Analysis of International Research Collaborations at Stockholm University

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Contents

1. Introduction

The aim of this report is to map and assess the level of international collaborations of Stockholm University (SU) by looking at scientific co-publications. Even if it is not a direct indicator, analysing co-publications is one of the common ways to map the output of international collaborations. Together with other data, it might also offer clues as to what factors might encourage international collaborations and co-publications. We have complemented publication data with information from Stockholm University Research Database about externally funded international collaborations and post docs destinations for Stockholm University scholars. Other types of complementary data are discussed in the last section.

The report is one of several studies being written in late 2017 and early 2018 as background material for Stockholm University's coming strategy for continued internationalisation 2019-22. Together with other reports, it provides information about the current level of, and possible ways to increase, internationalisation at Stockholm University. In a shorter perspective, it provides data for current work with international contacts and collaborations e.g. by pointing to potential strategic partner universities in the United Kingdom in the wake of Brexit. The main author of the report is Gabor Schubert (Bibliometrician, Stockholm University Library). From the Research Support Office Maria Wikse, Head of International Affairs, has contributed to certain sections and Emre Özlü, Project Manager, has provided data about externally funded international collaborations from Stockholm University Research Database.

Indicators for scientific publications

It is generally hard to find quality indicators for scientific publications. The most common method is to use citation-based indicators, although these are usually controversial and often not functional for comparisons. Another possibility is to analyse co-publications to identify fields where Stockholm University has a leading role in international co-publications.

Many studies have shown that citation-based indicators are usually higher for publications from international collaborations, and this leads to the assumption that international collaboration leads to higher quality, even if there is no proof that this advantage is a result of higher quality[1] or other factors (for example wider reading public because of the larger networks of authors). There are fields, for example Organic Chemistry at Stockholm University, where an exceptionally high citation rate was achieved by publications without international collaborations.

Whether or not internationalisation leads to higher quality per se, it is important to have correct and up to date information about Stockholm University's international co-publications. Research is a global activity and Sweden is a relatively small actor so in most cases international collaborations area necessity.

Mapping co-publications might sound relatively simple, but the available data will demonstrate that it is far from straightforward. Probably the most important task is to adjust the analysis to the questions

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[1] Lutz Bornmann: "Is collaboration among scientists related to the citation impact of papers because their quality increases with collaboration? An analysis based on data from F1000Prime and normalized citation scores", Journal of the Association for Information Science and Technology, 68, 1036 (2017) http://dx.doi.org/10.1002/asi.23728

asked, which means that we first need to formulate them. The tentative questions that have guided this analysis so far are:[2]

 – What countries and universities are Stockholm University's most common partners in co-publications?
 – What fields of research at Stockholm University are most active in terms of international co-publications?

Methods and source material

The first section will demonstrate some complications involved in using basic publication statistics about international collaborations. The second section illustrates some general basic publication statistics, and gives some examples, through cases, with more detailed analysis. In the third section some aspects of quality indicators are discussed and analysed. Section four is a case study where the co-publications with researchers at a university in the United Kingdom are analysed in more detail. Complementing this, data from Stockholm University Research Database about externally funded international collaborations with universities in the United Kingdom is provided, as well as data about international post docs funded by the Swedish Research Council.

1. Some examples of sources of complexity in publication analysis

This chapter discusses the most problematic issues involved in the analysis of international co-authorship. Most are relevant for publication analysis in general.

1.1. Publication databases

The first task is to find relevant publications to analyse. An obvious choice is the database at Stockholm University, DiVA, which contains the relevant metadata about all Stockholm University's publications. Unfortunately, DiVA only includes information about the affiliations of authors from the university and is therefore insufficient for analysis about international collaborations. There are two global subscription-based publication-citation databases, which contain metadata about all authors: Web of Science from Clarivate Analytics, and Scopus from Elsevier. These databases have structured metadata at country and university level, but there is no metadata at the level of departments, (available in DiVA only for Stockholm University authors). A plausible strategy is to combine information from DiVA and the global databases to create a dataset.

1.2. Publication types

Many publication analyses concentrate on peer-reviewed publications in journals since most of the available publication databases mainly contain usable and structured data about journal publications. A relatively substantial portion (15-20%) of the peer-reviewed scientific output of Stockholm University is published in non-journal publication types such as books, book chapters and conference proceedings, mostly from the field of humanities and social sciences. These non-journal publications are scarcely covered in Web of Science or Scopus. Stockholm University´s local publication database DiVA is the only database that includes a well-curated collection of these other publication types, but it only with information of Stockholm University authors. Thus, it is not possible to carry out an international co-authorship analysis for non-journal publications based on DiVA data. However, DiVA data indicates that non-journal publications are relatively seldom internationally co-authored

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[2] Other questions that could be asked are for instance:

 • How does Stockholm University compare to other universities in Sweden or elsewhere in terms of international publication? Is it relevant to make such comparisons?
 • Can a positive effect of international recruitments be seen in bibliometric analysis?
 • Can other positive effects be seen and investigated further?

since more than 50% of these publications have only one author, and 25% have only two authors, many times both from Stockholm University.

This also implies that statistics based purely on journal publications usually underestimate the fields of humanities and social sciences and overestimate the ratio of international co-authored publications. Hypothetically, an inclusion of non-journal publication types would lower the overall average ratio of internationally co-authored Stockholm University publications from 65% to 60%. Given these restrictions, co-publication analysis is mainly meaningful for journal articles. Thus, the results discussed here are relevant for the field of sciences and partly for social sciences, but not for the field of humanities.

1.3. Definition of countries

If the aim is to identify the most common collaborating countries for Stockholm University researchers, it is not easy to find and define countries in different databases:

- − The Web of Science database defines Scotland, Wales, Northern Ireland and England as separate country level entities. Conversely the Scopus database only uses United Kingdom as a country level entity, thus further differentiation is not possible.
- − A similar case is Hong Kong and China, which are merged to China in the Web of Science but handled separately in Scopus.

In theory, it is possible to reconstruct the more detailed country level data from the university names, but this is extremely time-consuming. It is also possible to merge data from several different databases, but since the coverage is somewhat different in different databases, a complete picture is never possible. For an analysis that focuses on collaborating countries, it is therefore important to know which countries are relevant, i.e. when a study focuses on co-publications with Great Britain or China/Hong Kong comparisons between Scopus and Web of Science are needed.

1.4. Fractional counting / weighing

It is quite common to use some form of weighing method (or fractionalization) in publication analysis. Such tools are important to address some mathematical and statistical problems, but quite often, it makes the interpretation of the results somewhat difficult. We should keep in mind that different weighing methods can give quite different results, so it is important to adjust the fractionalization to the questions asked.

A demonstration through a real-life example[3]

The article in question has 16 authors from two different countries: Sweden and Norway. The authors are affiliated to four universities, three in Sweden and one in Norway. The only author affiliated to Norway is also affiliated to Sweden. Finally, there is one author is affiliated to Stockholm University, who also has double affiliation to another Swedish university.

Fractional counting 1: We share the publication between the countries equally: both Sweden and Norway get 0.5 parts. **Count for Stockholm University: 0.5**

Fractional counting 2a: We share the publication according to the ratio of authors from the countries: 1 author is affiliated to Norway, 15 to Sweden: Sweden gets 0.9375 Norway gets 0.0625 parts. **Count for Stockholm University: 0.9375**

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[3] : https://doi.org/10.1105/tpc.17.00153

Fractional counting 2b: We share the publication according to the ratio of authors from the countries fractionalized among multiple affiliations: 0.5 author is affiliated to Norway, 15.5 to Sweden: Sweden gets 0.96875 Norway gets 0.03125 parts. **Count for Stockholm University: 0.96875**

Fractional counting 3a: We count the publication for Stockholm University according to the number of Stockholm University authors: 1 out of 16 authors has a Stockholm University affiliation: Stockholm University gets 0.0625 parts. **Count for Stockholm University: 0.0625**

Fractional counting 3b: We count the publication for Stockholm University according to the number of Stockholm University authors fractionalized among multiple affiliations: 0.5 out of 16 author has a Stockholm University affiliation: Stockholm University gets 0.03125 parts. **Count for Stockholm University: 0.03125**

There are several other possibilities including university or person level fractional counting. It is obvious that the choice of weighing makes a huge difference in the final analysis: in the example above the same publication can have a value for Stockholm University between **0.03** and **0.97** depending on the choice of fractionalization.

All the above fractional counting examples can be meaningful, but the choice is always dependent on the question. For example, if we were interested in how countries collaborate, *Fractional counting 1* would give a useful number by attributing to this article to Norway as a collaborating country. If we were trying to weigh the publications according to the participation of different universities, *Fractional counting 3a* or *3b* would be useful.

Another interesting case is the so-called "mega-authored" publications, which are the results of large international projects mainly in the field of particle physics. Stockholm University participates with dozens of researchers in such projects, and these result in several hundreds of publications with several thousands of authors each. If we count these publications without fractional counting, they will heavily distort any statistics. With the choice of *Fractional counting 3a or 3b* Stockholm University would get only ca. 0.01 fractionated count for these, which would be a serious underrepresentation of this research in any statistics: more than 500 such articles were published in recent years, with 20-30 Stockholm University researchers participating in each. Counting these as ca. 1 publication per year would be a serious underrepresentation of this research. A country level fractional counting (such as *Fractional counting 1*) might give a more balanced picture.

Generally, we can say that fractional counting is necessary when the absolute numbers would distort the result of the analysis, but the choice of fractionalization is dependent on the questions and the level of analysis.

1.5. Multiple affiliations

A researcher can be affiliated to several different institutions, or even countries, at the same time. This is often shown in the publications and the publication databases, which gather metadata from publishers. In the extreme case, a publication with one author can be affiliated to several different countries. In one example[4], a Stockholm University author has listed three different institutions in three different countries: Sweden, Brazil and Belgium as affiliations. Ca. 3-4% of the Stockholm University publications have at least one author who is multi-affiliated. It is not obvious how to handle these. In the case of one-author publications, it is not meaningful to define them as collaborations, even though, from the perspective of identifying international activities, these researchers could be seen as important links between countries and institutions.

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[4] https://doi.org/10.1016/j.jdeveco.2014.02.005

The most common way is to use some kind of fractional counting to tackle this problem, but again it is important to carefully choose the relevant level of fractionalization according to the nature of the analysis.

1.6. Research subject fields

There are several different subject categorization systems, however, they are seldom compatible with each other. Web of Science, Scopus and DiVA all use different systems.

Web of Science and Scopus use journal level categories, where every publication in a given journal is categorized into the same subject category/categories. This produces relatively meaningful categories for journals that are highly specialized in a particular field, whereas articles published in general multidisciplinary journals (for example: Science, Nature, PLOS One) are not categorized at all. Both Web of Science and Scopus use different levels of categories: they have a rudimentary categorization system with a few dozen subject fields, and they have a finer system with several hundred research categories. However, these systems are not convertible between the databases.

DiVA uses the official Swedish research subject categorization system[5], and librarians at Stockholm University Library categorize each article. This gives relevant categories for most of the publications, but the method is time-consuming and prone to human errors and subjective decisions. It might also be difficult to use this system for international benchmarking, because it is only used in Sweden and not totally compatible with other categorization systems.

Another possibility is to use the organizational structure of Stockholm University to categorize publications according to the affiliated Stockholm University departments. The relevancy of this kind of categorization is dependent on the size and internal structure of the departments: for example, most of the publications from the Department of Organic Chemistry could most probably be categorized as *chemistry*, but publications from a multidisciplinary department, such as the Department of Ecology, Environment and Plant Sciences (DEEP), which was formed through the merging of several different departments, could be categorized as belonging to several different subject fields.

Some attempts[6] to use artificial intelligence based automated categorization systems have been made, but these are still under development and not generally available. They often give erroneous categories, so they need manual control.

Different subject categorization systems also cause differences in field-weighted indicators. For example, the value of a field-weighted citation index is heavily dependent on the subject fields used in the calculation of the index. This can lead to quite different results in different subject categorization systems and databases.

The following analysis takes Stockholm University's departments as its organizing model, when applicable.

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[5] http://www.scb.se/dokumentation/klassifikationer-och-standarder/standard-for-svensk-indelning-av-forskningsamnen/
[6] http://www.ep.liu.se/hsv_categories/index.en.asp

2. Quantitative analysis

2.1. Data collection

This analysis focuses on peer-reviewed journal publications. The data for publications between 2012 and 2017 was collected in November 2017 from the Web of Science publication database, which means that data for 2017 is not complete. The identification of publications from Stockholm University was made from combined searches in Web of Science and DiVA. Only journal publication types *Articles* and *Reviews* were considered and only publications which were identified in both databases. This covers at least 95% of all Stockholm University journal publications. Fractional counting is used if necessary and the level of fractionalization is specified. Collaborations with other Swedish universities are not analysed in this study.

2.2. General statistics

The dataset includes 13,532 publications. Table 1 and Figure 1 shows the distribution of publications during the observed period. A publication was counted as international if it had at least one author with an affiliation address outside of Sweden. Nota bene that data for 2017 is not complete.

Table 1. Distribution of publications between international and local authorship in the observed period (2012-2017)

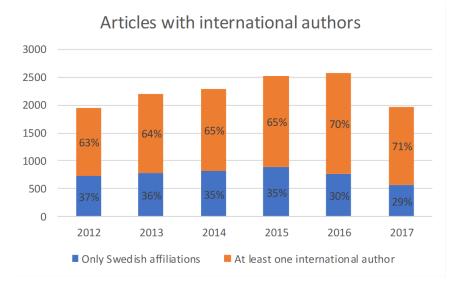| Year	Number of publications		
	Only Swedish affiliations	International authors	Total
2012	728	1226	1954
2013	787	1419	2206
2014	815	1484	2299
2015	881	1643	2524
2016	771	1805	2576
2017	564	1409	1973

Figure 1. The percentage of publications with international authors

Both the total number of publications and the ratio of publications with international co-authorship increase steadily from 2012 to 2017.

To compare these numbers to other universities we can use data from the Leiden Ranking[7], which is an international university ranking, based purely on bibliometric data from Web of Science database, and prepared by CWTS at Leiden University, Belgium. The latest published dataset from the Leiden Ranking includes publications between 2012 and 2015. Although CWTS has a slightly different set of publications in their analysis from Web of Science, the results are comparable to the data included in this study. In the next table the level of international collaborations is shown at different Swedish universities according to the Leiden Ranking.

Table 2. Share of international co-publications according the Leiden Ranking (2012-2015)

Rank in Sweden	University	Number of publications	Number of international co-publications	Share of international co-publications (%)	Rank in the world
1	Stockholm University*	8832	5805	**65.7%**	24
2	Karolinska Institutet	18814	12054	**64.1%**	32
3	KTH Royal Institute of Technology	9096	5753	**63.2%**	40
4	Swedish University of Agricultural Sciences	5471	3414	**62.4%**	50
5	Lund University	16094	10032	**62.3%**	51
6	Uppsala University	15120	9296	**61.5%**	62
7	University of Gothenburg	11134	6328	**56.8%**	140
8	Umeå University	6557	3678	**56.1%**	153
9	Chalmers University of Technology	5711	3158	**55.3%**	168
10	Linköping University	6804	3411	**50.1%**	275

*The respective values from the data set of the current study are: 8983/5772/64.3%

Table 2 shows that several Swedish universities are among the top 50 universities with the highest shares of international co-publications in the world. Stockholm University has the highest share of all Swedish universities and is ranked 24 in the world. The other top universities in international co-publications according to the Leiden Ranking are mostly from Saudi Arabia, Chile, Belgium, Switzerland, South Africa, and Austria. Generally, it can be observed that research intensive universities from smaller countries tend to have a higher share of international co-publications. The exact reasons for the high share of international collaborations might vary from case to case, but some common reasons could be: the presence of large international research centres (Switzerland: CERN, Chile: astronomy), active recruiting of international researchers (Saudi Arabia), or multi-lingual countries (Belgium, Switzerland).

The nature of the international collaborations can be quite different: some of them are bilateral collaborations with two researchers or smaller research groups from two countries, but some of them are so-called mega-authored publications in the field of particle physics or medicine/genetics with dozens of participating countries.

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[7] http://www.leidenranking.com/ranking/2017/list

In Table 3 the distribution of the number of participating countries in the publications of Stockholm University is shown (2012-2017).

Table 3. Distribution of the number participating countries in the publications (2012-2017)

Number of participating countries including Sweden	Number of publications (2012-2017)	Percent of total number of publications
1	4546	30%
2	3974	27%
3	3273	22%
4 to 10	2026	14%
11 or more	982	7%

Many collaborations have authors from two countries (bilateral collaborations). There are almost 1000 publications which have authors from more than 11 countries, mostly the result of large collaboration projects in the fields of physics and astronomy.

2.3. Country based statistics

The most common collaborating countries for Stockholm University are shown in Table 4. (2012-2017)

Table 4. The most common collaborating countries in Stockholm University publications (2012-2017)

Rank	Country	Absolute number of publications	World rank*
1	USA	3483	1
2	Germany	2808	4
3	UK	2636	3
4	France	1648	6
5	Italy	1472	9
6	Spain	1398	10
7	Netherlands	1381	14
8	Australia	1341	11
9	Switzerland	1331	18
10	Norway	1289	29
11	Denmark	1283	23
12	Canada	1269	7
13	China	1182	2
14	Japan	1121	5
15	Russia	997	15
…	…	…	…
19	Finland	830	30
23	Brazil	768	13
41	India	373	8
43	South Korea	257	12

* Total number of journal articles in Web of Science (2012-2017)

Table 4 shows the absolute number of publications where at least one author is affiliated to a given country. The last column in Table 4 shows the world rank of the country according to the total number of publications indexed in Web of Science between 2012 and 2017. Some countries are overrepresented in collaborations with Stockholm University compared to the publication output of the country, most notably Norway, Denmark and Finland. Conversely China, Japan and especially Brazil, South Korea and India are underrepresented.

The absolute numbers might give a somewhat distorted picture because of the relatively large number of multilateral collaborations. Therefore, Table 5 shows the most common collaborating countries using a simple fractional counting, where each publication is equally shared among the participating countries.

Table 5. Most common collaborating countries according to fractional publication counts, where the publications are shared equally between the participating countries (2012-2017)

Rank	Country	Fractional publication count	Rank without fractional counting (Table 4)
1	USA	845	1
2	Germany	576	2
3	UK	534	3
4	Finland	233	19
5	Norway	229	10
6	France	223	4
7	China	214	13
8	Italy	206	5
9	Australia	204	8
10	Netherlands	199	7
11	Spain	192	6
12	Denmark	176	11
13	Canada	171	12
14	Switzerland	169	9
15	Japan	122	14

It is notable that Finland appeared at the 4th place in Table 5 according to fractional counting, even though it has only rank 19 according to absolute publications. This means that Finland participated in fewer publications (830), but these have fewer collaborating countries.

To illustrate tighter collaborations, Table 6 shows absolute number publications for bilateral collaborations between Sweden and one other country.

Table 6. Countries with most publications in bilateral collaborations (2012-2017)

Rank	Country	Absolute number of publications	Rank with fractional counting (Table 5)
1	USA	729	1
2	Germany	389	2
3	UK	366	3
4	China	231	7
5	Finland	215	4
6	Norway	215	5
7	Australia	179	9
8	Netherlands	141	10
9	Italy	128	8
10	Spain	127	11
11	Denmark	102	12
12	Canada	96	13
13	France	95	6
14	Switzerland	85	14
15	South Africa	67	17

The distribution of countries in bilateral collaborations is quite similar to that of the fractional counted publications. Maybe the only notable difference is the case of France that has a high ratio of multilateral collaborations with Stockholm University, while Stockholm University has few bilateral collaborations with France.

There are some countries that participate in large collaboration projects and appear in many multilateral publications but have very few other collaborations with Stockholm University. Some examples are shown in Table 7.

Table 7. Some typical countries with mostly multilateral collaborations (2012-2017)

Country	Absolute number of publication	Fractional publication count for countries	Number of publications with bilateral
Serbia	587	16	1
Belarus	579	17	1
Georgia	577	16	0
Morocco	571	16	2
Azerbaijan	563	14	0

In summary, the most important collaborating partner countries for Stockholm University are **USA**, **Germany** and the **UK**. These three countries are followed by **China**, **Finland** and **Norway** if we look at the number of bilateral collaborations and fractional counting by the number of participating

countries. There is a slightly lower level of bilateral and fractional counted collaboration with **Denmark** than with the other Nordic countries.

The most common collaborating countries are those that have the largest overall publication output in world. However, some countries with large absolute publication output are underrepresented in the co-publications listed, most notably India. The collaboration levels with China and Japan are also lower than could be expected from their size. A common feature for them is that they are geographically and culturally far from Sweden. There are some collaborating countries that almost exclusively appear in large multilateral collaboration projects.

2.4. Faculty/Department based statistics

This section gives further details about the level of internationalisation through co-publication at Stockholm University's faculties and departments. The organizational structure of Stockholm University has changed several times; between 2012 and 2017 some new departments were formed, some older departments ceased to function or were merged, and some interdisciplinary research centres became a part of a faculty. The following section uses the most recent organizational structure of Stockholm University, where the older departments have been mapped to the current ones. Table 8 illustrates the distribution of publications among the four Stockholm University faculties

Table 8. Distribution of journal publications among the Stockholm University faculties (2012-2017)

Faculty	Absolute number of publications*	Percentage of total number of publications	Absolute number of international** publications	International publications (%)
Natural Sciences (SCI)	9395	68%	7083	75%
Social Sciences (SOC)	450	25%	1724	50%
Humanities (HUM)	757	6%	219	29%
Law (LAW)	17	1%	3	18%

*No fractional counting is applied, because the number of inter-faculty collaborations are very low (less than 1%)
** Publications which have at least one author with an affiliation outside of Sweden

Table 8 clearly illustrates that social sciences and humanities are underrepresented in journal publications in general and in Web of Science specifically. Law traditionally publishes very few articles in Web of Science indexed journals. Almost 70% of all the journal publications are authored by researchers from natural science fields. The percentage of these that are international publications is far higher (75%) for SCI. Roughly half of the social science publications and one third of the humanity's publications have international co-authorships.

If we look at data at the more detailed departmental level, more specific trends are visible. It is important to note that while inter-faculty collaborations are rare (less than 1%) inter-department collaborations are relatively common: 20% of the observed publications have at least two affiliated Stockholm University departments. A large number of the inter-departmental collaborations are actually the result of researchers who are doubly affiliated to a department and a research centre. Some common double affiliations are: Oskar Klein Centre and the Department of Physics, Oskar Klein Centre and the Department of Astronomy, SciLifeLab and the Department of Biochemistry and Biophysics. In Table 9 some publication statistics from the 30 most productive departments and the percentage of their international publications are shown. In the all the following tables Stockholm University's independent research institutes and research centres are counted as departments.

Table 9. The 30 most productive Stockholm University departments in the observed period (2012-2017)

Department	Faculty	Number of publications*	Percentage international publications**	Most frequent collaborating country
Department of Physics	SCI	1201	87%	USA
Department of Environmental Science and Analytical Chemistry (ACES)	SCI	836	71%	USA
Department of Materials and Environmental Chemistry (MMK)	SCI	798	70%	China
The Oskar Klein Centre for Cosmo Particle Physics (OKC)	SCI	696	96%	USA
Department of Psychology	SOC	636	48%	USA
Department of Physical Geography	SCI	579	76%	USA
Department of Ecology, Environment and Plant Sciences (DEEP)	SCI	524	70%	USA
Nordic Institute for Theoretical Physics (Nordita)	SCI	506	90%	USA
Stockholm Resilience Centre (SRC)	SCI	501	80%	USA
Department of Biochemistry and Biophysics (DBB)	SCI	500	64%	USA
Department of Astronomy	SCI	462	94%	USA
Aging Research Center (ARC), (together with KI)***	SOC	442	71%	Germany
Department of Molecular Biosciences, Wenner-Gren Institute (MBW)	SCI	432	65%	Germany
Department of Organic Chemistry	SCI	427	37%	China
Department of Geological Sciences	SCI	423	85%	USA
Department of Zoology	SCI	396	70%	UK
Department of Meteorology	SCI	357	75%	USA
Stress Research Institute	SOC	322	57%	UK
Department of Mathematics	SCI	276	57%	USA
Department of Sociology	SOC	229	51%	USA
Centre for Health Equity Studies (CHESS)	SOC	222	56%	Finland
The Swedish Institute for Social Research (SOFI)	SOC	210	49%	UK
Centre for Social Research on Alcohol and Drugs (SoRAD)	SOC	191	62%	Australia
Department of Computer and Systems Sciences (DSV)	SOC	173	46%	UK
Stockholm Business School	SOC	173	53%	Finland
Science for Life Laboratory (SciLifeLab)	SCI	147	64%	USA
Department of Neurochemistry	SCI	133	75%	Estonia
Department of Archaeology and Classical Studies	HUM	126	53%	USA
Department of Social Work	SOC	118	30%	Norway
Department of Economics	SOC	107	55%	USA

*A simple fractional counting at department level was applied, because of the relatively high number of inter-department collaborations. The publications were equally shared among the participating departments.

** Publications which have at least one author with an affiliation outside of Sweden

*** Aging Research Center (ARC) is a collaboration between KI and SU. Most of the researchers at ARC are employed by KI, but the publications are doubly affiliated with KI and SU. All ARC publications are registered in DiVA, but not all of them are correctly assigned to Stockholm University by Web of Science.

Of a total of 60 departments at Stockholm University, the 30 most productive departments produced almost 90% of all the journal publications of Stockholm University in the observed period.

There are three departments with higher than 90% international publications: Oskar Klein Centre, Astronomy, NORDITA. On the other hand, the Department of Organic Chemistry has only 37% percent international publications, making it one of the lowest among science departments. However, this department has the second highest number of post docs who obtain international fellowships from the Swedish Research Council (See Appendix 2). The Department of Social Work has only 30% international publications, which is significantly lower than the average of 50% for the Faculty of Social Sciences.

Most of the departments (16 of 30) have American institutions as their most frequent collaborating partners. Some notable exceptions from this trend are the Department of Materials and Environmental Chemistry and the Department of Organic Chemistry, where the most common collaboration partner in publications is a Chinese institution. Aging Research Center and the Wenner-Gren Institute most frequently collaborate with German partners. A few other departments have their most frequent collaborators in the UK and in the Nordic countries. There are two outliers: SoRAD has Australian and the Department of Neurochemistry has Estonian institutions as their most frequent co-publication partners. In many cases, this might be explained by the fact that some prominent researchers from the given country prefer to collaborate with colleagues from their home countries or use multiple affiliations in their publications.

This becomes evident on the heat map of the 30 most productive departments and the countries of the co-authors in Figure 2. In order to dampen the effect of large multilateral collaborations and multidepartment publications the numbers are fractionalized with both the number of participating countries and the number of participating Stockholm University departments.

	Physics	OKC	ACES	MMK	Nordita	Phys Geog	Astronomy	SRC	DEEP	Geol Sci	DBB	ARC	Psychology	MBW	Zoology	Meteorology	Stress	Mathematics	Organic Chem	CHESS	Sociology	SoRAD	SOFI	Neurochemistry	SciLifeLab	Stockholm Bus Sch	DSV	Archaeology	Economics	IIES
USA	88	50	47	34	76	47	54	41	27	40	38	26	36	20	20	38	13	16	11	8	15	3	7	7	12	6	8	10	8	7
Germany	72	46	37	33	23	28	41	35	19	20	20	26	15	20	12	19	10	14	9	8	6	16	8	2	7	0	0	2	5	6
UK	44	36	27	18	24	37	31	28	10	30	17	16	17	18	21	23	15	11	4	12	5	4	11	4	4	6	10	9	5	5
Finland	6	4	28	6	14	11	9	5	18	3	4	19	5	2	15	4	14	0	1	14	4	6	4	2	2	13	6	1	1	0
Norway	15	9	39	5	7	15	8	8	14	9	3	5	17	3	9	10	2	2	1	4	3	2	8	0	1	2	3	2	0	3
France	35	24	10	10	11	9	19	6	6	11	10	9	1	7	7	9	10	4	4	2	1	2	0	2	2	2	0	1	3	0
China	18	9	16	68	7	4	3	2	3	8	3	18	4	3	4	1	1	4	16	0	3	0	1	1	1	5	3	0	0	0
Italy	34	24	11	12	12	4	14	4	5	7	5	19	8	6	3	5	2	4	3	1	4	4	1	1	2	1	0	0	3	1
Australia	16	18	6	2	2	10	8	21	8	15	5	8	9	3	11	4	10	1	1	5	3	22	0	1	0	4	1	2	0	0
Netherlands	27	14	15	4	6	6	10	16	10	3	12	6	9	5	3	3	10	4	1	2	4	1	9	1	1	0	1	1	1	0
Spain	32	21	8	25	5	3	20	8	6	4	8	5	2	4	9	2	0	2	7	2	3	1	2	0	3	1	2	3	1	0
Denmark	22	17	15	3	14	9	8	4	11	10	7	2	4	6	3	5	6	1	1	4	1	1	3	0	4	1	1	1	1	0
Canada	24	15	17	4	5	12	9	21	5	10	2	4	3	3	4	7	3	2	1	1	3	1	0	1	3	1	0	1	2	
Switzerland	28	16	24	6	9	21	10	3	2	7	7	4	4	2	3	3	0	2	2	1	1	1	0	0	1	2	0	1	1	2
Japan	27	19	2	10	7	5	12	3	1	4	7	1	2	3	3	1	2	1	1	1	0	1	2	2	0	1	0	2	0	
Russia	16	11	9	9	16	8	7	4	4	7	1	0	0	3	3	3	1	4	2	0	0	0	0	0	0	1	1	1	0	0
South Africa	13	13	2	5	1	2	3	14	5	2	0	0	8	1	3	1	1	0	5	0	1	0	0	0	1	1	0	0	0	0
Austria	19	12	5	0	0	5	2	2	3	1	2	3	1	5	3	2	1	1	1	0	0	0	0	1	1	1	3	0	0	1
Poland	24	11	3	4	2	2	2	2	2	2	2	1	2	9	2	1	1	1	3	0	0	0	0	0	0	0	0	0	0	0
Belgium	8	5	4	8	2	7	5	1	6	1	4	2	5	3	3	0	3	0	1	1	1	0	0	1	1	0	0	0	0	1
Israel	13	13	0	0	7	1	10	0	1	1	2	0	1	2	0	4	0	1	1	0	0	0	1	0	1	0	0	0	0	0
Czech	11	9	4	7	0	5	1	0	2	0	2	5	0	6	2	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0
Brazil	17	9	4	1	1	1	0	3	2	1	1	0	1	1	1	1	5	1	1	5	0	0	0	0	0	0	0	0	0	0
India	9	5	5	3	7	1	4	1	0	1	1	0	1	1	1	4	2	0	3	0	0	0	0	0	1	0	0	0	0	0
South Korea	5	4	4	12	1	0	4	0	0	1	4	0	1	0	0	2	1	1	2	0	7	0	0	0	1	0	0	0	0	0
Estonia	0	0	1	0	0	3	0	0	4	2	5	0	0	0	4	1	0	0	0	1	1	0	0	0	22	0	0	1	0	0
Chile	9	14	0	1	2	1	12	3	3	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Portugal	11	9	2	1	1	1	1	2	7	0	1	0	1	1	1	3	0	0	0	0	0	1	0	2	1	0	0	0	1	0
Greece	11	7	6	2	2	7	1	1	1	2	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
New Zealand	4	4	1	0	1	2	0	2	1	5	1	0	5	1	2	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0

Figure 2. Heat map of co-authored publications by Stockholm University departments and countries

Figure 2 illustrates some interesting details about collaboration patterns. Probably the most striking is the high number of co-publications between MMK (Department of Materials and Environmental Chemistry) and Chinese institutions. This reveals that that MMK is responsible for a substantial part of Stockholm University´s collaboration publications with China. An explanation for this might be the recruitment of prominent researchers from China at MMK. The previously mentioned strong links between SoRAD and Australia, and between Neurochemistry and Estonia are also obvious from the figure. There are some other notable nodes: Astronomy/OKC and Chile, Stockholm Business School and Finland, Wenner-Gren Institute and Poland. It might be interesting to further investigate these nodes, but that requires a more detailed analysis.

3. Qualitative analysis

3.1. The role of Stockholm University in the collaborations

Apparently, as indicated by its journal publications, Stockholm University researchers participate in many international collaborations. It would be interesting to know more about the role of the university's researchers in these collaborations. There is no straightforward method to determine the role of co-authors in a multi-authored publication. There are some journals that require authors to give details about the roles of contributing authors[8]. However, this is neither general nor standardized. [9]

There are traditional ways to mark the importance of the authors of an article. In some research areas, the order of the authors might give a clue: the first or the last authors usually have special roles. Conversely, in some other research areas the co-authors appear in alphabetical order. There is one special role in most of the journal publications: the corresponding author (or sometimes called reprint author). Most of the multi-authored publications have a designated author, who takes the responsibility to answer questions or sometimes send copies of the publication. It is plausible to assume that this author and his or her affiliation play a major role in the work. Some of the publication databases (including Web of Science) collect metadata about the name, affiliation, and email address of the corresponding authors, thus making it possible to use this data in an analysis. Table 10 shows some basic statistics about the corresponding authors.

Table 10. Distribution of corresponding authors in Stockholm University publications (2012-2017)

	Absolute number of publications	International*
Total	13532	8986
Corresponding author with Swedish affiliation**	8638	4117
Corresponding author from Stockholm University***	6422	3033

* Publications which have at least one author with an affiliation outside of Sweden

** Publications which have a corresponding author whose address contains the word "Sweden", or email address ends with ".se"

***Publications which have a corresponding author whose address contains the word "Stockholm Univ", or email address ends with "su.se"

Table 10 shows that almost half (47%) of the Stockholm University publications have a corresponding author from Stockholm University. 16% of the publications have a Swedish

[8] Proceedings of the National Academy of Sciences of the USA, http://www.pnas.org/site/authors/editorialpolicies.xhtml#iii

[9] There is an initiative to standardize this process, but it has not gained widespread use yet. CRediT, http://docs.casrai.org/CRediT

corresponding author from universities other than Stockholm University. 37% of the publications have a corresponding author outside of Sweden.

The ratio of Stockholm University corresponding authors in the international publications is 34%.

Table 11 shows the distribution of publications with Stockholm University corresponding authors among the Stockholm University departments.

Table 11. Departments with the highest number of publications with Stockholm University corresponding authors (2012-2017) (fractional counting, where publications are equally shared among the participating departments)

Department	Faculty	No f publications with SU corresponding authors	Total number of publications	% of publications with SU corresponding authors	% of international collaborations among publications with SU corresponding authors
Department of Materials and Environmental Chemistry (MMK)	SCI	432	798	54%	58%
Department of Environmental Science and Analytical Chemistry (ACES)	SCI	410	835	49%	56%
Department of Physics	SCI	383	1200	32%	68%
Department of Organic Chemistry	SCI	357	427	84%	29%
Department of Physical Geography	SCI	282	579	49%	61%
Department of Ecology, Environment and Plant Sciences (DEEP)	SCI	280	521	54%	53%
Department of Psychology	SOC	277	636	44%	40%
Department of Biochemistry and Biophysics (DBB)	SCI	262	500	52%	49%
Department of Mathematics	SCI	214	276	78%	49%
Department of Zoology	SCI	213	396	54%	55%
Stockholm Resilience Centre (SRC)	SCI	212	500	42%	62%
Department of Molecular Biosciences, Wenner-Gren Institute (MBW)	SCI	212	431	49%	46%
Department of Geological Sciences	SCI	193	423	46%	77%
Department of Meteorology	SCI	165	357	46%	60%
The Swedish Institute for Social Research (SOFI)	SOC	154	210	73%	40%
Department of Sociology	SOC	131	229	57%	32%
The Oskar Klein Centre for Cosmo Particle Physics (OKC)	SCI	125	696	18%	78%
Stockholm Business School	SOC	122	173	71%	43%
Centre for Health Equity Studies (CHESS)	SOC	114	222	51%	41%
Department of Astronomy	SCI	113	462	24%	85%
Nordic Institute for Theoretical Physics (Nordita)	SCI	97	505	19%	87%
Department of Computer and Systems Sciences (DSV)	SOC	93	173	54%	36%
Department of Economics	SOC	91	107	85%	53%
Stress Research Institute	SOC	87	322	27%	39%
Department of Political Science	SOC	87	102	85%	28%

Table 11 shows some departments with a very high share of publications with Stockholm University corresponding authors (dark red cells): Mathematics and Organic Chemistry from the Faculty of Natural Sciences, and Economics and Political Sciences from the Faculty of Social Sciences. Departments in the fields of physics and astronomy usually have a relatively lower share of publications with Stockholm University corresponding authors (white-light red cells) because of the high number of large collaboration projects.

The rightmost column of Table 11 (green shades) shows the percentage of international publications among publications with Stockholm University corresponding authors. Some departments have a

relatively low ratio of international collaborations where they have Stockholm University corresponding author (white/light green cells): Organic Chemistry, Sociology and Political Sciences.

MMK, Mathematics, Economics and Geological Sciences have both a high share of Stockholm University corresponding authors and international collaborations (dark red + dark green cells).

3.2. Citation based analysis

The use of number of citations as a quality indicator for scientific publications is a common but somewhat controversial method. It is true that higher number of citations usually means greater impact in science, but it is very hard or even impossible to create a method where different research areas are truly comparable. There is an ever-increasing demand from the managements of universities, funders and other scientific policymakers to use such indicators, but one should be very careful when using these to compare different research fields. For instance, the number of citations in psychology and organic chemistry are not comparable, even if they are normalized to their respective fields. The normalization methods and the categorization of publications are always somewhat arbitrary.

This section shows an example of a relatively simple and readily available method to demonstrate citation excellence from the Web of Science database. It is possible to create a much more detailed and more advanced citation analysis, but the data is not available with Stockholm University's current database subscriptions. The cost to buy such data can be substantial (several 100 thousand SEK per year), and the usefulness of such analysis is not straightforward. It would be possible to assign a field weighted citation index to each publication and then sum these to different units (for example faculties, departments), and make some comparisons between these. Even so, the problems with the lower citation rates and publication numbers in social sciences and humanities would still be present.

Web of Science identifies a number of publications that are marked as "Highly Cited Papers" (HCP). These are publications, which are among the 1% top cited publications in a given subject field and a given year. The publications are categorized into 22 different broad subject fields, according to the Essential Science Indicators (ESI)[10], a product from Clarivate Analytics. The baseline threshold for each field and each year is continuously calculated: for example, a publication from 2013 in Chemistry should have at least 113 citations today to qualify as highly cited. Each publication is categorized to exactly one subject field. Table 12 shows highly cited papers and some statistics about Stockholm University publications in these subject fields.

Table 12. Distribution of Highly Cited Papers in the different subject fields (2012-2017)

ESI subject field*	Absolute number of publications**	Highly Cited Papers	% of Highly Cited Papers in a subject category at SU	% of international publications among the Highly Cited Papers	Number of Highly Cited Papers with SU corresponding author	Number of Highly Cited Papers with SU corresponding author without international collaboration
PHYSICS	1681	88	5%	98%	14	1
GEOSCIENCES	1285	48	4%	96%	10	2
ENVIRONMENT/ECOLOGY	1268	47	4%	94%	7	1
SPACE SCIENCE	1075	45	4%	100%	2	0
SOCIAL SCIENCES, GENERAL	1885	40	2%	78%	16	8
CHEMISTRY	1137	33	3%	67%	17	11
CLINICAL MEDICINE	928	21	2%	95%	0	0
BIOLOGY & BIOCHEMISTRY	608	16	3%	75%	4	3
MOLECULAR BIOLOGY & GENETICS	301	8	3%	88%	0	0
PLANT & ANIMAL SCIENCE	523	7	1%	100%	1	0
ECONOMICS & BUSINESS	451	7	2%	86%	3	1
NEUROSCIENCE & BEHAVIOR	373	6	2%	100%	1	0
PSYCHIATRY/PSYCHOLOGY	613	5	1%	80%	1	1
MATERIALS SCIENCE	237	3	1%	67%	2	0
PHARMACOLOGY & TOXICOLOGY	147	3	2%	67%	1	1
MATHEMATICS	197	2	1%	100%	1	0
ENGINEERING	138	2	1%	50%	2	1
AGRICULTURAL SCIENCES	55	2	4%	100%	0	0
COMPUTER SCIENCE	118	1	1%	100%	0	0
ARTS & HUMANITIES***	345	0	0%-	-	0	0
IMMUNOLOGY	89	0	0%	-	0	0
MICROBIOLOGY	78	0	0%	-	0	0

*All the publications categorized as "Multidisciplinary" in the ESI categorization, were re-categorised manually to the other categories, based on the subject categories of the journals in their references.

** No fractional counting was applied, because each publication is assigned to only one subject category

***Publications in the subject category of "ARTS AND HUMANITIES" are not included in the Web of Science calculation of Highly Cited Papers, it is just shown for comparison purposes.

There are altogether 384 publications between 2012 and 2017 that are "Highly Cited Papers" according to Web of Science. This is 2.8% of all the publications in the observed dataset, which is substantially higher than the expected value of 1%: i.e. on average we can expect that 1% of a random sample of publications are categorized as the top 1% most cited publications. An interesting fact is that most of the highly cited publications (346 of 384; 90%) are from international collaborations.

There are only 30 publications that have a Stockholm University corresponding author and have obtained a highly cited status without international collaborations. These publications are mainly from the field of Chemistry (Department of Organic Chemistry and Department of Materials and Environmental Chemistry) and Social Sciences (Stockholm Resilience Center and The Swedish Institute for Social Research). There are also several Highly Cited Papers in the categories of Physics, Geosciences and Environment/Ecology that have one or several corresponding authors from Stockholm University, but these are mainly international collaborations.

The subject categories used in the above example also demonstrate one of the biggest problems of such a categorization system: smaller and more specialized fields such as Immunology or Microbiology are compared to broader and much more general fields such as Social Sciences or Clinical Medicine. Some of these broad fields are practically unsuitable for further analysis, so it might be interesting to break down the Highly Cited Papers to Stockholm University departments.

Table 13. Distribution of Highly Cited Papers among Stockholm University departments (2012-2017) (fractional counting, where publications are equally shared among the participating departments, only departments with at least one Highly Cited Paper are shown)

Department	Faculty	Number of publications	Highly Cited Papers	% of Highly Cited Papers from the department	% of international publications among the Highly Cited Papers	Number of Highly Cited Papers with SU corresponding author	Number of Highly Cited Papers with SU corresponding author without international collaboration
Department of Physics	SCI	1200	67	6%	99%	10	1
The Oskar Klein Centre for Cosmo Particle Physics (OKC)	SCI	696	49	7%	98%	7	1
Department of Environmental Science and Analytical Chemistry (ACES)	SCI	835	37	4%	87%	5	2
Stockholm Resilience Centre (SRC)	SCI	500	36	7%	92%	8	3
Aging Research Center (ARC), (together with KI)	SOC	442	20	5%	95%	1	0
Department of Physical Geography	SCI	579	20	3%	95%	5	1
Department of Materials and Environmental Chemistry (MMK)	SCI	798	18	2%	83%	7	3
Nordic Institute for Theoretical Physics (Nordita)	SCI	506	14	3%	93%	1	0
Department of Geological Sciences	SCI	423	13	3%	100%	2	0
Department of Organic Chemistry	SCI	427	13	3%	31%	12	9
Department of Ecology, Environment and Plant Sciences (DEEP)	SCI	521	9	2%	95%	1	1
Department of Biochemistry and Biophysics (DBB)	SCI	500	9	2%	75%	2	2
Department of Astronomy	SCI	462	8	2%	100%	0	0
Stress Research Institute	SOC	322	8	2%	93%	1	1
Department of Meteorology	SCI	357	7	2%	85%	2	1
Department of Psychology	SOC	636	6	1%	73%	3	2
Department of Molecular Biosciences, The Wenner-Gren Institute (MBW)	SCI	431	5	1%	84%	1	1
Science for Life Laboratory (SciLifeLab)	SCI	147	5	3%	62%	2	1
Department of Zoology	SCI	396	4	1%	100%	1	0
Department of Political Science	SOC	102	4	4%	75%	4	1
Department of Mathematics	SCI	276	4	1%	100%	2	0
The Swedish Institute for Social Research (SOFI)	SOC	210	3	1%	33%	3	2
Department of Sociology	SOC	229	3	1%	100%	0	0
Centre for Health Equity Studies (CHESS)	SOC	222	3	1%	67%	0	0
Department of Archaeology and Classical Studies	HUM	124	3	2%	100%	0	0
Department of Neurochemistry	SCI	133	3	2%	100%	0	0
Department of History	HUM	64	3	4%	82%	1	1
Stockholm Business School	SOC	173	2	1%	50%	1	1
Centre for Social Research on Alcohol and Drugs (SoRAD)	SOC	191	2	1%	100%	0	0
Institute for International Economic Studies (IIES)	SOC	69	2	3%	100%	1	0
Stockholm University Baltic Sea Centre	SCI	58	2	3%	100%	0	0
Stockholm Environment Institute (SEI)	SCI	16	2	10%	100%	0	0
Numerical Analysis and Computer Science (NADA)	SCI	37	1	4%	100%	0	0
Department of Human Geography	SOC	99	1	1%	100%	0	0

Table 13 shows that the major producers of Highly Cited Papers at Stockholm University are from the Department of Physics, OKC, ACES, SRC, ARC, and Physical Geography. Most of these publications are from international collaborations. Some of these departments have relatively few publications with Stockholm University corresponding authors. There is a striking outlier: the Department of Organic Chemistry, which published the highest number of Highly Cited Papers with Stockholm University corresponding authors, and also the highest number of Highly Cited Papers without international collaborations. SEI, OKC and SRC are the departments that have the highest ratio of Highly Cited Papers compared to their total output.

4. The case of the United Kingdom

In this section, the co-publications with the United Kingdom (UK) are analysed at a more detailed level. The UK is interesting for many reasons; It is one of the largest collaborating partners of Stockholm University, and the future changes that will come from Brexit will have implications for the status of academic collaborations with the UK. The following analysis will be useful for Stockholm University's plans for how to tackle these changes, it can steer the efforts of seeking closer relationships with partners in the UK.

4.1. Publications

Publication databases (Web of Science and Scopus) contain relatively reliable data about the affiliations of the authors at the institution level. However, from a comparison with Stockholm University's own publication database, DiVA, it is obvious that the matching of addresses to universities is far from perfect. Nevertheless, it is possible to use the available data to make statistically relevant analysis about collaborating institutions for Stockholm University researchers in the UK.

There are 2,636 publications in the dataset where Stockholm University has at least one collaborating author from the UK (see also Table 3). 366 (14%) of these are bilateral collaborations between Sweden and the UK (see also Table 5). 55% of the bilateral co-publications have a corresponding author from the UK and 45% from Stockholm University, which implies that the bilateral collaborations are relatively well-balanced between the UK and Sweden, although there are slightly more publications with a corresponding author from the UK.

Figure 3 shows a heat map of the collaboration publications between Stockholm University and universities in the UK. Only the most productive Stockholm University departments and the UK institutions shown. The publications are counted by fractional counting according to the number of participating the UK institutions and participating Stockholm University departments. Only the most prolific departments and institutions are shown.

	Physics	OKC	Astronomy	Phys Geog	SRC	ACES	Geol Sci	Nordita	Meteorology	ARC	Zoology	MBW	Stress	MMK	DBB	Psychology	DEEP	DSV	CHESS	Mathematics	Archaeology	SOFI	Sociology	Stockholm Bus Sch
Univ Oxford	84	64	4	3	4	6	5	24	4	4	2	5	1	4	13	5	4	0	1	2	0	10	3	0
UCL*	24	24	10	1	2	2	4	2	2	12	7	1	26	3	2	5	2	21	3	2	0	3	2	0
Univ Cambridge	25	30	18	9	2	2	3	8	2	2	2	3	0	2	5	1	1	2	0	1	1	0	0	0
Univ Manchester	29	20	1	1	1	14	1	1	1	0	4	1	2	5	4	4	0	1	1	0	0	0	1	1
Univ Edinburgh	22	19	9	3	2	1	2	2	0	1	2	6	6	1	1	0	0	1	0	0	1	0	0	1
Univ Southampton	16	20	12	1	7	1	9	4	2	3	0	0	0	0	1	2	0	0	1	0	0	0	1	0
Queens Univ Belfast	6	26	32	3	0	2	6	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	1
Univ Sussex	19	29	12	0	2	0	0	2	0	1	3	1	0	1	0	0	0	0	0	0	2	0	0	0
Imperial Coll London	15	4	3	4	4	1	2	3	2	7	1	3	2	1	2	3	9	0	0	3	0	0	0	0
Univ Sheffield	19	20	2	2	1	2	2	2	0	1	1	2	0	0	0	4	1	0	0	1	1	0	0	0
Queen Mary Univ London*	23	18	0	1	1	0	0	7	0	0	0	0	0	2	0	0	1	0	0	0	0	3	0	1
Univ Lancaster	27	18	0	2	2	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Univ Glasgow	21	18	0	7	1	0	1	0	0	0	1	1	0	0	2	1	0	0	0	0	2	0	0	0
Rutherford Appleton Lab	19	18	5	0	0	0	0	0	0	0	0	0	0	14	1	0	0	0	0	0	0	0	0	0
Univ Leeds	3	3	1	3	1	13	2	4	18	1	1	0	0	2	1	3	0	0	0	0	0	0	0	1
Univ Birmingham	19	18	0	0	1	6	0	0	3	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1
Kings Coll London*	13	12	0	0	4	4	0	7	0	3	0	1	1	0	0	5	0	0	0	0	0	1	2	0
Univ Bristol	7	0	0	2	4	6	0	0	0	4	0	0	6	1	0	2	0	2	1	1	4	0	1	0
Univ Liverpool	25	18	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	1	0	0
Univ Exeter	0	1	6	9	7	6	3	1	6	1	7	0	0	0	0	0	1	0	0	0	0	0	0	0
Univ Warwick	15	16	2	0	0	0	0	0	0	0	0	0	4	1	0	1	0	0	1	0	0	0	0	0
Univ Durham	10	14	6	5	2	0	2	1	0	0	1	1	0	0	2	0	0	0	0	0	0	0	0	0
Royal Holloway Univ London*	17	17	0	2	1	0	2	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0
Univ Leicester	13	14	2	0	0	0	5	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	1
Univ Aberdeen	0	0	0	5	16	4	2	0	0	0	3	0	0	0	1	0	0	0	0	0	2	0	0	0
Univ St Andrews	0	0	3	12	0	0	1	0	5	0	4	0	2	0	1	2	0	0	0	2	0	0	1	0
Cardiff Univ	2	3	4	1	0	1	6	2	0	1	0	3	0	0	2	2	0	0	0	1	0	0	0	1
Swansea Univ	6	0	0	12	0	0	2	0	0	0	1	0	6	0	0	1	1	0	0	0	0	0	0	0
Univ E Anglia	0	0	0	4	12	2	5	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Univ Reading	0	0	0	5	3	0	0	0	9	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0
Univ Nottingham	4	2	0	0	0	0	0	2	0	1	2	2	0	2	1	0	1	0	0	0	6	0	0	0
Newcastle Univ	0	0	0	1	2	7	2	0	0	3	1	1	0	2	0	0	1	0	0	0	0	0	0	0
London Sch Hyg & Trop Med*	0	0	0	0	1	0	0	0	0	0	3	1	0	0	0	0	0	14	1	1	1	0	0	0
Open Univ	5	6	3	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Liverpool John Moores Univ	1	6	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nat Hist Museum	0	0	1	3	0	1	1	0	0	0	5	0	0	0	0	0	2	0	0	0	1	0	0	0
Univ York	2	0	0	1	3	0	2	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0
Univ Portsmouth	1	2	2	0	3	0	0	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0
City Univ London*	0	0	0	0	1	0	0	2	0	2	0	0	0	0	0	1	0	0	0	1	0	0	0	5
Publ Hlth England	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0

* These institutions are part of the University of London. University of London is a federal university with 18 independent member institutions[11]. In most cases, like in international university rankings, these institutions are listed separately.

Figure 3. Heat map of co-authored publications by Stockholm University departments and UK institutions (2012-2017)

[11] https://london.ac.uk/ways-study/study-campus-london/member-institutions

Figure 3 clearly shows that the majority of the co-authored publications with the UK are from the fields of astronomy and physics, because of the large international collaboration projects. The most prolific collaborating partners are the large British universities.

The heat map also shows which Stockholm University departments have tighter collaborations with specific UK universities (apart from the large astronomy/physics collaborations). Some of the significant collaborations are shown in Table 14.

Table 14. Some of the most productive collaborations between Stockholm University departments and UK institutes (2012-2017)

SU department	UK institution	Number of co-publications*
Stress Research Institute	University College London (UCL)	26
Department of Computer and Systems Sciences (DSV)	University College London (UCL)	21
Department of Meteorology	University of Leeds	18
Stockholm Resilience Centre (SRC)	University of Aberdeen (Scotland)	16
Department of Materials and Environmental Chemistry (MMK)	Rutherford Appleton Laboratory	14
Centre for Health Equity Studies (CHESS)	London School of Hygiene & Tropical Medicine	14
Department of Environmental Science and Analytical Chemistry (ACES)	University of Manchester	14
Department of Biochemistry and Biophysics (DBB)	University of Oxford	13
Department of Physical Geography	University of St Andrews (Scotland)/Swansea University (Wales)	12/12
Department of Molecular Biosciences, The Wenner-Gren Institute (MBW)	Public Health England	11
The Swedish Institute for Social Research (SOFI)	University of Oxford.	10
Department of Ecology, Environment and Plant Sciences (DEEP)	Imperial College London	9

* Publications counts are fractionalized by the number of participating SU department and UK institutes.

The institution names are extracted from the Web of Science data, and in some cases, they might be somewhat ambiguous. An analysis at this level usually needs manual data cleaning, and some knowledge about the structure of the institutions. If further analysis is required at the institution level it is important to be aware of this and choose the level of analysis according to the questions to be answered.

4.2. FP7 and Horizon 2020 projects with the UK

As a complement to the study on publications, data on EU projects where Stockholm University collaborates with the UK are presented. The data for the projects between 2008 and 2017 was collected in December 2018 from the EU Participant Portal and Stockholm University Research Database. UK institutions dominate as Stockholm University partners (see Appendix 3).

Partners in EU projects range from a couple to over 40 partners. Horizon 2020 is open to the world. This means that participants from all over the world, regardless of their place of establishment or residence, can participate in most of the calls of Horizon 2020. In order to be able to count the cooperation we have with different organisations; one partner has been counted as one collaboration. If there is a project with four different partners from the UK (within the same project), this is counted as four collaborations.

The table below illustrates the universities that Stockholm University works with in the UK in different FP7 and Horizon 2020 projects. The table is limited to 16 UK universities where there was at least one collaboration with a start year 2008-2011.

Table 15. Research cooperation between the UK and Stockholm University within FP7 and Horizon 2020, start year 2008-2017

UK university	Number of cooperation			Rank according to the number of publications in Figure 3
	start year: 2008-2017	start year: 2008-2011	start year: 2012-2017	
University of Oxford	15	9	6	1
Imperial College of Science Technology and Medicine	12	9	3	9
The University of Birmingham	10	2	8	16
University College London	9	2	7	2
The University of Sheffield	9	2	7	10
University of Cambridge	8	2	6	3
University of Leeds	8	4	4	15
The University of Manchester	6	2	4	4
The University of Edinburgh	6	2	4	5
The University of Liverpool	6	3	3	19
University of Newcastle Upon Tyne	6	2	4	32
London School of Economics and Political Science	6	3	3	42
University of Southampton	5	1	4	6
King's College London	5	2	3	17
The University of Reading	5	2	3	30
The Queen's University of Belfast	4	1	3	7

Table 15 shows that the UK universities with the highest number of research cooperation overlap with the universities that are most productive in co-publications: The top 10 most productive UK institutions according to co-publications with Stockholm University are all listed in Table 14, except for one: University of Sussex. This suggests that there is probably a correlation between the number of co-publications and the number of active collaboration projects, although there are several factors that might affect this:

- The number of actual publications might depend on the subject field, and the total number of collaborating partners in the project.
- There are other types of collaborations outside of the FP7/Horizon 2020 frameworks.
- Research publications might be delayed by several years compared to the start date of collaboration project.

In spite of the above-mentioned factors, the data presented in this section makes it possible to identify with relatively high precision, which are the most important collaboration partners of Stockholm University from the UK. It is possible to further analyse the data, and for example locate the actual researchers who are involved in the specific collaborations, but that is beyond the scope of this current analysis. It is also possible to carry out similar analysis for other countries or for a group of institutions.

5. Closing remarks and recommendations

This report is a first attempt to demonstrate some analysis types that can give insights about the nature of the output of international collaborations in publications. It is possible to carry out more detailed or other types of analyses if needed. It all depends on what questions need to be answered. However, the aforementioned limitations are important to remember.[12]

Keeping these in mind, we can draw some conclusions from this first analysis:

- The ratio of international co-authored publications by Stockholm University is continuously increasing, today it is more than 70%.
- International co-publications are common in natural sciences publications (more than 75%), but only 50% in social sciences, and less than 30% in humanities and law.
- The most common collaborating countries are those which have the highest publications rate in the world: USA, the UK and Germany. They are followed by China, Finland and Norway.
- There are some exceptionally strong specific linkages between certain departments and countries (for example MMK/China, Neurochemistry/Estonia, SoRAD/Australia) that are the result of international recruitments.
- According to "Highly Cited Papers" the University's strongest research areas are physics, astronomy, chemistry, environmental sciences and geosciences within natural sciences; and aging research, psychology, stress research and sociology within social sciences. The humanities are underrepresented in publications of journal article.
- The "Highly Cited Papers" have almost exclusively resulted from international collaborations. Although there are some exceptions: quite a few organic chemistry publications and some

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[12] Detailed analyses which include departments are only possible for Stockholm University's publications http://su.se/english/library/publish/bibliometrics/measuring-tools-for-bibliometrics#norska. The categorization of publications into subject fields is always somewhat arbitrary. There are limitations concerning coverage of subject fields, publication data about fields in the Humanities and some Social Sciences are lacking. There are complications concerning how to count publications due to double or multiple affiliations and finally, most of the different citation analysis are only meaningful at least 1-2 years after publication.

from the field of social sciences (SOFI and psychology) reached highly cited status without international collaborations.

If we assume that it is desirable to increase the number of Highly Cited Papers, it might be interesting to investigate how to do that. It is possible to try to further increase the number of successful international collaborations, another solution might be to focus on strong fields locally.

As mentioned in the introduction, this report is a part of mapping the situation for international research collaboration at Stockholm University for the coming international strategy for 2019-22. In addition, it is intended to serve as a useful tool for current internationalisation processes.

This study can be expanded with further details, or it can be deemed sufficient for the purposes given above. The latter is recommended by the authors of this report as it provides a first analysis that is useful as a compass for in-depth studies when they are required. It is also recommended that this mapping, using the same methods as far as possible, should be repeated with a certain frequency, for instance every four years (in line with the time line of Stockholm University's Strategies) or more often, so that trends can be identified. Furthermore, this report provides information that could be used in strategic communication projects to increase the visibility of Stockholm University as a global actor.

Apart from these recommendations, the results in this report also indicate the need for further studies in the future, often with a more qualitative approach. For instance, it would be valuable to:

- Investigate the fields of research in humanities and social sciences that are not visible in Web of Science and Scopus by looking at other sources or through internal investigations.[13][2]
- Look more closely at the causes behind unusual data in this report. When there are very few or several co-publications with a certain country, what are the causes behind it? If, as was mentioned as a possible explanation for a large number of Estonian co-publications with a department at Stockholm University, it is due to the recruitment of an individual researcher, what does this mean? Is this a situation that is just worth noting, or is it something that can be used as a good example or something to avoid? Or could it be precarious to rely too heavily on an individual researcher for international collaborations?
- As in the case study included, short reports should be produced using the case study as a model to serve as background material for short term strategies, e.g. in specific scenarios such as the one created by Brexit and the ensuing need to approach universities in the UK.

Finally, Stockholm University should communicate and put more focus on its international academic environment. Thus, the university should enhance its communicative efforts on researchers around the world and participation in scientific co-publications. When a scientific co-publication is released, the University should strive to take part in joint communication efforts to ensure that the Stockholm University participation is visible within the cooperation. Also, when a specific region or country is targeted, it is recommended that co-publication projects with that specific region are highlighted to put emphasis on the University's collaboration efforts around the world.

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[13][2] "Stockholm University uses additional sources to analyse publication frequency since Web of Science and Scopus are not comprehensive, in particular regarding published social sciences and humanities material. In Norway, a database that contains a list of publishing channels sorted into different levels of scientific validity has been developed. It is sometimes called 'the Norwegian list', and is used to ensure that researcher's writings are published in accordance with good scientific practice." For more info: http://su.se/english/library/publish/bibliometrics/measuring-tools-for-bibliometrics#norska

Appendix

Appendix 1. List of funded EU projects that have partners in the UK with start date January 1, 2012 – 31 December 2017

Stockholm University has many collaborations with universities from United Kingdom. The majority of the collaborations are in chemistry, astronomy but also in social sciences such as computer and systems sciences and social research. 24 of Stockholm University's departments are involved in research collaboration within EU-projects with these universities. Stockholm University departments have closer collaborations with specific UK universities. Some of the most significant partners are the University of Birmingham, the University of Sheffield, University College London, University of Cambridge and University of Oxford. In 13 of the 49 EU projects listed below, UK universities are coordinators.

Acronym	Project leader SU	Department	Start date	End date	Collaboration 1	Collaboration 2	Collaboration 3	Collaboration 4	Coordinator
A-TEAM	Prof Cynthia de Wit	Department of Environmental Science and Analytical Chemistry	01/01/2013	31/12/2016	University of Birmingham	University of Reading			University of Birmingham
SOLUTIONS	Prof Ian Cousins	Department of Environmental Science and Analytical Chemistry	01/10/2013	30/09/2018	Brunel University West London	University of Birmingham	University of Liverpool		
SOLARNET	Dr Dan Kiselman	Department of Astronomy	01/04/2013	31/03/2017	Queen's University Belfast	University of Birmingham	University College London		
INTERFLAME	Prof Cynthia de Wit	Department of Environmental Science and Analytical Chemistry	01/01/2012	31/12/2015	University of Birmingham				University of Birmingham
DiasporaLink	Dr Henrik Hansson	Department of Computer and Systems Sciences	01/02/2015	31/12/2019	University of Birmingham	University of East London	University of Strathclyde		
HypoTRAIN	Dr Anna Sobek	Department of Environmental Science and Analytical Chemistry	01/01/2015	31/12/2018	Cranfield University	University of Birmingham	University of Roehampton		
INTERWASTE	Prof Cynthia de Wit	Department of Environmental Science and Analytical Chemistry	01/01/2017	31/12/2020	University of Birmingham	University of Bath			University of Birmingham
CID	Prof Erik Palmgren	Department of Mathematics	01/04/2017	31/03/2021	Swansea University	University of Birmingham	Aston University		
RESL.eu	Dr Alireza Behtoui	Department of Social Anthropology	01/02/2013	31/01/2018	The University of Sheffield	Middlesex University			

EuRuCAS	Dr Susanne Kratzer	Department of Ecology, Environment and Plant Sciences	01/05/2012	30/04/2015	The University of Sheffield			
SMART	Prof Mauro Zamboni	Stockholm Centre for Commercial Law (SCCL)	01/03/2016	29/02/2020	University of Sheffield			
INTAROS	Prof Michael Tjernström	Department of Meteorology	01/12/2016	30/11/2021	Open University	University of Exeter	The University of Sheffield	
CATMEC	Prof Belén Martín-Matute	Department of Organic Chemistry	01/01/2017	31/12/2020	University of Sheffield	University of Bristol		University of Sheffield
INTERACT	Prof Gunhild Rosqvist	Department of Physical Geography	01/10/2016	30/09/2020	The University of Sheffield			
PRE-EST	Dr Dan Kiselman	Department of Astronomy	01/04/2017	31/03/2021	The Queen's University of Belfast	The University of Sheffield	University College London	
DRIVERS	Prof Olle Lundberg	Centre for Health Equity Studies (CHESS)	01/01/2012	31/12/2014	University College London			
we.learn.it	Dr Henrik Hansson	Department of Computer and Systems Sciences	17/10/2012	31/12/2014	University College London			
SOLARNET	Dr Dan Kiselman	Department of Astronomy	01/04/2013	31/03/2017	Queen's University Belfast	University of Birmingham	University College London	
PARISSE	Dr Carl-Johan Rundgren	Department of Mathematics and Science Education	01/01/2014	31/12/2017	University College London	University of Southampton	Institute of Education, University of London	
GREST	Dr Dan Kiselman	Department of Astronomy	01/06/2015	31/05/2018	Queen's University Belfast	University College London		
PRE-EST	Dr Dan Kiselman	Department of Astronomy	01/04/2017	31/03/2021	Queen's University Belfast	The University of Sheffield	University College London	
AiPBAND	Prof Mats Nilsson	Department of Biochemistry and Biophysics	01/01/2018	31/12/2021	Imperial College of Science	University College London	University of Plymouth		University of Plymouth

Project	PI	Department	Start	End					
					Technology And Medicine				
NOROSENSOR	Prof Mats Nilsson	Department of Biochemistry and Biophysics	01/12/2013	30/11/2016	University of Cambridge	Loughborough University			
DEMETRIQ	Prof Olle Lundberg	Centre for Health Equity Studies (CHESS)	01/01/2012	31/01/2014	University of Cambridge	University of Liverpool	University of Bath	University of Oxford	
pNMR	Prof Jozef Kowalewski	Department of Materials and Environmental Chemistry	01/01/2013	31/12/2016	University of Cambridge				
REMIX	Prof Martin Ott	Department of Biochemistry and Biophysics	01/10/2016	30/09/2020	University of Cambridge	University Of Newcastle Upon Tyne			
BE-OI	Prof Margareta E Hansson	Department of Physical Geography	01/10/2016	30/09/2019	University of Cambridge				
STYLE	Prof Eskil Wadensjö	Swedish Institute for Social Research (SOFI)	01/03/2014	30/09/2017	University of Oxford	University of Brighton			
MeCoDEM	Prof Christian Christensen	Department of Media studies	01/02/2014	31/01/2017	University of Oxford	University of Leeds			University of Leeds
FamiliesAndSocieties	Dr Livia Olah	Department of Sociology	01/02/2013	31/01/2017	University of Edinburgh	University of Liverpool	London School of Economics and Political Science	University of Oxford	Stockholm University
PRIMAVERA	Prof Annica Ekman	Department of Meteorology	01/11/2015	31/10/2019	University of Leeds	University of Oxford	University of Reading		
DIAPHORA	Prof Kathrin Glüer-Pagin	Department of Philosophy	01/01/2016	31/12/2019	University of Edinburgh	The University of Stirling			
GreenCarbon	Dr Niklas Hedin	Department of Materials and Environmental Chemistry	01/10/2016	30/09/2020	University of Edinburgh	Queen Mary, University of London	Aston University		
InGRID	Prof Kenneth Nelson	Swedish Institute for Social Research (SOFI)	01/02/2013	31/01/2017	University of Manchester	University of Essex	University of Southampton		

MULTIMAT	Prof Lennart Bergström	Department of Materials and Environmental Chemistry	01/03/2016	29/02/2020	University of Manchester				
CORCON	Prof Erik Palmgren	Department of Mathematics	01/01/2014	31/12/2017	University of Leeds	Swansea University	University of Strathclyde		University of Leeds
nEUROSTRESSPEP	Prof Dick Nässel	Department of Zoology	01/06/2015	31/05/2019	University of Leeds	The Pirbright Institute	University of Glasgow		University of Glasgow
COMPLEX	Prof Uno Svedin	Department of Computer and Systems Sciences	01/10/2012	30/09/2016	University of Newcastle Upon Tyne	The University of Sussex			University of Newcastle Upon Tyne
OPERRA	Prof Andrzej Wojcik	Department of Molecular Biosciences, The Wenner-Gren Institute	01/06/2013	31/05/2017	University Of Newcastle Upon Tyne				
RELOCAL	Dr Peter Schmitt	Department of Human Geography	01/10/2016	30/09/2020	University Of Newcastle Upon Tyne				
SENSE4US	Dr Aron Larsson	Department of Computer and Systems Sciences	01/10/2013	01/10/2016	University of Southampton	The Open University			University of Southampton
	Prof Kenneth Nelson	Swedish Institute for Social Research (SOFI)	01/05/2017	30/04/2021	University of Manchester	University of Essex	University of Southampton		
MembraneNanoPart	Prof Alexander Lyubartsev	Department of Materials and Environmental Chemistry	01/01/2013	31/12/2015	Imperial College London				
SmartNanoTox	Prof Alexander Lyubartsev	Department of Materials and Environmental Chemistry	01/03/2016	28/02/2020	Imperial College London				
ImResFun	Prof Per Ljungdahl	Department of Molecular Biosciences, The Wenner-Gren Institute	01/10/2013	30/09/2017	King's College London				
EMI-TB	Prof Carmen Fernández	Department of Molecular Biosciences, The Wenner-Gren Institute	01/01/2015	31/12/2018	King's College London				

PODER	Prof Jakob Svensson	Institute for International Economic Studies (IIES)	01/09/2013	31/08/2017	London School of Economics and Political Science				London School of Economics and Political Science
Transcrisis	Dr Mark Rhinard	Department of Economic History	01/04/2015	31/03/2018	London School of Economics and Political Science				London School of Economics and Political Science
AQUACROSS	Dr Maja Schlüter	Stockholm Resilience Centre	01/06/2015	30/11/2018	University of Liverpool				
APPLICATE	Prof Gunilla Svensson	Department of Meteorology	01/11/2016	31/10/2020	University of Reading				

Appendix 2.

USA is the most popular country for foreign residence. 12 of 40 of our awarded researchers have chosen US as their host country. In total, our researchers have chosen 14 different host countries.

Table of International postdoc funded by The Swedish Research Council

Country	Number of projects
USA	12
Germany	7
UK	6
Australia	2
France	2
Netherlands	2
Spain	2
Belgium	1
Denmark	1
Italy	1
Japan	1
Canada	1
Switzerland	1
Austria	1

International postdoc by country and department

Department	Country
Department of Philosophy	France
Department of Philosophy	UK
Department of Physics	Denmark
Department of Physics	Netherlands
Department of Physics	Germany
Department of Physics	Germany
Department of Physics	Germany
Department of Physics	Austria
Department of History	Germany
Department of Archaeology and Classical Studies	USA
Department of Astronomy	Spain
Department of Biochemistry and Biophysics	Germany
Department of Biochemistry and Biophysics	USA
Department of Computer and Systems Sciences	USA
Department of Geological Sciences	USA
Department of Culture and Aesthetics	UK

Department of linguistics	Japan
Department of Materials and Environmental Chemistry	Belgium
Department of Materials and Environmental Chemistry	Switzerland
Department of Media Studies	UK
Department of Environmental Science and Analytical Chemistry	Netherlands
Department of Molecular Biosciences, The Wenner-Gren Institute	USA
Department of Physical Geography	Canada
Department of Physical Geography	USA
Department of Physical Geography	USA
Department of Organic Chemistry	USA
Department of Organic Chemistry	USA
Department of Organic Chemistry	USA
Department of Organic Chemistry	USA
Department of Language Education	Spain
Department of Human Geography	UK
Department of Organic Chemistry	USA
Department of Psychology	Germany
Department of Romance Studies and Classics	Italy
Department of Romance Studies and Classics	France
Department of Social Anthropology	UK
Department of Political Science	Germany
Stockholm Resilience Centre	Australia
Department of Zoology	Australia
Department of Zoology	UK

Appendix 3.

The table below illustrates the countries that Stockholm University works most frequently with in different FP7 and Horizon 2020 projects. The table is limited to the top 20 countries.

A total of 1,471 participants in different EU projects were found for the observed period. One project can have several collaborating countries, and in fact that is the most common case. Therefore, the sum of the projects by countries is not equal to the total number of projects.

The top 20 collaborating countries of Stockholm University, start year 2008-2017

Rank	Country	Number of partners/cooperations in FP7 and Horizon 2020
1	UK*	343
2	Germany	326
3	France	202
4	Italy	198
5	Netherlands	160
6	Spain	156
7	Belgium	106
8	Norway	103
9	Finland	72
10	Denmark	64
11	Austria	61
12	Poland	61
13	Switzerland	59
14	Greece	54
15	Portugal	39
16	Czech Republic	37
17	Hungary	37
18	Slovenia	35
19	Ireland	25
20	Russia	23

*The United Kingdom (UK) comprises four countries: England, Scotland, Wales and Northern Ireland.

The table shows the number of EU projects with international collaboration. According to data from the Participant Portal, the following countries have the highest number of EU projects with Stockholm University: the UK, Germany, France and Italy. The Netherlands, Spain, Belgium and Norway are ranked 5-8. Of all Stockholm University EU projects with the start year 2008-2017, 23% of the partners are from the UK (342 of 1,471 number of participants).

The top 20 collaborating countries of Stockholm University, start year 2012-2017

Rank	Rank	Number of partners/cooperations in FP7 and Horizon 2020
1	UK	179
2	Germany	166
3	Italy	116
4	France	108
5	Spain	106
6	Netherlands	87
7	Belgium	75
8	Norway	54
9	Austria	40
10	Denmark	36
11	Greece	35
12	Finland	35
13	Portugal	34
14	Poland	32
15	Switzerland	27
16	Slovenia	26
17	Czech Republic	24
18	Hungary	24
19	Island	15
20	Ireland	14