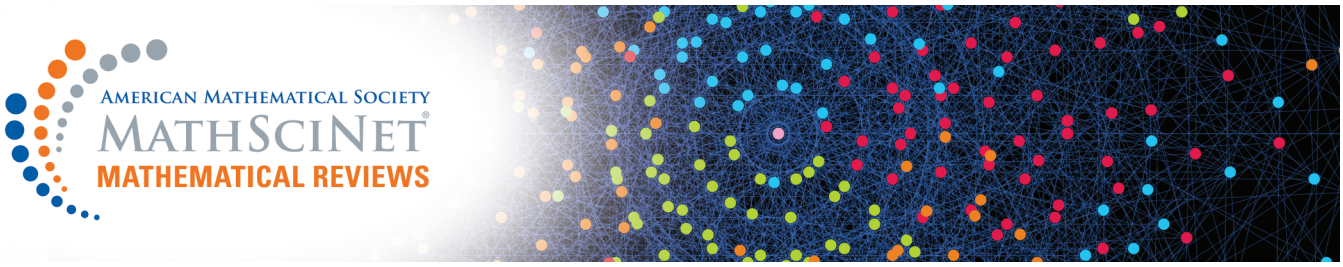

Geography and MathSciNet® / Mathematical Reviews

Edward Dunne

Mathematics, like any of the sciences or any scholarly activity, is international. The international aspect shows itself in multiple ways. Our penchant for naming theorems or ideas after people[1] encodes this via a broad cast of characters, including al-Khwarizmi (Persia), Diophantus of Alexandria (Egypt), Euclid (Greece), Laplace and Poincaré (France), Gauss and Riemann and Noether (Germany), Abel and Lie (Norway), Euler and Bernoulli—with multiplicity (Switzerland), Ricci and Levi-Civita (Italy), Lobachevsky and Kovalevskaya (Russia), Jones (New Zealand), Harish-Chandra and Ramanujan (India), Chern and Chow (China), Nakayama and Kodaira (Japan), Calderón (Argentina), Birkhoff and Whitney (United States), and so on. In this column, I look at three ways to explore the geographic distribution of mathematics using the information in the Mathematical Reviews Database (MR Database), which is what underlies MathSciNet.

Before diving into the analysis, let me point out that place names are inherently political, meaning that they can be complicated. Many publishers now include disclaimers about locations provided by authors and editors. Elsevier's disclaimer for editors reads, "All members of the Editorial Board have identified their affiliated institutions or organizations, along with the corresponding country or geographic region. Elsevier remains neutral with regard to any jurisdictional claims." On articles, Springer Nature's disclaimer reads, "Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations." In this article, I will be repeating places as named by the organization or person. For reviewers, the place names are what they have given us as their mailing addresses. For authors, they come from the institutional addresses that the authors list on the papers or in the books. For journals, they are the addresses given to us by the publisher.

Reviewers

A key part of MathSciNet, and the original *Mathematical Reviews*, is that we publish reviews of articles and books. Indeed, Mathematical Reviews has an eighty-year tradition of reviewing the mathematical literature. As a result, we have direct contact with the more than 24,000 active reviewers. In particular, we have mailing addresses for them.

Looking at counts from November 2020, Table 1 shows the top 20 countries in terms of reviewers.

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[1]*Naming of things in science and mathematics is, to say the least, inexact. It is helpful to bear in mind the following principles:*

The Arnold Principle: *If a notion bears a personal name, then this name is not the name of the discoverer.*

The Berry Principle: *The Arnold Principle is applicable to itself.*

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Rank	Country	Reviewers	% of Reviewers
1	China	4,110	17.0%
2	United States	3,736	15.4%
3	India	1,336	5.5%
4	Italy	1,111	4.6%
5	France	984	4.1%
6	Germany	961	4.0%
7	Spain	876	3.6%
8	United Kingdom	755	3.1%
9	Japan	709	2.9%
10	Iran	702	2.9%
11	Brazil	661	2.7%
12	Turkey	570	2.4%
13	Poland	530	2.2%
14	Russia	483	2.0%
15	Canada	472	2.0%
16	Romania	332	1.4%
17	Mexico	292	1.2%
18	South Korea	291	1.2%
19	Australia	263	1.1%
20	Portugal	243	1.0%

Table 1. Reviewer counts by country, as of November 29, 2020.

Just two years earlier, in November 2018, the United States had the greatest number of reviewers, with China second. For obvious reasons, large countries dominate the top spots, but even so, there is a fair amount of dispersion around the globe. Looking at all countries, the distribution of reviewers by continents is given in Table 2.

Region	Reviewers	% of Reviewers
Asia	9,314	38.5%
Europe	8,171	33.8%
North America	4,500	18.6%
South America	1,111	4.6%
Africa	779	3.2%
Australia + Oceania	315	1.3%
Total	**24,190**	**100%**

Table 2. Reviewer counts by continent, as of November 29, 2020.

The number of reviewers per million population. The top three countries in terms of numbers of reviewers also happen to be the top three countries in terms of population. If we normalize by population, counting the number of reviewers per million people in the country, a different picture emerges (see Table 3). For me, it gives a picture of the degree of engagement with reviewing in the country.

Rank	Country	Pop. in 2019	Reviewers per 1M pop.
1	Slovenia	2,078,654	39.45
2	Austria	8,955,102	26.13
3	Luxembourg	615,729	25.99
4	Portugal	10,226,187	23.76
5	Israel	8,519,377	21.72
6	Croatia	4,130,304	20.58
7	Czech Republic	10,689,209	19.55
8	Spain	46,736,776	18.74
9	Italy	60,550,075	18.35
10	Greece	10,473,455	18.14
11	Finland	5,532,156	17.71
12	Montenegro	627,987	17.52
13	Romania	19,364,557	17.14
14	Cyprus	1,179,551	16.11
15	Malta	440,372	15.90
16	Guadeloupe	447,905	15.63
17	France	65,129,728	15.11
18	Estonia	1,325,648	15.09
19	Norway	5,378,857	15.06
20	Sweden	10,036,379	14.75

Table 3. Number of reviewers per 1 million population, as of November 29, 2020. Population counts are from Wikipedia.

The countries with large populations have all disappeared. These numbers are quotients. As mathematicians we know that there are two ways to make a quotient large: increase the numerator or decrease the denominator. I suspect that a little of both is happening with these twenty countries.

Publications by Country

Counting papers per country is tricky. Multi-authored papers are quite frequent in mathematics, though not quite at the level of the laboratory sciences. Moreover, international teams of authors are not uncommon. I queried the MR Database twice, each time looking at all items (journal

Rank	Country	1985	1985 as %	Country	1999	1999 as %	Country	2019	2019 as %
1	USA	10,642	26.4%	USA	15,042	19.4%	CN	23,688	16.2%
2	USSR	2,937	7.3%	CN	7,389	9.5%	USA	23,238	15.8%
3	FRG	2,687	6.7%	DE	5,200	6.7%	FR	7,357	5.0%
4	FR	2,163	5.4%	FR	4,835	6.2%	DE	7,347	5.0%
5	JP	2,084	5.2%	RU	4,497	5.8%	UK	7,016	4.8%
6	CN	2,068	5.1%	JP	3,983	5.1%	IN	6,281	4.3%
7	UK	2,032	5.0%	UK	3,661	4.7%	IT	5,899	4.0%
8	CA	1,741	4.3%	IT	3,226	4.2%	RU	5,219	3.6%
9	IT	1,731	4.3%	CA	3,005	3.9%	JP	4,819	3.3%
10	PL	1,223	3.0%	ES	2,429	3.1%	CA	4,095	2.8%
11	IN	1,099	2.7%	IN	2,040	2.6%	IR	3,895	2.7%
12	ES	753	1.9%	PL	1,734	2.2%	ES	3,650	2.5%
13	GDR	658	1.6%	AU	1,499	1.9%	BR	3,635	2.5%
14	NL	640	1.6%	UA	1,374	1.8%	TR	2,819	1.9%
15	AU	631	1.6%	IL	1,350	1.7%	AU	2,477	1.7%
16	IL	604	1.5%	RO	1,334	1.7%	PL	2,413	1.6%
17	RO	589	1.5%	NL	1,099	1.4%	KR	2,176	1.5%
18	HU	493	1.2%	KR	1,074	1.4%	IL	2,155	1.5%
19	ČSSR	462	1.1%	BR	1,048	1.4%	NL	1,837	1.3%
20	BE	441	1.1%	BE	868	1.1%	CH	1,681	1.1%

Table 4. Counts are of publications in the MR Database with at least one author in the country. The year is the year of publication. Country abbreviations are expanded in the table at the end of the article. The percentages are the country's percentage of the total number of publications. The total was obtained by adding up the total for each country, making it larger than the actual number of papers published.

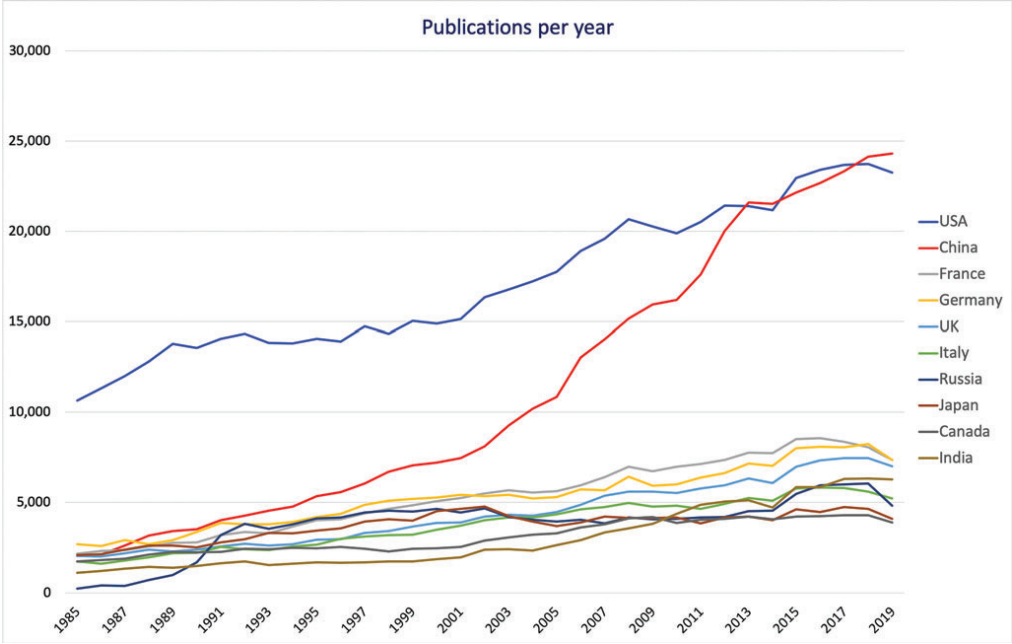

Figure 1. Publications, by country and year of publication, in the MR Database for the ten countries with highest output in 2019.

articles, proceedings papers, books, and so on) from 1985 through 2019. The first query looked at the countries of all the authors and added them up. Thus, if a paper had 3 authors from the United States, 2 authors from Mexico, and 1 author from Canada, the United States would get a count of 3 papers, Mexico a count of 2 papers, and Canada a count of 1 paper. The second query just looked to see what countries were involved. In the example just mentioned, the United States would get a count of 1 paper, Mexico a count of 1 paper, and Canada a count of 1 paper. I considered, but did not do, a fractional count whereby in the example, the United States would have had 3*(1/6) = 1/2, Mexico 2*(1/6) = 1/3, and Canada 1*(1/6) = 1/6. I call the first count "Authors with multiplicity" and the second count "Authors without multiplicity." The third count is often called "fractional authorship." In what follows, I only discuss the counts without multiplicity. There are some slight differences in the results obtained from different counts, but the general picture is the same.

There are lots of data over 35 years. Let's look more closely at three of these years: 1985, 1999, and 2019. The top twenty countries in each of these years, counting without multiplicity, are given in Table 4. Country codes are used to save space. A table of expansions is at the end of the article.

The dominance of the United States in 1985 is remarkable. I was surprised that the count for the Soviet Union in 1985 wasn't higher. In the data for 2019, however, the sum of output from the fifteen countries that came from the Soviet Union is 7,122, which would be fifth in the list. Between 1985 and 1999, the FRG and GDR unified to become a single Germany. In 1999, the United States continued to be dominant, but with a much smaller fraction of the total output. Meanwhile, China moved up considerably. Among the top 20 countries, many of their percentages of the total changed, as did their ranks. By 2019, things had changed again. China passed the United States, though the counts and percentages are close. (The two countries actually traded places three times from 2013 to 2019.) There was some relative rearranging of positions in the rest of the list. India, for instance, increased its percentage of publications by nearly two thirds. Interestingly, from 1999 to 2019, the combined share of the top two countries stayed roughly the same.

It may be easier to see trends from the chart (Figure 1) of the publications of the top ten countries in 2019 over the full 35-year span.

The output for the United States grew at about 2.2% per year over this period. Several of the countries in the lower graphs had growth rates of about 4.0%. China's output, however, grew at about 7.4%.

Table 5 gives a look at the distribution of publications by UN statistical region for 2019.

UN statistical region	% of 2019 Pubs
Eastern Asia	22.5%
Northern America	19.7%
Western Europe	13.8%
Southern Europe	8.5%
Eastern Europe	8.2%
Southern Asia	8.1%
Western Asia	5.2%
South America	3.5%
Northern Europe	2.7%
Australia and New Zealand	2.0%
South-eastern Asia	1.8%
Northern Africa	1.7%
Central America	0.9%
Southern Africa	0.5%
Western Africa	0.3%
Central Asia	0.3%
Eastern Africa	0.1%
Middle Africa	0.1%
Caribbean	0.1%
Melanesia	0.0%
Polynesia	0.0%
Micronesia	0.0%

Table 5. Percentages of publications in the MR Database for 2019, by UN statistical region.The regions are defined here: `https://unstats.un.org/unsd/methodology/m49/`.

As with reviewers, it is possible to normalize the number of publications per country by population. Table 6 shows the twenty countries that had the most publications in 2019 in the MR Database per one million population.

Once again, the top of the normalized list consists mostly of smaller countries. The exceptions are Germany, France, and Italy, which are 18th, 23rd, and 24th largest by population.

Rank by Pub per Pop	Country	Population in 2019	2019 count	2019 Papers / 1M pop
1	Israel	8,519,377	1837	215.6
2	Luxembourg	615,729	123	199.8
3	Switzerland	8,591,365	1624	189.0
4	Austria	8,955,102	1419	158.5
5	Slovenia	2,078,654	324	155.9
6	Singapore	5,804,337	737	127.0
7	Norway	5,378,857	662	123.1
8	Denmark	5,771,876	694	120.2
9	Iceland	339,031	40	118.0
10	Sweden	10,036,379	1173	116.9
11	France	65,129,728	7357	113.0
12	Canada	37,411,047	3895	104.1
13	Finland	5,532,156	565	102.1
14	Belgium	11,539,328	1120	97.1
15	Australia	25,203,198	2413	95.7
16	Czech Republic	10,689,209	979	91.6
17	Portugal	10,226,187	934	91.3
18	Germany	83,517,045	7347	88.0
19	Italy	60,550,075	5219	86.2
20	Ireland	4,882,495	388	79.5

Table 6. Publications in 2019 per 1 million population. Population counts are from Wikipedia.

Journals

There is more than one way to attach journals to places. At Mathematical Reviews, we know the location of the publisher, but not necessarily the location of the editorial office, which is often different. This disconnect between place of publication and the "home" of the journal has become particularly pronounced as journals associated with societies and institutions have moved to publishing houses, both commercial and non-profit. Thus, a journal from a Korean society may be listed in my data as being from the Netherlands. Here are a few examples, by publisher, of journals associated with a country different from the country of the publisher's headquarters. Mathematicians have historically identified Springer, now Springer Nature, with its offices in Germany and the United States, though its business headquarters are now in Switzerland and they have offices in 50 countries. Meanwhile, a few of their journals normally associated with places other than the place of publication include *Publications mathématiques de l'IHÉS*, *Vietnam Journal of Mathematics*, *Vestnik St. Petersburg University (Mathematics)*, the *Journal of the Operations Research Society of China*, and the *Journal of the Egyptian Mathematical Society*. The headquarters for Elsevier is in the Netherlands. A selection of their mathematical journals with geographic affiliations outside the Netherlands includes *Annales de l'Institut Henri Poincaré (C) Analyse Non Linéaire*, *Journal of the Korean Statistical Society*, and *Journal de Mathématiques Pures et Appliquées*. In a similar fashion, Cambridge University Press publishes the *Journal of the Australian Mathematical Society*, the *Canadian Journal of Mathematics*, the *Journal of the Institute of Mathematics of Jussieu*, and the *Nagoya Mathematical Journal*. Even smaller publishers demonstrate this international phenomenon. For instance, the non-profit Mathematical Sciences Publishers (MSP), who publish *Moscow Journal of Combinatorics and Number Theory* and the *Tunisian Journal of Mathematics*, is based in Berkeley in the United States. Globalism in publishing has its advantages, but it can make data analysis complicated.

With that proviso, let's take a look at the geography of mathematics journals. The distribution is more concentrated than the other two we have looked at. For reviewers (respectively, publications), it takes the top 15 (respectively, 16) countries to get to 75% of the total. With journals, the

top 10 countries already represent about 75% of the journals. With journals, it takes 22 countries to get to 90%. For reviewers (respectively, publications), it takes 35 (respectively, 34) countries to get to 90%. The top 21 countries for journals are given in Table 7. Note, 21 countries are listed because of the tie in the 20th spot.

Rank	Country	# Journals
1	United States	366
2	United Kingdom	208
3	Germany	182
4	Netherlands	140
5	China	82
6	Russia	71
7	Japan	61
8	Singapore	58
9	Poland	53
10	Switzerland	49
11	India	45
12	France	37
12	Romania	37
14	Italy	26
15	Canada	19
15	Ukraine	19
17	Iran	17
17	Hungary	17
17	Spain	17
20	Turkey	12
20	South Korea	12

Table 7. Journals, by country of the publisher, in the MR Database as of November 2019.

I don't have counts for journals over time, which is unfortunate. There are multiple important trends taking place in scientific publishing, such as consolidation at big publishing houses and open access. It would be interesting to look at the geographical changes that have occurred at the same time.

Some Final Thoughts

The example of journals points out at least one of the limitations of compiling geographical data as I have done. What does it mean for a journal to be associated with a country? I have chosen the location of the publisher. As someone who has been involved in the publishing world, I find this useful. I pointed out earlier that many journals are affiliated with institutions or national societies with definite locations. But the editors of those journals are not always in those locations. For example, both the *Tunisian Journal of Mathematics* and the *Journal of the Institute of Mathematics of Jussieu* have globally dispersed editorial boards. I have not tried to compile lists of authors per country, mostly because I am not sure what basis to use. Many mathematicians move around, making location time dependent. It is not uncommon for a mathematician to be born in one country, to be educated in another, and to be currently working in yet a third. There are also examples of mathematicians with simultaneous, international appointments, a sort of Schrödinger's cat phenomenon. In other words, the data in these analyses are inherently imprecise. That imprecision, however, reinforces the point that mathematics is decidedly international.

References

Country & region data.
Wikipedia
`https://en.wikipedia.org/wiki/List_of_countries_and_dependencies_by_population`
`https://en.wikipedia.org/wiki/United_Nations_geoscheme`
United Nations
`https://unstats.un.org/unsd/methodology/m49/`

Country Abbreviations

Abbrev	Country
AU	Australia
BE	Belgium
BR	Brazil
CA	Canada
CH	Switzerland
CN	China
ČSSR	Czechoslovakia
DE	Germany
ES	Spain
FR	France
FRG	Federal Republic of Germany
GDR	German Democratic Republic
HU	Hungary
IL	Israel
IN	India
IR	Iran
IT	Italy

* *Table continues on next page.*

JP	Japan
KR	South Korea
NL	The Netherlands
PL	Poland
RO	Romania
RU	Russia
TR	Turkey
UA	Ukraine
UK	United Kingdom
USA	United States
USSR	Soviet Union

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Credits

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