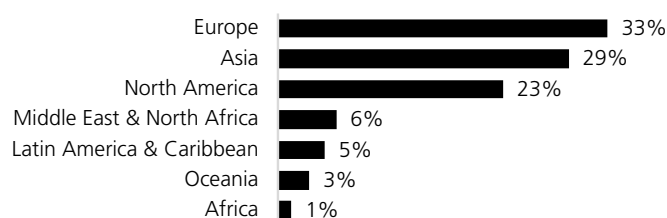
Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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1.2 Publications by world region²

In 2016–2020 the region that published the most was Europe, with a share of 33% of global publications, followed by Asia (29%) and North America (23%) (Fig. 6). This differs from the 2008–2012 period, when North America was in second place. However, although all the world's regions are seeing an increase in absolute numbers of publications, the rate of increase is not the same everywhere. Europe and North America are seeing their world share decrease, while the others are increasing (Fig. 7). The region gaining the most in terms of share is Asia, which has seen its world share increase from 22% in 2008–2012 to 29% in 2016–2020.

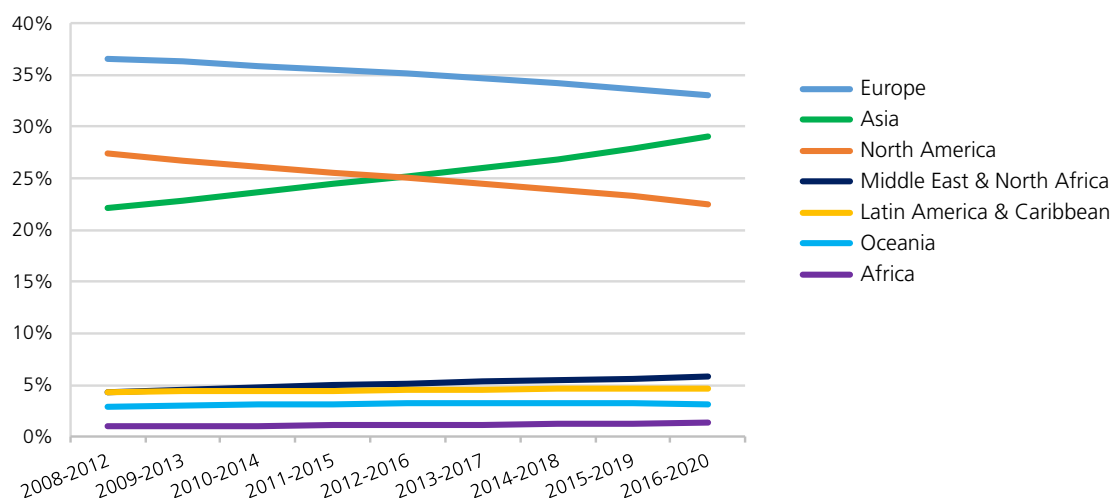
Figure 6: Publication volume by geographical region, as a percentage of the global total, 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Figure 7: Evolution of world shares of publications by world region



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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² United Nations: composition of world regions <https://unstats.un.org/unsd/methodology/m49/>.

The regions taken into account in this report are: Africa (Eastern Africa, Middle Africa, Southern Africa and Western Africa); North America (northern America); Latin America and the Caribbean (Central America, South America and the Caribbean); Asia (Central Asia, Eastern Asia, Southern Asia and South-Eastern Asia); Europe (Eastern Europe, Northern Europe, Southern Europe and Western Europe); Middle East and North Africa (Western Asia and Northern Africa); and Oceania (Australia and New Zealand, Melanesia, Micronesia and Polynesia).

Methods of counting publications: an overview

A publication is the result of the research of one or more authors working for one or more institutions in the same or different countries. While attributing each researcher whose name appears on the article to an institution, and subsequently attributing each institution to a country is straightforward, attributing each scientific paper to these authors, institutions and countries necessitates a choice of methods that goes beyond simple enumeration. How and to whom would we attribute a scientific paper signed for example by 15 authors belonging to 7 institutions in 4 different countries?

To start with, it is important to note that only the institutions (to which the authors are affiliated) are counted. Each article is thus counted under the name of the institution or institutions its authors belong to, and not under the name of the authors themselves (if several authors belong to a single institution, only one publication will be counted for that institution).

Next, all the worldwide publications are broken down into one of the 109 sub-fields of research (see Annex B.2) in order to take account of the different citation practices in each research field and to only compare publications with the same practices and approach to citation.

Finally, we need to choose between two counting methods: (a) fractional counting, which attributes a fraction of a paper to each of the institutions whose name appears on the paper. This method has the advantage that the number of publications corresponds exactly to the sum of the individual publications included, but the disadvantage is that it makes the number of contributions of each institution dependent on the number of institutions participating in the drafting of a paper; (b) full counting, where a publication produced by authors from several institutions is counted in full for each address appearing on the paper. In other words, each institution featured on the paper is considered as having produced a publication. The disadvantage of this method is that it multiplies the number of publications by the number of institutions appearing on the publication. Nonetheless, it is the method used in this report as it has the advantage of better reflecting the efforts of institutions.

Publications are counted over five-year periods.

The databases used in this report are the *Science Citation Index Expanded (SCIE)*, the *Social Science Citation Index Expanded (SSCIE)*, the *Arts & Humanities Citation Index (A&HCI)* and the *Emerging Sources Citation Index (ESCI)* from Clarivate Analytics (formerly Thomson Reuters), for the years 2008 to 2020.

See Annex B Methods for more details on definitions and methods.

Country selection

In order to obtain reliable statistical results, a minimum number of publications is required. In this study, the minimum number was fixed at 5,000 publications over a five-year period. Ninety-six countries meet this criterion for the 2016–2020 period.

The graphs in this report in principle present the top 20 countries in the ranking for each indicator concerned. Nevertheless, other interesting countries are also shown in an additional graph: these may be the main countries which Switzerland collaborates with (United States, Germany, France, Italy, United Kingdom), or a selection of countries that are interesting to compare with Switzerland, such as Japan, Brazil, India, China, South Africa, South Korea and Taiwan.²

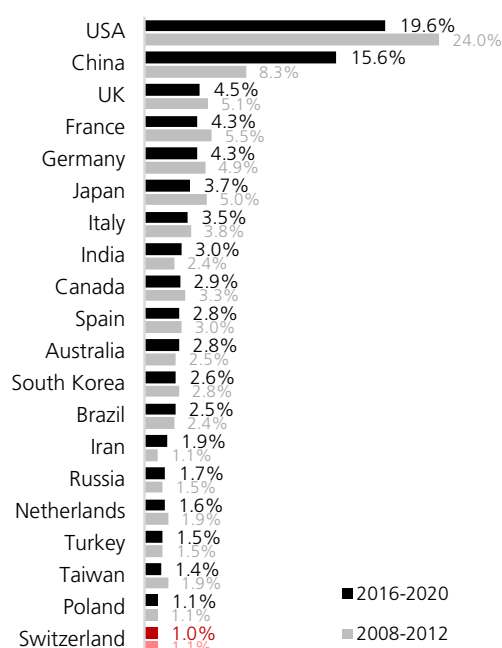
³ Switzerland has bilateral research programmes in place with Brazil, Russia, India, China, South Africa and South Korea, among others.

1.3 Switzerland in the global ranking of publications by country

Over many years, Switzerland maintained its share of worldwide publications at 1.1%, increasing its output at roughly the same speed as the rest of the world. However, this share has fallen slightly over the past two periods and is currently at 1%. Switzerland nonetheless remains in 20th place in the global ranking of countries in terms of scientific publication output.

The United States is still the country with the largest number of publications (19.6% of worldwide publications) but its share has been declining in recent years as competition grows. For example, China's share of worldwide publications increased from 8.3% in 2008–2012 to 15.6% in 2016–2020, and Iran's from 1.1% to 1.9% (Fig. 8).

Figure 8: Share of worldwide publications by country for the periods 2008–2012 and 2016–2020, for the 20 most productive countries in 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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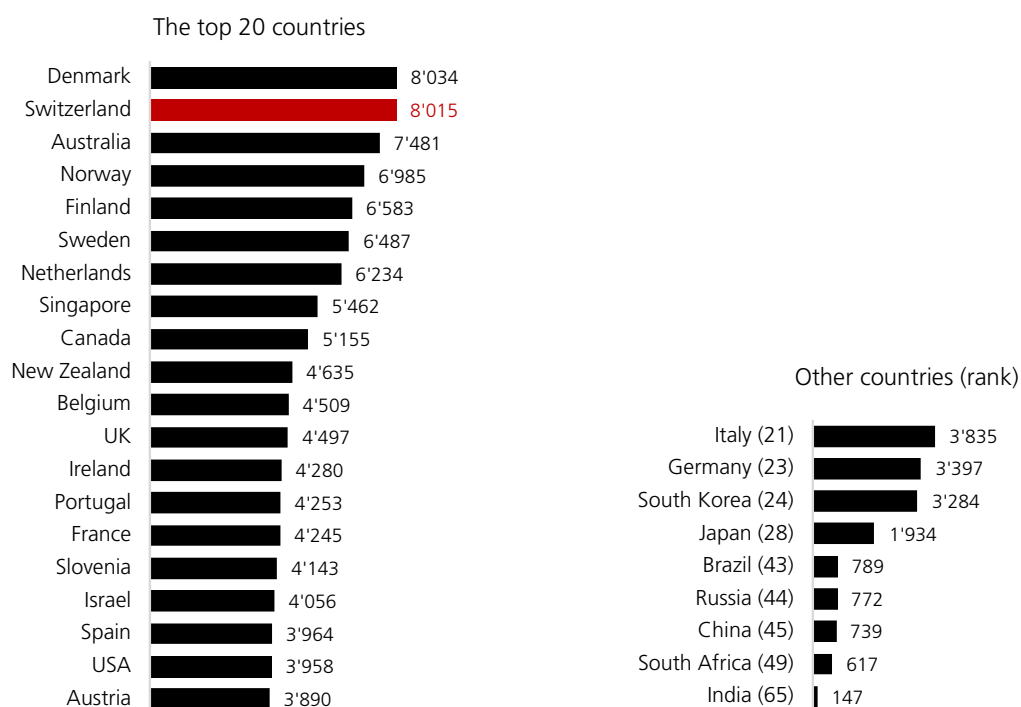
All the countries ranked in the top 20 in 2008–2012 increased their absolute number of publications in the more recent period, including countries like the United States, the United Kingdom, Germany, France and even Japan, which already published a great deal. However, these countries are seeing their shares of worldwide publications drop due to the stronger growth in publications from other countries (see annex A.1 which details the volumes and world shares of the 60 most productive countries in 2016–2020).

1.4 Publications by number of inhabitants

If we consider the ranking independent of the country's size, Switzerland takes 2nd place in terms of publications per million inhabitants, with just over 8,000 publications per million inhabitants (Fig. 9) in 2016–2020.

The United States and China – two important countries in terms of total publication output, but also with large populations – are not among the highest-ranked countries in this respect, ranking only 19th (US) and 45th (China).

Figure 9: Publications per year per million inhabitants, 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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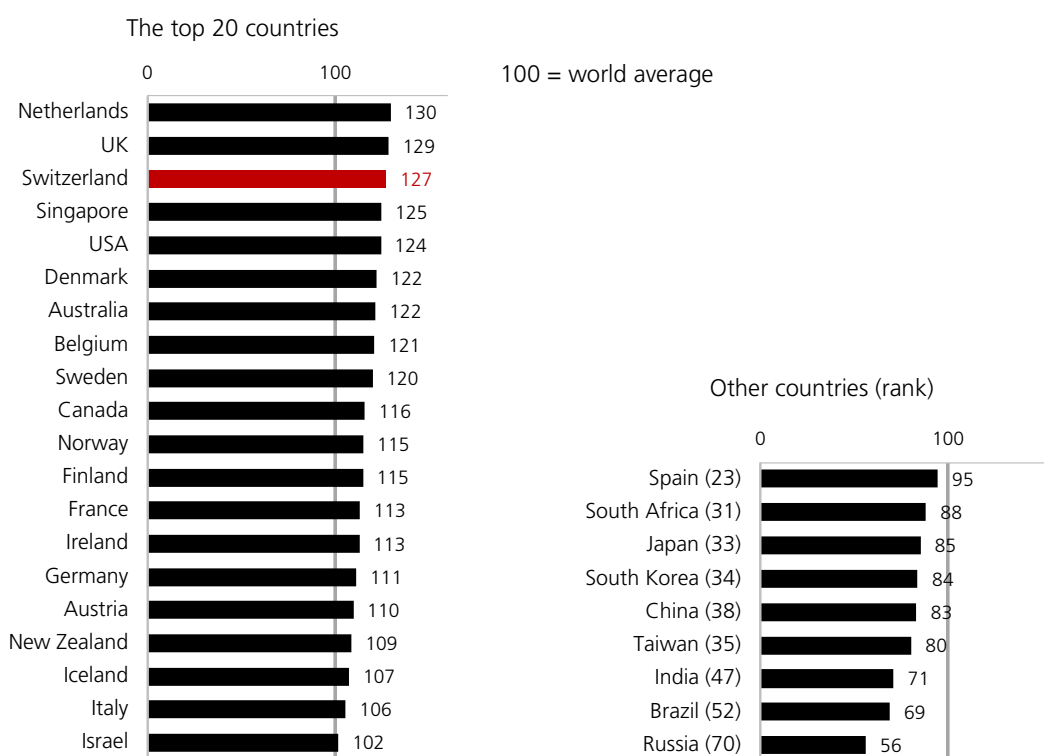
1.5 Impact of publications

A publication's impact is measured by the number of times the publication in question is cited by researchers (see box for definition). The impact is an indicator of the level of recognition among peers.

1.5.1 Impact of Switzerland's publications by international comparison

The impact of Switzerland's publications exceeds the world average of 100 by 27 points (Fig. 10), placing it in 3rd position after the Netherlands and the UK.

Figure 10: Impact indicator, 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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See annex A.2 which details the impact for 60 countries in 2008–2012 and 2016–2020.

Calculating impact (relative citation indicator)

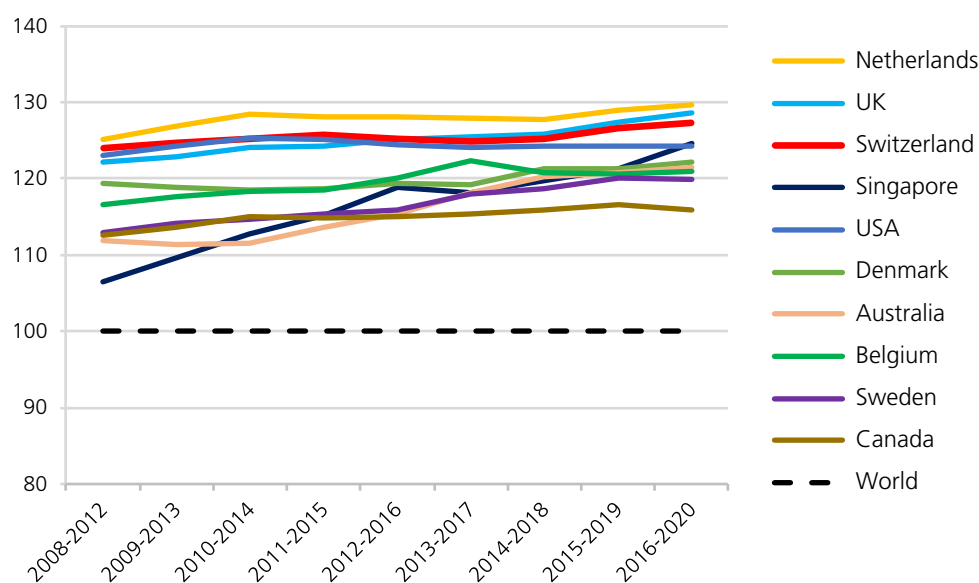
The impact of a country's publications indicates the readership that these publications reach among the research community. It is measured by the number of citations a publication receives. For each publication, the number of citations is put into context, i.e. divided by the global average citations in the research field in question, and then standardised on a scale where 100 represents the world average. The analysis window is five years, as for publication counting. See annex B.3 for more details on definition and calculation methods.

1.5.2 Switzerland compared with the top 10 countries in terms of impact

The impact of Switzerland's publications has been relatively stable since 2008–2012, rising from 124 (or 24 points above the world average) to 127 in 2016–2020 (Fig. 11).

The leading countries are broadly the same since the beginning of the overall period. The only newcomer among the leaders is Singapore, with an impact that has grown substantially since 2008–2012.

Figure 11: Evolution of impact for the top 10 countries



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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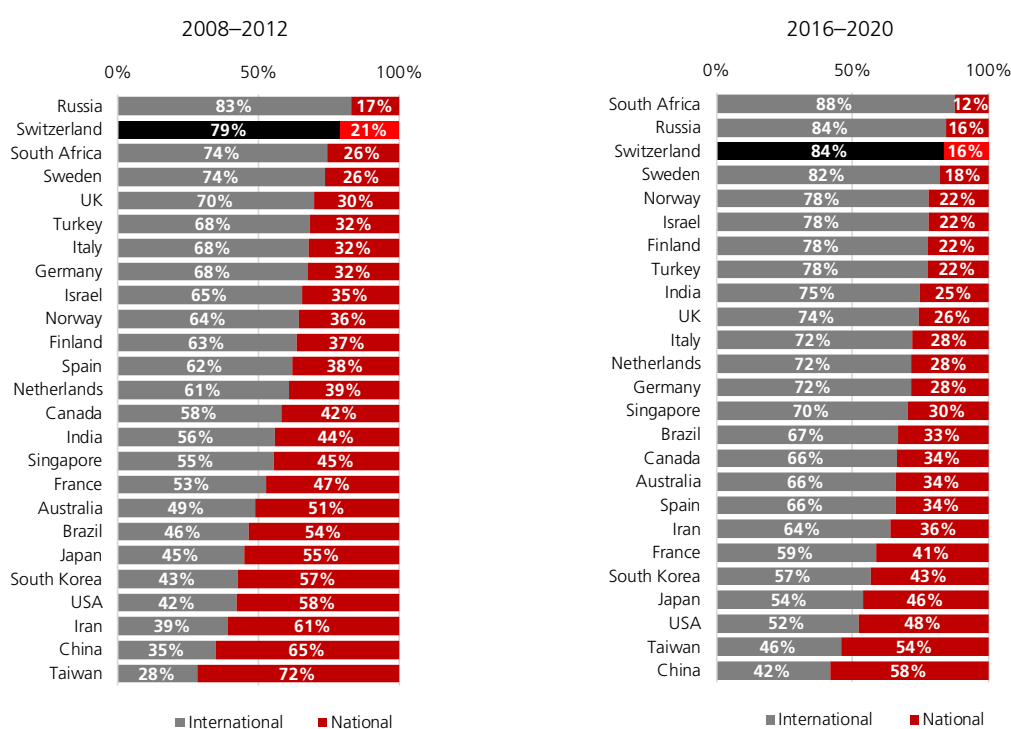
1.6 Publication partnerships

This section refers only to publications that came about as a result of collaboration between several authors (in Switzerland's case, this represents four fifths of all publications)⁴ and excludes from the outset any publications with no collaboration (see box for definition of partnerships). This gives us an overview of the share of national and international partnerships, as well as the countries and regions with which Swiss researchers collaborate the most.

1.6.1 Percentage of national and international partnerships by country

In the period 2008–2012, 79% of Switzerland's partnerships were international (Fig. 12). This figure increased to 84% in 2016–2020. It is noteworthy that international collaborations saw strong growth in all countries in the most recent period and that currently, only two countries have a higher level of national than international partnerships (China and Taiwan), although in 2008–2012 this was the case in eight countries.

Figure 12: Percentage of national and international partnerships for a selection of 25 countries, for the periods 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

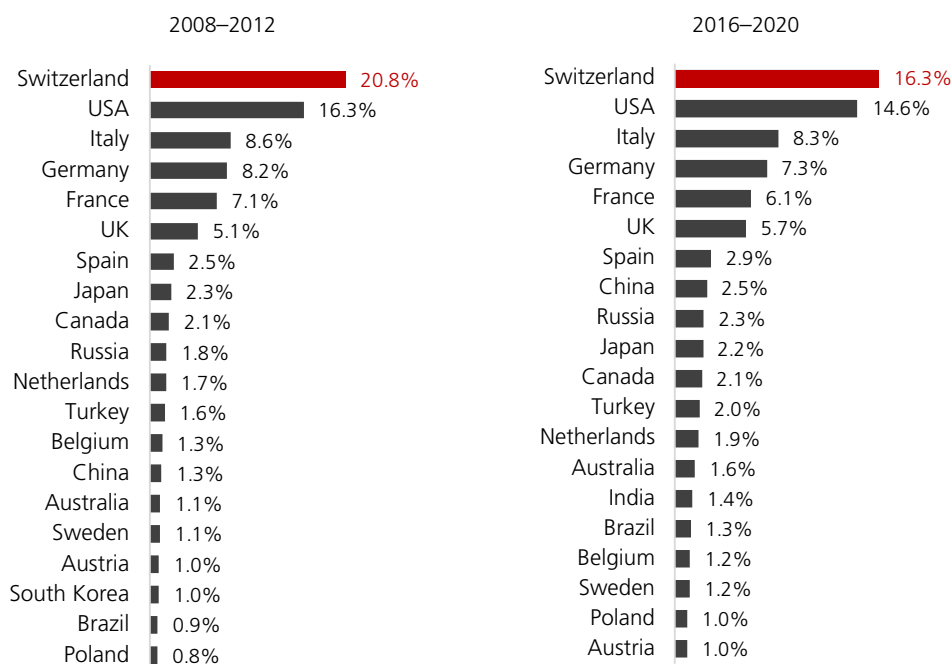
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⁴ See report 'Bibliometric analysis of scientific research in Switzerland 1981–2013', SERI 2016.

1.6.2 Partnerships in Swiss publications

National partnerships, which represented a fifth of partnerships (20.8%) in 2008–2012, made up just 15.6% of total partnerships in 2016–2020 (Fig. 13). Internationally, researchers in Switzerland mainly collaborate with peers in the United States (14.6%), followed by those in neighbouring countries: Italy (8.3%), Germany (7.3%) and France (6.1%).

Figure 13: Origin of partners of Swiss-based researchers as a percentage of Switzerland's total partnerships, top 20 countries, for the periods 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Methods of counting publication partnerships

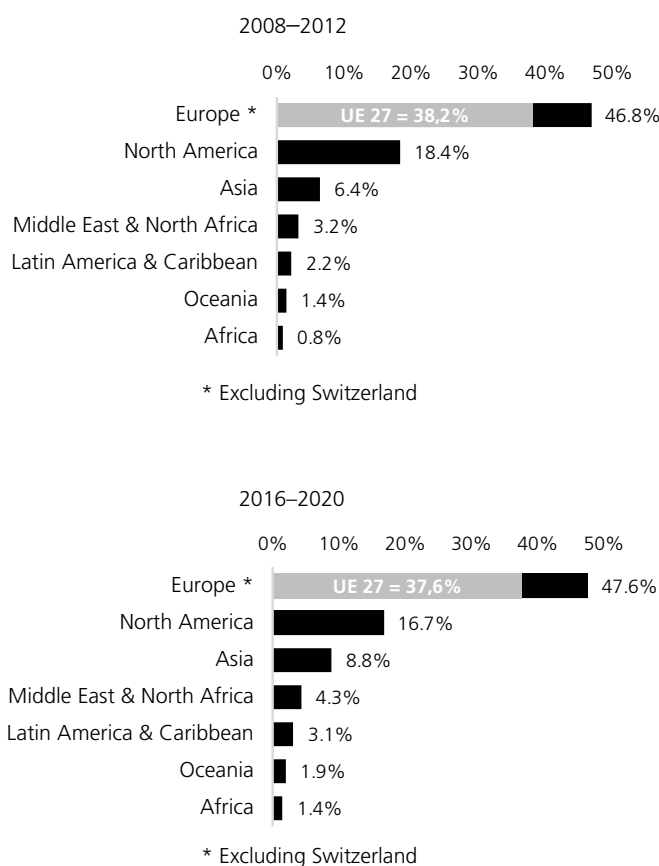
For each Swiss institution appearing on a publication, we count the other institutions involved in the publication, and according to the country where these institutions are located, we classify the partnership as national or international. The percentages of partnerships are calculated on the basis of the country's total partnerships. This indicator thus refers to total partnerships and not total publications.

1.6.3 Swiss partnerships by geographical region

If we count Switzerland's partnerships by geographical region (see definition in section 1.2), it is clear that collaboration with Asia has increased significantly (rising from 6.4% to 8.6%; Fig. 14), although Europe remains Switzerland's most important partner by far, accounting for 47.6% of partnerships in 2016–2020. This is followed by North America with 16.7%.

The share of partnerships with the EU 27 has decreased slightly from 38.2% in 2008–2012 to 37.6% in 2016–2020.

Figure 14: Origin by geographical region of partners of Swiss-based researchers, as a percentage of Switzerland's total partnerships, for the periods 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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1.7 Research fields

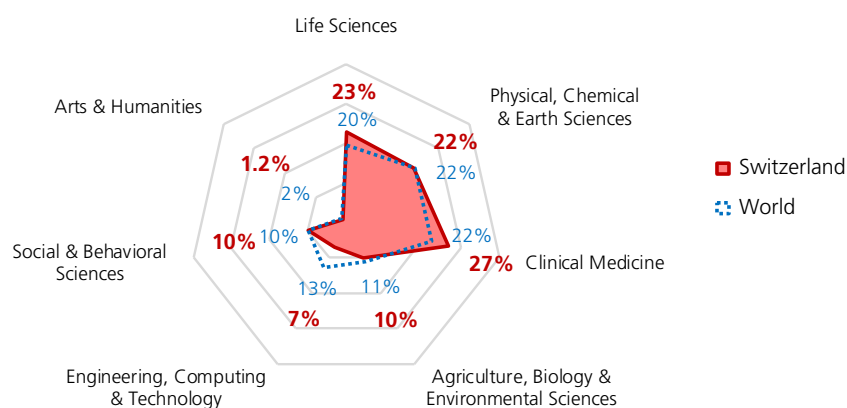
1.7.1 Switzerland's publication profile by research field

Publications are classified in seven broad research fields (see box for definitions) in order to obtain an overall research profile for each country and thus identify the areas in which research efforts are focused.

In the period 2016–2020, Switzerland published most in the field of Clinical Medicine (27% of Swiss publications), followed by Life Sciences (23%) and Physical, Chemical & Earth Sciences (22%; Fig. 15).

The breakdown of Switzerland's publications is very similar to the global pattern, with just two fields having a larger share than the worldwide distribution (Clinical Medicine and Life Sciences) and one field having a much smaller share (Engineering, Computing & Technology).

Figure 15: Breakdown of publications by research field, Switzerland and the world, 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Research fields

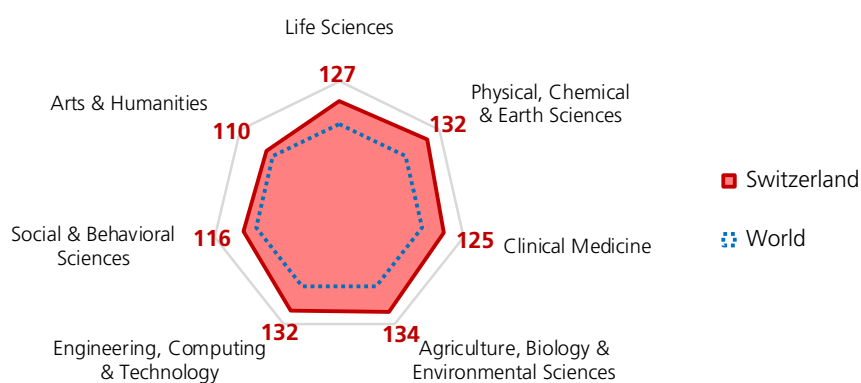
The definition of research fields depends on the classification used by a database to split scientific journals into categories. Here, scientific journals are split according to their content into seven broad categories (or research fields; see *Current contents* <https://mjl.clarivate.com/search-results> Web of Science coverage/Current contents): Life Sciences; Physical, Chemical & Earth Sciences; Clinical Medicine; Agriculture, Biology & Environmental Science; Social & Behavioural Science; Engineering, Computing & Technology; and Arts & Humanities. The research fields themselves are split into several sub-fields. See annex B.2 for a full list of research fields and sub-fields.

1.7.2 Switzerland's impact by research field

In the period 2016–2020, Switzerland's publications had an impact above the world average (100) in all research fields (Fig. 16).

The three fields of Agriculture, Biology & Environmental Sciences; Physical, Chemical & Earth Sciences; and Engineering, Computing & Technology exceeded the world average by more than 30 points, while the fields of Life Sciences and Clinical Medicine exceeded it by over 20 points, and finally Social & Behavioural Sciences and Arts & Humanities by more than 10 points.

Figure 16: Impact of Switzerland's publications by research field, 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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1.7.3 Impact of countries by research field

Switzerland is currently ranked:

- 1st in the research field of Agriculture, Biology & Environmental Sciences
- 2nd in the research fields of Physical, Chemical & Earth Sciences; and Life Sciences
- 3rd in the research field of Engineering, Computing & Technology
- 5th in the field of Clinical Medicine, and
- 8th in Social & Behavioural Sciences.

With the exception of the field of Arts & Humanities, Switzerland therefore achieves a good ranking in all research fields. That being said, we should not set too much store by a country's exact position, as the differences between the impacts of the various countries are minimal, and a difference of one or two points can cause a major shift in a country's position from one year to the next. The important thing is to feature at the top of the ranking, and Switzerland does that. The ranking has been dominated by virtually the same countries for a number of years. The emerging nations have yet to make an appearance among the best-performing countries in terms of impact, with the exception of Qatar, which currently has a high ranking in the field of Engineering, Computing & Technology.

Figure 17: Ranking of top 10 countries based on impact by research field, 2016–2020

Engineering, Computing & Technology	Physical, Chemical & Earth Sciences	Agriculture, Biology & Environmental Sciences	Life Sciences	Clinical Medicine	Social & Behavioural Sciences	Arts & Humanities
Singapore	Singapore	Switzerland	UK	Netherlands	Netherlands	Netherlands
Australia	Switzerland	Netherlands	Switzerland	UK	UK	UK
Switzerland	USA	UK	USA	Norway	Belgium	Australia
UK	UK	Denmark	Netherlands	Sweden	USA	Denmark
Denmark	Netherlands	Sweden	Iceland	Switzerland	Denmark	Finland
Netherlands	Australia	Singapore	Belgium	Denmark	Australia	Singapore
USA	Denmark	Australia	Singapore	USA	Singapore	Norway
Qatar	Germany	Ireland	Ireland	Canada	Switzerland	New Zealand
Sweden	France	Belgium	Denmark	Australia	Sweden	Sweden
Belgium	Belgium	USA	Australia	Belgium	Finland	USA

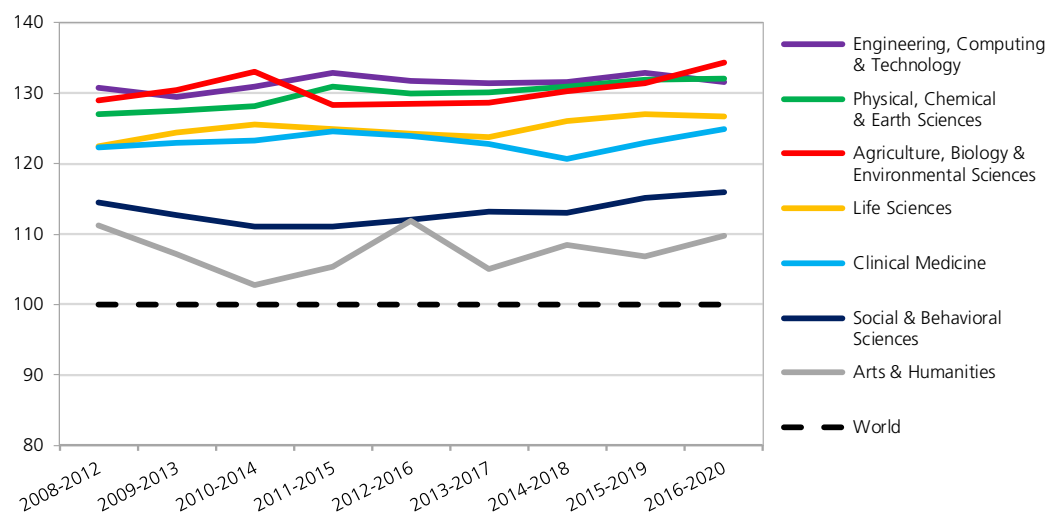
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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1.7.4 Evolution of Switzerland's impact by research field

Switzerland's impact in the seven research fields has been well above the world average of 100 since 2008–2012 (Fig. 18). Switzerland has thus succeeded in maintaining high-quality research over a long period.

Figure 18: Evolution of Switzerland's impact by research field



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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1.7.5 Partnerships according to research field

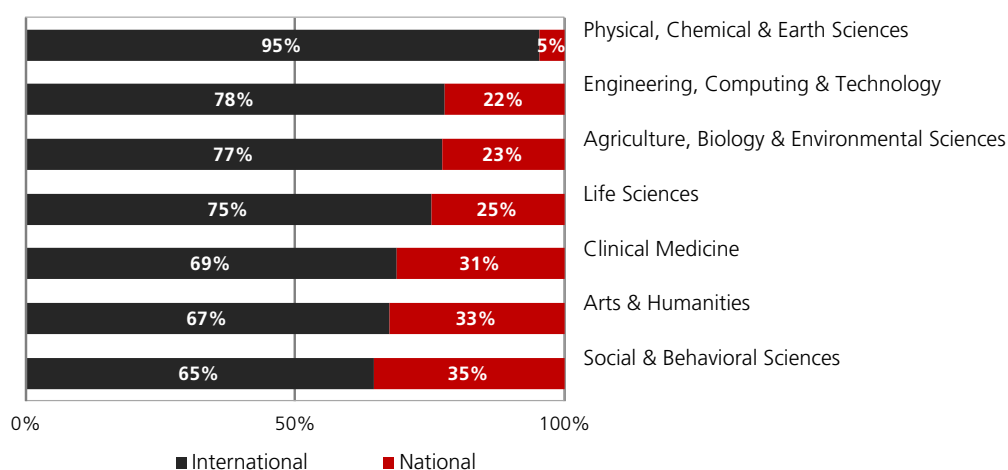
1.7.5.1 National and international partnerships by research field

Research and the drafting of publications are highly international activities and the majority of Switzerland's partnerships are international across all research fields (Fig. 19).

The field with the highest percentage of international partnerships is Physical, Chemical & Earth Sciences, where 95% of partnerships were international in 2016–2020. The field where national partnerships are still significant is Social & Behavioural Sciences, although this field is also characterised by a very high percentage of international partnerships at 65%.

The field of Arts & Humanities has a large number of publications with no institutional cooperation (more than 60% of publications were written without institutional collaboration, see 2016 SERI report, Fig. 24), but those that are collaborative are also very international (67%).

Figure 19: Percentage of national and international partnerships by research field in Switzerland, 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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1.7.5.2 Partnerships by country according to research field

International collaboration is important to Swiss-based researchers in all research fields (Fig. 19). However, a detailed analysis of the countries with which Switzerland collaborates shows that in six of the seven research fields, researchers in Switzerland primarily collaborate with other researchers in Switzerland, then with researchers from the United States and Germany (Fig. 20). Only in the field of Physical, Chemical & Earth Sciences do Swiss-based researchers primarily collaborate with peers in the United States, Italy, France, Germany and the UK ahead of other researchers in Switzerland.

Figure 20: Origin of partners of Swiss-based researchers (top 10 countries) by research field, 2016–2020

Engineering, Computing & Technology	Physical, Chemical & Earth Sciences	Agriculture, Biology & Environmental Sciences	Life Sciences	Clinical Medicine	Social & Behavioural Sciences	Arts & Humanities
Switzerland	USA	Switzerland	Switzerland	Switzerland	Switzerland	Switzerland
USA	Italy	USA	USA	USA	USA	Germany
Germany	France	Germany	Germany	Germany	Germany	USA
UK	Germany	France	UK	UK	UK	France
Italy	UK	UK	France	France	France	UK
France	Switzerland	Spain	Italy	Italy	Netherlands	Italy
China	Russia	Italy	Netherlands	Netherlands	Canada	Russia
Australia	Turkey	Australia	Spain	Spain	Australia	Spain
Spain	Japan	Canada	Canada	Canada	Italy	Netherlands
Netherlands	China	Netherlands	Australia	Australia	Spain	Australia

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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1.8 Switzerland's institutional sectors

1.8.1 Swiss publications by institutional sector

The research institutions that produce publications in Switzerland were split into four institutional sectors (see box for a definition of the sectors). Higher education institutions are the biggest producers of scientific publications (accounting for 70.8% of Switzerland's publication output), followed at some distance by research institutes (14.8%), private businesses (8.8%) and international organisations (5.6%) (Fig. 21). This sectoral breakdown has not changed since 2008–2012.

Figure 21: Breakdown of Swiss publications by institutional sector, 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Institutional sectors

The breakdown of research institutions into institutional sectors has been done only for those located in Switzerland. Four institutional sectors have been defined:

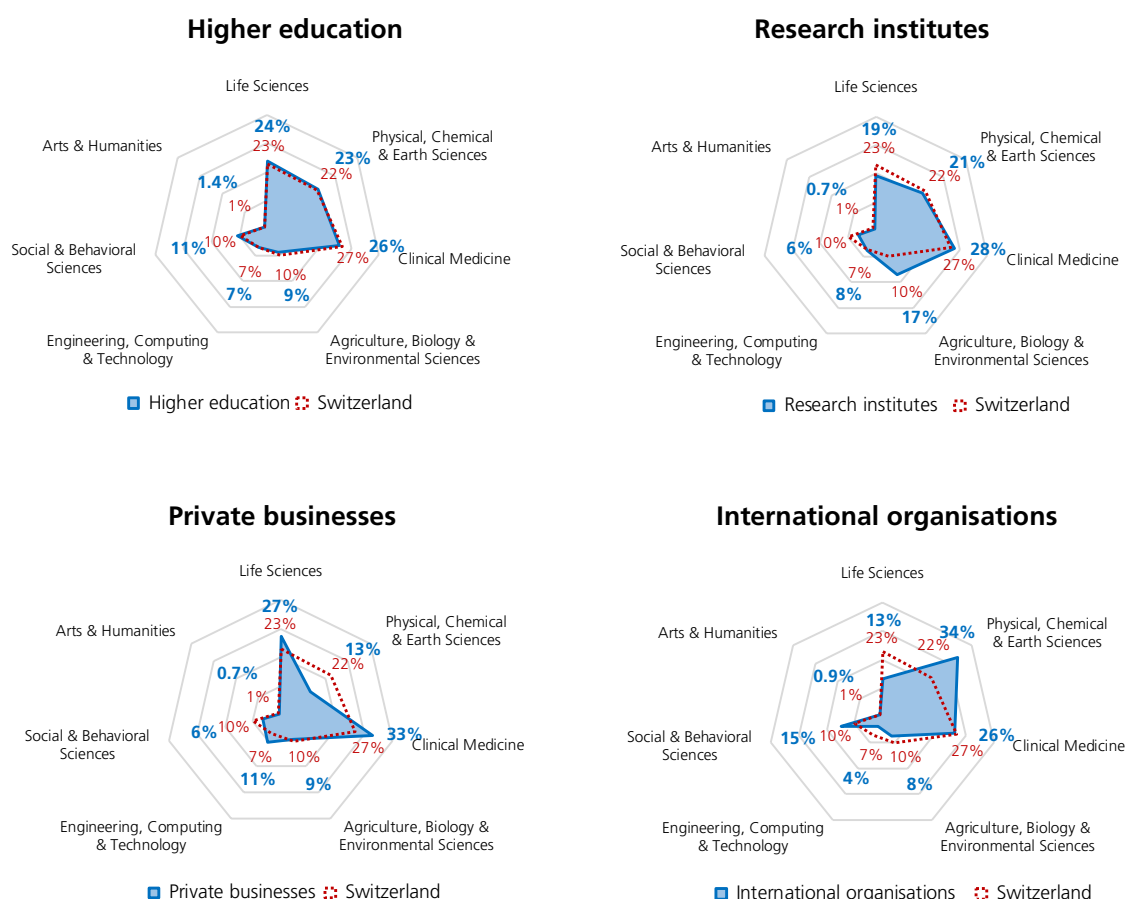
- Higher education: cantonal universities, Swiss federal institutes of technology, universities of applied sciences, private colleges and universities, and teaching hospitals.
- Private businesses: private companies in Switzerland, as well as private clinics and hospitals.
- Research institutes: research institutes of the ETH Domain, federal research institutes, foundations, as well as public hospitals that are not teaching hospitals.
- International organisations.

1.8.2 Publications of institutional sectors by research field

By comparing the overall profile for Switzerland (see section 1.7.1) with the profile of each of the institutional sectors, we can see which research fields are specific to each institutional sector:

- Higher education: the distribution of publications by research field in the higher education sector is very similar to that of Switzerland overall (Fig. 15); this is hardly surprising given that higher education institutions produce the vast majority of Switzerland's publications (70.8%).
- Research institutes: this sector is very active in the field of Agriculture, Biology & Environmental Sciences, which makes up 17% of this sector's publications versus 10% on average for the whole of Switzerland.
- Private businesses: this sector is very active in the fields of Life Sciences and Clinical Medicine, which account for 27% and 33% of this sector's publications respectively.
- International organisations: the publication profile of this sector is different from that of Switzerland in the field of Physical, Chemical & Earth Sciences, with a share of 34% versus 22%, and in the field of Social & Behavioural Sciences with a share of 15% versus 10%.

Figure 22: Publication profile of Switzerland's institutional sectors, 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

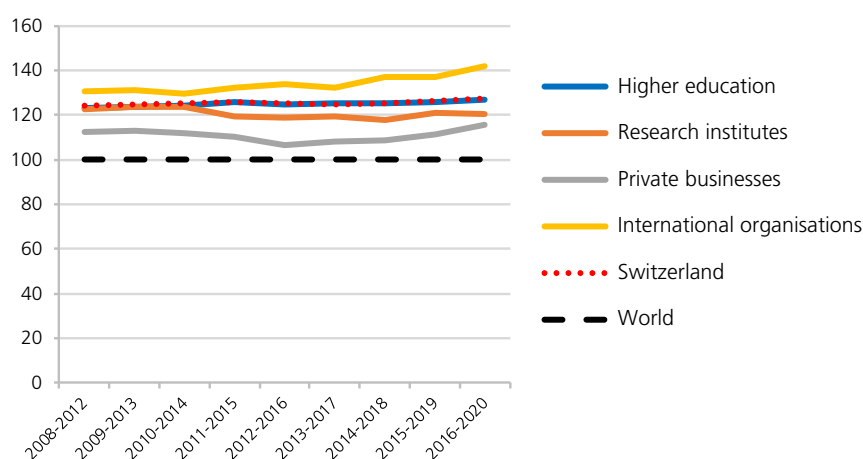
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1.8.3 Impact of Switzerland's institutional sectors

All of Switzerland's institutional sectors have performed very well since the early 2000s (Fig. 23) as their impact scores are above the world average of 100. As the higher education sector produces the highest volume of publications in Switzerland, the impact of these publications plays a pivotal role in the impact of Switzerland's total publications. Indeed, and unsurprisingly, the curves for Switzerland as a whole and for the higher education sector are almost identical.

While the evolution of the publication impact of different sectors is more or less stable (within a five-point range), that of international organisations has increased markedly since the early 2010s.

Figure 23: Evolution of the publication impact of Switzerland's institutional sectors



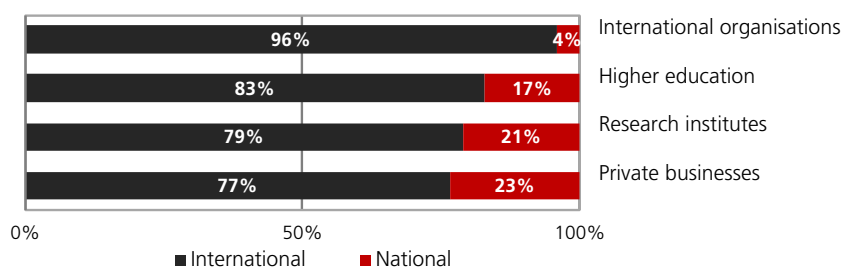
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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1.8.4 National and international partnerships by institutional sector

The percentage of international partnerships of Switzerland's institutional sectors is very high, ranging from 77% for private businesses to 96% for international organisations. These figures approaching 100% are fine examples of the internationally-minded approach taken by staff working at these organisations (Fig. 24).

Figure 24: Percentage of national and international partnerships by institutional sector in Switzerland, 2016–2020



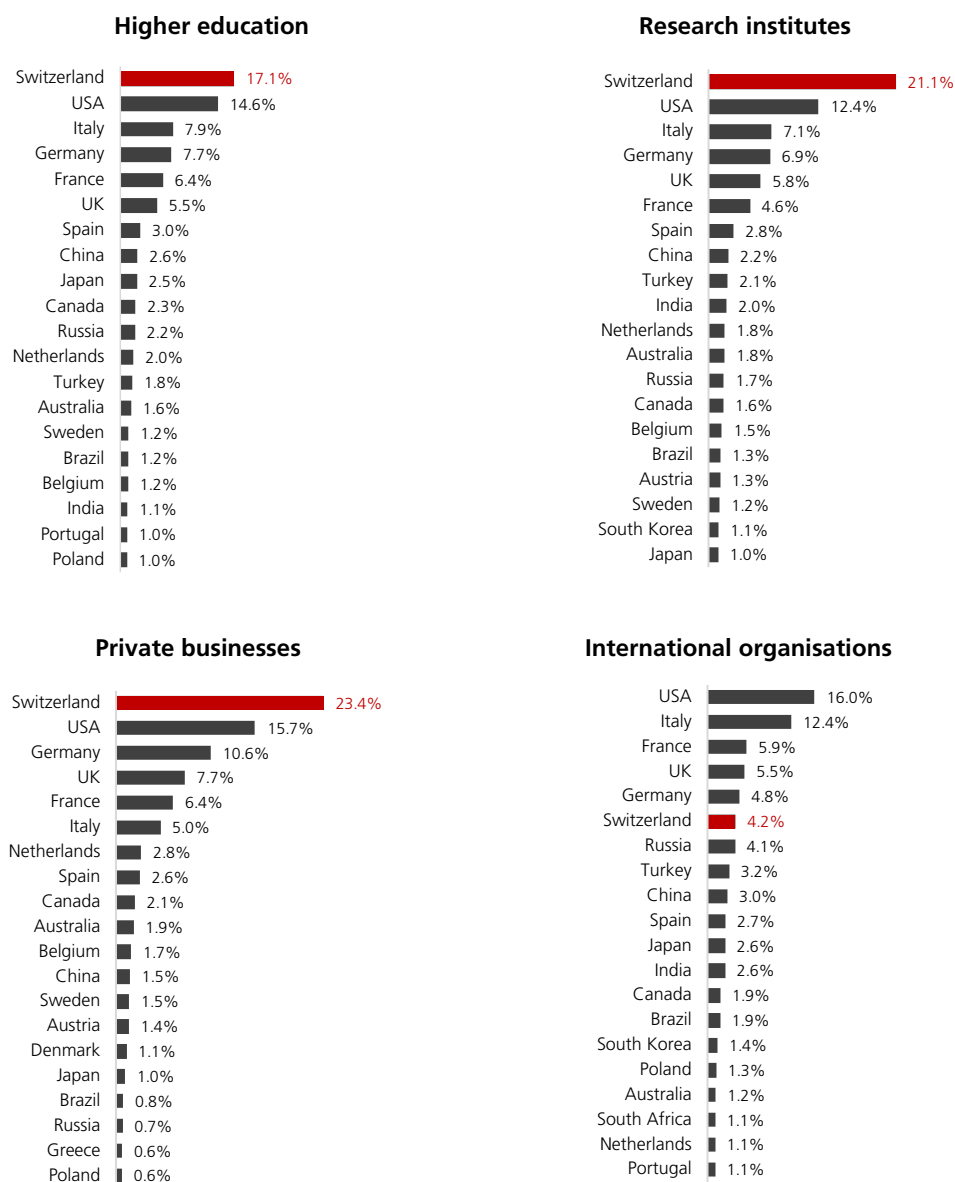
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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1.8.5 Partnerships of institutional sectors by country

Switzerland's institutional sectors mainly collaborate with partners in the United States and the European countries neighbouring Switzerland (Fig. 25).

Figure 25: Origin of the partners of Swiss-based researchers, top 20 countries, 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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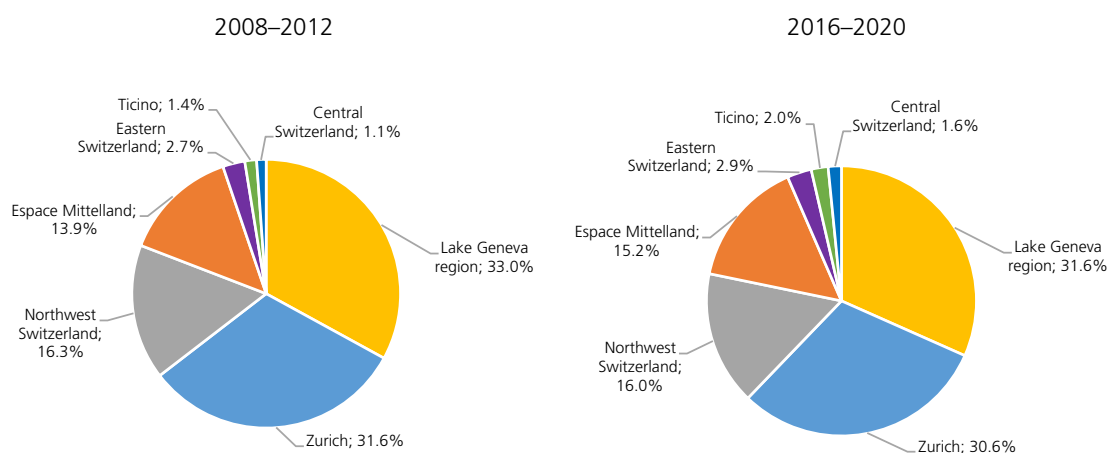
1.9 Regions of Switzerland

1.9.1 Breakdown of publications by region

Swiss publications were broken down into seven regions: the Lake Geneva region, Zurich, Northwest Switzerland, Espace Mittelland, Eastern Switzerland, Ticino, and Central Switzerland (see box overleaf).

The Lake Geneva and Zurich regions produce the vast majority of Switzerland's publications (62% of publications: around 106,600 for the Lake Geneva region and 101,900 for Zurich in 2016–2020). The regions Northwest Switzerland (54,500 publications) and Espace Mittelland (52,000 publications) together produce just over 31%, and the three remaining regions (Eastern Switzerland, Ticino and Central Switzerland) produce the remaining 7%. We can also note that there has been little variation in these percentages, apart from a very slight decline in the shares of the two leading regions (Fig. 26), which together accounted for 65% of Switzerland's publications in 2008–2012.

Figure 26: Publications of Swiss regions as a percentage of Switzerland's total publication output, 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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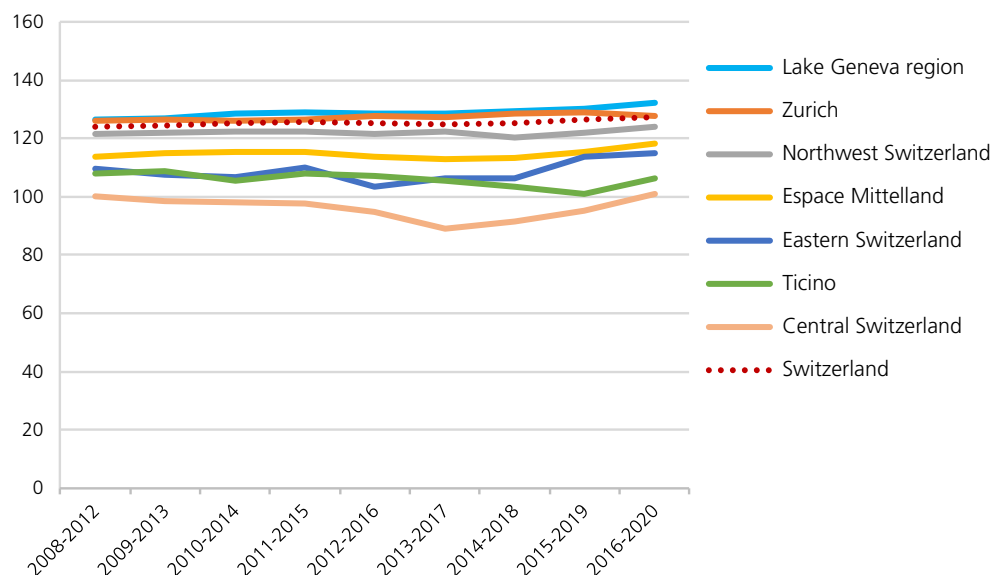
The performances of the regions naturally reflect the research activities of the universities and public or private research institutes that are located there (see annex A.5 for the results by institution).

The publication profiles by research field for the regions can be found in annex A.6.

1.9.2 Impact of Swiss publications by region

The publication impact of all seven Swiss regions exceeded the world average in the 2016–2020 period, with the following results: Lake Geneva region (132), Zurich (128), Northwest Switzerland (124), Espace Mittelland (118), Eastern Switzerland (115), Ticino (106) and Central Switzerland (101) (Fig. 27).

Figure 27: Evolution of the impact of Swiss regions



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Region definitions

The 26 Swiss cantons were grouped into seven regions based on the nomenclature of the Federal Statistical Office:

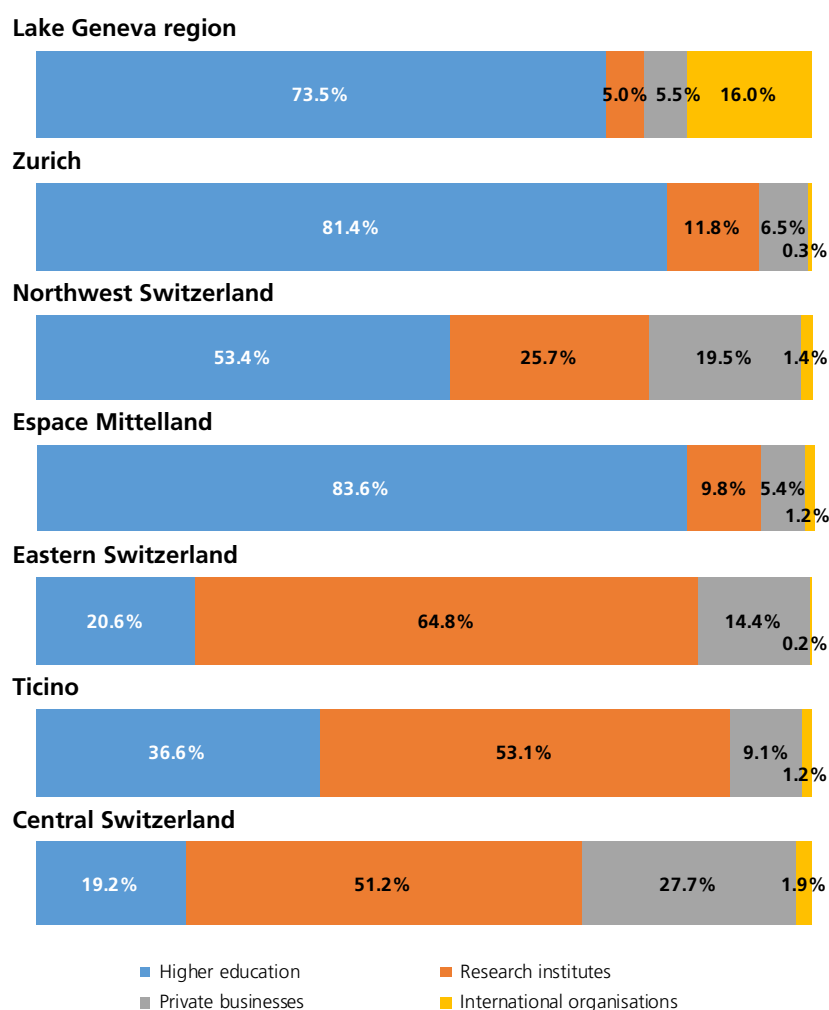
- Lake Geneva region: Geneva, Vaud and Valais
- Zurich: Zurich
- Northwest Switzerland: Aargau, Basel-Stadt and Basel-Landschaft
- Espace Mittelland: Bern, Fribourg, Jura, Neuchâtel and Solothurn
- Eastern Switzerland: Schaffhausen, Appenzell Ausserrhoden, Appenzell Innerrhoden, Thurgau, St Gallen, Glarus and Graubünden
- Ticino: Ticino
- Central Switzerland: Lucerne, Nidwalden, Obwalden, Schwyz, Uri and Zug.

Source: <https://www.bfs.admin.ch/bfs/fr/home/statistiques/themes-transversaux/analyses-spatiales/niveaux-geographiques/regions-analyse.html>

1.9.3 Publications of Swiss regions by institutional sector

The higher education sector in the Lake Geneva region is the most productive, accounting for almost 73.5% of the region's publication output, followed by the international organisations sector (16% of publications; Fig. 28). In the Zurich and Espace Mittelland regions, the higher education sector represented 81.4% and 83.6% respectively of publication output in 2016–2020. In the regions of Eastern Switzerland, Ticino and Central Switzerland, the research institutes sector is very important; this sector is dominated by research institutions of national importance supported by the Confederation.

Figure 28: Publications of Swiss regions by institutional sector, 2016–2020



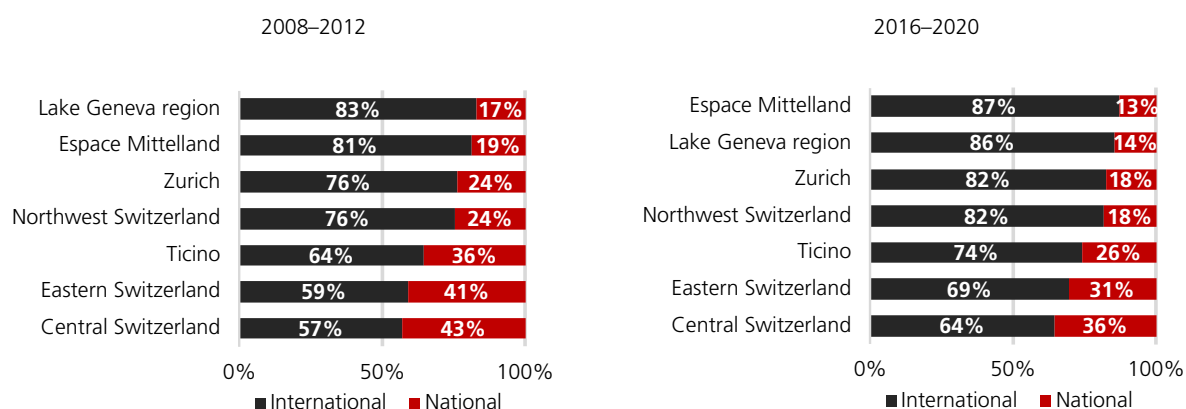
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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1.9.4 National and international partnerships by Swiss region

As is the case for Switzerland as a whole, all Swiss regions have a very high percentage of international partnerships. Two regions, Espace Mittelland and the Lake Geneva region, already had a level of international partnerships above 80% in 2008–2012 (Fig. 29). International partnerships accounted for more than 80% in four regions.

Figure 29: Percentage of national and international partnerships for the seven Swiss regions, 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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The various regions' partnerships by country can be found in annex A.7.

2 Most-cited publications (Top 10%)

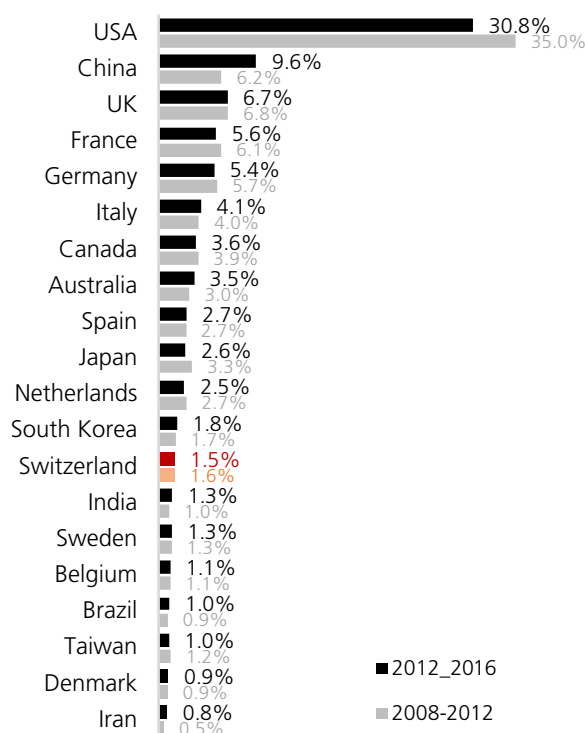
The parts of the report look at all publications, from the least cited to the most cited. Here we focus on a sub-set of publications, the Top 10%, i.e. those which are the most cited (see definition in the box).

2.1 Top 10% publications by country

Switzerland's world share of most-cited publications is 1.5% (Fig. 30). This is greater than Switzerland's world share of total publications (Fig. 8). Switzerland therefore has greater international weight in this Top 10% category, and is ranked 13th.

The United States is the country with the greatest share of Top 10% publications, although this share has fallen over time in the face of competition from other countries such as China, which increased its world share of Top 10% publications from 6.2% to 9.6% between 2008–2012 and 2012–2016.

Figure 30: World share of Top 10% publications by country for the periods 2008–2012 and 2012–2016, for the top 20 countries in 2012–2016



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

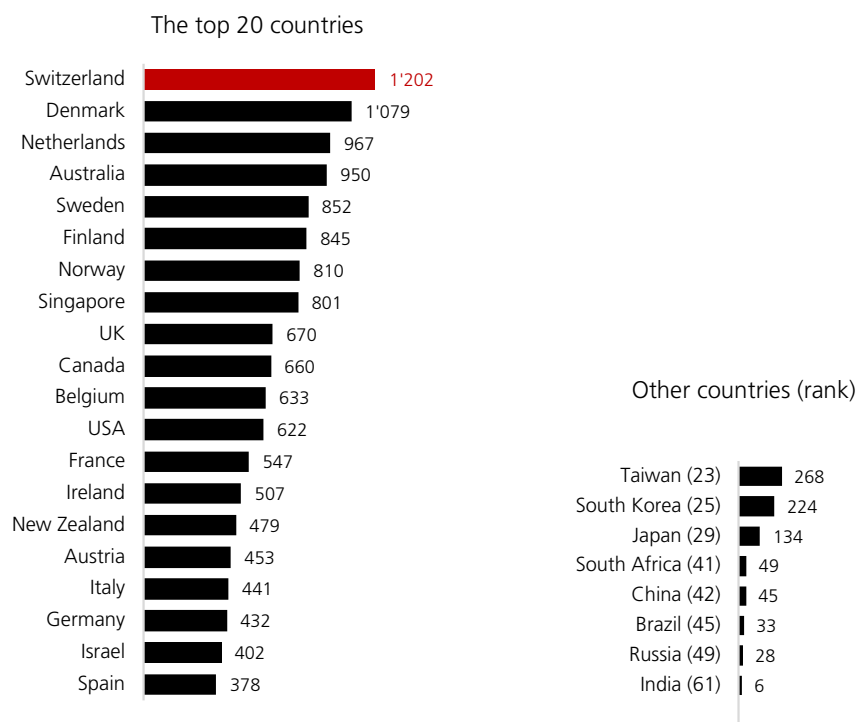
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The figures and world shares of Top 10% publications for 57 countries can be found in a table in annex A.3.

2.2 Top 10% publications by number of inhabitants

Switzerland was in 1st place with 1,202 Top 10% publications per million inhabitants in 2012–2016 (Fig. 31) followed by Denmark and the Netherlands (1,079 and 967 Top 10% publications per million inhabitants). The top spots in this ranking are occupied by relatively small countries, while two very populous countries – the United States and China – are ranked only 12th and 42nd respectively.

Figure 31: Number of Top 10% publications per million inhabitants per year, 2012–2016



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Method used to determine the most cited publications

The method used to count the most cited publications involves two steps:

- First, the number of citations for each publication needs to be counted for the five-year period following the year in which the publication appears.
- These publications are then classified in descending order of citations, and only those which are in the top 10% of this classification are retained (Top 10% publications). The 10% threshold is a convention that is also used in many other studies – although some prefer a 5% or 1% threshold.

Periods of Top 10% publications:

This report draws on a database of publications up to the end of 2020. For the Top 10%, only publications which appeared in 2016 can be taken into account as citations have to be calculated on the basis of a five-year period. This means that the most recent period for Top 10% publications is 2012–2016, not 2016–2020.

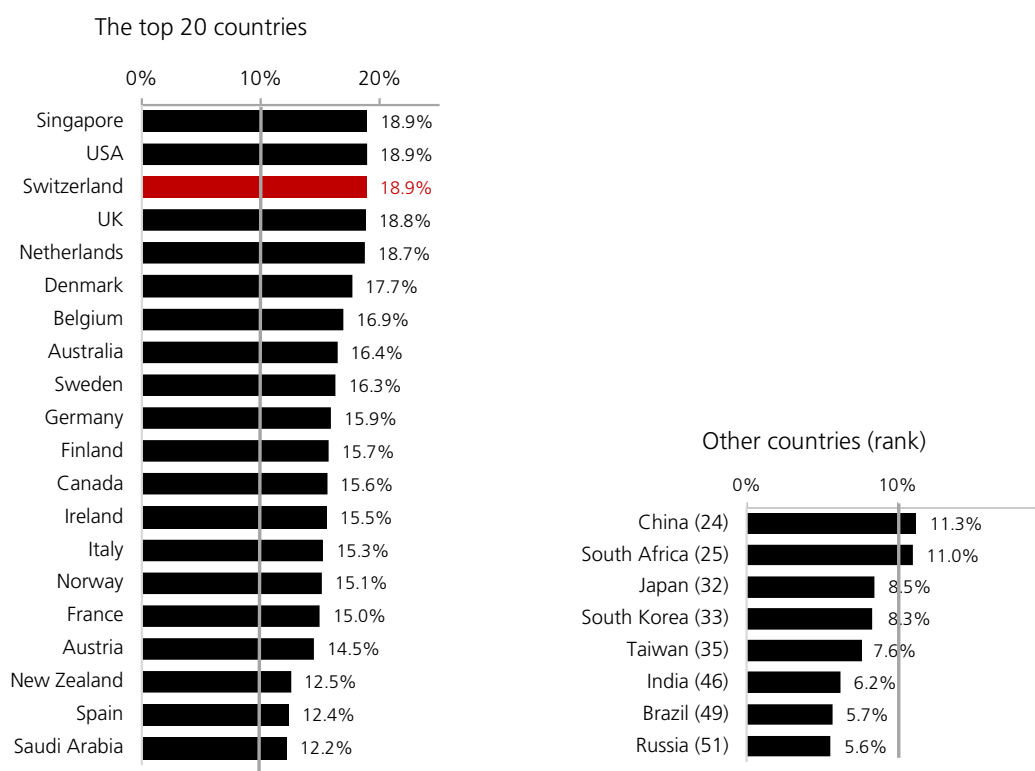
See the method used in annex B.4 and the 2015 SERI report 'Most cited publications: Switzerland's performance 1997–2011'.

2.3 Share of Top 10% publications in a country's publication output

If a country's share of Top 10% publications exceeds the 10% threshold (global performance threshold; see box), this means that that country's research is performing better than the rest of the world.

Switzerland is in joint 1st place with both Singapore and the United States, with 18.9% of its national output in the most-cited publications worldwide (Fig. 32). China slightly exceeded the 10% threshold and is ranked 24th.

Figure 32: Share of Top 10% publications in countries' national publication output, 2012–2016



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Annex A.3 shows, for 57 countries, the shares of Top 10% publications in each country's overall output.

10% threshold to evaluate share of Top 10% publications

Fixing a 10% threshold to demarcate the most cited publications also means fixing a world performance threshold. If the Top 10% publications of a country account for 10% of all its publications, this means that the country is performing as well as the rest of the world. A country that exceeds this threshold, i.e. that has more than 10% of its publications among the most cited publications, is performing better than average, and conversely a country that does not reach this 10% score is performing worse than average. This performance criterion does not depend on country size.

2.4 Share of Top 10% publications in the output of each institutional sector

The international organisations sector produces the largest share of Top 10% publications (Fig. 33). However, all the other institutional sectors also have a significant share of Top 10% publications, ranging from 15.5% for private businesses to 19.0% for higher education.

Figure 33: Share of world Top 10% publications in the output of each institutional sector, 2012–2016

Institutional sector	Share of Top 10% publications in institutional sector's output
Higher education	19.0%
Research institutes	17.6%
Private businesses	15.5%
International organisations	25.9%

Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

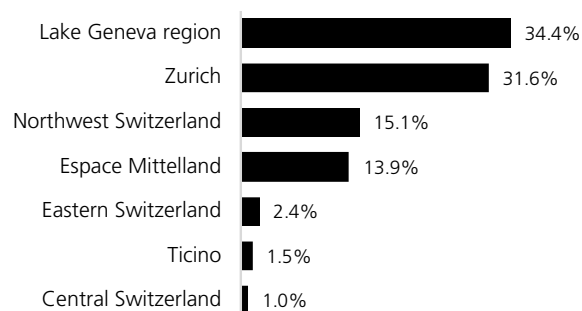
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2.5 Top 10% publications by Swiss region

2.5.1 Breakdown of Top 10% publications by Swiss region

The shares of Top 10% publications by Swiss region more or less mirror the shares of total publications (Fig. 26), with a slight difference in favour of the two major regions whose combined shares represented 66% of Top 10% publications in (Fig. 34).

Figure 34: Breakdown of Swiss Top 10% publications by region, 2012–2016



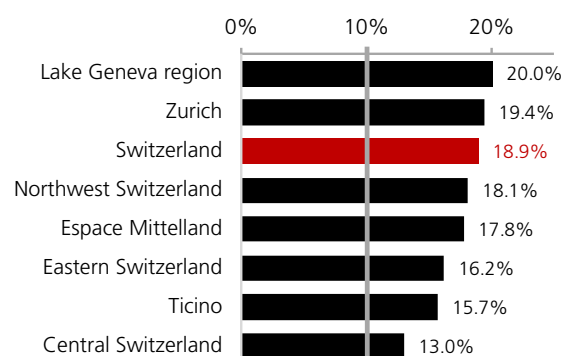
Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI/ESCI), graphic by SERI

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2.5.2 Share of Top 10% publications in the output of each region

The shares of Top 10% publications in the output of Swiss regions also highlight the importance of the two leading regions in Switzerland's scientific production, although the other regions also significantly exceed the 10% threshold (Fig. 35).

Figure 35: Share of Top 10% publications in the publication output of Swiss regions, 2012–2016



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI/ESCI), graphic by SERI

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3 Open access publications

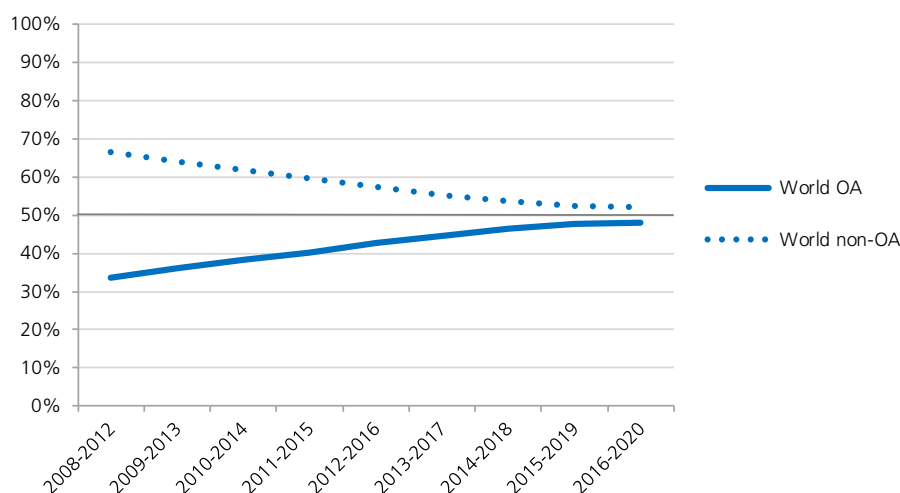
Open access (OA) refers to information that is freely available online. This literature is free of charge and often has less restrictive copyright and licensing restrictions than traditionally published works, for both users and authors. There are several open access publishing options (e.g. gold, green, hybrid); for the purposes of this chapter, these are all grouped together as open access publications with no further distinction.

3.1 OA publications worldwide

The global number of OA publications is steadily increasing, from 5.8 million in 2008–2012 (or about 1.2 million a year) to 15.8 million in 2016–2020 (or about 3.2 million a year).

The share of publications published in OA form in relation to total publications is growing all the time, up from 34% in 2008–2012 to 48% in 2016–2020 (Fig. 24).

Figure 24: OA and non-OA publications as world share of publications for 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Open access publications

Open access publications are publications that are made available to the public online free of charge. There are several open access publishing options:

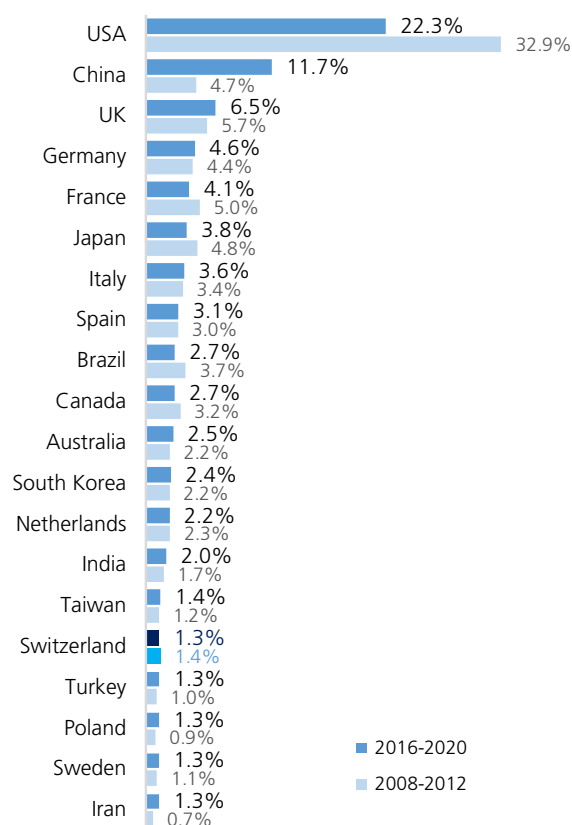
- Gold open access: publications in a freely available journal
- Green open access: publications in a journal that are also available in an open access repository
- Hybrid open access: publications in a subscription journal that are open access with a licence
- Bronze open access: publications that are freely available without a licence in a subscription journal

3.2 Comparison of the volume of OA publications by country

The United States produces the majority of the world's OA publications, but its share is declining (from 32.9% to 22.3%, Fig. 25) as the volume of OA publications from other countries increases, with more and more countries encouraging this publishing option.

In 2008–2012 Switzerland produced 1.4% of the world's OA publications and ranked 15th. In 2016–2020 Switzerland produced 1.3% of the world's OA publications and ranked 16th.

Figure 25: World share of OA publications by country for 2008–2012 and 2016–2020, top 20 countries



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

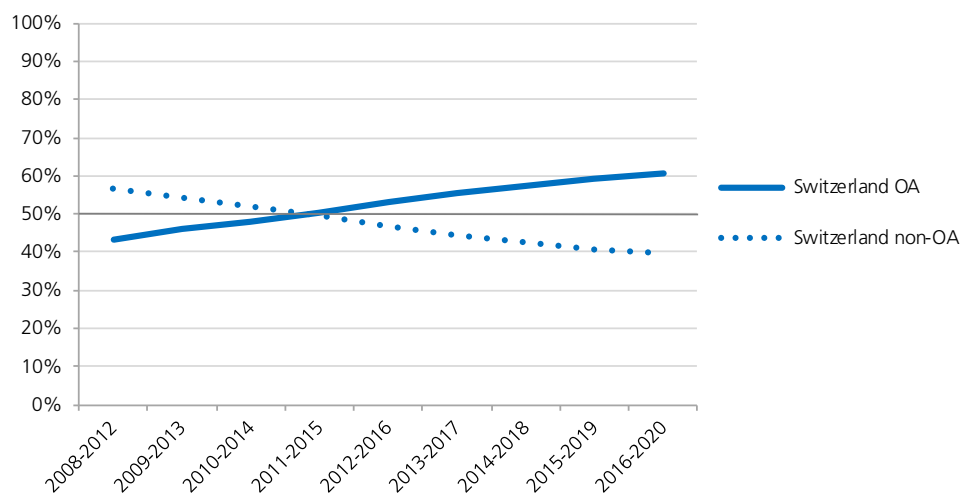
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All countries in the top 20 have increased their absolute number of OA publications in recent years. For example, the United States has seen its absolute number of OA publications rise from 1.9 million in 2008–2012 to 3.5 million in 2016–2020 (x 1.8), China from 0.3 million to 1.8 million (x 6.8). A country like the United States is therefore losing share in worldwide publications because of the stronger growth of other countries. (See annex A.4 for the world volumes and shares of the 50 most productive countries in 2016–2020.)

3.3 Evolution in the share of OA publications in Switzerland

The share of OA publications in Switzerland's total publications, 43% for the period 2008–2012, has been rising steadily, exceeding 50% in 2011–2015 and then reaching 60% in 2016–2020 (Fig. 26).

Figure 26: Evolution of the share of OA and non-OA publications from Switzerland, 2008–2012 to 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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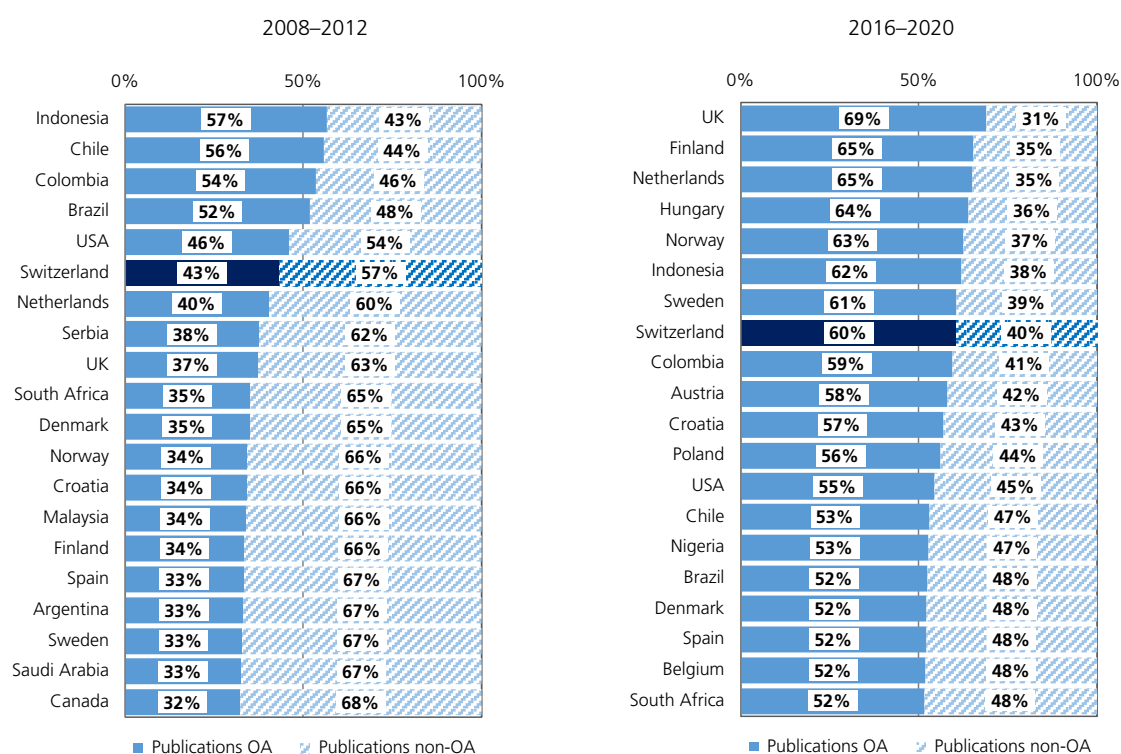
3.4 Comparison of the share of OA publications in countries' publication output

In 2008–2012 only four of the 50 selected countries* had a share of more than 50% of OA publications in their output: Indonesia (57%), Chile (56%), Colombia (54%) and Brazil (52%). These were followed by the United States (46%), Switzerland (43%) and the Netherlands (40%).

The share of OA publications is increasing for all countries, and currently 22 of the selected countries publish more than 50% of their publications in OA form.

In the 2016–2020 period, the UK holds the lead with 69% of its output in the form of OA publications, followed by Finland (65%) and the Netherlands (65%). Switzerland ranks 8th with 60% of its production in OA form (Fig. 27).

Figure 27: Share of OA publications in countries' national output, for 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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*: only the top 50 countries in terms of publications were selected for this indicator.

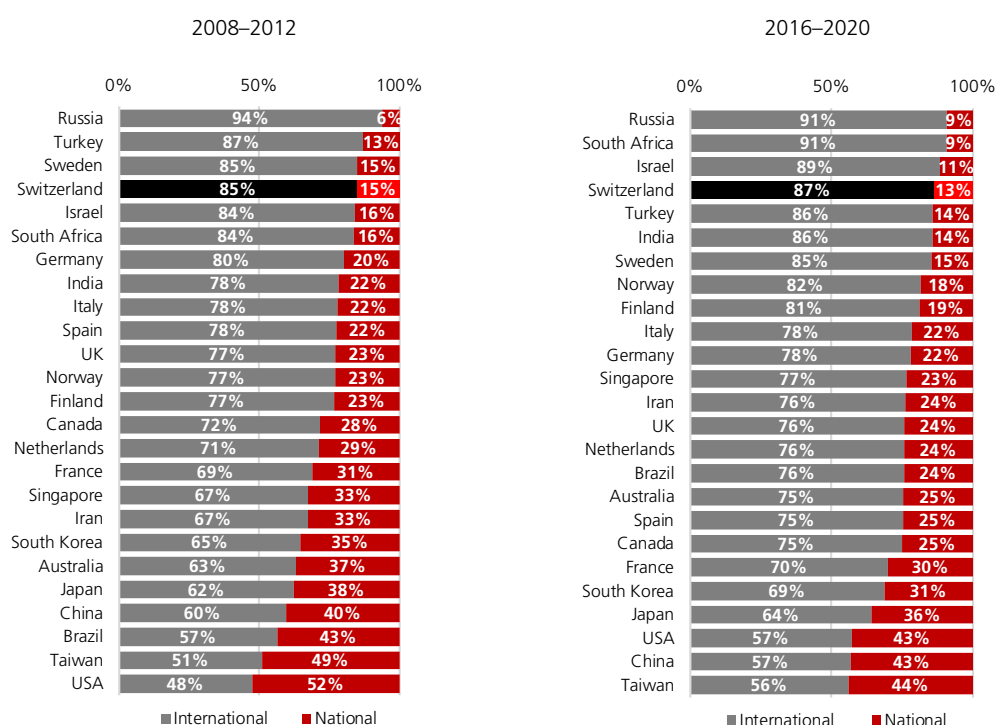
See annex A.4 for the shares of OA publications in the national output of the 50 most productive countries in 2016–2020.

3.5 Partnerships in OA publications

3.5.1 National and international partnership rates for OA publications by country

OA publications also have a very high rate of international collaboration. In 2008–2012 the rate for Switzerland was 85% (Fig. 28), higher than that for publications as a whole (79%, Fig. 12). This rate increased slightly to 87% for 2016–2020, again higher than the overall rate (84%, Fig. 12).

Figure 28: Rate of national and international partnerships in OA publications for a selection of 25 countries, for 2008–2012 and 2016–2020



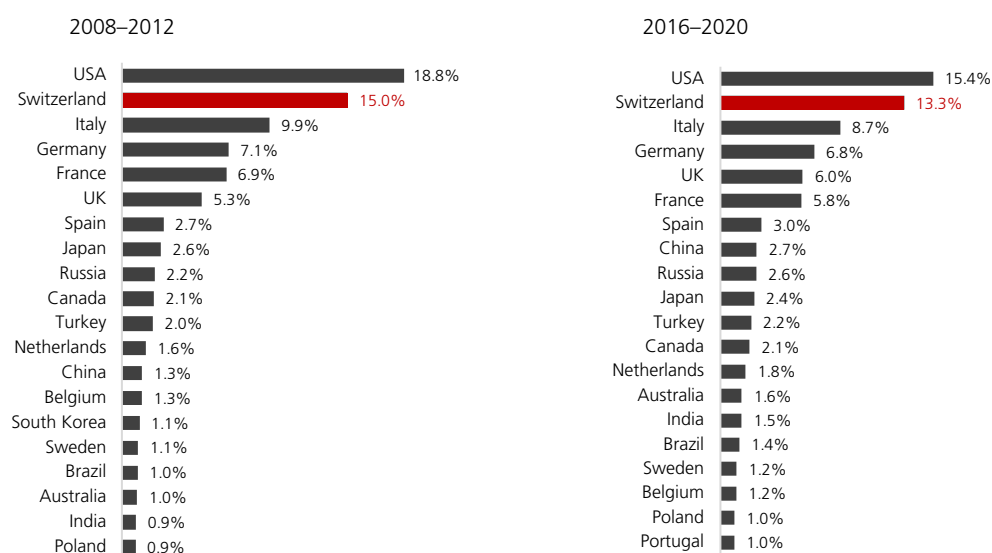
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.5.2 Partnerships in Swiss OA publications

The leading partner for Swiss researchers is the United States with 18.8% in 2008–2012 and 15.4% in 2016–2020 (Fig. 29). As with total publications (see Fig. 13), neighbouring countries are the second most important partners for Swiss researchers.

Figure 29: Origin of partners in OA publications of Swiss-based researchers as a percentage of Switzerland's total OA partnerships, top 20 countries, 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

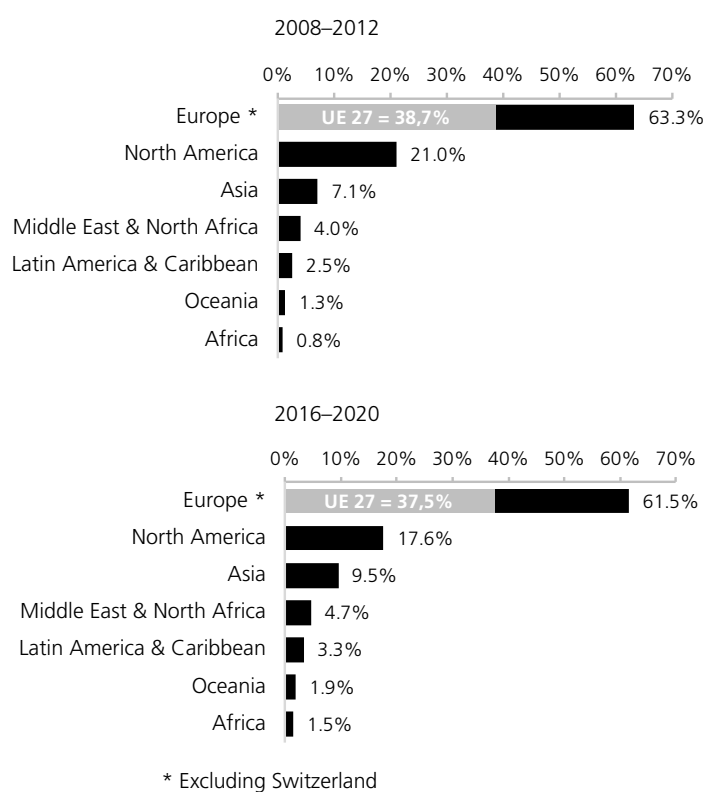
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3.5.3 Partnerships of Swiss OA publications by major region

As for total publications (see Fig. 14), the region with which Swiss researchers collaborate most is Europe, with 63.3% in 2008–2012 and 61.5% in 2016–2020 (Fig. 30). This share of collaboration (and that with North America) is decreasing slightly as collaboration with other regions grows.

Partnerships with the EU 27 decreased slightly from 38.7% in 2008–2012 to 37.5% in 2016–2020.

Figure 30: Origin of partners in OA publications of Swiss-based researchers as a percentage of Switzerland's total OA partnerships, by major region, for 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

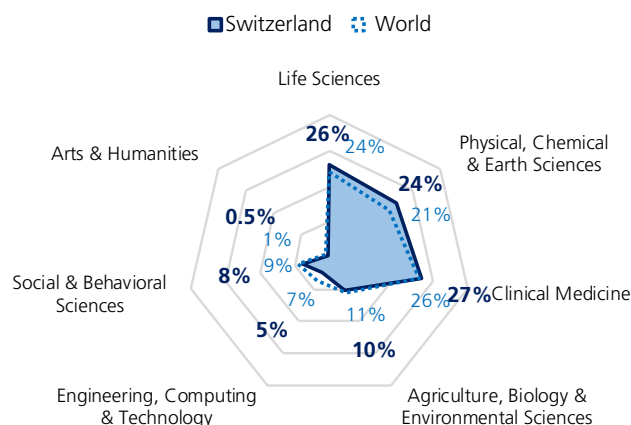
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3.6 OA publications by research area

3.6.1 Publication profile by research field

The breakdown of OA publications over the seven research fields is similar to that for total publications (see Fig. 15). The three largest are Clinical Medicine (27% of Swiss OA publications) followed by Life Sciences (26%) and Physical, Chemical & Earth Sciences (24%) (Fig. 31).

Figure 31: Breakdown of OA publications by research field, Switzerland and the world, 2016–2020



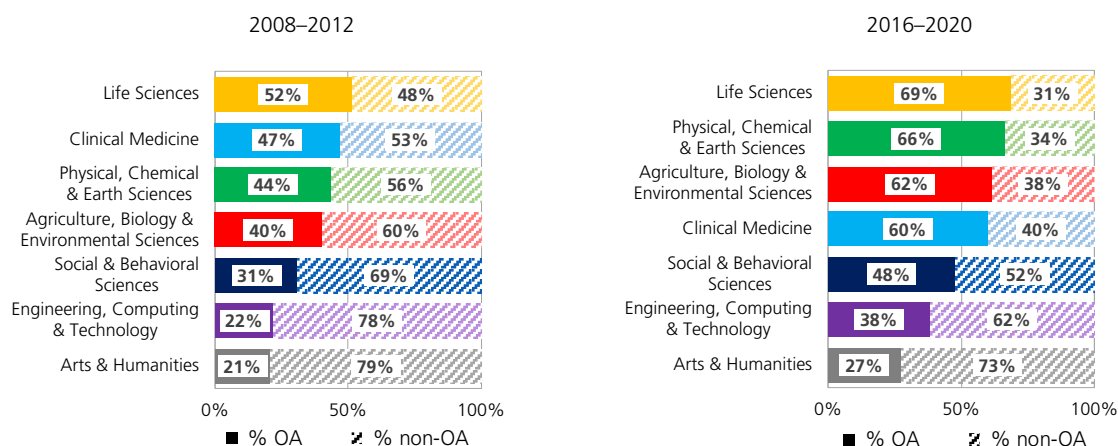
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.6.2 OA publications as a percentage of publications in the research field

In Switzerland, Life Sciences is the field with the largest share of its output in the form of OA publications: 69% in 2016–2020. This is followed by Physical, Chemical & Earth Sciences (66%), Agriculture, Biology & Environmental Sciences (62%) and Clinical Medicine (60%). The other three fields publish less than 50% in OA form (Fig. 32) but have nonetheless shown a significant increase since the beginning of the entire period under review.

Figure 32: Share of OA and non-OA publications by research field, periods 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.7 OA publications by institutional sector

3.7.1 Breakdown of OA publications by institutional sector

The breakdown of OA publications across the four institutional sectors is almost identical to the overall breakdown (see Fig. 21), i.e. 70.4% by higher education, followed by 14.8% by research institutes, 7.9% by private businesses and 6.9% by international organisations (Fig. 33).

Figure 33: Breakdown of Swiss OA publications by institutional sector, Switzerland and the world, 2016–2020



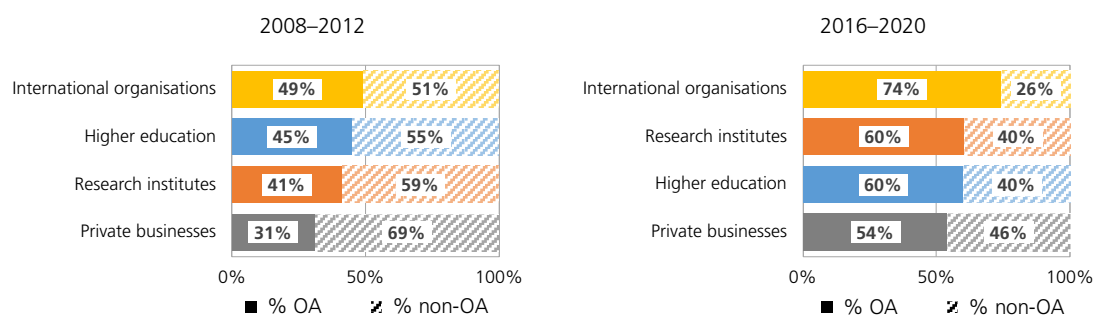
Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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3.7.2 Share of OA publications by institutional sector

In 2008–2012 the share of OA publications for all institutional sectors was less than 50% (Fig. 34). This share increased since then and, in the 2016–2020 period, all sectors published more in OA than in non-OA form, ranging from 74% (international organisations) to 54% (private businesses).

Figure 34: Share of OA and non-OA publications by institutional sector, 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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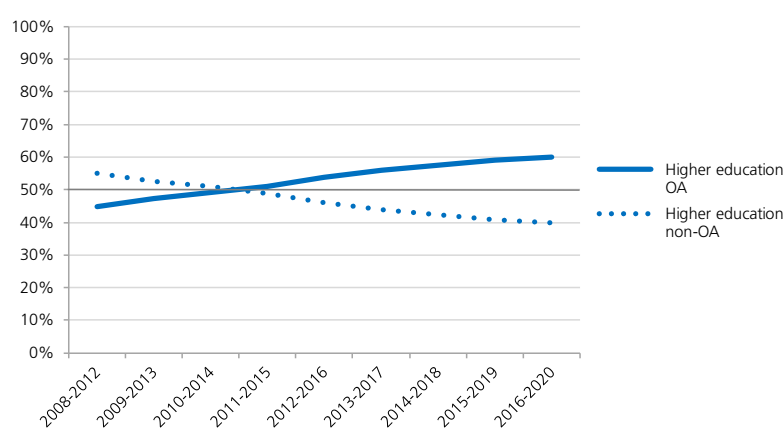
3.7.3 Evolution of the breakdown of OA publications by institutional sector

Today all four institutional sectors have more than 50% OA publications but differ in their development of open access. The higher education and research institute sectors are similar, but quite different from international organisations and private businesses.

3.7.3.1 Higher education

In 2008–2012 the share of OA publications from higher education was 45%, increasing then to over 50% in 2011–2015, and currently stands at 60% for 2016–2020 (Fig. 35).

Figure 35: Share of OA and non-OA publications in the output of the higher education sector, evolution from 2008–2012 to 2016–2020



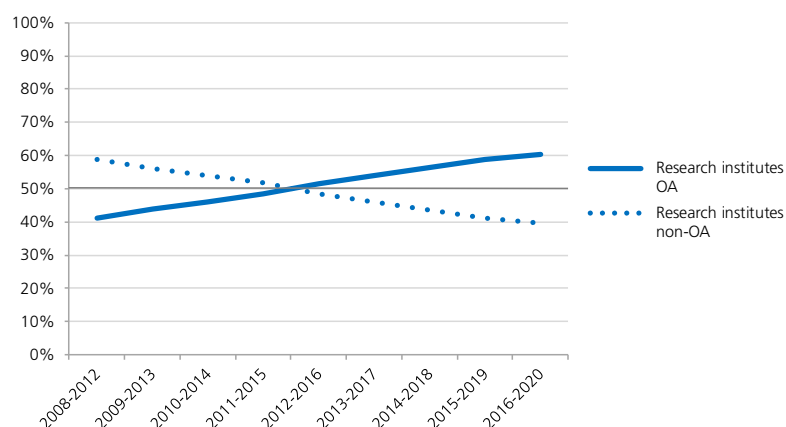
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.7.3.2 Research institutes

In 2008–2012 the share of OA publications from research institutes was 41%, exceeding 50% in 2012–2016, and currently stands at 60% (Fig. 36).

Figure 36: Share of OA and non-OA publications in the output of the research institutes sector, evolution from 2008–2012 to 2016–2020



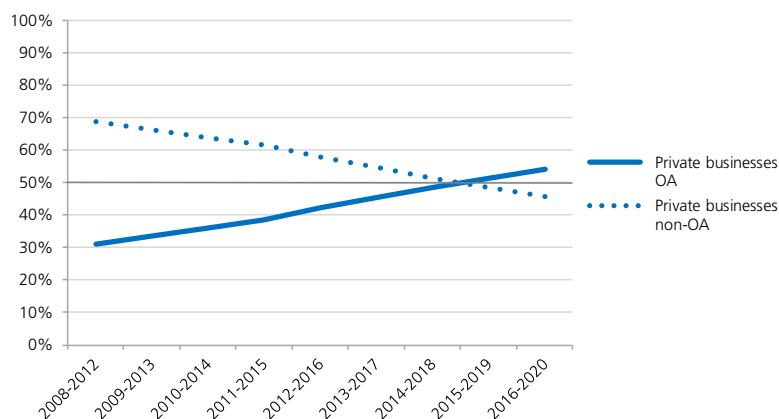
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.7.3.3 Private businesses

In 2008–2012 the share of OA publications from private businesses was 31%, increasing steadily to over 50% in 2015–2019, and currently stands at 54% (Fig. 37).

Figure 37: Share of OA and non-OA publications in the output of the private businesses sector, evolution from 2008–2012 to 2016–2020



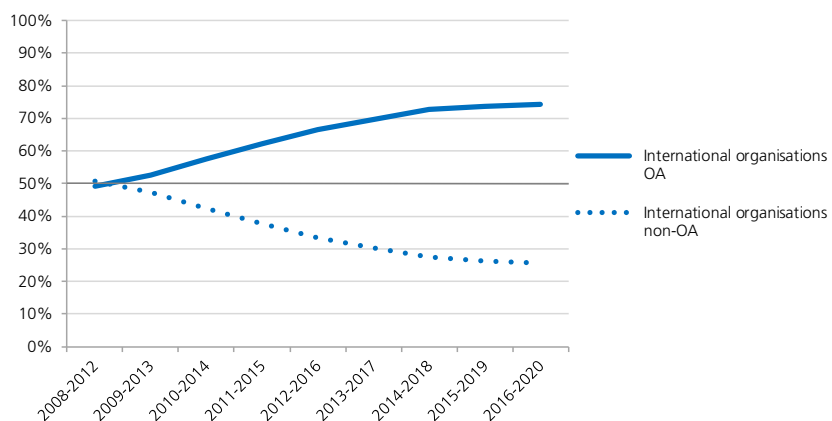
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.7.3.4 International organisations

In 2008–2012 the share of OA publications from international organisations was 49%, increasing rapidly to over 50% in 2009–2013, and currently stands at 74% (Fig. 38).

Figure 38: Share of OA and non-OA publications in the output of the international organisations sector, evolution from 2008–2012 to 2016–2020



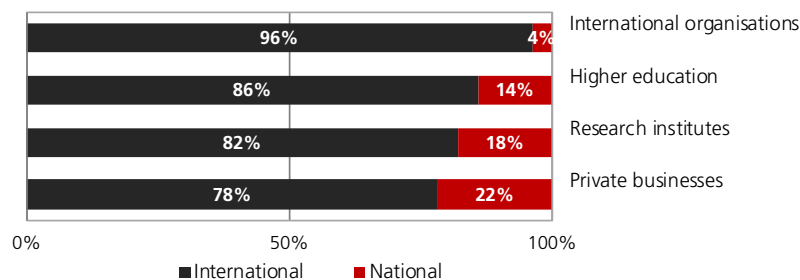
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.7.4 National and international OA partnerships by institutional sector

As with total publications (Fig. 24), OA publications from the institutional sectors are highly international (Fig. 39).

Figure 39: National and international partnership rate of OA publications from institutional sectors in Switzerland, 2016–2020



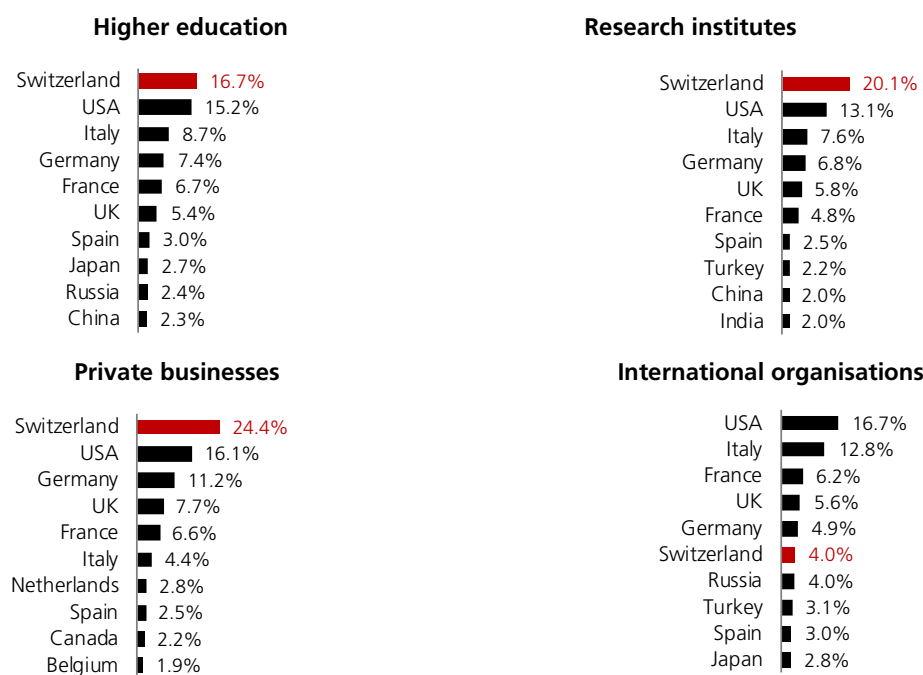
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.7.5 Partnerships in OA publications per institutional sector by country

The main foreign partners of Swiss institutional sectors are the United States and Switzerland's European neighbours (Fig. 40).

Figure 40: Origin of the partners in OA publications of Swiss-based researchers, by institutional sector, 2016–2020, top 10 countries



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

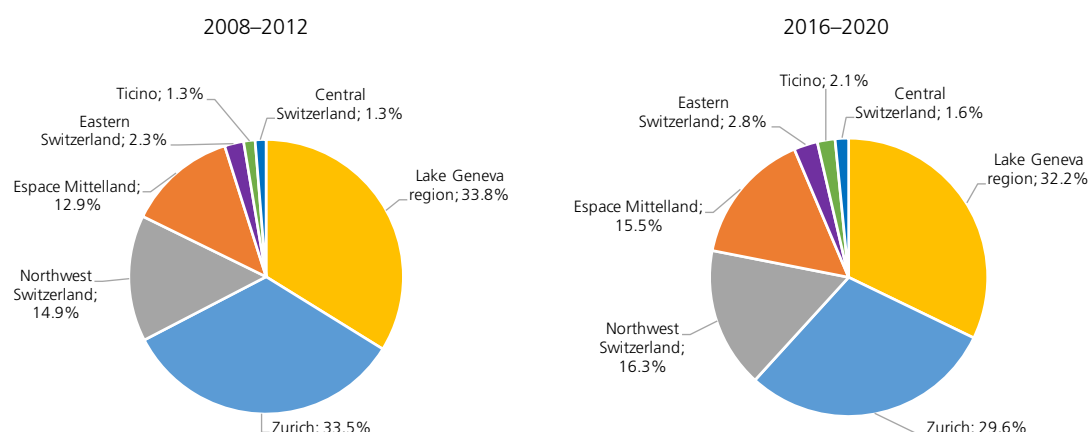
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3.8 Swiss OA publications by region

3.8.1 Breakdown of Swiss OA publications by region

The breakdown of OA publications by region is very similar to that of total publications (see Fig. 26), with the Lake Geneva and Zurich regions leading the way (Fig. 41).

Figure 41: OA publications of Switzerland's regions as a percentage of total Swiss OA publications, 2008–2012 and 2016–2020



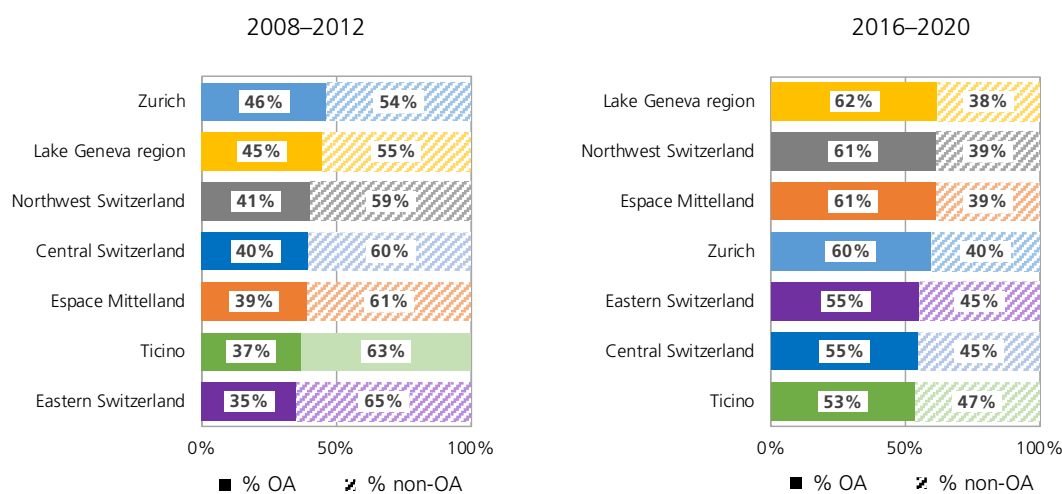
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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3.8.2 Share of OA publications by region

The share of OA publications was below 50% for all regions in Switzerland in 2008–2012 (Fig. 42). As of the 2016–2020 period, all regions publish more in OA than non-OA form, with over 60% for the Lake Geneva region, Northwest Switzerland, Espace Mittelland and Zurich, and between 50% and 55% for Eastern Switzerland, Central Switzerland and Ticino.

Figure 42: Share of OA and non-OA publications by research field, 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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4 Case study: Quantum publications

A keyword search was conducted in the database and publications with the word 'quantum' in their title and journals with the word 'quantum' in their name were extracted. While the term 'quantum' appears in publications from philosophy, social sciences and history, these have not been included in this study as our focus here is on quantum science, computing, technology and physics (i.e. the 'hard sciences').

This chapter presents the number of publications (in peer-reviewed journals in the Clarivate Analytics database) at the country level, at the level of institutional sectors in Switzerland as well as the top publishing Swiss institutions, the impact of publications (i.e. the relative citation indicator) and the rate of national/international collaboration and collaboration with other countries.

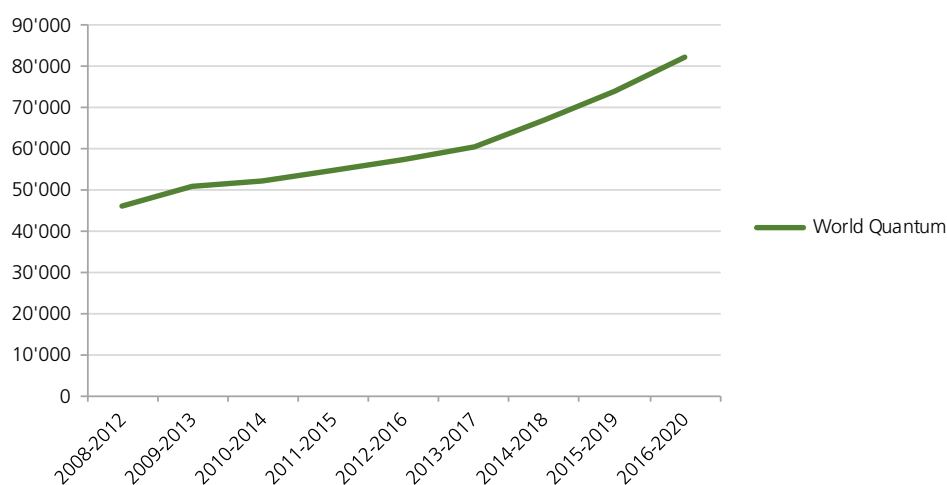
4.1 Quantum publications

4.1.1 Worldwide quantum publications

The number of quantum publications worldwide is steadily increasing and has almost doubled (x 1.8) since the first period under review, from 42,000 publications to some 82,200 publications in 2016–2020. Growth has been strongest since the period 2013–2017 and beyond (Fig. 43).

Quantum publications represent about 0.25% of the world's total scientific publications.

Figure 43: Evolution of quantum publications worldwide, from 2008–2012 to 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

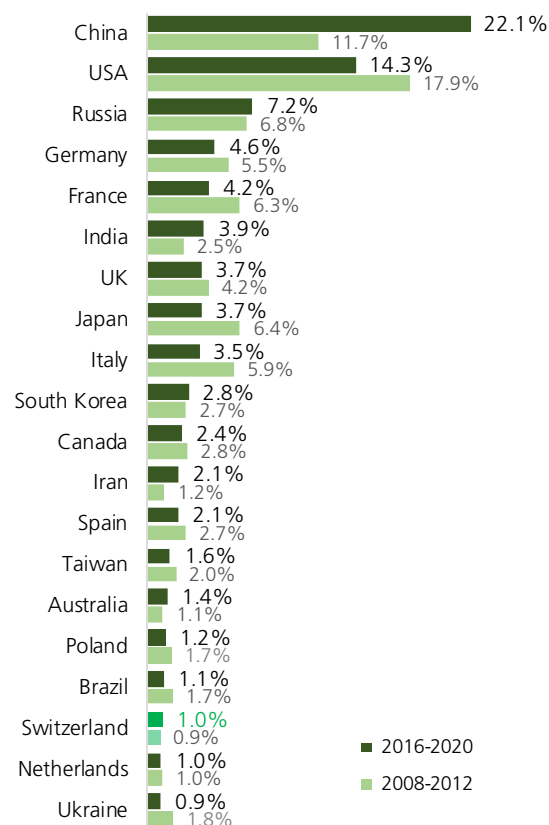
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4.1.2 Switzerland in the world ranking of quantum publications by country

In 2008–2012 the United States was the largest producer of quantum publications (17.9% of world share) but since then has been overtaken by China with a share of 22.1% in 2016–2020 (Fig. 44).

Switzerland increased its world share of quantum publications slightly from 0.9% in 2008–2012 to 1% in 2016–2020. It thus ranked 18th among the countries producing quantum publications in 2016–2020.

Figure 44: World share of quantum publications by country for 2008–2012 and 2016–2020, top 20 countries in 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

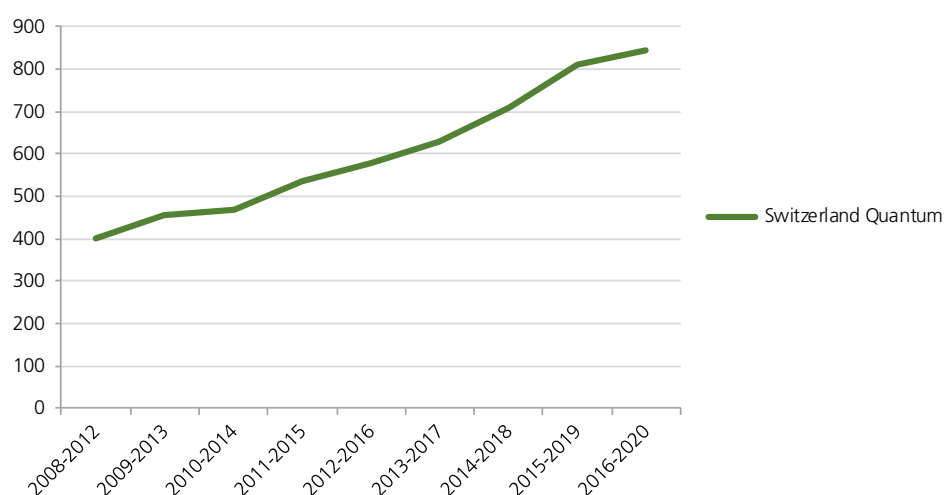
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As of 2016–2020, Switzerland is producing 1% of the world's total scientific publications (see Fig. 8), meaning that its share in the output of quantum publications is proportionate. On the other hand, while the United States is the main producer of total publications, followed by China, the situation is the opposite for quantum publications.

4.1.3 Quantum publications in Switzerland

As at the worldwide level (see Fig. 43), the number of quantum publications from Switzerland has also been rising steadily since the beginning of the overall period under review, from 399 publications in 2008–2012 to 845 publications in 2016–2020 (x 2.1). The rate of growth has slowed down in the most recent period (Fig. 45).

Figure 45: Evolution of quantum publications in Switzerland, from 2008–2012 to 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

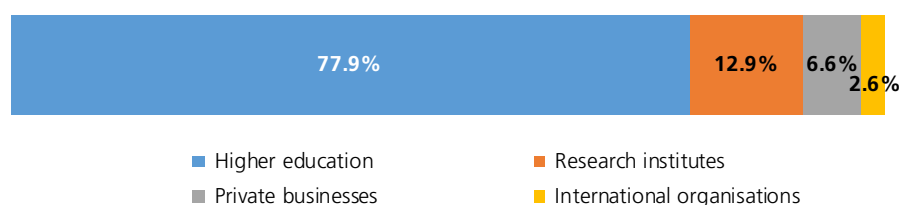
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As at the worldwide level, quantum publications from Switzerland represent about 0.25% of total Swiss publications.

4.1.4 Quantum publications from Switzerland by institutional sector

In 2016–2020, the higher education sector produced the largest share of Switzerland's quantum publications (77.9%), followed by research institutes (12.9%), private businesses (6.6%) and international organisations (2.6%) (Fig. 46).

Figure 46: Breakdown of Swiss quantum publications by institutional sector, 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

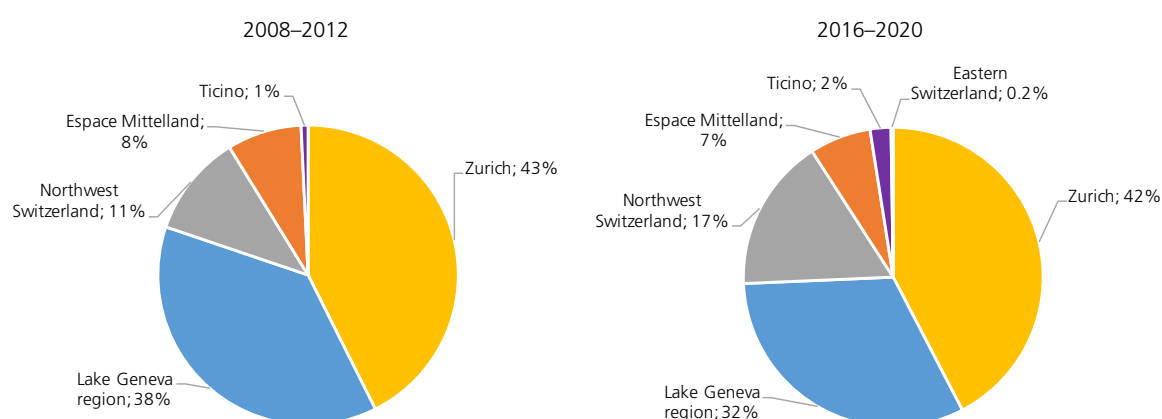
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This share of higher education in this type of publication is greater than for total publications, where this sector produces 70.8% of Switzerland's total output (Fig. 21).

4.1.5 Swiss quantum publications by region

The Zurich and Lake Geneva regions produce the vast majority of Switzerland's quantum publications, with 42% and 32% respectively in 2016–2020; both regions have lost – albeit in different ways – their (relative) position compared to 2008–2012. The remaining 26% is distributed as follows in terms of size: Northwest Switzerland 17% (showing the largest growth compared to 2008–2012), Espace Mittelland 7%, Ticino 2% and Eastern Switzerland 0.2% (Fig. 47).

Figure 47: Quantum publications of Switzerland's regions as a percentage of total Swiss publications, 2008–2012 and 2016–2020



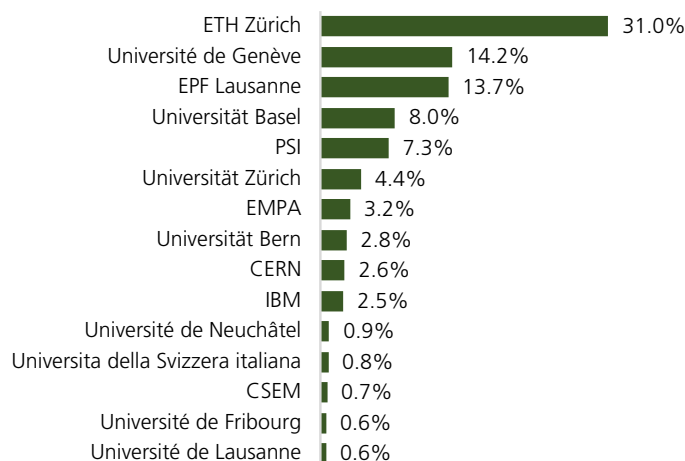
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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4.1.6 Swiss quantum publications by institution

In 2016–2020 the number of Swiss institutions with at least one publication meeting the quantum criteria is 47 institutions. ETH Zurich produces 31.0% of Switzerland's quantum publications, followed by the University of Geneva (14.2%) and EPFL (13.7%) (Fig. 48).

Figure 48: Share of quantum publications for the top 15 institutions in Switzerland, 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

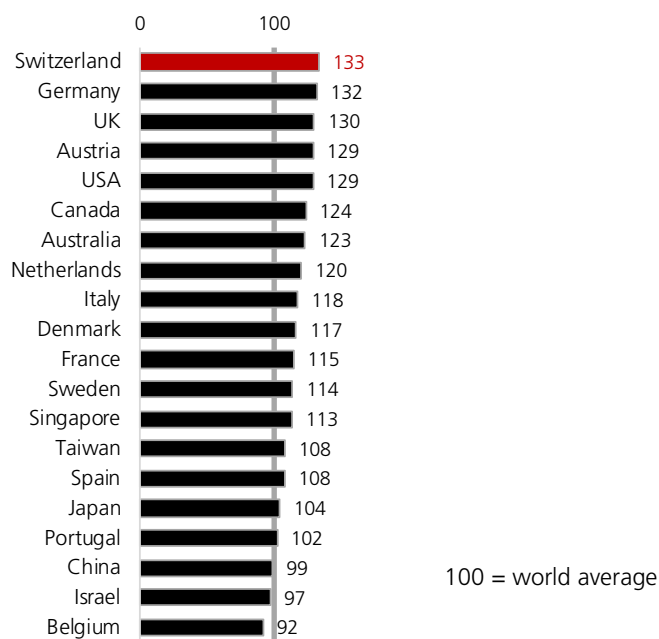
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4.2 Impact of quantum publications

4.2.1 Impact of Swiss quantum publications in a global comparison

Switzerland has fared very well in terms of the impact of quantum publications, taking the lead over Germany and the UK in 2016–2020, with an impact that was 33 points above the world average of 100 (Fig. 49).

Figure 49: Impact indicator for quantum publications, 2016–2020



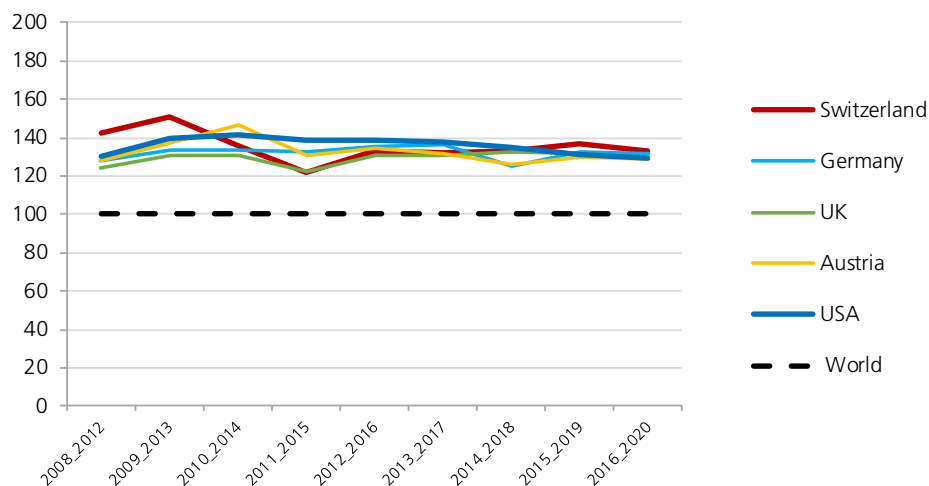
Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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4.2.2 Evolution of the impact of quantum publications for the top 5 countries

The impact of Swiss quantum publications is consistently well above the world average throughout the periods studied (Fig. 50).

Figure 50: Evolution of the impact of quantum publications for the top 5 countries



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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NB: Given the low numbers of quantum publications (for Switzerland and Austria), the variations in impact between periods can be significant.

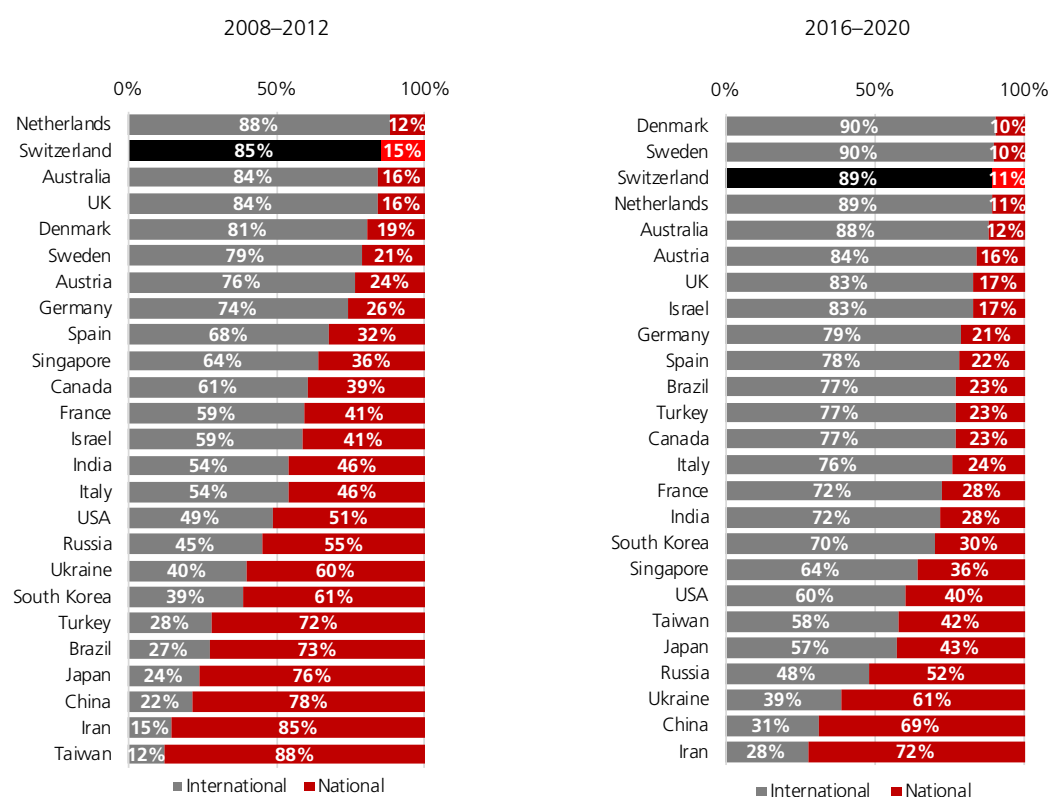
4.3 Partnerships in quantum publications

4.3.1 National and international partnership rates for quantum publications by country

The rate of international collaboration for Swiss quantum publications has consistently been very high: 85% in 2008–2012, increasing to 89% in 2016–2020 (Fig. 51).

The rate of international collaboration is increasing for all countries. As of 2016–2020, only four countries (Russia, Ukraine, China and Iran) still have a higher rate of national than international cooperation.

Figure 51: Rate of national and international partnerships in quantum publications for a selection of 25 countries, for 2008–2012 and 2016–2020



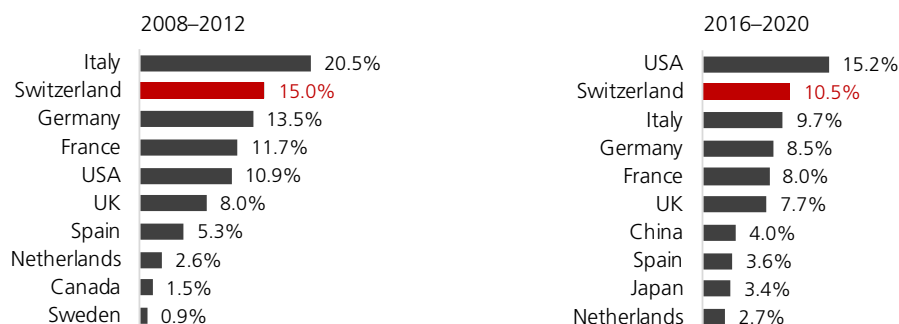
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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4.3.2 Partnerships in Swiss quantum publications

In 2008–2012 Swiss quantum researchers collaborated mainly with neighbouring countries: Italy (20.5%), Germany (13.5%), France (11.7%), followed by the United States (10.9%) (Fig. 52). In 2016–2020, the United States moved up to Switzerland's main partner for quantum publications (15.2%), followed by Italy (9.7%), Germany (8.5%) and France (8.0%).

Figure 52: Origin of partners in quantum publications of Swiss-based researchers as a percentage of Switzerland's total partnerships, top 10 countries, for 2008–2012 and 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Annexes

A Detailed results

A. 1 Volume and global share of publications

The 60 countries selected are the top 60 in terms of publication volume in 2016–2020. The table compares the first and the last periods.

Figure 53: Volume and world share of publications for 60 countries in alphabetical order

Country	Number of publications (rounded figures)		World share of publications	
	2008–2012	2016–2020	2008–2012	2016–2020
Algeria	13 900	45 900	0.1%	0.1%
Argentina	93 600	156 200	0.5%	0.5%
Australia	441 900	923 000	2.5%	2.8%
Austria	102 500	171 300	0.6%	0.5%
Bangladesh	10 000	31 400	0.1%	0.1%
Belgium	157 200	256 700	0.9%	0.8%
Brazil	419 100	820 800	2.4%	2.5%
Bulgaria	19 500	29 200	0.1%	0.1%
Canada	580 300	944 900	3.3%	2.9%
Chile	49 200	128 300	0.3%	0.4%
China	1 431 200	5 125 500	8.3%	15.6%
Colombia	36 200	83 100	0.2%	0.3%
Croatia	37 200	53 000	0.2%	0.2%
Czech Republic	88 600	156 600	0.5%	0.5%
Denmark	113 500	234 100	0.7%	0.7%
Egypt	50 900	174 700	0.3%	0.5%
Ethiopia	5 300	33 000	0.03%	0.1%
Finland	114 500	181 400	0.7%	0.6%
France	947 900	1 420 300	5.5%	4.3%
Germany	854 200	1 404 700	4.9%	4.3%
Greece	104 600	139 400	0.6%	0.4%
Hungary	53 800	90 000	0.3%	0.3%
India	415 800	985 300	2.4%	3.0%
Indonesia	14 600	74 100	0.1%	0.2%
Iran	192 400	609 800	1.1%	1.9%
Ireland	57 200	103 100	0.3%	0.3%
Israel	114 100	177 400	0.7%	0.5%
Italy	652 700	1 160 300	3.8%	3.5%
Japan	874 100	1 225 200	5.0%	3.7%
Malaysia	60 500	175 400	0.3%	0.5%
Mexico	99 900	227 200	0.6%	0.7%
Morocco	14 300	39 600	0.1%	0.1%
Netherlands	329 800	534 600	1.9%	1.6%
New Zealand	65 700	111 500	0.4%	0.3%
Nigeria	25 100	63 500	0.1%	0.2%
Norway	100 800	184 600	0.6%	0.6%
Pakistan	46 800	193 300	0.3%	0.6%
Poland	182 100	356 800	1.1%	1.1%
Portugal	98 100	219 000	0.6%	0.7%
Romania	62 200	118 400	0.4%	0.4%

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Figure 53 (cont.): Volume and world share of publications for 60 countries in alphabetical order

Country	Number of publications (rounded figures)		World share of publications	
	2008–2012	2016–2020	2008–2012	2016–2020
Russia	253 200	557 400	1.5%	1.7%
Saudi Arabia	33 500	180 000	0.2%	0.5%
Serbia	42 200	67 400	0.2%	0.2%
Singapore	77 100	153 600	0.4%	0.5%
Slovakia	25 300	47 300	0.1%	0.1%
Slovenia	29 500	42 900	0.2%	0.1%
South Africa	78 700	176 400	0.5%	0.5%
South Korea	485 100	845 600	2.8%	2.6%
Spain	524 300	924 100	3.0%	2.8%
Sweden	187 900	327 000	1.1%	1.0%
Switzerland	189 300	339 200	1.1%	1.0%
Taiwan	330 300	443 700	1.9%	1.4%
Thailand	56 400	126 800	0.3%	0.4%
Tunisia	23 700	50 700	0.1%	0.2%
Turkey	260 500	479 200	1.5%	1.5%
UK	892 300	1 487 200	5.1%	4.5%
Ukraine	43 900	79 900	0.3%	0.2%
United Arab Emirates	7 700	32 300	0.04%	0.1%
USA	4 164 200	6 443 100	24.0%	19.6%
Vietnam	9 700	74 900	0.1%	0.2%

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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A. 2 Impact

The table below shows the publication impact for the same countries and periods as for publication volume (Fig. 53)

Figure 54: Impact of 60 countries, in alphabetical order

Country	Impact	
	2008–2012	2016–2020
Algeria	58	56
Argentina	71	71
Australia	112	111
Austria	105	105
Bangladesh	61	59
Belgium	117	118
Brazil	65	65
Bulgaria	54	52
Canada	113	114
Chile	68	69
China	75	74
Colombia	31	31
Croatia	59	60
Czech Republic	83	81
Denmark	119	119
Egypt	62	63
Ethiopia	75	69
Finland	110	112

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Figure 54 (cont.): Impact of 60 countries, in alphabetical order

Country	Impact	
	2008–2012	2016–2020
France	106	108
Germany	110	109
Greece	91	93
Hungary	82	81
India	69	68
Indonesia	39	37
Iran	67	66
Ireland	105	108
Israel	103	104
Italy	98	98
Japan	89	89
Malaysia	63	63
Mexico	60	60
Morocco	49	51
Netherlands	125	127
New Zealand	106	107
Nigeria	47	48
Norway	111	111
Pakistan	70	66
Poland	59	59
Portugal	90	89
Romania	54	51
Russia	45	44
Saudi Arabia	55	57
Serbia	58	57
Singapore	106	110
Slovakia	66	64
Slovenia	83	83
South Africa	88	86
South Korea	78	78
Spain	90	91
Sweden	113	114
Switzerland	124	125
Taiwan	82	84
Thailand	74	75
Tunisia	58	62
Turkey	62	61
UK	122	123
Ukraine	42	39
United Arab Emirates	69	72
USA	123	124
Vietnam	70	66

Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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A. 3 Top 10% publications

Top 10% publications for the 57 countries that meet the selection criteria (see annex B.4)

Figure 55: World share of Top 10% publications and share of Top 10% publications in national publication output, for 57 countries, in alphabetical order

Country	World share of Top 10% publications		Share of Top 10% publications in national publication output	
	2008–2012	2012–2016	2008–2012	2012–2016
Algeria	0.03%	0.04%	4.8%	5.0%
Argentina	0.3%	0.3%	6.3%	6.5%
Australia	3.0%	3.5%	16.0%	16.4%
Austria	0.6%	0.6%	14.4%	14.5%
Belgium	1.1%	1.1%	16.9%	16.9%
Brazil	0.9%	1.0%	4.9%	5.7%
Bulgaria	0.04%	0.05%	5.1%	6.3%
Canada	3.9%	3.6%	15.6%	15.6%
Chile	0.2%	0.2%	7.9%	9.1%
China	6.2%	9.6%	10.1%	11.3%
Colombia	0.1%	0.1%	4.3%	5.6%
Croatia	0.1%	0.1%	5.0%	7.1%
Czech Republic	0.3%	0.3%	8.8%	9.2%
Denmark	0.9%	0.9%	18.1%	17.7%
Egypt	0.1%	0.2%	6.2%	7.1%
Finland	0.7%	0.7%	14.8%	15.7%
France	6.1%	5.6%	15.2%	15.0%
Germany	5.7%	5.4%	15.7%	15.9%
Greece	0.5%	0.4%	10.1%	11.7%
Hungary	0.2%	0.2%	9.1%	9.7%
India	1.0%	1.3%	5.7%	6.2%
Indonesia	0.03%	0.04%	4.6%	4.8%
Iran	0.5%	0.8%	6.3%	7.2%
Ireland	0.4%	0.4%	14.7%	15.5%
Israel	0.6%	0.5%	12.1%	11.9%
Italy	4.0%	4.1%	14.2%	15.3%
Japan	3.3%	2.6%	8.8%	8.5%
Malaysia	0.2%	0.3%	6.2%	8.1%
Mexico	0.2%	0.3%	5.8%	5.7%
Morocco	0.05%	0.1%	7.5%	10.5%
Netherlands	2.7%	2.5%	19.5%	18.7%
New Zealand	0.4%	0.3%	12.5%	12.5%
Nigeria	0.03%	0.04%	2.5%	3.9%
Norway	0.6%	0.6%	14.9%	15.1%
Pakistan	0.1%	0.2%	5.0%	6.7%
Poland	0.4%	0.5%	5.3%	6.4%
Portugal	0.5%	0.6%	11.0%	11.4%
Romania	0.1%	0.2%	4.9%	6.3%
Russia	0.4%	0.6%	4.1%	5.6%
Saudi Arabia	0.1%	0.4%	8.6%	12.2%
Serbia	0.1%	0.1%	5.3%	6.0%
Singapore	0.6%	0.7%	17.4%	18.9%
Slovakia	0.1%	0.1%	6.1%	7.3%
Slovenia	0.1%	0.1%	8.4%	9.8%
South Africa	0.3%	0.4%	10.0%	11.0%
South Korea	1.7%	1.8%	8.0%	8.3%

Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Figure 55 (cont.): World share of Top 10% publications and share of Top 10% publications in national publication output, for 57 countries, in alphabetical order

Country	World share of Top 10% publications		Share of Top 10% publications in national publication output	
	2008–2012	2012–2016	2008–2012	2012–2016
Spain	2.7%	2.7%	12.0%	12.4%
Sweden	1.3%	1.3%	15.8%	16.3%
Switzerland	1.6%	1.5%	19.8%	18.9%
Taiwan	1.2%	1.0%	8.4%	7.6%
Thailand	0.2%	0.2%	7.1%	6.9%
Tunisia	0.04%	0.1%	4.1%	5.3%
Turkey	0.6%	0.7%	5.2%	5.5%
UK	6.8%	6.7%	17.9%	18.8%
Ukraine	0.1%	0.1%	2.9%	3.6%
USA	35.0%	30.8%	19.7%	18.9%
Vietnam	0.04%	0.1%	9.3%	9.3%

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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A. 4 Volume, world share and proportion of OA publications

The 50 countries selected are the top 50 in terms of volume of OA publications for 2016–2020. The table compares the first period recorded with the most recent.

Figure 56: Volume, world share and proportion of OA publications from 50 countries, in alphabetical order

Country	Number of OA publications (rounded figures)		World share of OA publications		Proportion of OA publications	
	2008–2012	2016–2020	2008–2012	2016–2020	2008–2012	2016–2020
Argentina	30 900	74 800	0.5%	0.5%	33.0%	47.8%
Australia	130 900	400 800	2.2%	2.5%	29.6%	43.4%
Austria	29 400	99 500	0.5%	0.6%	28.7%	58.0%
Belgium	50 700	133 600	0.9%	0.8%	32.3%	52.02%
Brazil	217 700	430 200	3.7%	2.7%	51.9%	52.4%
Canada	187 900	428 700	3.2%	2.7%	32.4%	45.4%
Chile	27 500	68 200	0.5%	0.4%	55.9%	53.1%
China	273 400	1 845 500	4.7%	11.7%	19.1%	36.0%
Colombia	19 400	49 400	0.3%	0.3%	53.7%	59.4%
Croatia	12 700	30 200	0.2%	0.2%	34.2%	57.0%
Czech Republic	24 600	70 700	0.4%	0.4%	27.7%	45.1%
Denmark	39 800	122 500	0.7%	0.8%	35.1%	52.3%
Egypt	12 000	66 000	0.2%	0.4%	23.5%	37.8%
Finland	38 400	118 400	0.7%	0.8%	33.5%	65.3%
France	292 100	643 200	5.0%	4.1%	30.8%	45.3%
Germany	257 000	718 400	4.4%	4.6%	30.1%	51.1%
Greece	24 300	60 400	0.4%	0.4%	23.2%	43.3%
Hungary	14 200	57 500	0.2%	0.4%	26.4%	63.9%
India	96 300	307 900	1.7%	2.0%	23.2%	31.2%
Indonesia	8 300	45 900	0.1%	0.3%	56.6%	61.9%

Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Figure 56 (cont.): Volume, world share and proportion of OA publications from 50 countries, in alphabetical order

Country	Number of OA publications (rounded figures)		World share of OA publications		Proportion of OA publications	
	2008–2012	2016–2020	2008–2012	2016–2020	2008–2012	2016–2020
Iran	40 000	198 000	0.7%	1.3%	20.8%	32.5%
Ireland	18 500	49 700	0.3%	0.3%	32.2%	48.2%
Israel	29 900	66 600	0.5%	0.4%	26.1%	37.5%
Italy	200 800	565 500	3.4%	3.6%	30.8%	48.73%
Japan	279 400	602 900	4.8%	3.8%	32.0%	49.2%
Malaysia	20 500	80 400	0.4%	0.5%	33.8%	45.8%
Mexico	28 900	106 500	0.5%	0.7%	28.9%	46.8%
Netherlands	133 400	347 700	2.3%	2.2%	40.4%	65.0%
New Zealand	16 500	42 800	0.3%	0.3%	25.0%	38.4%
Norway	34 500	115 600	0.6%	0.7%	34.2%	62.6%
Pakistan	11 500	72 300	0.2%	0.5%	24.4%	37.4%
Poland	53 500	200 000	0.9%	1.3%	29.4%	56.0%
Portugal	29 900	103 200	0.5%	0.7%	30.5%	47.1%
Romania	10 100	53 500	0.2%	0.3%	16.1%	45.2%
Russia	39 900	192 900	0.7%	1.2%	15.7%	34.6%
Saudi Arabia	11 000	83 400	0.2%	0.5%	32.6%	46.3%
Serbia	15 900	34 600	0.3%	0.2%	37.6%	51.3%
Singapore	17 300	64 000	0.3%	0.4%	22.4%	41.6%
Slovenia	9 200	22 000	0.2%	0.1%	0.0%	0.0%
South Africa	27 700	91 100	0.5%	0.6%	35.2%	51.6%
South Korea	128 800	374 800	2.2%	2.4%	26.5%	44.3%
Spain	174 700	483 100	3.0%	3.1%	33.3%	52.3%
Sweden	61 900	198 300	1.1%	1.3%	33.0%	60.6%
Switzerland	82 200	205 100	1.4%	1.3%	43.4%	60.5%
Taiwan	71 800	218 900	1.2%	1.4%	21.7%	49.3%
Thailand	14 500	52 900	0.2%	0.3%	25.7%	41.7%
Turkey	58 500	203 000	1.0%	1.3%	22.4%	42.3%
UK	334 400	1 024 700	5.7%	6.5%	37.5%	68.9%
Ukraine	8 800	39 800	0.2%	0.3%	20.0%	49.8%
USA	1 920 400	3 514 800	32.9%	22.3%	46.1%	54.6%

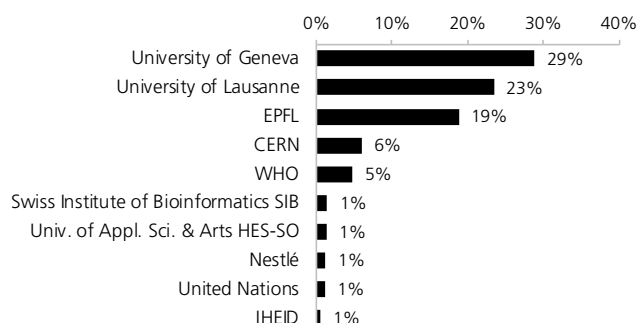
Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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A. 5 Publications of the principal institutions by Swiss region

Lake Geneva region (Geneva, Vaud and Valais)

Figure 57: Publications in the Lake Geneva region, top 10 institutions, 2016–2020

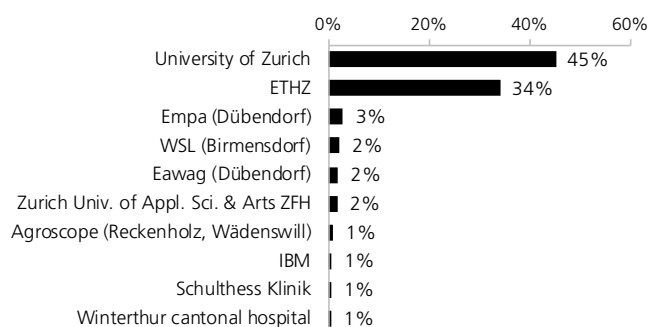


Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Zurich (Zurich)

Figure 58: Publications in the Zurich region, top 10 institutions, 2016–2020

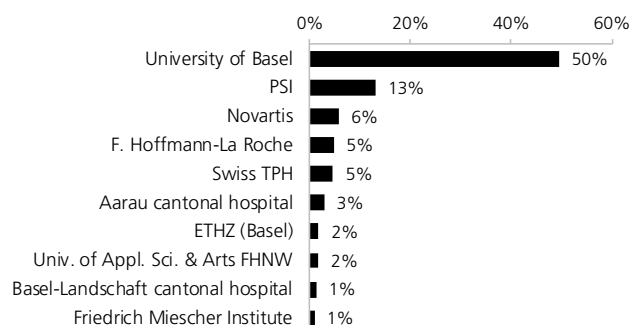


Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Northwest Switzerland (Aargau, Basel-Stadt and Basel-Landschaft)

Figure 59: Publications in the Northwest Switzerland region, top 10 institutions, 2016–2020

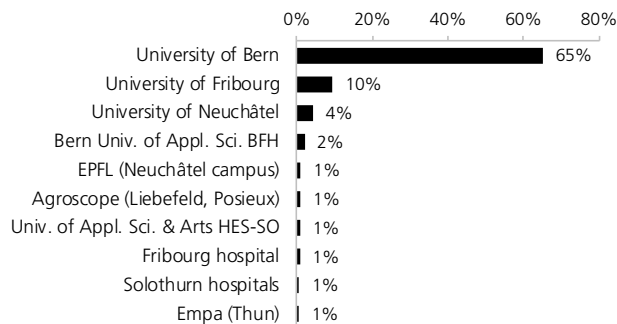


Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Space Mittelland (Bern, Fribourg, Jura, Neuchâtel and Solothurn)

Figure 60: Publications in the Space Mittelland region, top 10 institutions, 2016–2020

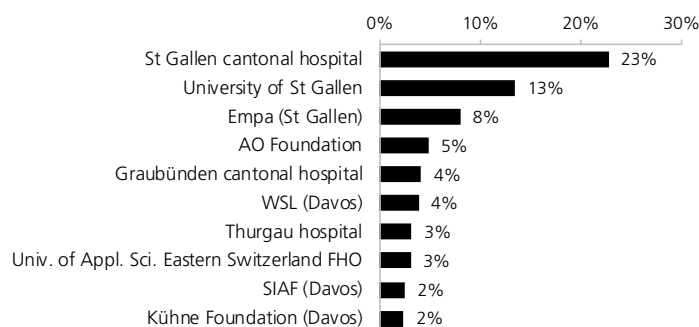


Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Eastern Switzerland (Schaffhausen, Appenzell Ausserrhoden, Appenzell Innerrhoden, Thurgau, St Gallen, Glarus and Graubünden)

Figure 61: Publications in the Eastern Switzerland region, top 10 institutions, 2016–2020

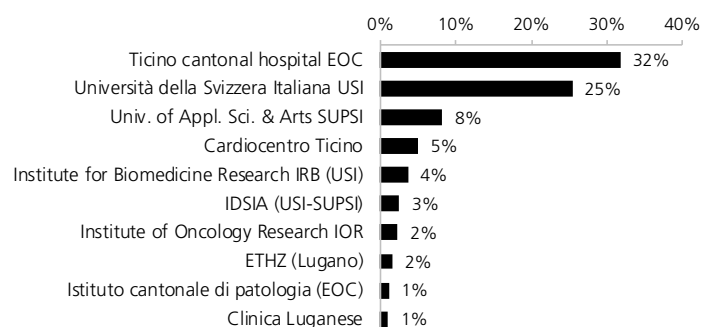


Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Ticino (Ticino)

Figure 62: Publications in the Ticino region, top 10 institutions, 2016–2020

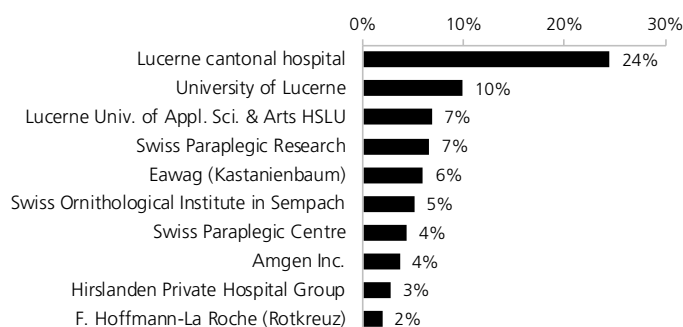


Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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Central Switzerland (Lucerne, Nidwalden, Obwalden, Schwyz, Uri and Zug)

Figure 63: Publications in the Central Switzerland region, top 10 institutions, 2016–2020



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

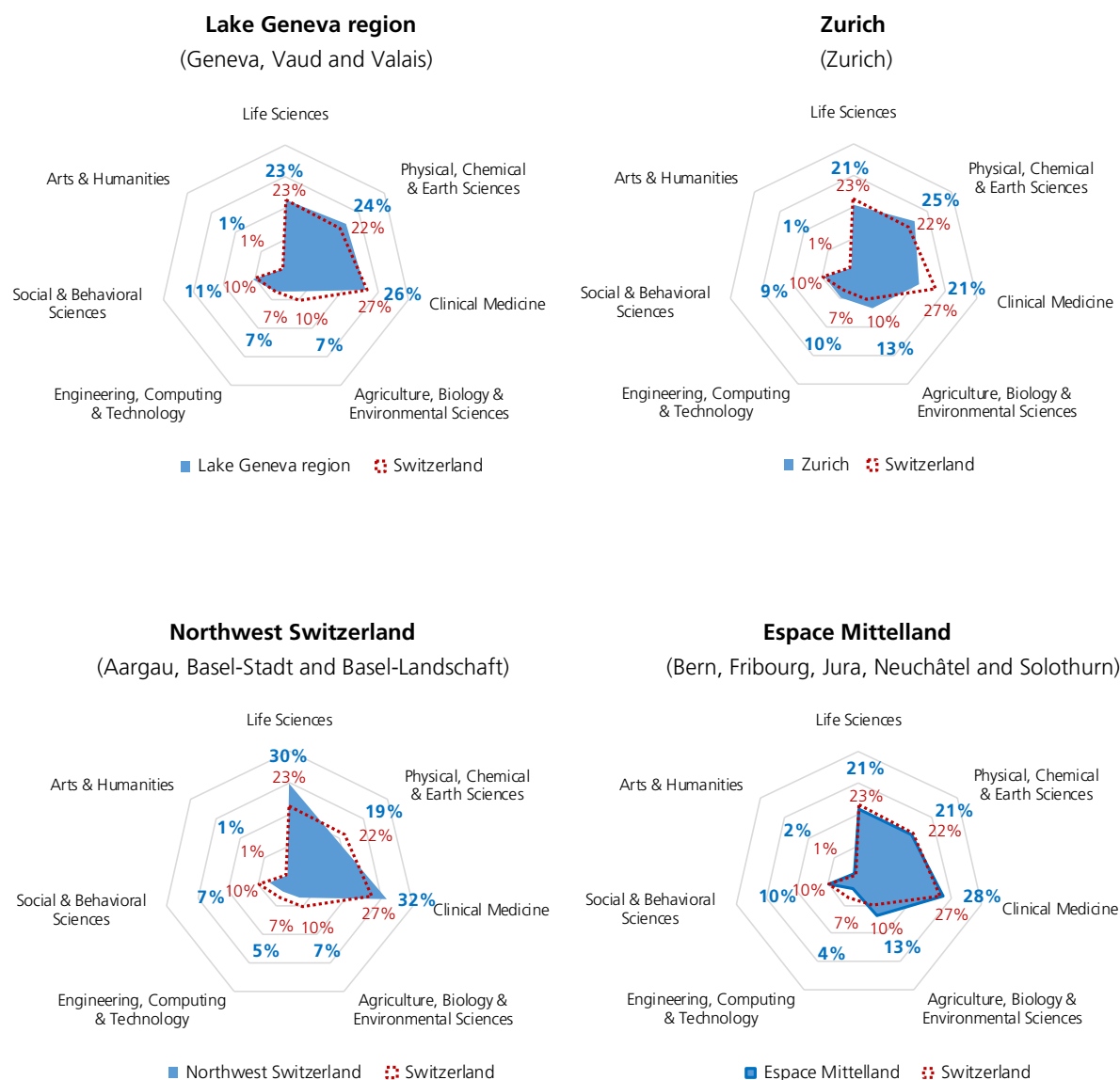
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List of abbreviations

CERN	European Organization for Nuclear Research
EAWAG	Swiss Federal Institute of Aquatic Science and Technology
Empa	Swiss Federal Laboratories for Materials Science and Technology
EPFL	Swiss Federal Institute of Technology Lausanne
EPF Zurich	Swiss Federal Institute of Technology Zurich
IDSIA	Swiss AI Lab (Istituto Dalle Molle di Studi sull'Intelligenza Artificiale)
IHEID	Graduate Institute of International and Development Studies
PSI	Paul Scherrer Institute
SIAF	Swiss Institute of Allergy and Asthma Research
SUPSI	University of Applied Sciences and Arts of Southern Switzerland
Swiss TPH	Swiss Tropical and Public Health Institute
USI	Università della Svizzera Italiana
WHO	World Health Organization
WSL	Swiss Federal Institute for Forest, Snow and Landscape Research

A. 6 Publications of Swiss regions by research field

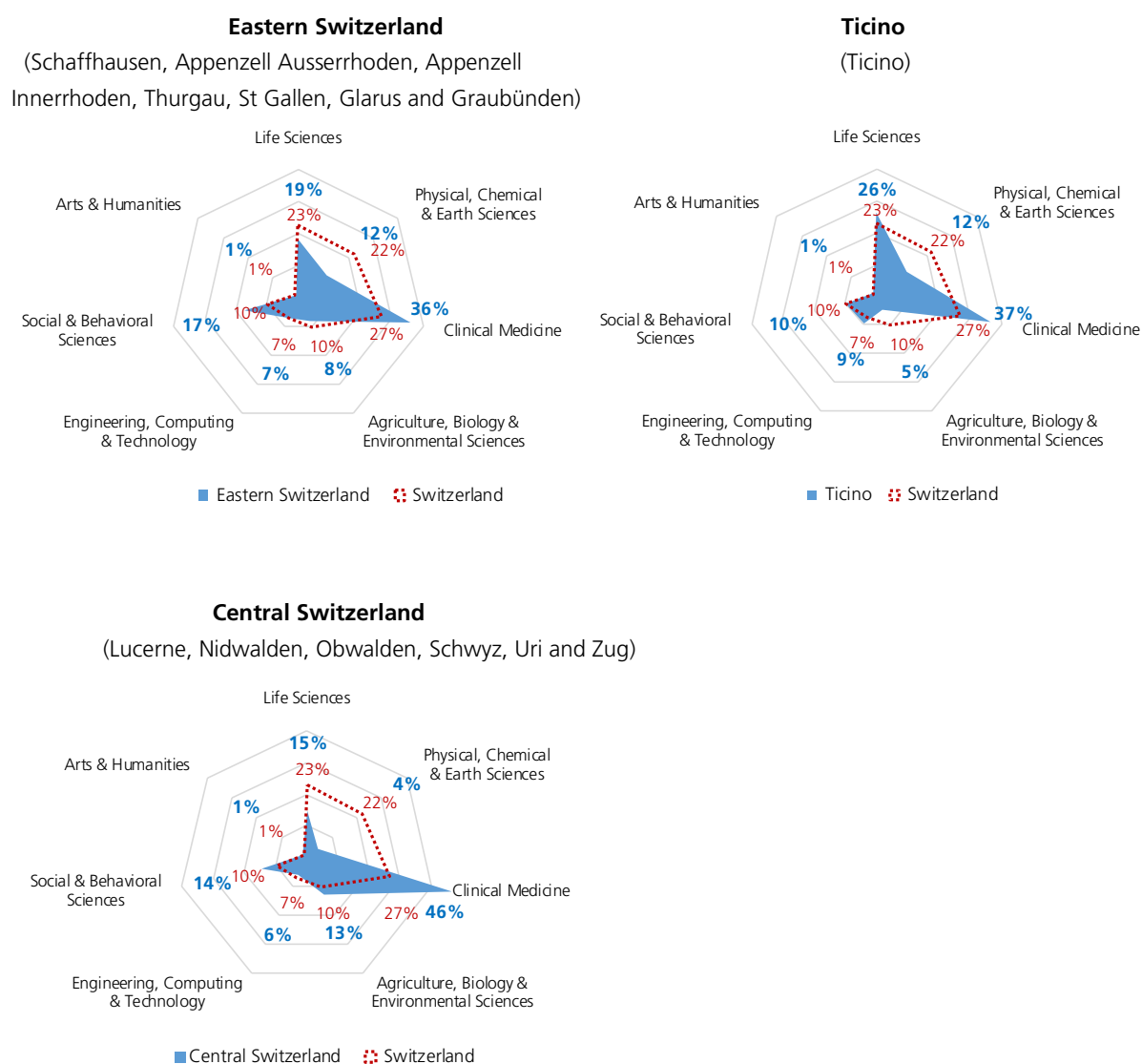
Figure 64: Publication profiles of Swiss regions, 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Figure 64 (cont.): Publication profiles of Swiss regions, 2016–2020

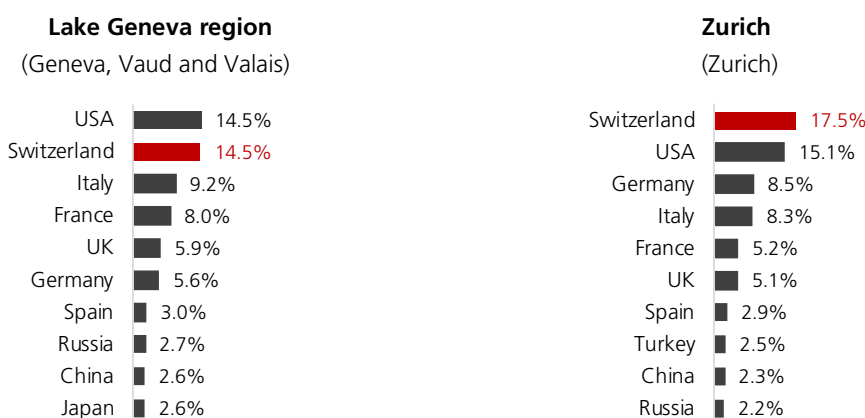


Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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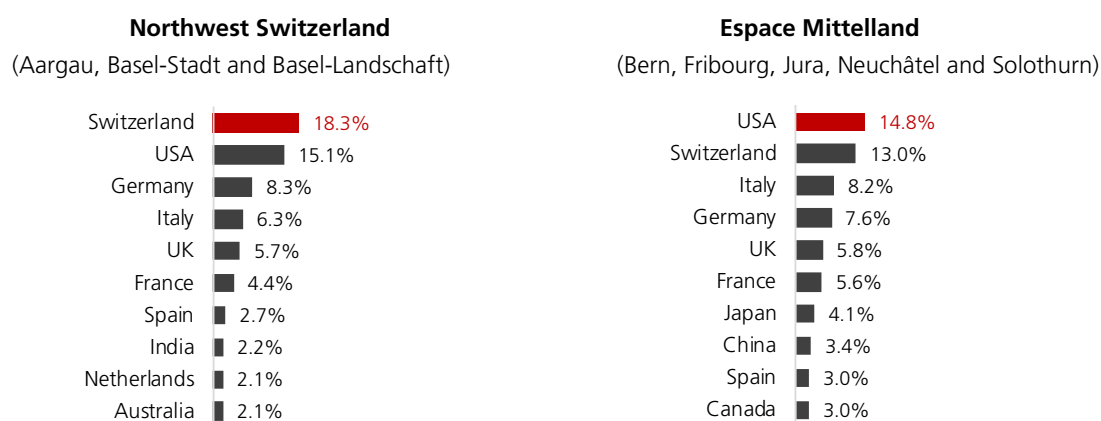
A. 7 Partnerships of Swiss regions by country

Figure 65: Origin of partners of researchers in the region, as a percentage of region's total partnerships, top 10 countries, 2016–2020



Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

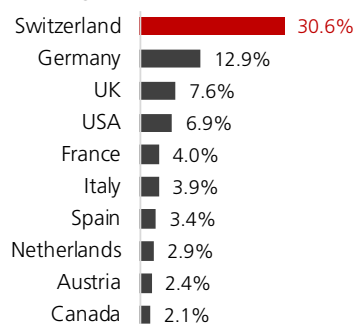
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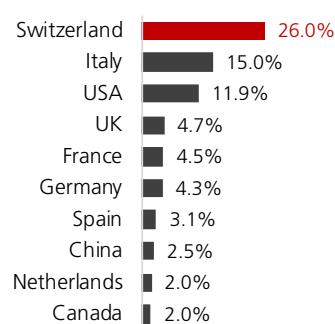
Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Eastern Switzerland (Schaffhausen, Appenzell Ausserrhoden, Appenzell Innerrhoden, Thurgau, St Gallen, Glarus and Graubünden)



Ticino (Ticino)

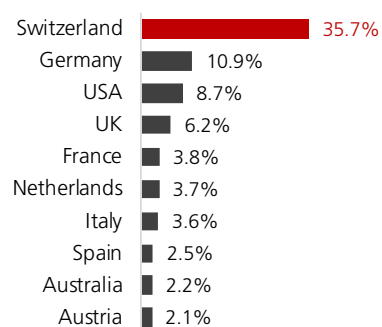


Source: Clarivate Analytics (SCIE/SSCI/A&HCI/ESCI), graphic by SERI

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Figure 65 (cont.): Origin of partners of researchers in the region, as a percentage of region's total partnerships, top 10 countries, 2016–2020

Central Switzerland (Lucerne, Nidwalden, Obwalden, Schwyz, Uri and Zug)



Source: Clarivate Analytics (SCIE/SSCIE/A&HCI/ESCI), graphic by SERI

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B Methods

B. 1 Databases

The following databases were used in this report: the *Science Citation Index Expanded (SCIE)*, the *Social Science Citation Index Expanded (SSCIE)*, the *Arts & Humanities Citation Index (A&HCI)* and the *Emerging Sources Citation Index (ESCI)* produced by Clarivate Analytics (formerly Thomson Reuters) for the years 2008 to 2020. These databases contain the bibliographical references of articles published in almost 24,000 peer-reviewed scientific journals, most of which have an international readership. Journals are selected by Clarivate Analytics according to an evaluation process.⁵ Consequently, this bibliometric analysis does not take account of articles which are not recorded in this database, or articles printed in general-interest journals, books or at conferences.

B. 2 Volume of publications

One of the key methodological issues is the method used to count publications. A scientific article usually has multiple authors, can contain one or more institutional addresses (institutional affiliation of the researchers), and authors can come from one or more countries. Attributing this article to a single author, institution or country would be unfair to the other authors, countries or institutions.

Bibliometric experts generally use one of two methods for counting scientific publications:

- **Full address counting** in which each address referred to in the article is counted as one unit. If an article has only one author who is affiliated to one institution in one country, it will be counted only once. If multiple institutions were involved (even with the same authors), the number of times that an article is counted will match the number of institutional addresses appearing on it.
- **Fractional address counting** divides each article by the number of institutional addresses indicated by its authors, so that the sum of the fractions relating to each publication is 1. In the case of multiple institutions or countries, an article will be counted once, but a share of this article (the relevant percentage) will be assigned to each institution and country.

In order to obtain comparable data, it is vital that scientific production is classified in the same way for all institutions and all countries. One way of doing this is to classify research activities by fields and sub-fields of research, so they can then be compared on the basis of their contribution to each of these fields of research. This report uses the Current Contents (CC) classification system. This divides research activities into seven research fields (Engineering, Computing & Technology; Physical, Chemical & Earth Sciences; Agriculture, Biology & Environmental Sciences; Life Sciences; Clinical Medicine; Social & Behavioural Sciences; and Arts & Humanities), which are in turn subdivided into 109 sub-fields (see list below).

⁵ See journal selection process: <https://clarivate.com/essays/journal-selection-process/>

List of the seven research fields and 109 research sub-fields

Engineering, Computing & Technology

AI, Robotics & Automatic Control
Aerospace Engineering
Chemical Engineering
Civil Engineering
Computer Science & Engineering
Electrical & Electronics Engineering
Engineering Management / General
Engineering Mathematics
Environmental Engineering & Energy
Geological, Petroleum & Mining Engineering
Information Technology & Communications Systems
Instrumentation & Measurement
Materials Science & Engineering
Mechanical Engineering
Metallurgy
Nuclear Engineering
Optics & Acoustics

Physical, Chemical & Earth Sciences

Applied Physics / Condensed Matter / Materials Science
Chemistry
Earth Sciences
Inorganic & Nuclear Chemistry
Mathematics
Multidisciplinary in Physical, Chemical & Earth Sciences
Organic Chemistry / Polymer Science
Physical Chemistry / Chemical Physics
Physics
Space Science
Spectroscopy / Instrumentation / Analytical Sciences

Agriculture, Biology & Environmental Sciences

Agricultural Chemistry
Agriculture / Agronomy
Animal Sciences
Aquatic Sciences
Biology
Biotechnology & Applied Microbiology
Entomology / Pest Control
Environment / Ecology
Food Science / Nutrition
Multidisciplinary in Agriculture, Biology & Environmental Sciences
Plant Sciences
Veterinary Medicine / Animal Health

Life Sciences

Animal & Plant Science
Biochemistry & Biophysics
Cardiovascular & Haematology Research
Cell & Developmental Biology
Chemistry & Analysis
Endocrinology, Nutrition & Metabolism
Experimental Biology
Immunology
Medical Research, Diagnosis & Treatment
Medical Research, General Topics
Medical Research, Organs & Systems
Microbiology
Molecular Biology & Genetics
Multidisciplinary in Life Sciences
Neurosciences & Behaviour
Oncogenesis & Cancer Research
Pharmacology & Toxicology
Physiology

Clinical Medicine

Anaesthesia & Intensive Care
Cardiovascular & Respiratory Systems
Clinical Immunology & Infectious Disease
Clinical Psychology & Psychiatry
Dentistry / Oral Surgery & Medicine
Dermatology
Clin. Endocrinology, Metabolism & Nutrition
Environmental Medicine & Public Health
Gastroenterology & Hepatology
General & Internal Medicine
Health Care Sciences & Services
Haematology
Neurology
Nursing
Oncology
Ophthalmology
Orthopaedics, Rehabilitation & Sports Medicine
Otolaryngology
Paediatrics
Clin. Pharmacology / Toxicology
Radiology, Nuclear Medicine & Imaging
Reproductive Medicine
Research / Laboratory Medicine & Medical Technology
Rheumatology
Surgery
Urology & Nephrology

Social & Behavioural Sciences

Anthropology
Communication
Economics
Education
Environmental Studies, Geography & Development
Law
Library & Information Sciences
Management
Political Science & Public Administration
Psychiatry
Psychology
Public Health & Health Care Science
Rehabilitation
Social Work & Social Policy
Sociology & Social Sciences

Arts & Humanities

Archaeology
Art & Architecture
Classical Studies
General
History
Language & Linguistics
Literature
Performing Arts
Philosophy
Religion & Theology

B. 3 Impact (relative citation indicator)

A scientific publication usually cites other publications on which it draws. Impact is calculated by the number of citations received per publication. In principle, the more a publication is cited, the greater the impact it is considered to have. It can be concluded that the absolute number of citations is an adequate measurement of impact. This is true within a field of research, but not between different fields. As the number of citations depends on publication and citation practices, which can vary considerably according to the field of research, a more sophisticated and standardised indicator is needed to allow individual fields to be compared fairly with one another. The absolute number of citations received by publications is set against the world average of citations per publication for each research field, and then this relative indicator is standardised on a scale of 0 to 200, where 100 represents the world average.

A minimum of 50 publications per year are required in order to calculate this indicator.

B. 4 Top 10% publications

To calculate the Top 10% publications, all the publications in each sub-field are classified by year in descending order of citations, and only those in the top 10% of this ranking are retained. By setting the bar at 10% of most cited publications, we are also theoretically setting a 'world average' at 10%. If the distribution of Top 10% publications were uniform across countries, each country should have 10% of its publications among the most cited.

To obtain results by country and by research field, we need to (a) count the number of citations per year per sub-field; (b) select the Top 10% publications for each sub-field; and then (c) calculate the average of these Top 10% publications over five years of publications.

A country has to produce at least 4,000 publications per year to meet the selection criterion for this indicator.

B. 5 Partnerships

Only articles written collaboratively are taken into account for this indicator. Partnerships are determined by the number of partnership pairs between the institutional addresses of authors featured on a single publication. For this indicator, publications are counted using the *full counting* method, which means that an article written collaboratively is attributed to each institutional address and to each contributing country. The number of partnerships does not therefore designate a number of articles, but the frequency with which a country is involved in collaboration. The counting of addresses allows us to calculate both national collaborations and those with other countries. The results (national or international partnerships) are expressed as a percentage of a country's total partnerships.

B. 6 Institutional sectors

In Switzerland, institutions conducting research are split into four institutional sectors:

- Higher education: cantonal universities, the Swiss federal institutes of technology, universities of applied sciences, private colleges or universities, and teaching hospitals.
- Private businesses: Switzerland's large corporations (such as Novartis, Hoffmann-La-Roche, ABB, IBM, Nestlé), small and medium-sized enterprises, as well as private clinics, veterinary practices and hospitals.
- Research institutes: the research institutes of the ETH Domain (PSI, EAWAG, WSL and Empa), cantonal laboratories, federal research institutes (e.g. Agroscope), research facilities of national importance (Art. 15 RIPA), foundations (such as the Friedrich Miescher Institute, ISREC), as well as public hospitals that are not teaching hospitals.
- International organisations: institutions such as CERN, WHO, Unicef and various UN agencies, the Ludwig Institute, the World Bank, etc.

C References

- SERI 2020 'Scientific publications in Switzerland, 2008–2018: A bibliometric analysis of scientific research in Switzerland'. This study is available on the SERI website under Publications & Services/ Publications, or at https://www.sbf.admin.ch/dam/sbf/en/dokumente/webshop/2020/bibliometrie-2020.pdf.download.pdf/Bibliometrie_SERI_2008_2018_EN.pdf
- SERI 2018 'Switzerland's performance in scientific publications, 2011–2015 – A bibliometric analysis of Switzerland's performance by research sub-field'. This study is available on the SERI website under Publications & Services/Publications, or at https://www.sbf.admin.ch/dam/sbf/en/dokumente/webshop/2018/publications-scientifiques-2011%E2%80%932015.pdf.download.pdf/bibliometrie_sbf_2018_d.pdf
- SERI 2017 'Scientific publications in Switzerland, 2006–2015: A bibliometric analysis of scientific research in Switzerland'. This study is available on the SERI website under Publications & Services/ Publications, or at https://www.sbf.admin.ch/dam/sbf/en/dokumente/webshop/2018/Analyse%20bibliom%C3%A9trique_20180214_de.pdf.download.pdf/analyse_bibliometrique_20180214_en.pdf
- SERI 2016 'Bibliometric analysis of scientific research in Switzerland 1981–2013'. This study is available on the SERI website under Publications & Services/ Publications, or at https://www.sbf.admin.ch/dam/sbf/en/dokumente/webshop/2016/bibliometrische_untersuchung_zurforschunginderschweiz19812013.pdf.download.pdf/analyse_bibliometriquedelarecherchescientifiqueensuisse1981-2013.pdf
- SERI 2015 'Most cited publications: Switzerland's performance 1997–2011'. This study is available on the SERI website under Publications & Services/ Publications, or at https://www.sbf.admin.ch/dam/sbf/en/dokumente/webshop/2015/meist_zitierte_publicationenleistungderschweiz1997-2011.pdf.download.pdf/publications_lesplusciteesperformancedelasuisse19972011.pdf
- SERI 2014 'Bibliometric study of research in Switzerland 1981–2011'. This study is available (in German and French only) on the SERI website under Publications & Services/ Publications, or at <https://www.sbf.admin.ch/sbf/fr/home/services/publications/base-de-donnees-des-publications/analyse-bibliometrique-81-11.html>
- SERI 2011 'Bibliometric study of research in Switzerland 1981–2009'. This study is available (in German and French only) on the SERI website under Publications & Services/ Publications, or at <https://www.sbf.admin.ch/sbf/fr/home/services/publications/base-de-donnees-des-publications/analyse-bibliometrique-81-09.html>