**Introduction**

Science knows no limits or borders. Scientific inquiry has therefore gone global long before the economy or culture. Nevertheless, this does not necessarily mean that science is global to the same extent everywhere.

To what extent are scientific outputs published in global journals as opposed to local journals? How does this differ across countries and disciplines? How much has this changed over the last decade?

The aim of this study is to show that. We provide new evidence on the globalization of science that allows us to compare over space, fields and time. Specifically, we compare 174 countries and various country groups in 4 broad and 27 narrow disciplines over the period from 2005 to 2017.

The study is based on six journal-level indicators of globalization. The benchmark indicators are derived from data on authors by the country of origin. For comparison, we also use data on documents by the country of origin and English-written documents.

The journal-level indicators are then aggregated to countries and disciplines. These results are standardized between 0 and 1, in which 0 refers to the lowest and 1 to the highest globalization.

The analysis is based on data from the [Scopus citation database](https://www.scopus.com/). The list of journals and assigned disciplines is obtained from the [Scopus Source List](http://ec2-18-188-88-0.us-east-2.compute.amazonaws.com:8080/data/ext_list_April_2018_2017_Metrics.xlsx).

Globalization of science should not be confused with quality (or relevance) of science; they are likely to be related in many ways, depending on the discipline, but they are different phenomena.

The results are presented in an interactive manner that allows readers to customize the analysis. Further, the results should be of interest not only to academics, but also to policy-makers and to a broader audience across the globe.

Please see this link [here](https://idea-en.cerge-ei.cz/publicationslist" \t "_blank) for earlier studies by the IDEA think tank on related topics, including on local journals, predatory publishing, and quantity vs. influence of academic publications.

**How to use the application**

Each point depicts the globalization index GSc,d,y,iGc,d,y,iS of a respective country and discipline in a given year and indicator. For more details, see the definition of the journal-level indicators and aggregation procedure.

Use the upper dropdown menus to customize the output. One can compare either:

* countries within a discipline, or
* disciplines within a country.

The main dimension is fixed by the button . Up to 10 items can be included in the comparison.

You may move the text windows by dragging the button  in the top-left corner.

**Bear in mind while using**

* The globalization indexes are standardized between 0 and 1 across all countries (174), narrow disciplines (27) and years (13).
* Large year-by-year jumps in some series can be driven by adding (or removing) important journals in Scopus.
* Results for country groups are computed as simple averages of member countries. Germany has the same weight as Luxembourg, etc.
* Results for broad and narrow disciplines are calculated separately from scratch; the former are not simply aggregations of the latter.
* Only data on the following document types are taken into account: journal articles, reviews, and conference papers.
* Journals are fully counted in each discipline to which they are assigned. Large interdisciplinary journals may affect the results for smaller disciplines.
* Comparison of indicators within a country or a discipline could be misleading, hence not provided.
* The Gini-Simpson and Local Authors indicators do not take into account the research sector size in the estimation.
* For the sake of robustness, only journals with at least 30 documents in the given year are included in the calculation.
* Only results of the aggregation to countries and disciplines based on data from at least 30 journals are reported.
* Smaller countries and disciplines suffer from gaps in the displayed results due to insufficient data.
* Results for smaller countries and disciplines based on relatively thin data should be interpreted with caution.

**Broad picture**

**Transition outsiders**

Science in advanced countries has traditionally been globalized.

In contrast, transition countries continue to be relatively isolated.

Developing countries remain in the middle and close to the world average.

Interestingly, there does not seem to be much change here.

*Tip: Display the discipline of your interest using the upper menu. For the definition of country groups, see the note below the figure.*

**Big 7**

**The contrast of China and Russia**

Not surprisingly, the Unites States, jointly with the EU-28, set the upper standard, followed by Japan.

China scores last initially, but then globalizes its science base enormously, eventually converging to a similar level as Brazil and India.

Russia starts and remains low, lagging increasingly behind the rest of the pack.

*Tip: Add (or remove) countries (or country groups) using the upper menu. Replace the EU-28 average by individual member countries of your interest.*

**Bottom 10**

**The least globalized (period average)**

Not only Russia, but also other former members of the Soviet bloc, cluster at the bottom of the worldwide ranking.

Chinese science in fact turns out to be the least globalized in the whole world initially.

*Tip: Replace China by other members of the Soviet bloc to see how they fare in comparison to the world average.*

**Advanced countries by disciplines**

**Consistently global**

In advanced countries, science is, on average, highly globalized across disciplines.

Physical and Life Sciences are the most globalized. Health Sciences rank even below Social Sciences, though the differences are very small.

In fact, it is difficult to find a sub-discipline that deviates significantly from this narrow corridor.

*Tip: Add the sub-disciplines of your interest using the upper menu. For the definition of disciplines, see the note below the figure.*

**Russia by disciplines**

**Science of its own**

Russian science does not ever break from its inward-looking Soviet past, regardless of the discipline.

Russian Physical and Life Sciences remain significantly less globalized than elsewhere in the world.

The only major exception is the sub-discipline of Pharmacology, Toxicology and Pharmaceutics.

Interestingly, in many disciplines this is in a sharp contrast to the relatively high share of documents published in English.

In fact, about four-fifths of documents with at least one author from Russia were written in English over this period.

*Tip: Display results for a different indicator using the upper menu.*

**China by disciplines**

**From zero to hero**

China has profoundly globalized its science system, gradually moving from the lowest globalization rates to prominence on the world stage.

Chinese Social Sciences have become even more globalized than other broad disciplines and have already caught up with the EU-28 and the world average.

In some sub-disciplines, China has already surpassed the United States and is steaming forward to the top ranking.

If the trend continues, China will soon eliminate the gap with advanced countries in most of the sub-disciplines.

*Tip: Compare the results for Hong Kong using the upper menu (the results for China do not include Hong Kong, which continues to be reported separately by Scopus).*

**Social Sciences in Central and Western Europe**

**Social Sciences in question**

In Western Europe, Social Sciences are highly globalized, as are Natural Sciences.

In Central (and Eastern) Europe, however, Social Sciences continue to maintain their own local publication silos.

The prime exception is Hungary, where Social Sciences used to be more oriented to the West even before the fall of the Berlin Wall.

*Tip: Add other transition countries (or the group average) to the comparison using the upper menu.*

**Czechia by disciplines**

**Czechia in the spotlight**

Czechia is a prime example of a formerly advanced country that have been tarnished during the communist era.

Physical and Life Sciences have continued to be connected to the global arena.

However, Social Sciences have been locked behind the Berlin Wall; they steadily globalize, but from a low base, and there is still a long way to go.

*Tip: Explore other countries of the former Soviet bloc using the upper menu. Note, for instance, the development in Ukraine.*

**Concluding remarks**

Globalization of science provides a new perspective on the scientific landscape, which deepens what we know from standard bibliometrics in many respects.

The traditional science powerhouses in the North and West remain strong and at the core of the global system; highly interconnected and as globalized as ever.

In many countries of the former Soviet block, the low globalization of science is a symptom of a systemic failure; of science that is out of sync with the rest of the world and is inefficient.

After the fall of the Berlin Wall, it was understandable that science in transition countries would need time to catch up. In many disciplines, new infrastructure had to be built from scratch. However, three decades on, there is no longer any excuse.

China shows that where there is a will, there is a way. In little more than a decade, Chinese science has moved from relative isolation to the front pages of global journals amid an enormous expansion in size.

Other developing countries also allocate increasing resources to science and run the risk of creating ecosystems of local publishing similar to transition countries, or worse, e.g. falling for predatory journals.

Globalization of science that is pervasively lower than in similar countries should be a cause for concern, as it suggests that the science system has gone astray and needs an overhaul of its evaluation and funding framework.

More research is needed to better understand globalization of science. Does globalization of the national science system go hand in hand with quality and impact? Are there spillovers outside of the realm of science? What can be done about it?

*Tip: Spend more time with the interactive app to explore the position of the country and discipline of your interest.*

**Thanks for your attention!**

If you liked it, do not forget to share!

See full list of references

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Note: This study represents only the views of the authors and not the official position of the Economics Institute of the Czech Academy of Sciences or the Center for Economic Research and Graduate Education (CERGE), Charles University.

### Countries

Of 240 countries and territories, for which at least some information is available, we have excluded entities that are either dependent territories, too small, and/or with too few data to derive reliable results.

The resulting sample consists of 174 countries, including a large number of developing and transition countries, which together cover the overwhelming majority of the world's population and research output.

Data with "undefined" country origin of authors (about 5% of observations) has been excluded from the analysis. Data for Yugoslavia before 2007 were added to Serbia.

### Country groups

##### Development status

**Advanced countries**: Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Liechtenstein, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Portugal, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, United States.

**Transition countries**: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Mongolia, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.

**Developing countries**: Rest of the world.

Source: IMF (2003) [World Economic Outlook](https://www.imf.org/external/pubs/ft/weo/2003/02/) (Statistical Appendix; pp. 163-169).

##### Income

**High income**, **Upper middle income**, **Lower middle income** and **Low income** depending on Gross National Income (GNI) per capita in US dollars (Atlas methodology).

Source: World Bank (2018) [How does the World Bank classify countries?](https://datahelpdesk.worldbank.org/knowledgebase/articles/378834-how-does-the-world-bank-classify-countries) (June 2018 version).

##### Regions

**Europe**, **North America**, **South America**, **Central Asia**, **Middle East**, **East Asia**, **South Asia**, **Pacific**, **North Africa**, **Sub-Saharan Africa** based on geography and administrative borders.

Source: World Bank (2018) [How does the World Bank classify countries?](https://datahelpdesk.worldbank.org/knowledgebase/articles/378834-how-does-the-world-bank-classify-countries) (June 2018 version).

##### Other

**EU-15**: "Old" EU member countries (before 2004).

**EU-13**: "New" EU member countries (accession between 2004 and 2018).

**EU-28**: EU-15 and EU-13 combined.

**OECD**: OECD member countries (as of January 2019).

**Disciplines**

According to the [Scopus Journal Classification](http://ec2-18-188-88-0.us-east-2.compute.amazonaws.com:8080/data/ext_list_April_2018_2017_Metrics.xlsx), journals are classified into the following 4 broad subject clusters:

1. Life Sciences,
2. Physical Sciences,
3. Health Sciences,
4. Social Sciences,

which are further subdivided into 27 major subject areas, such as:

1.1 Agricultural and Biological Sciences,

1.2 Biochemistry, Genetics and Molecular Biology,

1.3 Immunology and Microbiology,

1.4 Neuroscience,

1.5 Pharmacology, Toxicology and Pharmaceutics,

etc.

If a journal is assigned to multiple categories, it is fully counted in each of them.

### Journal Globalization Indicators

The methodology builds on the pioneering work of [Zitt and Bassecoulard (1998)](https://link.springer.com/article/10.1007/BF02457982" \t "_blank), which we complement with the contributions by [Buela-Casal (2006)](https://link.springer.com/article/10.1007/s11192-006-0050-z" \t "_blank), [Aman (2016)](http://ocs.editorial.upv.es/index.php/STI2016/STI2016/paper/viewFile/4543/2327" \t "_blank) and two indicators of our own.

In essence, the most globalized journals have a structure (of documents by the country of origin of authors, etc.) that closely resembles the global structure of the whole discipline and vice-versa.

Only journals with at least 30 documents in the particular year are included in the calculation.

#### Definitions

Nc,j,yNc,j,y and Nc,d,yNc,d,y is the number of documents with authors affiliated to the country cc in journal jj and discipline dd, respectively, in year yy.

NLOCAL,j,yNLOCAL,j,y is the number of documents with authors from the same country as the publisher of journal jj in year yy.

NENG,j,yNENG,j,y is the number of English-written documents in the journal jj in year yy.

Tj,yTj,y denotes the total number of documents published in the journal jj in year yy.

Note: Documents by authors from multiple countries are fully attributed to each country, i.e. Tj,y≠∑cNc,j,yTj,y≠∑cNc,j,y.

#### Indicators:

##### Euclidian distance of journal and discipline country distribution

gEuclidj,d,y=√∑(xc,j,y−mc,d)2gj,d,yEuclid=∑(xc,j,y−mc,d)2

in which xc,j,yxc,j,y is the share of the country cc in journal jj and year yy:

xc,j,y=Nc,j,yTj,yxc,j,y=Nc,j,yTj,y

and mc,dmc,d is the share of the country cc in the aggregate discipline dd over all years:

mc,d=∑yNc,d,y∑y∑cNc,d,ymc,d=∑yNc,d,y∑y∑cNc,d,y

Source: [Zitt and Bassecoulard (1998)](https://link.springer.com/article/10.1007/BF02457982" \t "_blank)

##### Gini-Simpson diversity of journal country distribution

gGiniSimpsonj,d,y=1−∑N2c,j,y(∑Nc,j,y)2gj,d,yGiniSimpson=1−∑Nc,j,y2(∑Nc,j,y)2

Source: [Aman (2016)](http://ocs.editorial.upv.es/index.php/STI2016/STI2016/paper/viewFile/4543/2327" \t "_blank)

##### Gini Index of author’s countries weighted by discipline country distribution

gGinij,d,y=∑ni=1vi∗wi−1−∑n−1i=0vi∗wi+1gj,d,yGini=∑i=1nvi∗wi−1−∑i=0n−1vi∗wi+1

in which

w=⎡⎢

⎢⎣∑1c=1mc,d..∑nc=1mc,d⎤⎥

⎥⎦v=⎡⎢

⎢⎣∑1c=1xc,j,ymc,d..∑nc=1xc,j,ymc,d⎤⎥

⎥⎦w=[∑c=11mc,d..∑c=1nmc,d]v=[∑c=11xc,j,ymc,d..∑c=1nxc,j,ymc,d]

and xc,j,yxc,j,y is the share of the country cc in journal jj and year yy:

xc,j,y=Nc,j,yTj,yxc,j,y=Nc,j,yTj,y

and mc,dmc,d is the share of the country cc in the aggregate discipline dd over all years:

mc,d=∑yNc,d,y∑y∑cNc,d,ymc,d=∑yNc,d,y∑y∑cNc,d,y

##### Surplus of three largest contributing countries

gTop3j,d,y=∑3c=1(xc,j,y−mc,d)gj,d,yTop3=∑c=13(xc,j,y−mc,d)

in which xc,j,yxc,j,y is the share of the country cc in journal jj and year yy:

xc,j,y=Nc,j,yTj,yxc,j,y=Nc,j,yTj,y

and mc,dmc,d is the share of the country cc in the aggregate discipline dd over all years:

mc,d=∑yNc,d,y∑y∑cNc,d,ymc,d=∑yNc,d,y∑y∑cNc,d,y

##### Share of documents from a journal's domicile

gLocalSharej,d,y=NLOCAL,j,yTj,ygj,d,yLocalShare=NLOCAL,j,yTj,y

Source: [Zitt and Bassecoulard (1998)](https://link.springer.com/article/10.1007/BF02457982" \t "_blank)

##### Share of English-written documents

gShareEnglishj,d,y=NENG,j,yTj,ygj,d,yShareEnglish=NENG,j,yTj,y

Source: [Buela-Casal (2006)](https://link.springer.com/article/10.1007/s11192-006-0050-z" \t "_blank)

### Aggregation to countries and disciplines

Following [Zitt and Bassecoulard (1999)](https://link.springer.com/article/10.1007/BF02459619" \t "_blank), the evidence from journals is aggregated to the level of countries and disciplines.

The aggregated figures are calculated as an average of the journal-level indicator weighted by the journal's share on the country’s total documents in the respective discipline.

Only the results of the aggregation procedure based on data from at least 30 journals are reported.

#### Definitions

Globalization of science in the country cc, discipline dd and year yy measured by the indicator ii is calculated as follows:

Gc,d,y,i=J∑j=1ac,d,y,jgj,d,y,i(.)Gc,d,y,i=∑j=1Jac,d,y,jgj,d,y,i(.)

aj,c,d,yaj,c,d,y is the share of documents with authors from the country cc in journal jj on all documents of the country cc in discipline dd in year yy.

gj,d,y,igj,d,y,i is the globalization indicator ii of journal jj in discipline dd and year yy.

#### Standardization and scaling

Subsequently, the aggregated globalization index was standardized between 00 and 11 and converted to an ascending scale to simplify the interpretation of the results:

GSc,d,y,i=Gc,d,y,i−GminiGmaxi−GminiαiGc,d,y,iS=Gc,d,y,i−GiminGimax−Giminαi

in which GminiGimin and GmaxiGimax is the minimum and maximum value of the indicator ii across all years, countries, and disciplines and αiαi equals −1−1 for the minimizing indicator (i.e. low values for high globalization) and 11 otherwise, as the results of which 00 refers to the lowest and 11 to the highest globalization.

### Database

[Scopus Source List](http://ec2-18-188-88-0.us-east-2.compute.amazonaws.com:8080/data/ext_list_April_2018_2017_Metrics.xlsx) (April 2018 version) provided International Standard Serial Numbers (ISSNs), classification by disciplines, and publisher’s domicile of 34,964 academic journals.

In August 2018, detailed data on authors by the country of origin and language of documents in these ISSNs were downloaded from the [Scopus](https://www.scopus.com/) citation database over the period from 2005 to 2017.

Only the following document types are included in this analysis: journal articles, reviews, and conference papers, i.e. so-called “citable documents”.

The following Scopus API request was used to download the data:

ISSN(AAAA-BBBB) AND DOCTYPE(AR OR RE OR CP) AND PUBYEAR = YYYY

in which *AAAA-BBBB* is the journal's ISSN and *YYYY* is the year.

### Local Journals in Scopus

In this study, we analyzed local academic publishing in selected European countries over the 2013-2016 period.

The results reveal a strong tendency to publish locally in the former communist countries. Local journals are prevalent in Croatia, Romania, Slovenia, Lithuania, and Czechia, but are rather rare in comparable advanced countries.

In Czechia, for instance, nearly one fifth of all indexed results are concentrated in Czech journals, with a high percentage (>33%) of articles by domestic authors. About half of authors contributing to Czech journals are based in Czechia, and another tenth in Slovakia.

In contrast, the vast majority of articles that appear in journals published in comparable advanced countries are written by foreigner authors. The publishing of local, or at best regional, journals appears to be a distinctly Eastern European phenomenon.

**Local journals in selected EU and OECD countries (2013-2016)**

(% of authors from the same country as the journal publisher)

*Note: Number of active journals with more than 30 articles over the 2013-2016 period; number of researchers in the latest available year in full-time equivalent (FTE).*

*Source: Scopus (April and October 2017), Eurostat, OECD, Scimago, authors' calculations.*

V. Macháček, M. Srholec (2017) [Local Journals in Scopus](https://idea.cerge-ei.cz/files/IDEA_Studie_17_2017_Mistni_casopisy_ve_Scopusu/mobile/index.html) (only in Czech). *IDEA think-tank at CERGE-EI*, Study 17/2017.

### Predatory Journals in Scopus

In this study, we mapped patterns of predatory publishing across the globe over the 2015-2017 period.

The analysis is based on Beall's lists of "potentially predatory" journals and publishers, of which we found 3,218 journals in Ulrichsweb and 405 journals in Scopus.

The results show that predatory publishing has become most widespread in middle-income countries in Asia and North Africa.

However, the analysis also indicates that Beall’s lists need to be used with caution, as some of the implicated journals may not be necessarily fraudulent in the strict sense.

**Share of predatory articles on the total number of articles (2015-2017)**

*Note: Articles in journals published by the Frontiers Research Foundation are excluded from predatory publications.*

*Scopus (October 2016), Beall's lists (April 2016), authors' calculations.*

V. Macháček and M. Srholec (2016) [Predatory Journals in Scopus](https://idea-en.cerge-ei.cz/files/IDEA_Study_2_2017_Predatory_journals_in_Scopus/files/downloads/IDEA_Study_2_2017_Predatory_journals_in_Scopus.pdf). *IDEA think-tank at CERGE-EI*, Study 2/2017.

### International Comparison of Academic Publication Output and its Influence

The authors analyzed the publication output of countries in each WoS category. They compared the output size with the Article Influence Score (AIS) in the 2012-2016 period.

For each category, the output and influence of the country is benchmarked relative to the chosen set of other countries.

The analysis reveals that both the size and influence of research in most Central and Eastern European countries continue to lag behind Western Europe.

This gap is especially strong in the *Social Sciences*, *Medical and Health Sciences,* and *Arts and Humanities*

The results are available in the [interactive application](https://ideaapps.cerge-ei.cz/Comparison/).

**Academic Publication Output and its Influence in the Czech Republic (2012-2016)**

*Note: Each dot represent one WoS category; Only articles from the first quartile are taken into account.*

*All available countries are used as a benchmark.*

Š. Jurajda, S. Kozubek, Münich and Škoda (2017) [Scientific publication performance in post communist countries: still lagging far behind](http://dx.doi.org/10.1007/s11192-017-2389-8). *Scientometrics*, 112(1). p. 315-328

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