Mapping of Danish Neuroscience research from 2004 – 2015

Report by

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In early 2016, Lundbeckfonden's board of trustees decided on a number of activities with the ambition to contribute to making Denmark the world's strongest brain research nation.

Delivering on such an ambition requires a solid starting point, based on a deep insight into the current strengths of Danish brain research.

The most robust method for measuring research strength is bibliometric (also known as scientometric) analysis whereby the impact of the research output is evaluated using indices derived from information on where scientific articles are published (i.e. in which scientific journals) and how often the scientific articles are cited by authors of other scientific articles.

Therefore, Lundbeckfonden decided to conduct a scientometric analysis of Danish brain research (n this report referred to as neuroscience research encompassing basic and clinical research including psychiatry) describing the standing of Danish brain research and how this field has developed over the past 10 years (2005-2015) compared to seven other countries; USA, Canada, the Netherlands, UK, Germany, Switzerland and Sweden.

The report shows that Danish Brain Research is doing well being placed in the top of a group of countries also comprising Germany, Sweden and Canada. However, there is room from improvement as the four other countries USA, Switzerland, UK and the Netherlands cluster in a group well ahead of the aforementioned countries. For all the countries, scientific output is steadily increasing over the years with Denmark having the highest relative growth of publication output. The proportion of publications with international collaboration grows for all countries. In the latest two-year period the proportion for Denmark is 60% whilst Danish publications originating from a single institution are becoming fewer and with a declining impact. Since the financial crisis there has been a general decline in the number of publications coming out of public-industry collaborations. This is also so for Brain research. The development for Denmark is however pronounced as the decline seems to set in before the crisis and is markedly intensified in the period from 2009 until now. The most prolific funding sources of Danish Brain research measured through acknowledgements in publications are the Danish Research Council, Lundbeckfonden and the Danish National Research Foundation. It is noticeable that there are mutually strong links between these funding institutions.

The present analysis was performed as contracted research conducted by Jesper W. Schneider and Jens Peter Andersen, Danish Centre for Studies in Research & Research Policy, Department of Political Science, Aarhus University, Denmark in close collaboration with Lundbeckfonden. This work could not have been performed without valuable specialist input on search strategy and research terminology not least in the field of psychiatry. Thus, Lundbeckfonden is indebted for advice provided by Anders Nykjær, Professor, Ph.D. Gitte Moos Knudsen, Professor, DMSc, Birte Glenthøj, Professor, DMSc, Kerstin von Plessen, Professor, Ph.D. and Poul Videbech, Professor, DMSc.

Lene Skole, CEO

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1. Summary

The present report presents advanced scientometric analyses of the international neuroscience research literature from 2004 to 2015. The analyses are initiated and funded by Lundbeckfonden. The report examines the publication and citation performance of Danish neuroscience research, as well as its development, and compares it with seven carefully chosen high-performing benchmark countries. The report also examines the performance of four Danish universities and their affiliated hospitals, as well as examining collaboration and funding patterns within Danish neuroscience research.

Contrary to traditional scientometric performance analyses, the present approach is based on a specially constructed publication set that is assumed to broadly cover neuroscience and related research areas. The publication set is constructed by querying the PubMed database for neuroscience topics using Medical Subject Heading (MeSH) descriptors and subsequently the identified publications from PubMed are matched with corresponding records in the Web of Science (WoS) citation database enabling advanced scientometric analyses. This approach has several advantages over traditional scientometric analyses; most importantly we identify relevant articles according to their subject indexing at the individual publication level. Traditional performance analyses rely on arbitrary journal subject categories for delimiting the topic of interest which often leads to the inclusion of irrelevant publications and exclusion of relevant publications from broader multidisciplinary journals.

We first report the main findings for the country analyses. Irrespective of counting method, publication output is generally increasing over the period examined, however, relative growth rates are obviously inversely related to the country size measured as publication output. In that sense Denmark is the smallest country examined, but the one with the highest relative growth of publication output within neuroscience and related areas. Noticeable, among the four smallest countries, Denmark, Netherlands and Switzerland clearly stand out with the highest relative growth rates; whereas the growth rate of Sweden is more moderate and more comparable to considerably larger countries such as Canada or Germany.

The size-effect of countries is also visible when we examine the proportion of collaborative publications; again, the four smallest countries stand out, where 82% of the Danish neuroscience publications in 2013-15 are a result of collaboration between at least two institutions. However, the pattern changes when we exclusively examine international collaboration; here Switzerland stands out with a consistent 10-percent point gap over the period to a group of six other countries (Denmark highest among them). The proportion of publications with international collaboration grows for all countries, yet in the latest periods the proportion for Switzerland in around 70% whereas the Danish proportion is 60%. This observation is important because internationally co-authored publications on average have higher citation rates compared to national collaborative or non-collaborative publications. Notice that the USA in an exception to this.

At the aggregate level, publication profiles are good predictors of citation performance. When we examine the journal publication profiles (using the Mean Normalised Journal Score (MNJS) indicator) for the eight countries two groups clearly emerge. A group comprising Switzerland, USA, UK and the Netherlands that have profiles of generally publishing in journals with higher visibility (i.e. journals with more citation activity). Denmark belongs to the second group also comprising Canada, Germany and Sweden. The Danish journal publication profile has been slightly increasing until 2010-12 where after it has stagnated. Most interestingly, the separation between the two groups has been distinct through the whole period examined. This observation is also important as the journal publication profiles are good predictors of citation performance. If we scrutinize the journal publication profiles according to collaboration types, we clearly see that international collaborative publications generally are published in journals with higher visibility. Publications with no inter-institutional collaboration are generally published in journals with lower visibility. For all countries, this no inter-institutional collaboration set of publications constitute the smallest set, i.e. since 2009-11 less than 20% of the Danish neuroscience publications. Nevertheless, the general pattern with two distinct groups is less clear when examined according to collaboration type. The journal publication profile for Danish publications with no inter-

institutional collaboration changes significantly with a marked rise moving the Danish profile into the top group from 2008-10 to 2010-12, where after the Danish profile drops markedly, not only out of the top group, but also to a position as the lowest in the other group in 2013-15. Interestingly, the Danish journal publication profile for international collaborative publications are below all other countries except Sweden until 2009-11; from 2009-11 we see a marked increase solidly placing the Danish profile among the other countries. What should be considered here is the potential influence of these changes in journal publication profiles upon citation impact. No doubt, the publication profile for internationally collaborative publications will have the largest influence because 1) this is the largest set of publications among the three types, and 2) on average international collaborative publications have higher visibility.

The patterns seen in the collaboration and journal publication profiles for the countries do indeed influence the citation impact performance and developments both for the mean normalized citation scores (MNCS), as well as the proportion of highly cited publications (PPtop10%). We emphasize that citation impact means visibility in as much as it is a measure of the academic use of publications. The two groups of countries are clearly visible, essentially showing two performance levels where Switzerland, UK, USA and Netherlands stand out. Interestingly, while Switzerland and USA have consistently been the highest performing countries, the UK and to a lesser extent the Netherlands have experienced a continuous increase in impact over the period. In the second group, while more fluctuating over the period probably due the smaller publication set, Denmark has the highest performance peaking around 2010-12. It should be emphasized that all countries perform above the database average and the statistically expected performance levels. Among the countries in the lower level performance group, the set of Swedish neuroscience publications is distinctive. Sweden's performance levels are the lowest among all countries examined. If we examine citation impact according to collaboration types, then we also see the marked drop in the visibility of Danish publications with no inter-institutional collaboration. Notice, a similar marked drop can be seen in the PPtop10% indicator for Switzerland. It is unclear, however, why these drops are so marked.

Interestingly, doing a traditional scientometric analysis, where we delimit neuroscience according to WoS journal subject categories, we get comparable overall results with two distinct groups of countries at different performance levels. However, the internal rankings and developments are clearly different. In the highest performing group, the UK consistently has the highest impact whereas Switzerland sees a marked increase over the years reaching the UK level in the last period examined. In the lower performing group, Denmark and Sweden are clearly and consistently the lowest performing of the four countries. Notice, however, that such a traditional analysis leaves out potential neuroscience research published in broad medical and multidisciplinary journals. The latter is extremely important because such journals usually have markedly higher visibility and will therefore most likely influence citation performance. The difference between the results from the two approaches is therefore no doubt due to this difference in topic delineation.

A final main finding at the country level is the general trends in the proportion of so-called "industry publications". Denmark and Switzerland stand out with clearly the highest proportion of industry-publications (both industry alone and collaborative publications), no doubt a result of the relatively high concentration of pharmaceutical companies in these countries. However, the trend is declining for all countries, especially from 2010-12 and onwards, but most markedly for Denmark where the continuous drop begins in 2009-11.

Next, we present the main findings for the analyses of the four Danish universities and their affiliated hospitals. The relative difference in publication output between the four universities is stable over the period. Copenhagen has the largest output, almost twice as many publications in neuroscience and related areas as Aarhus, ranked second. Aarhus then has approximately twice as many publications as University of Southern Denmark ranked third, while the gap between Aalborg and University of Southern Denmark is somewhat smaller. Noticeable, three pharmaceutical companies are among the ten most productive units in Danish neuroscience research in period examined.

Compared to the country analyses, the disaggregate analyses of the universities brings about relatively smaller publication sets which mean that fluctuations become more likely. When we examine the journal publication profiles we clearly see these fluctuations, although the profiles for the two largest units, Copenhagen and Aarhus, are the most stable for the whole period. Until the end of the period, these two units also have the most visible profiles according to the MNJS indicator.

When it comes to citation impact, we also see that the largest units have the most stable developments with Copenhagen and Aarhus as the highest performing universities although differences between the units are small. However, from 2009-11 we see a sudden steep rise in impact for the set of publications linked to H.Lundbeck A/S. Clearly, this is an indication of some potential breakthrough research influencing the research front and reported in a relatively restricted set of publications that received a sudden short-term impact. In addition, the Danish Technical University seems to increase their general impact level in that period settling on a level comparable to Copenhagen and Aarhus. Notice, although the Danish Technical University does not have any formal affiliation with university hospitals, it is included in the analyses due to the university's publication volume in the dataset. If we exclude the volatile movements of H.Lundbeck A/S, what seems most interesting is the stable developments and impact levels of the four universities.

Perhaps not surprising, the Danish Technical University seems to have the largest share of collaborative publications with industry, however, the trends are fluctuating considerably. Also not surprising, but perhaps more interesting, is the development of the University of Copenhagen. In the early period the proportion of collaboration is considerably higher than the other units examined (except the Technical University), but the development over the period sees a general and continuous drop so that in the most recent periods the proportions between the four main universities are significantly diminished.

Finally, the funding pattern of Danish neuroscience research reveals four main clusters: 1) a cluster of pharmaceutical companies; 2) a cluster evolving around the National Institutes of Health (NIH) in the US; 3) a cluster of European funding sources both EU and national funding agencies; and 4) a cluster of Danish funding sources (including Lundbeckfonden) both public and private. The most prolific Danish funding sources are the Danish Research Council (DFF) and Lundbeckfonden. And there is a strong relation between the Danish Research Council, Lundbeckfonden and the Danish National Research Foundation, which means that these funding sources very often are acknowledged together in the same publications. Also, NIH funding seems to be linking national Danish funding activities with funding from pharmaceutical companies.

2. Introduction

This report presents results from scientometric analyses performed on a specially constructed publication set that is assumed to broadly cover neuro-/brain science and related research areas. The report and its analyses are initiated and funded by Lundbeckfonden. The publication set is constructed in two tempi. First the PubMed database is queried for neuroscience topics using Medical Subject Heading (MeSH) descriptors and subsequently the identified publications from PubMed are matched with corresponding publications in the Web of Science (WoS) citation database. The latter enables scientometric analyses including citation analyses. A recall approach has been taken so that priority is given to inclusion at the potential cost of precision in the search result. The approach has several advantages over traditional scientometric analyses of neuroscience, most importantly we identify relevant articles according to their subject indexing at the individual publication level. Traditional analyses rely on journal subject categories that often lead to exclusion of articles published in broader multidisciplinary journals.

The scientometric analyses are performed at two levels, first the aggregate country level where we examine the performance of Danish publications compared to seven benchmark countries: USA, UK, Sweden, Switzerland, Germany, Netherlands and Canada. The benchmark countries are selected based on their general interest to Danish research and their impact level in 'neuroscience' demonstrated in a previous report[1]. The group of benchmark countries includes the highest performers. Subsequently, we perform 'regional' analyses for the Danish set of publications. We define 'regional' as the four Danish universities with medical faculties and their locally affiliated university hospitals: Aarhus University, University of Southern Denmark, Copenhagen University and Aalborg University. Notice, Aalborg University is treated as an independent unit despite that Aalborg University Hospital has been affiliated with Aarhus University in the entire period examined, and that Aalborg University only recently established a medical faculty.

All scientometric analyses are carried out with state-of-the-art indicators using the same database and parameters as the Leiden Ranking (www.leidenranking.com). We caution readers to treat the results wisely and use them informatively and only in context with other information. We refer to the Leiden Manifesto (http://www.leidenmanifesto.org/) for good practice when it comes to handling of the metrics.

[1] Unpublished report by the Danish Ministry for Education and Research: "Kortlægning af Neuroscience" [Mapping of Neuroscience].

3. Data and methods

A main challenge in scientometric analyses is to delimit and construct a meaningful subject area to be studied. The Web of Science database includes a journal subject classification that is most often used for such purposes, but it is highly problematic for various reasons. Many journals do not have a sufficiently clear subject profile and the spread of topics among individual articles in a journal often go beyond the journal's often somewhat arbitrary subject classification. The subject classification systems include categories called 'multidisciplinary'. These are heterogeneous categories unsuitable for proper analyses. There are other problems, but the main point is that research or subject areas should be constructed based on individual research papers if possible and not the journals they are published in.

As the aim of the present analyses is to examine neuroscience and its related areas, we are fortunately able to utilize the elaborate Medical Subject Heading (MeSH) indexing system of individual publications in the PubMed database to identify potentially relevant publications. Subsequently, we try to match the identified PubMed publications with corresponding entries in the Web of Science database in order to retrieve the relevant information needed for the scientometric analyses.

In the next two sections, we will outline and document the identification and matching process, and in the final section of the chapter, we will present the citation database, the indicators and the parameters used in the scientometric analyses.

3.1. Databases: PubMed and Web of Science

Bibliographic information for this report is obtained from the two databases the US National Library of Medicine's PubMed Medline (hereafter PubMed) and Thomson Reuters' Web of Science: Science Citation Index-Expanded (hereafter simply WoS). PubMed is used to create a structured, systematic bibliographic search, as the majority of records in PubMed are indexed with the MeSH classification system. The hierarchical MeSH descriptors allow retrieval of subordinate terms for the written query, which is why, the search strategy (see Appendix 2: Search documentation) in some cases excludes certain explicit terms, which are already implied. The PubMed records are subsequently matched to WoS in order to obtain citation data and complete information on author affiliations (see following sections).

The search strategy for this analysis is divided into three facets. *Facet A* covers MeSH descriptors related to the nervous system, brain diseases and mapping, neurology and neurosciences, as well as mental disorders (see Appendix 2: Search documentation). *Facet B* covers text-word ("[TW]" in the PubMed interface) variations of the MeSH terms of Facet A and relevant subordinate variants, which ensures inclusion of missing classifications, PubMed Central records not included in Medline and the most recent records. *Facet C* covers a search of the most relevant journals to the topic. Additional facets were planned to delimit the search to molecular biology, cell biology, genetics, epidemiology, bioinformatics, physiology, pharmacology and also prevention and control, etiology, diagnosis, treatment and pathology. However, in cooperation with domain experts it was found that these limiting filters removed too many relevant records and that the current signal to noise ratio was more acceptable than the omission of relevant records. The overall search strategy is illustrated in Table 1.

Table 1. Overall search strategy and results

Facet	# records
Facet A	4,911,653
Facet B	338,122
Facet C	1,003,128
Facet A OR Facet B OR Facet C	5,132,327
(Facet A OR Facet B OR Facet C) AND 2004:2015[PDAT]	2,130,473

To illustrate the results of this search, the co-occurrence of major MeSH descriptor assignments per paper is illustrated in Figure 1. The descriptors are mapped according to their co-occurrence in papers, their frequency, and an algorithmically produced clustering of overall topics (e.g. the red cluster is clearly related to psychiatry).

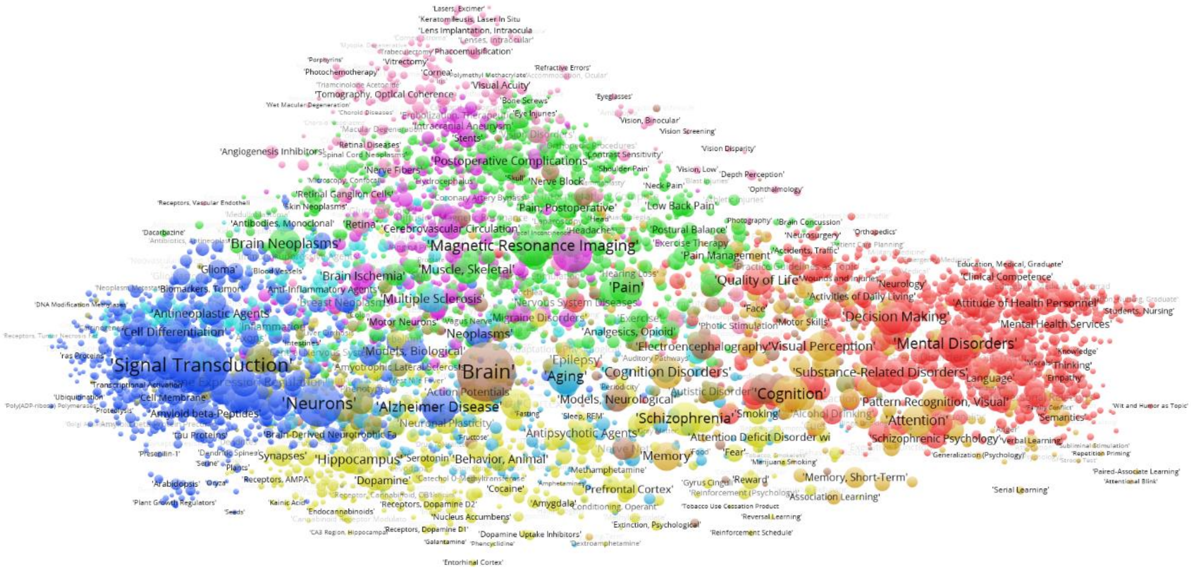

Figure 1. All major MeSH keywords for the complete set of papers.

3.2. Iterative matching procedure

In order to obtain citation data for PubMed records, it is necessary to try and match the PubMed records with corresponding entries in WoS. Notice, the PubMed database covers more medico journals than WoS. However, the WoS does cover a substantial number of medical journals including the most important international ones. A three-step process was implemented to maximize the matched percentage, using first direct ascension number matches existing in WoS, followed by Digital Object identifier (DOI) matching and finally a fuzzier, less precise matching of journal (through ISSN), volume, pagination and the first 32 characters of the titles. The fuzzy approach allowed for two character differences between titles in order to allow for small errors while ensuring quality through exact matches on the other data elements. No false positives were found in the resulting match.

The first iteration identified 1,781,799 records (83.6%), followed by 62,848 additional records through DOI matches (another 2.9%) and finally 8,582 records through fuzzy matches (0.4%) for a total of 1,853,229 matched records corresponding to a total match rate of 87.0%.

To get an overall impression of the main subject distribution of the matched publication set we examined the distribution of papers over WoS journal subject categories. The distribution for the entire set and specifically for the Danish publications are shown in Figure 2.

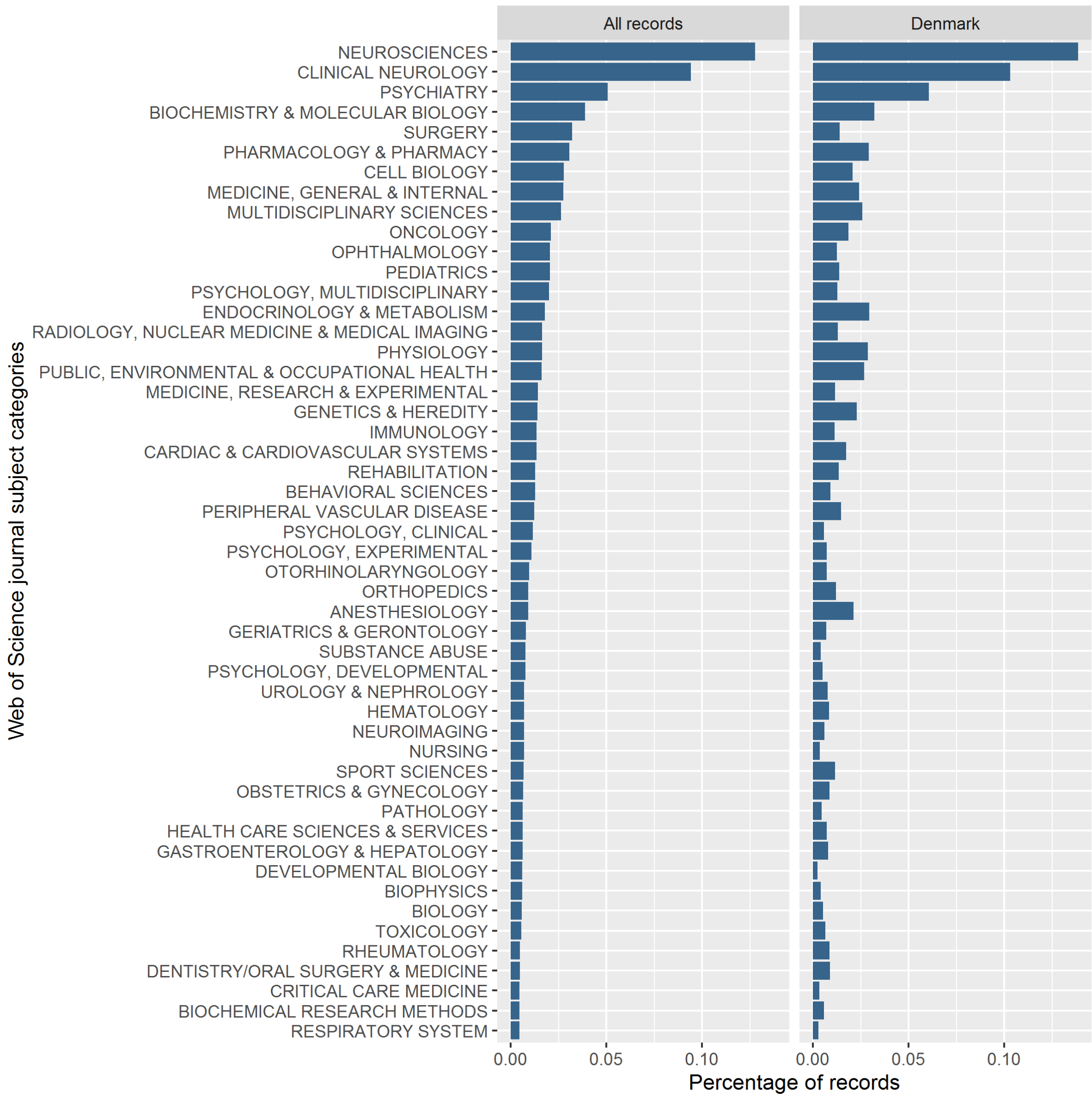

Figure 2. Distribution of records per subject category for all records and those with one or more authors affiliated to a Danish institution.

3.3. Citation database, indicators and parameters

The scientometric analyses are carried out in the enriched version of the WoS database at CWTS, Leiden University, the Netherlands. The analyses are based on the same data, state-of-the-art methodology and indicators, as used by CWTS in their annual Leiden Ranking (www.leidenranking.com). Hence, indicator results are comparable to those in the Leiden Ranking for universities.

Among the citation databases, the WoS offers a very good coverage of the international scientific journal literature and generally provides high quality data. Notice, only journal publications are included in the present analyses.

CWTS enriches WoS data in a number of ways. First, CWTS performs its own citation matching (i.e., matching of cited references to the publications they refer to), and secondly, CWTS puts a lot of effort in assigning publications to universities in a consistent and accurate way. This is by no means a trivial issue. Universities, and more generally institutional affiliations, may be referred to using many different name variants and the definition and delimitation is not obvious at all. In the present analyses, we can only partially rely on the enhanced university address matching by CWTS because we also include university hospitals and research institutions not included in the Leiden Ranking and therefore not subjected to the extensive name disambiguation and matching. Consequently, we have manually performed data cleaning and institutional matching for the Danish publications in the specially constructed neuroscience publication set. We should specify that even manual matching can be difficult and errors will therefore most likely be present, although we have good reason to assume that they are few and inconsequential.

Most impact analyses, especially ones using commercial software, will include all publications and base the normalization of the citation scores on the general citation activity in the various journal subject categories. For purposes of citation analysis, this is inexpedient. In the present analyses we utilize the same methodology as used in the Leiden Ranking where only ‘core’ publications are included and the normalization of the citation scores are based on so-called ‘micro clusters’ of related publications.

3.3.1. Core publications

The Leiden Ranking does not simply take into account all publications in WoS. Instead, the ranking is based on so-called ‘core’ publications, which are a subset of all publications in WoS. Core publications are publications in international scientific journals in fields that are suitable for citation analysis. In order to be classified as a core publication, a publication must satisfy the following criteria:

- The language of the publication should be English.
- The publication has one or more authors. (Anonymous publications are not allowed.)
- The publication has not been retracted.
- The publication has appeared in a core journal.

The last criterion is a very important one. A journal is considered a core journal if it meets the following conditions:

- The journal has an international scope, as reflected by the countries in which researchers publishing in the journal and citing to the journal are located.
- The journal has a sufficiently large number of references to other core journals, indicating that the journal is in a field that is suitable for citation analysis. Many journals in the arts and humanities do not meet this condition. The same applies to trade journals and popular magazines.
- In the calculation of indicators, only core publications are included. Excluding non-core publications ensures that results are based on a relatively homogeneous set of publications, namely publications in international scientific journals in fields that are suitable for citation analysis. Field-normalized impact indicators become more accurate by excluding non-core publications. It should be emphasized that non-core publications are excluded not because they are considered less important than core publications. Non-core publications may have an important scientific value. About one-sixth of the publications in WoS can be considered non-core publications.

3.3.2. Micro-clusters and normalization

CWTS has constructed their own algorithmically defined hierarchical classification of publications. Essentially, publications are assigned to 4113 so-called ‘micro-level fields of science’. This is done based on a large-scale analysis of hundreds of millions of citation relations between publications.

Traditionally, fields of science are defined by sets of related journals. This approach is problematic especially in the case of multidisciplinary journals such as Nature, PLOS One, PNAS, Science, BMJ, NEJM, JAMA etc., which do not belong to one specific field. By linking individual publications according to their mutual citation activity, publications in multidisciplinary journals can be properly assigned to a ‘field’. Essentially, the micro-fields are collapsed into meso- and macro-fields or clusters ending with five main fields as demonstrated in Figure 3.

Notice, the micro-level fields play an important role in the calculation of the field-normalized impact indicators. Traditionally, field normalization is done based on the 249 WoS journal categories. Research has shown that the citation behavior within these 249 categories are too heterogeneous for normalization purposes, smaller constructs are needed. The micro-fields provide such constructs as topic and citation behavior seems more homogenous at this level.

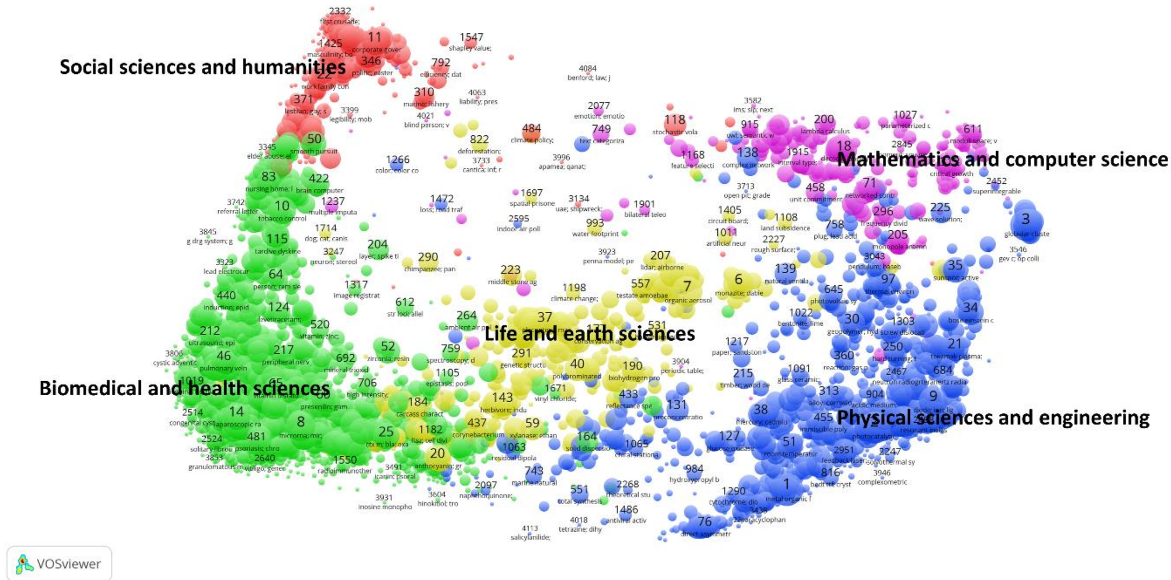

Figure 3. Map of science based on algorithmically defined micro-clusters of publications linked through their mutual citation activity.

In Figure 3, each circle represents a micro-level field. Each field is labeled using a numerical identifier (integer value between 1 and 4113). The size of a circle indicates the number of publications in a micro-level field. The larger the circle, the larger the number of publications. The distance between two circles indicates approximately the relatedness of two micro-level fields, where the relatedness is determined by citation relations between the fields. In general, the smaller the distance between two circles, the stronger the micro-level fields are related to each other. The color of a circle indicates the main field to which a micro-level field belongs. Some micro-level fields belong to multiple main fields. In that case, the color of a circle is determined by the main field to which a micro-level field is most strongly linked.

3.3.3. Indicators and their parameters

We use a number of standard bibliometric indicators of output, impact, and collaboration. We use the acronyms given by CWTS to designate the indicators.

Most analyses are presented as time series. Output is the number of publications in a given time period, most often we apply blocks of several years, advancing one year at a time, to obtain robust and smooth time series for trend analyses. Publication types include research articles and reviews. Letters are excluded from the impact analyses.

All impact analyses have been done with fractional counting (i.e. at the level of countries or institutions). With fractional counting each country is credited a fraction of each publication in proportion to its share of all author addresses given in the publication. Whereas in full counting each involved country would be given full credit for the publications they have contributed to. There is an ongoing debate in the scientometric research community of whether to use full counting or fractional counting, or both counting methods. There are valid arguments for both positions depending on aim. The fractional counting method is usually promoted because it has good mathematical properties. Field-normalized comparisons across countries sum up to unity in the database and provide an interpretable scale where one corresponds to the average citation impact in the database. Full counting may 'favor' minor countries, institutions or fields with more international publication activity. Due to multiple counts, full counting does not have same mathematical properties as fractional counting. Despite violating mathematical properties, full counting can certainly be relevant for specific analyses. Indeed, full and fractional counts can be seen as measuring different constructs, i.e. participation (full) and contribution (fractional). But for reasons of clarity and space, we do not present results based on both counting methods in relation to the indicators. We focus on fractional counts at the country level[2]. Notice, a decreasing trend in time series based on fractional counts may well be an expression of more international collaboration and not a general decline of output. On the contrary total output may well be rising.

We define "international collaboration" as publications where there are at least two different countries or institutions mentioned in the address field of the publication. We emphasize that measuring "collaboration" using co-authorships can only be a partial indicator of research collaboration.

Two complimentary indicators measure citation impact of publications: Mean Normalized Citation Score (MNCS) and the Proportion of Publications among the top *n* % of the most highly cited publications in the database (in the present case PPtop10% and PPtop2%). All citation indicators are item normalized according to publication type, publication year, and micro-field-specific citation rates. This means that citation rates per publication are compared to average citation rates for the same type of publications, in the same year, for the specific micro field (where the micro-field is assumed to delimit a coherent research area), before they are aggregated to provide totals. Providing such normalizations enables comparison of so-called relative citation indicators across research fields, publication types and publication years. Relative indicators are needed here because the typical number of citations is highly dependent on research field, publication type and the time allowed before citations are counted.

Self-citations are excluded from the calculation of citation rates. Citation rates are calculated with variable citation windows, i.e., the citations obtained in the publication year and the following years until 2015. Notice, for the most recent publications, citations have only been accumulated during one or two years.

In general, citation indicators become more robust as the number of publications involved increases. At the country level, indicators are usually very robust. This is different at the regional level; we have

[2] In the biomedical fields, first and last author positions in the byline often signify main responsibility of work. In the present analysis, we disregard such information because 1) it is not possible to link author byline positions to countries for the entire period examined, and 2) other studies have shown that such weighting have close to no influence on the aggregate country level of publications.

therefore implemented a threshold of 50 fractionalized publications cumulated for three years in order for an institution to be included in the citation analyses at the Danish regional level.

The MNCS indicator is an average field normalized citation rate. When fractional counts of publications are used an index of one is the “database average” citation rate for the aggregated field(s). An important weakness of the MNCS indicator is its strong sensitivity to publications with a very large number of citations. Especially for smaller publication sets, this can result in an overestimation of the actual impact of the publications assigned to the unit of analysis.

As the PPtop*n*% indicator is based on ranks and not averages, it is much less sensitive to publications with very large number of citations. By default, we apply 10% as the threshold for the PPtop*n*% indicator (i.e. PPtop10%), where 10% means all publications cited on or above the 90th percentile in the database. For each publication of a unit, this indicator determines whether the publication, based on its number of citations, belongs to the top 10% of all WoS publications in the same field and the same publication year and of the same document type. The PPtop10% indicator equals the proportion of the publications of a unit (i.e. country of regional institution) that belong to the top 10% highly cited publications. If a unit has a PPtop10% indicator of 10%, this means that the actual number of top 10% publications of the unit equals the statistically expected number. A PPtop10% indicator of 15% means that the unit has 50% more publications than expected among the 10% most cited in the database. A disadvantage of the PPtop*n*% indicator is the artificial dichotomy it creates between publications that are respectively above and just below the percentile threshold. Therefore, we apply both MNCS and PPtop*n*% as they can be seen as complementary, though they usually also correlate strongly at aggregated levels.

Finally, we use the Mean Normalized Journal Score (MNJS) to measure the impact of the journals in which a country or regional institution has published. To calculate the MNJS indicator for a unit, we first calculate the normalized journal score of each publication of the unit. The normalized journal score of a publication equals the ratio of, on the one hand, the average number of citations of all publications published in the same journal and, on the other hand, the average number of citations of all publications published in the same field. Only publications in the same year and of the same publication type are considered. The MNJS indicator is obtained by averaging the normalized journal scores of all publications of a unit. The MNJS indicator is closely related to the MNCS indicator. The only difference is that instead of the actual number of citations of a publication, the MNJS indicator uses the average number of citations of all publications published in a particular journal. If a unit has an MNJS of one this means that on average the country or regional institution publishes in journals that are cited equally frequently as would be expected based in their fields. A MNJS indicator of 1.5 means that on average the unity publishes in journals that are cited 50% more than would be expected based on their fields. To some extent the MNJS indicator resembles Thompson Reuters’ (in)famous Journal Impact Factor (JIF) in the sense that in both cases publications are assessed based on the journal in which they have appeared. However, compared with the MNJS indicator, JIFs have the important disadvantage that they do not correct for differences in citation characteristics between research fields.

3.3.4. Stability intervals

The handling of uncertainty is a contested topic in the current discourse on scientific practice, also in relation to research evaluation and scientometric indicators[3]. Traditional procedures using *p* values or confidence intervals are highly problematic in scientometric settings as the one examined in this report. Essentially, we are examining the whole population, all there is. There is no random sampling and even though some data are excluded, they are so systematically and thus not by some stochastic data generation process needed for calculating proper confidence intervals. In other words, calculating a confidence interval around an indicator value provides no real information as there is no random sampling variation. The indicator should be seen as the population parameter and not its estimate.

[3] See Schneider (2013; 2015) and the Leiden Manifesto (2015)

However, in order to provide some kind of robustness check, so-called ‘stability intervals’ have been suggested (and are provided in the Leiden Ranking). Stability intervals can provide some insight into the ‘vulnerability’ of indicator values. Vulnerability refers to the underlying publication set upon which an indicator value for a unit is calculated. Smaller publication sets are usually more vulnerable as their indicator values often decisively depended on a few highly cited publications. A stability interval indicates a range of values of an indicator that are likely to be observed if the underlying set of publications changes. For instance, the PPtop 10% indicator may be equal to 15.3% for a particular country, with a stability interval ranging from 14.1% to 16.5%. This means that the PPtop 10% indicator equals 15.3% for this country, but changes in the set of publications of the country may relatively easy lead to PPtop 10% values in the range from 14.1% to 16.5%.

We apply 95% stability intervals in this report. Such intervals are created by a statistical technique known as bootstrapping. Bootstrapping is a resampling technique where typically thousands of samples are drawn from the unit’s actual set of publications.

Notice that bootstrapping, and therefore stability intervals, have the same contested theoretical basis as confidence intervals (i.e. so-called frequentist inference). Nevertheless, stability intervals can be applied pragmatically because the size of the intervals give an impression on the vulnerability of the indicators if the set of publications change. As indicated above, this is useful information in a scientometric context because citation distributions over papers are highly skewed. Large stability intervals indicate less robust indicators. As always, with frequentist statistics, the sample size (i.e. publication set) is the determining factor when it comes to the size of the intervals. Larger publication sets, smaller intervals and thus more robust indicators. It is however important to re-emphasize that the indicator value is the parameter and not an estimate. Therefore, the stability interval informs us of a *what-if* situation, i.e. what we could expect if the underlying publication set was slightly different. This is informative especially when we examine smaller publication sets where we can expect indicator values to vary considerably over time as the underlying publication set changes. Finally, we caution against over-interpretation of the stability intervals. Readers should in no way interpret overlapping intervals as some kind of evidence for lack of “statistical significance”, or the other way around. Such attempts at ‘testing’ are misplaced in the present context.

3.3.5. Caveats for the interpretation of data

We strongly caution against unsophisticated interpretations of citation indicators especially linking them directly to research ‘quality’. This is erroneous. Research quality is a complex and multi-dimensional concept, which is very difficult if not impossible to measure by a single indicator.

The number of citations an individual paper receives cannot establish the “quality” of that paper. Citations to a paper can be given (or not given) for numerous different reasons some of which may relate to ‘quality’ issue and others not. Citation practices also vary across fields. In research areas with less consensus on theory and methodology, citation practices often tend to be more rhetorical than fields with more consensus. Biomedical fields can be thought of as areas with more consensus compared for example to the social sciences, albeit less than in the fields of physics and chemistry.

Despite these caveats, citation impact is still often used as a proxy for some vague notion of ‘quality’. While the number of citations to a single paper cannot be a measure of its quality per se, the citation impact for an aggregate set of papers linked to a unit of analysis is a different matter. Because citation distributions are so skewed, where approximately 10 percent of publications receive 50 percent of all citations, it becomes interesting to examine the impact at an aggregate level of units. Higher impact levels for some units mean that their set of publications have higher visibility, they stand out in an environment where most publications go unnoticed. Hence, citation impact is an important performance measure as it examines the use of the research literature, i.e. the academic impact, and therefore give indications of research fronts and intellectual bases of fields of research. Indeed, the concept of ‘impact’ in scientometrics was indeed constructed in order to signify the difference from ‘quality’. The open question then is to what extent ‘impact’ and ‘quality’ are related? In more consensus-like fields such as the biomedical ones, impact and indications of ‘quality’ such as peer review do have good correlations. However, it is generally problematic to think of impact as a direct measure of quality; it is primarily a measure of use.

4. Scientometric analyses for countries

The chapter presents results at the country level. First, we provide various publications counts to illustrate the production of publications, the size of the units examined, as well as the relative growth rate from over the periods examined. Next we provide aggregate journal publication profiles measured using the mean normalized journal score (MNJS). Subsequently, we present various collaboration analyses, and the final sections present citation impact results. All results are presented as time series with three-year publication blocks shifted one year at the time.

4.1. Publication analyses for countries

Below in Tables 2, 3 and 4 we present country publication counts, both full counts, fractional count at country level and fractional counts at author level. Countries are ranked according to output in the first period 2004-06. Publication output provides us with information on the size of the units and gives us indications for the robustness of the subsequently calculated indicators. Also, supplementing the individual tables are Figures 4, 5 and 6 that show the relative growth rates over the periods examined for the different counting methods. The first period examined 2004-06 corresponds to index 100. Finally, Tables 5, 6 and 7 depict the development in output from the first to the last period relatively as the number of neuroscience publications per 100,000 inhabitants.

Table 2. Publication output for countries, full counts

	2004-06	2005-07	2006-08	2007-09	2008-10	2009-11	2010-12	2011-13	2012-14	2013-15
USA	138353	144810	151916	158305	164580	171015	178804	186331	191041	186337
UK	33369	35107	36959	38565	40340	42089	44284	46865	48453	47841
Germany	24790	26216	27756	29002	30564	32315	34436	36535	37830	37358
Canada	18812	20338	21910	23558	24996	26121	27367	28866	30026	29822
Netherlands	10900	11888	12874	13788	15050	16166	17627	18723	19796	19757
Sweden	7105	7618	7956	8352	8698	9034	9594	10253	10919	11000
Switzerland	6405	6825	7296	7768	8348	9071	9950	10858	11457	11438
Denmark	3339	3578	3803	4192	4617	5073	5495	5944	6412	6769
Grand Total	243073	256380	270470	283530	297193	310884	327557	344375	355934	350322

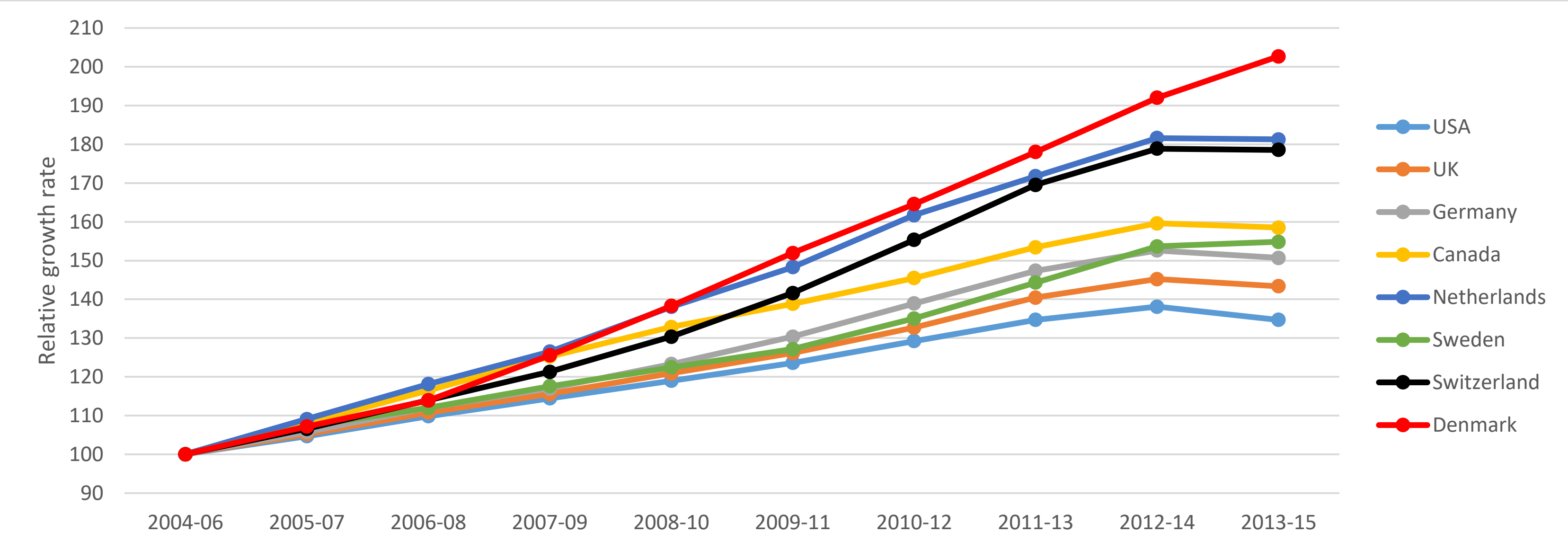

Figure 4. Publication growth for countries, full counts (index 100 = publication period 2004-06)

Table 3. Publication output for countries, fractional counts for unique country contributions

	2004-06	2005-07	2006-08	2007-09	2008-10	2009-11	2010-12	2011-13	2012-14	2013-15
USA	121472.9	126349.6	131665.9	136260.2	140608.4	145103.1	150434.9	155380.6	157657.0	151982.4
UK	25449.7	26344.3	27232.2	27857.6	28496.7	29246.9	30216.4	31427.4	31694.2	30407.2
Germany	18637.0	19443.4	20321.2	20896.5	21659.3	22534.4	23703.9	24833.8	25384.7	24691.9
Canada	14589.9	15651.4	16689.9	17747.4	18556.4	19173.8	19850.8	20780.3	21307.7	20790.2
Netherlands	8135.8	8818.8	9453.3	10055.5	10804.0	11394.4	12143.2	12600.9	13057.5	12753.0
Sweden	5179.5	5476.0	5643.4	5793.8	5907.8	6022.9	6277.6	6593.4	6894.7	6763.5
Switzerland	4176.5	4341.3	4584.2	4783.8	5101.3	5419.4	5851.7	6281.1	6540.6	6376.6
Denmark	2336.1	2418.6	2548.8	2767.0	3029.9	3273.9	3487.0	3736.0	4017.9	4149.6
Grand Total	199977.5	208843.3	218138.9	226161.9	234163.8	242168.8	251965.7	261633.4	266554.3	257914.3

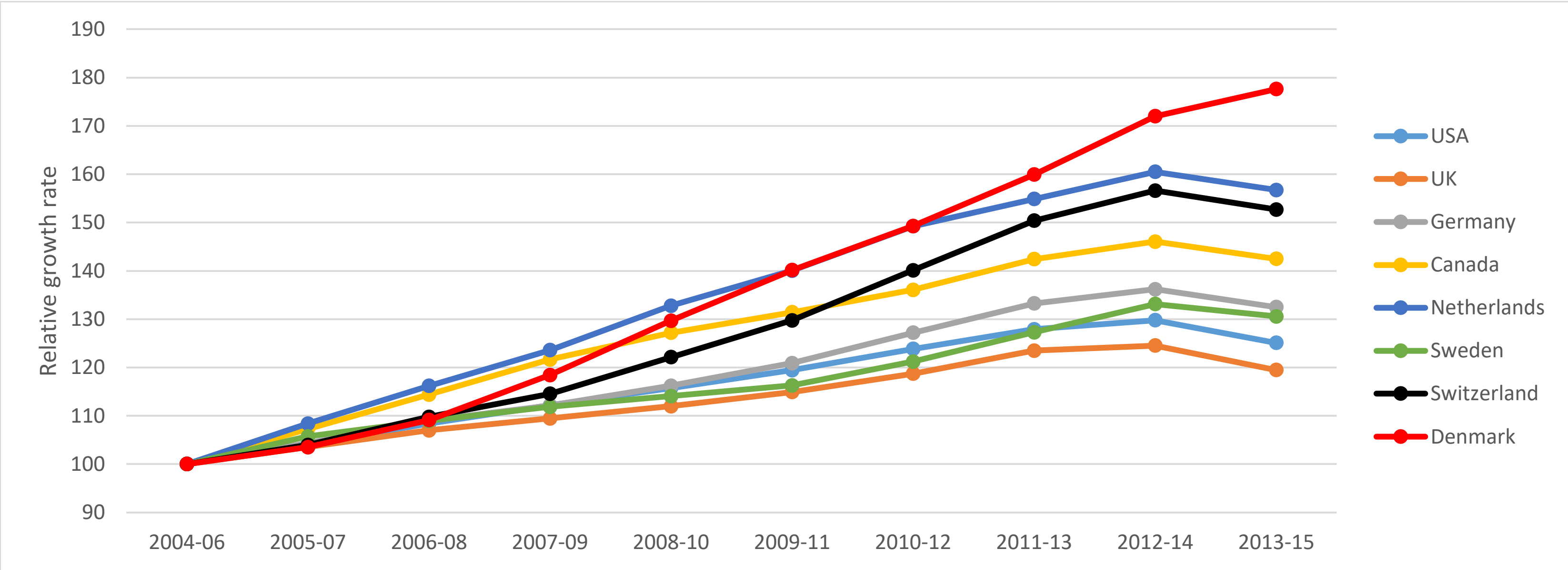

Figure 5. Publication growth for countries, fractional count for unique country contributions (index 100 = publication period 2004-06)

Table 4. Publication output for countries, fractional counts for authors

	2004-06	2005-07	2006-08	2007-09	2008-10	2009-11	2010-12	2011-13	2012-14	2013-15
USA	44901.1	46064.2	47724.0	48758.7	49749.0	50429.2	51333.3	51728.5	51359.6	48230.5
UK	10828.8	11166.0	11572.1	11731.7	11917.6	12041.3	12241.7	12543.7	12494.1	11841.3
Germany	6352.9	6562.8	6830.6	7014.4	7213.4	7439.4	7725.0	8061.2	8171.2	7813.0
Canada	5781.7	6122.2	6478.8	6867.1	7072.9	7214.3	7342.2	7548.6	7572.0	7198.7
Netherlands	2680.1	2860.7	3067.7	3223.4	3447.9	3610.1	3840.1	3943.6	4056.1	3898.4
Sweden	2044.5	2141.7	2162.0	2210.7	2233.8	2266.8	2333.2	2391.1	2484.0	2403.6
Switzerland	1592.1	1680.9	1768.0	1850.2	1944.0	2063.1	2199.2	2338.2	2395.3	2305.4
Denmark	897.4	918.9	966.5	1047.5	1141.6	1231.8	1283.8	1337.4	1390.8	1419.2
Grand Total	75078.5	77517.4	80569.7	82703.7	84720.1	86296.1	88298.5	89892.3	89923.1	85110.1

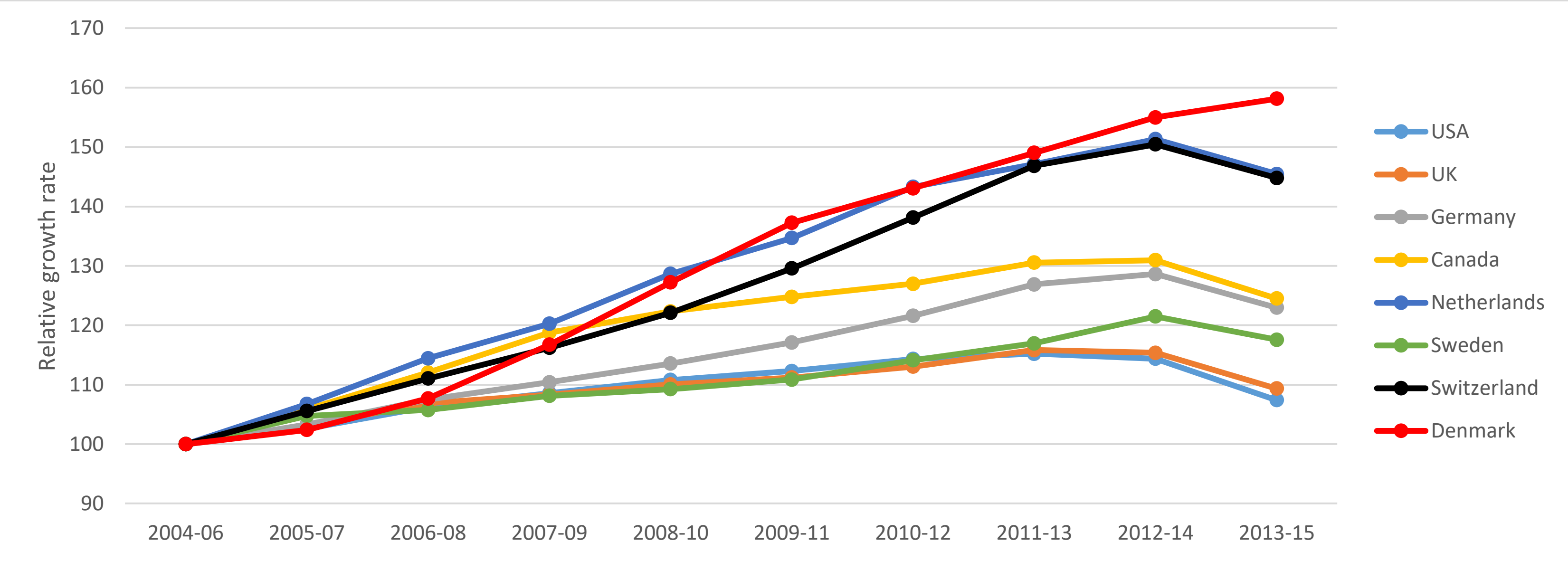

Figure 6. Publication growth for countries, fractional count for authors (index 100 = publication period 2004-06)

In Tables 5, 6 and 7 below the developments in publication output from the first to the last period is depicted relatively as the number of publications per 100,000 inhabitants. Similar to the tables above, we depicted this relative output for full counts, fractional counts for unique country contributions and fractional count for authors.

Table 5. Publication development from the first to last period examined as publications per 100,000 inhabitants, full counts.

	Publications: 2004-06	Publication per 100,000 inhabitants	2013-15	Publication per 100,000 inhabitants
USA	138353	46.4	186337	58.0
UK	33369	40.4	47841	58.5
Germany	24790	41.5	37358	57.4
Canada	18812	58.3	29822	83.2
Netherlands	10900	66.9	19757	116.7
Sweden	7105	78.6	11000	112.3
Switzerland	6405	88.3	11438	138.0
Denmark	3339	61.5	6769	119.3

Table 6. Publication development from the first to last period examined as publications per 100,000 inhabitants, fractional counts for unique country contributions.

	Publications: 2004-06	Publication per 100,000 inhabitants	2013-15	Publication per 100,000 inhabitants
USA	121472.9	40.7	151982.4	47.3
UK	25449.7	30.8	30407.2	37.2
Germany	18637	31.2	24691.9	37.9
Canada	14589.9	45.2	20790.2	58.0
Netherlands	8135.8	49.9	12753	75.3
Sweden	5179.5	57.3	6763.5	69.0
Switzerland	4176.5	57.6	6376.6	76.9
Denmark	2336.1	43.0	4149.6	73.1

Table 7. Publication development from the first to last period examined as publications per 100,000 inhabitants, fractional count for authors.

	Publications: 2004-06	Publication per 100,000 inhabitants	2013-15	Publication per 100,000 inhabitants
USA	44901.1	15.1	48230.5	15.0
UK	10828.8	13.1	11841.3	14.5
Germany	6352.9	10.6	7813	12.0
Canada	5781.7	17.9	7198.7	20.1
Netherlands	2680.1	16.4	3898.4	23.0
Sweden	2044.5	22.6	2403.6	24.5
Switzerland	1592.1	22.0	2305.4	27.8
Denmark	897.4	16.5	1419.2	25.0

The main observations from Tables 5, 6 and 7 aligns with the main findings from Tables 2, 3 and 4; the smaller countries seemingly have higher output rates per 100,000 inhabitants compared to the larger countries. Nevertheless, comparing the three different counting methods also reveal that some of the seemingly higher relative output for the smaller countries comes from more collaboration especially international collaboration.

Main observations:

- It is clear that the size-differences between the highest and lowest ranked countries are substantial.
- Relative growth rates are approximately inversely related to output size, so that the Danish growth rate is highest and that of USA lowest.
- The country closest to Denmark when it comes to size is Switzerland, albeit the output for Switzerland approximately twice that of Denmark no matter which counting method is used.
- Noticeable, among the four smallest countries, Denmark, Netherlands and Switzerland clearly stand out with the highest relative growth rates, whereas the growth rate of Sweden is more comparable to considerably larger countries such as Canada or Germany.

4.1.1. Publication profiles for countries according to journals

In this sub-section we compare the countries' journal publication profiles measured with mean normalized journal score. In principle, if a country's publications on average are published in journals with higher impact factors, then their MNJS score will be above one. Notice, this indicator is not a measure of own citations, but instead a measure of publication profile. Nevertheless, the MNJS and mean normalized citation score for individual publications are strongly correlated, so a strong publication profile measured with the MNJS will most likely also mean a relatively high citation indicator.

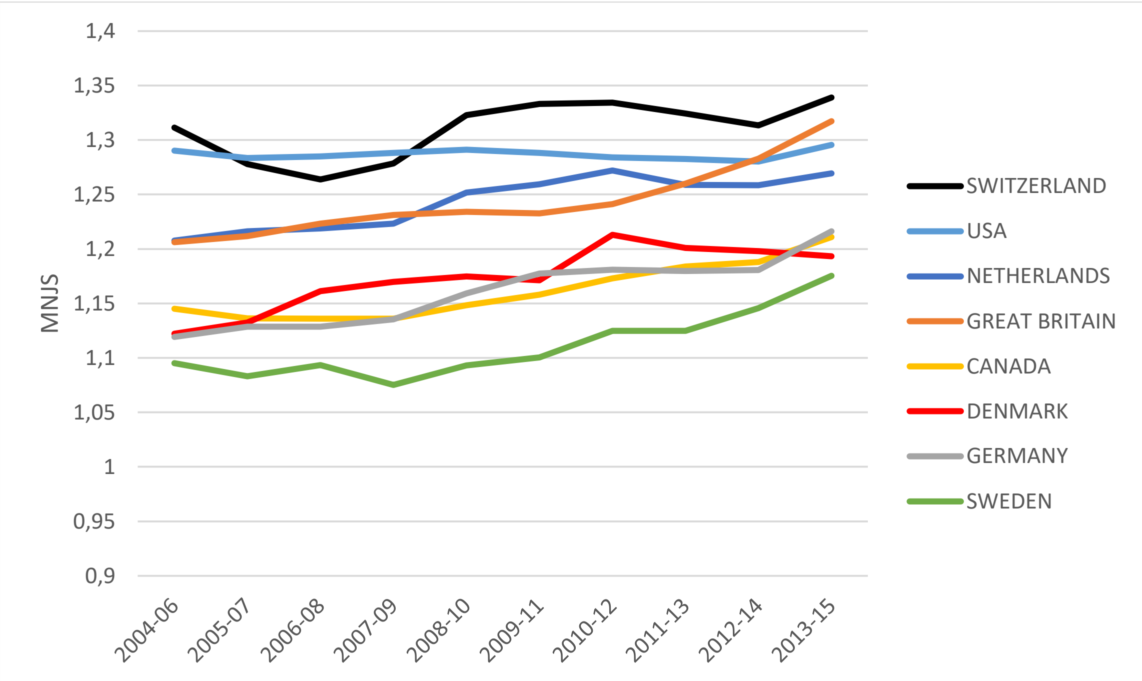

Figure 7. Publication profiles according to journal impact measured with the mean normalized journal score (MNJS).

Main observations:

- Two main groupings can be identified in Figure 7: Switzerland, USA, the Netherlands and UK in the top group with strong publication profiles above 1.2 for the whole period; and Canada, Denmark, Germany and Sweden in the lower group with profiles just exceeding 1.2 in the latest periods.
- At no point in the time series do the two groups overlap.
- The Danish profile increases over the period; but so does most of the countries except USA. To some extent, this growth is an artefact of the development in the database since the mid-2000 where a succession of lowly cited journals especially from Asia have been included. Nevertheless, the eight countries examined here are highly comparable and their relative developments to each other is important and is not polluted in the same way by the database growth. In that respect, the latest Danish developments are somewhat different, as the profile has stagnated.

4.2. Collaboration analyses for countries

The following sub-section presents main trends in the proportion of publications, which are results of national and international collaborations. We caution that 'collaboration' here is measured as co-authorships, while not a perfect indicator it is a reliable proxy. It is well-known from numerous scientometric analyses that the average number of authors in all fields of research have basically doubled from 1980 until now. It is also well-known that the degree of internationalization has also increased considerably over the last 35 years, yet the degree of internationalization is clearly related to country size measured in publication output, where the latter can be seen as a proxy for the size of the science system. Other things equal, the larger the science system the less need there is for internationalization measured as co-authorships between researchers in different countries.

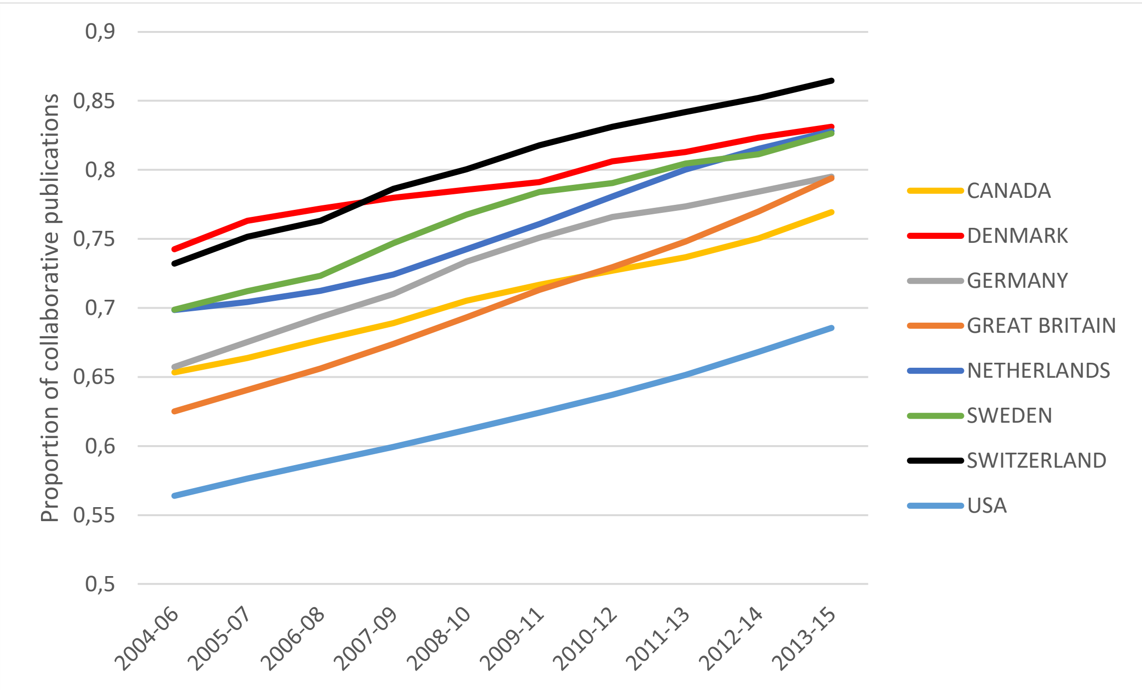

Figure 8. Proportion of collaborative full-count publications for countries.

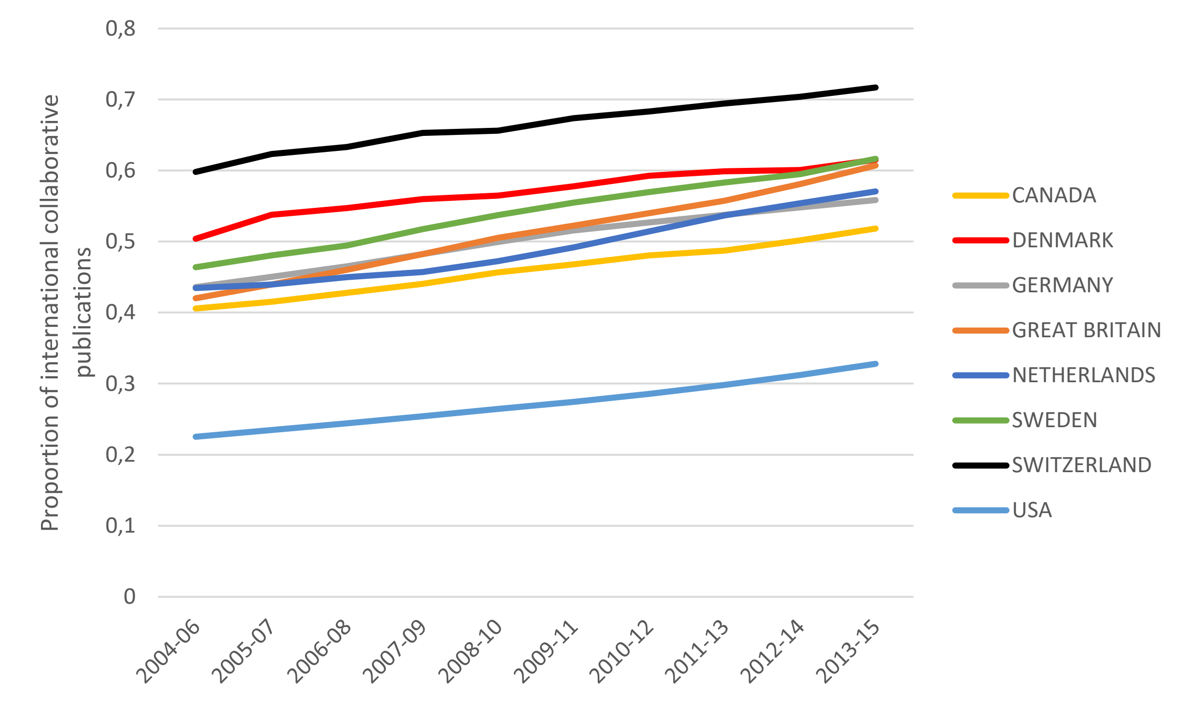

Figure 9. Proportion of international collaborative full-count publications for countries.

Main observations:

- The patterns are familiar. The smaller countries have larger proportions of co-authored publications, both national and international.
- In the latest period, around 80% of the Danish publications have at least two national institutional addresses and 60% also at least one international institutional address.
- The trends are similar with almost linear growth rates; the proportions of co-authored publications from the USA are considerably lower than the other countries (as expected).
- The proportions and trends are important as the citation activity between non-collaborative, national and international collaborative publications are markedly different as we will examine below.

4.2.1. Journal publication profiles according to different collaboration types

In Figures 10, 11, 12 and 13 we break down the journal publication profiles for the countries according to the collaboration type of the publication. We distinguish between three collaboration types: No collaboration (publications where all authors come from the same institution), national institutional collaboration (where at least two different national institutions are mentioned in the address list), and international collaboration (where at least one foreign institutional address is mentioned in the address list).

First, we present the results for Denmark alone (Figure 10), and the following three figures (11, 12 and 13) contextualize the Danish results by benchmarking them with the other seven countries.

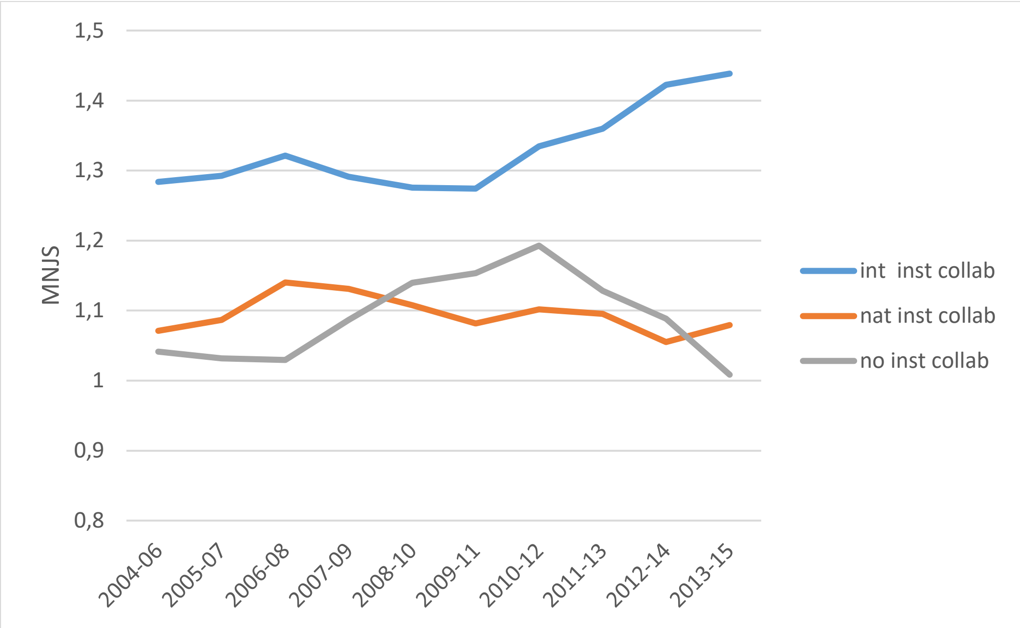

Figure 10. Danish publication profiles according to journal impact for different collaboration types measured with the mean normalized journal score (MNJS).

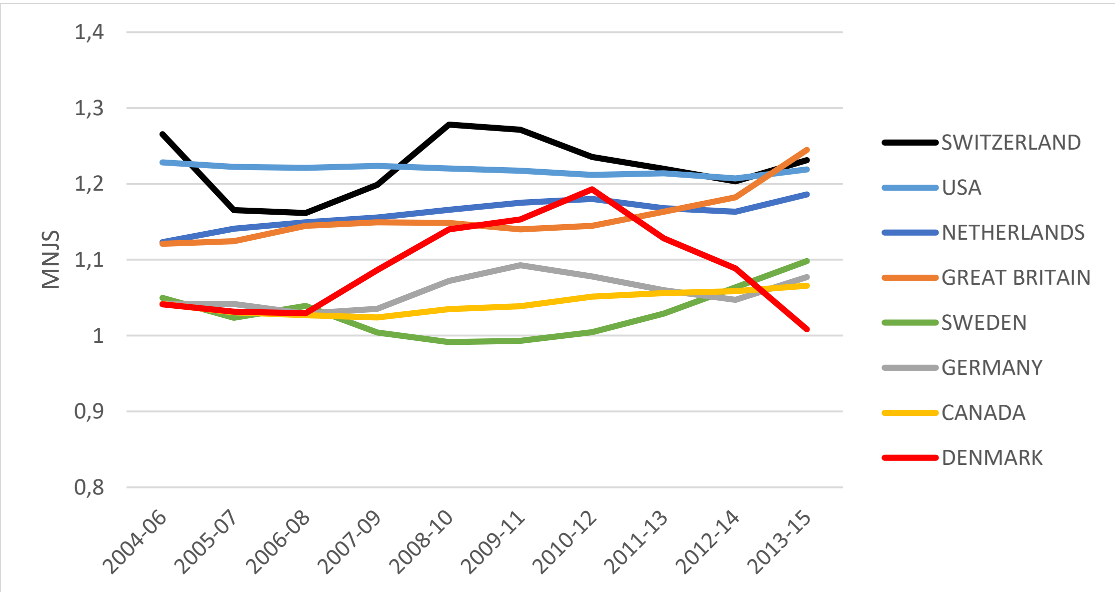

Figure 11. Country publication profiles according to journal impact for publications with <u>no inter-institutional collaboration</u> measured with the mean normalized journal score (MNJS).

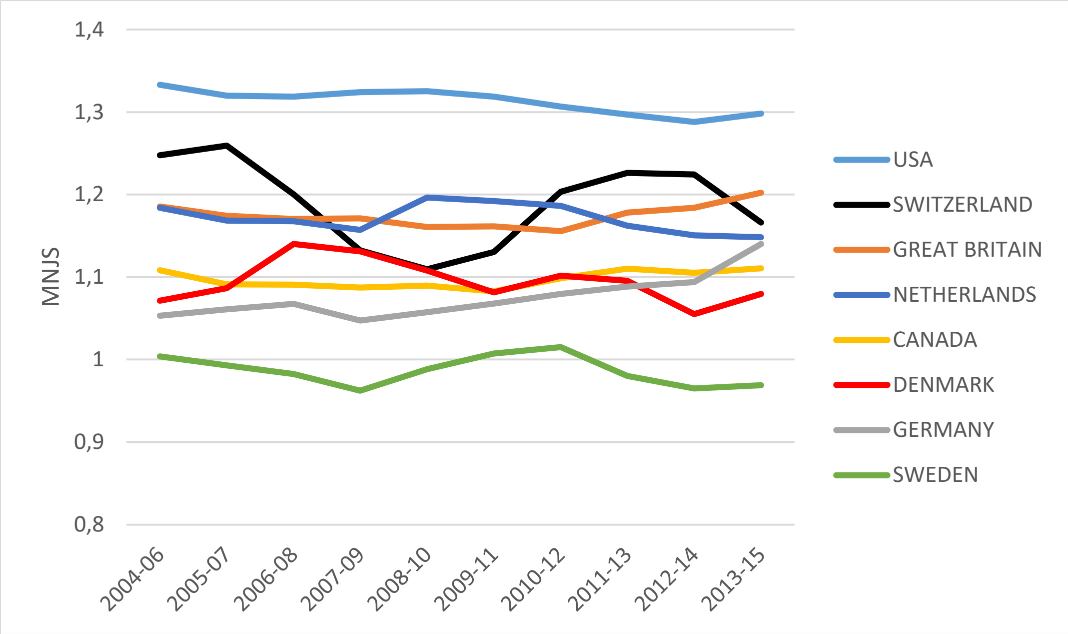

Figure 12. Country publication profiles according to journal impact for publications with <u>national inter-institutional collaboration</u> measured with the mean normalized journal score (MNJS).

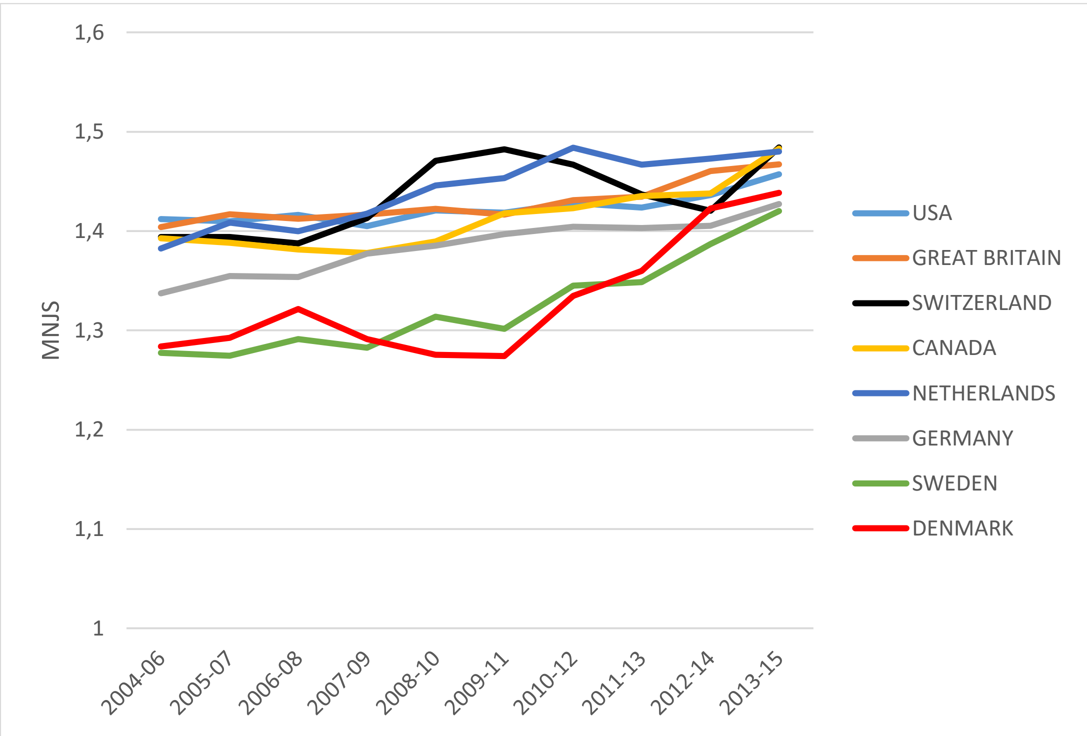

Figure 13. Country publication profiles according to journal impact for publications with <u>international institutional collaboration</u> measured with the mean normalized journal score (MNJS).

Main observations:

- A general and well-known observation is that internationally co-authored publications on average are published in journals with higher visibility (impact). This is also the case here for all countries.
- A most interesting finding is the trend of the Danish publications with no collaboration. In the first period these publications are increasingly published in journals with visibility, but then from 2010-12 onwards this trend drops markedly.
- In contrast to Danish publications, the trend for the internationally co-authored publications goes markedly up from 2009-11 and onwards.

4.3. Citation analyses for countries

This section presents trends in citation impact for countries based on the specially constructed set of 'neuroscience' publications in Web of Science from 2004 – 2015. Two complimentary indicators are used: The mean normalized citation Score (MNCS) and the proportion of publications among the 10% (PPtop10) percent most cited in the database. We refer to Chapter 3 for clarification. Notice, impact is calculated for three-year overlapping publication sets with a variable citation window. Inclusion of publications from 2014 and 2015 means that they will have shorter citation windows than traditionally used. Short citation windows mean less variability resulting in more publications being counted as 'highly cited'. When the windows are extended more variability is established and more robust impact scores are created. The effects of short windows for 2014 and 2015 may be visible in the sense that trends may seem to be rising in the last publication window examined. Such a trend should therefore be treated with caution as it will most likely change when the citation windows to these articles becomes longer. What is interesting though is to examine if there are differences in the trends among the countries when it comes to this last publication window. In that sense, the last publication period can be seen as a forecast of what we should expect in the future also when the citation windows can be extended.

The first section presents the overall trends in citation impact, the second section provides stability intervals for the MNCS and PPtop10 indicators, and the third section examines impact according to different collaboration types.

For comparative reasons Appendix 1 provides journal publication profiles (MNJS) and citation impact (MNCS and PPtop10) for the eight countries based on the Web of Science journal subject category 'neuroscience'; similar parameters are used to calculate the indicators which makes them directly comparable except for the different underlying journal sets.

4.3.1. Overall citation Impact

Figures 14, 15 and 16 presents the main citation indicators for the specially constructed publication set. We present MNCS, PPtop10%, as well as PPtop2%, the latter an indicator for the proportion of publications among the 2% most cited. We refer to Appendix 1 for comparisons to the more restricted WoS subject category neuroscience. Notice, especially the PPtop2% indicator can be volatile and unstable from one period to the next because of the relative small number of publications affected by this indicator. Larger countries will most likely have more stable PPtop2% indicators.

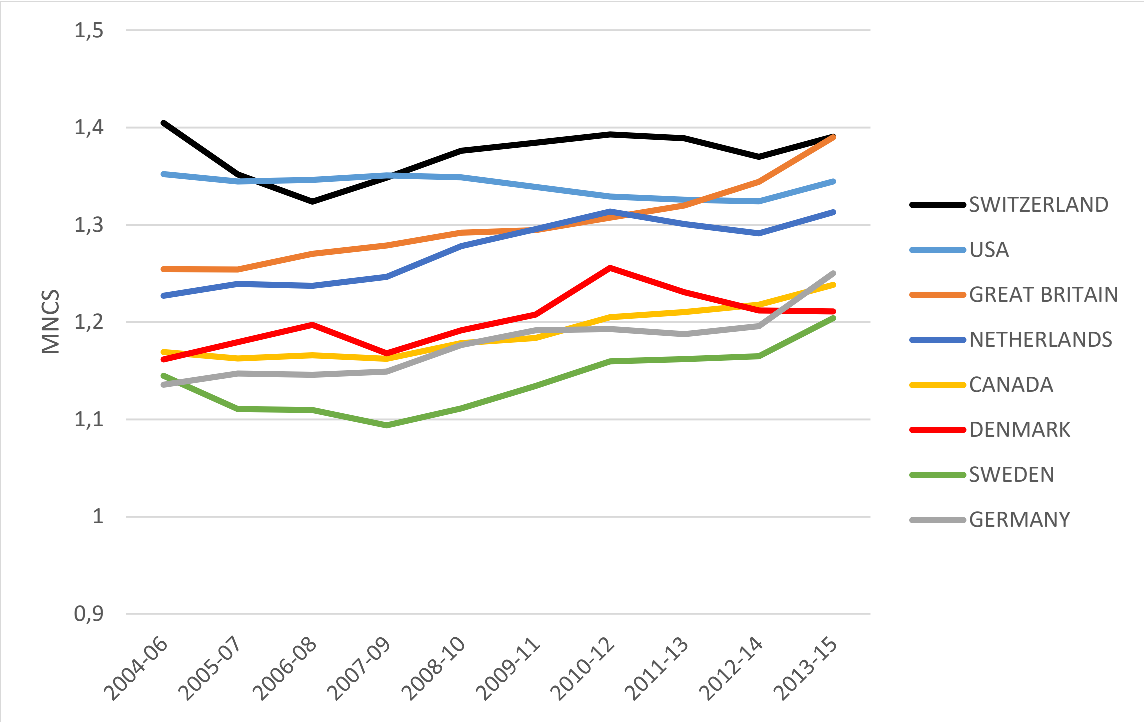

Figure 14. Country citation impact measured with the mean normalized citation score (MNCS).

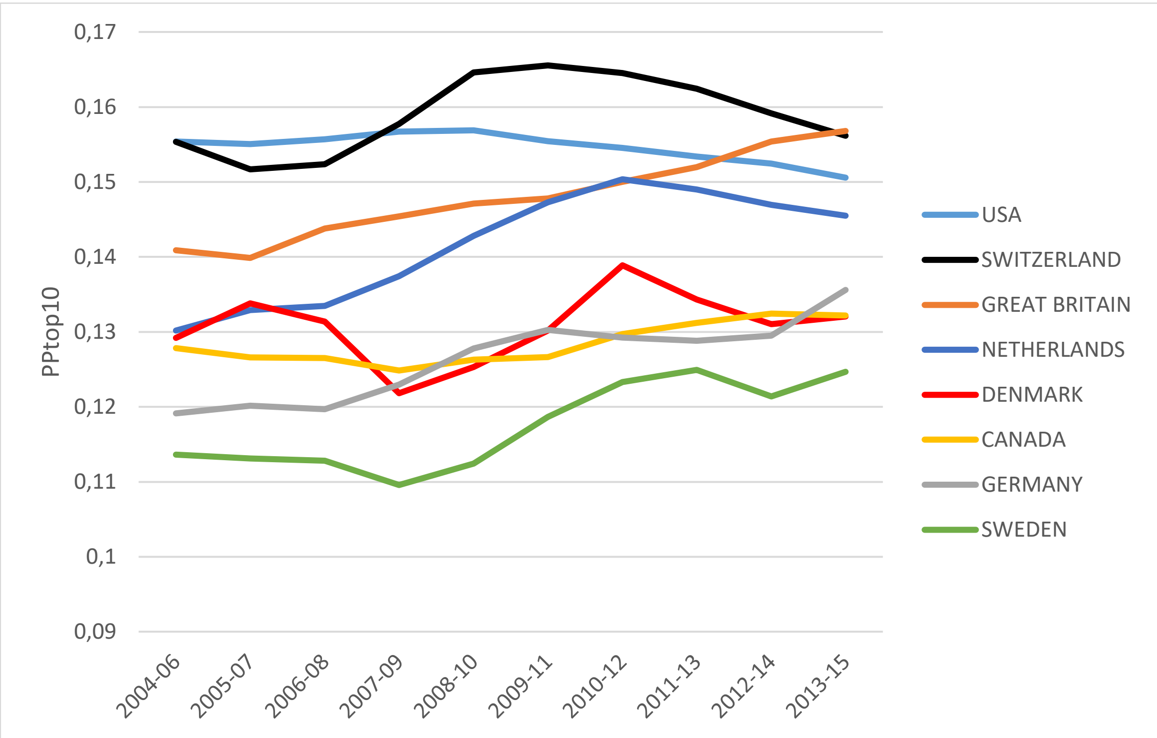

Figure 15. Country citation impact according to the proportion of publications among the 10% most cited (PPtop10%).

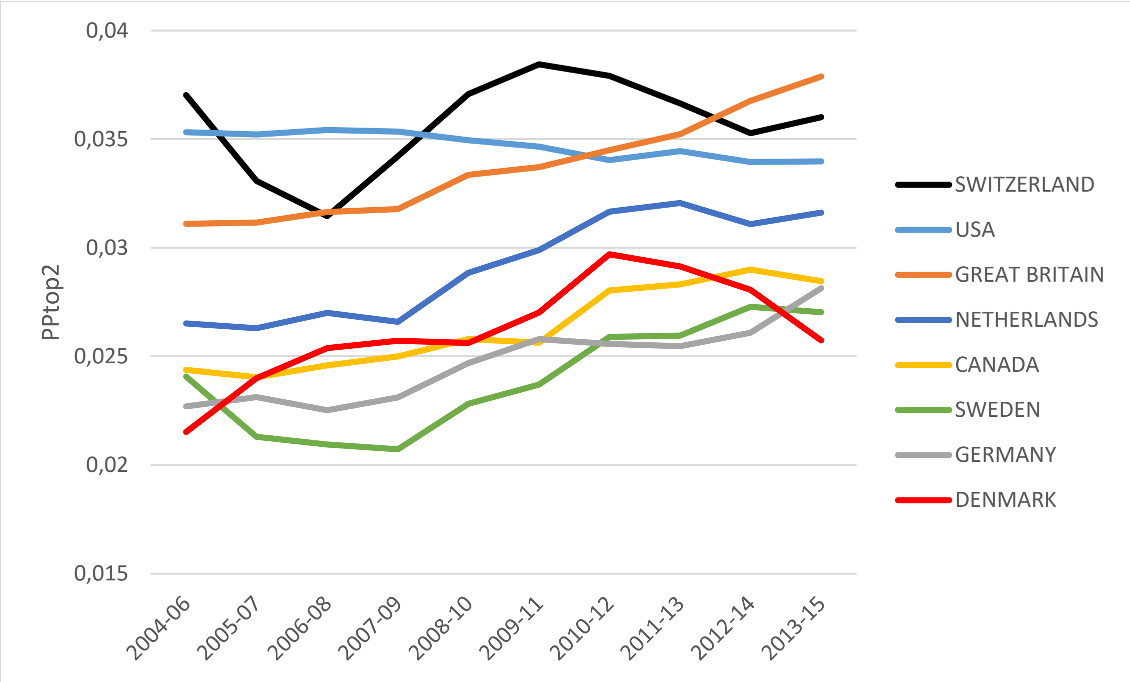

Figure 16. Country citation impact according to the proportion of publications among the 2% most cited (PPtop2%).Stability intervals

Main observations:

- As predicted by the journal publication profiles, the countries cluster in two groups albeit in the early period the Netherlands is somewhat below Switzerland, USA and UK.
- The trends are robust in the sense that the two groups never overlap.
- The trend in the impact of the Danish publications are somewhat fluctuating although during the whole period among the highest in the second group of countries. The fluctuation is probably due to the smaller number of Danish publications.
- The trend for Denmark is clear from the 2004-06 period until 2010-12 the proportion of the 2% highest cited publications generally rises; however, in the last three periods there is drop. It should be emphasized that during the whole period the impact for Denmark is above the statistically expected level of 2% and the current drop brings the Danish set of publications to the same level as that from 2006 to 2010.
- Obviously, the PPtop2 indicators are more volatile due to smaller numbers, yet it basically correlates with the PPtop10 (also a well-known phenomenon).

4.3.2. Stability intervals

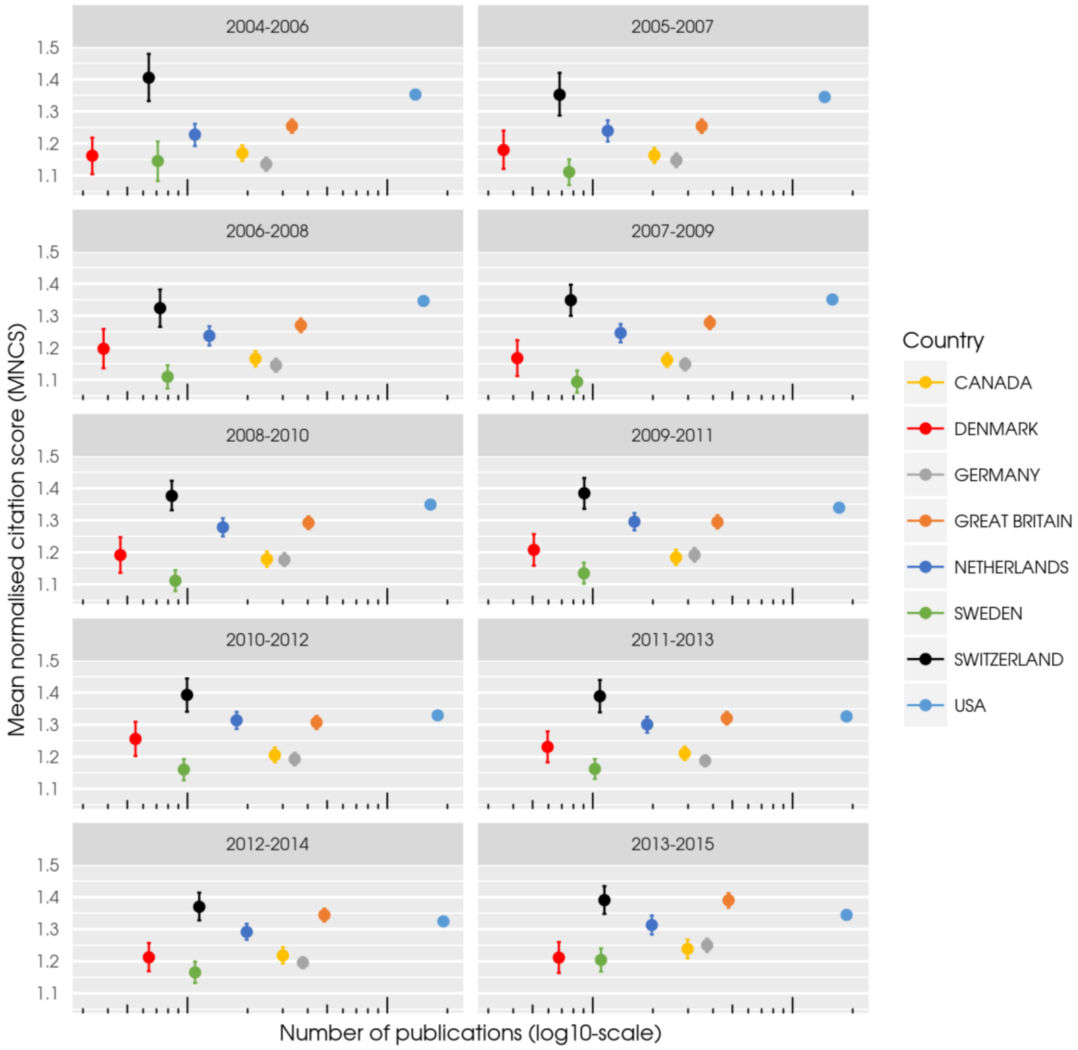

Figure 17. 95% stability intervals for the MNCS indicators; 1000 resamples.

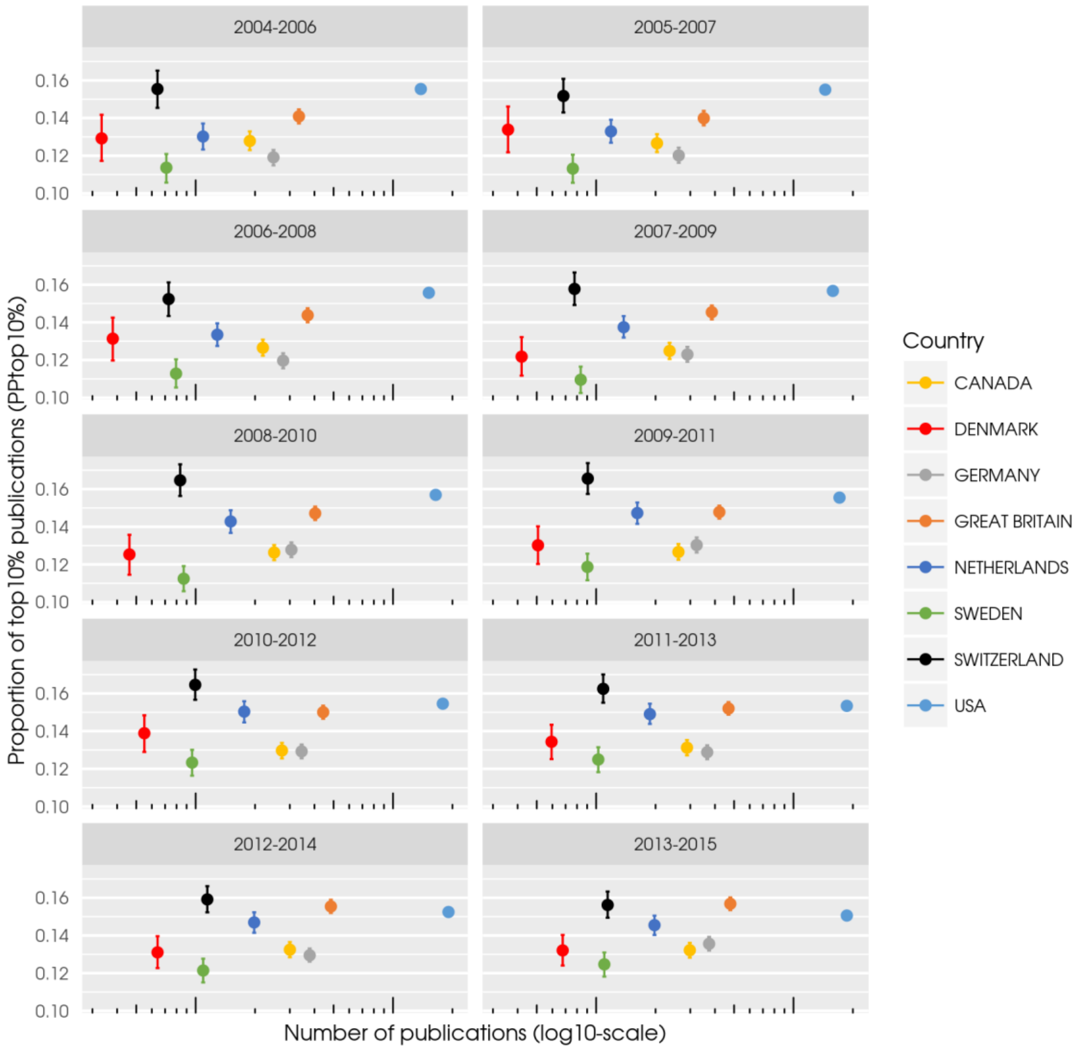

Figure 18. 95% stability intervals for the PPtop10 indicators; 1000 resamples.

Figures 17 and 18 provide the stability intervals for the MNCS and PPtop10 indicators. For each publication window in the time series, we have plotted the countries' indicator value as a function of their publication output (on a log scale) and then provided the indicator values with stability intervals. It is clear from the plots that the intervals become smaller as the publication volume rises. Hence, a larger publication output makes the underlying distribution more robust. We remind the reader that the indicator values are the population parameters and not sample estimates. We refer to section 3.3.4 for clarification and for warnings on how not to interpret the stability intervals.

4.3.3. Citation impact and collaboration types

In Figures 19 to 26 we break down the impact scores for the countries according to the collaboration type of the publication. We distinguish between three collaboration types: No collaboration (publications where all authors come from the same institution), national institutional collaboration (where at least two different national institutions are mentioned in the address list), and international collaboration (where at least one foreign institutional address are mentioned in the address list).

Notice, indicator scores correlate substantially with the aggregate journal publication profiles. A Journal Impact Factors in itself is not a good predictor for the citation impact of an individual publication.

However, at the aggregate level the publication profile of a specific unit is a good predictor for citation impact of the total set of publications for that unit. On average, publishing in journals with higher visibility will most likely also result in relatively higher impact for the publication set. Notice in Appendix 1, section 8.1 we provide similar analyses restricted to the WoS subject category neuroscience.

First we present the results for Denmark alone, and the following three figures contextualize the Danish results by benchmarking the result with those of the other seven countries.

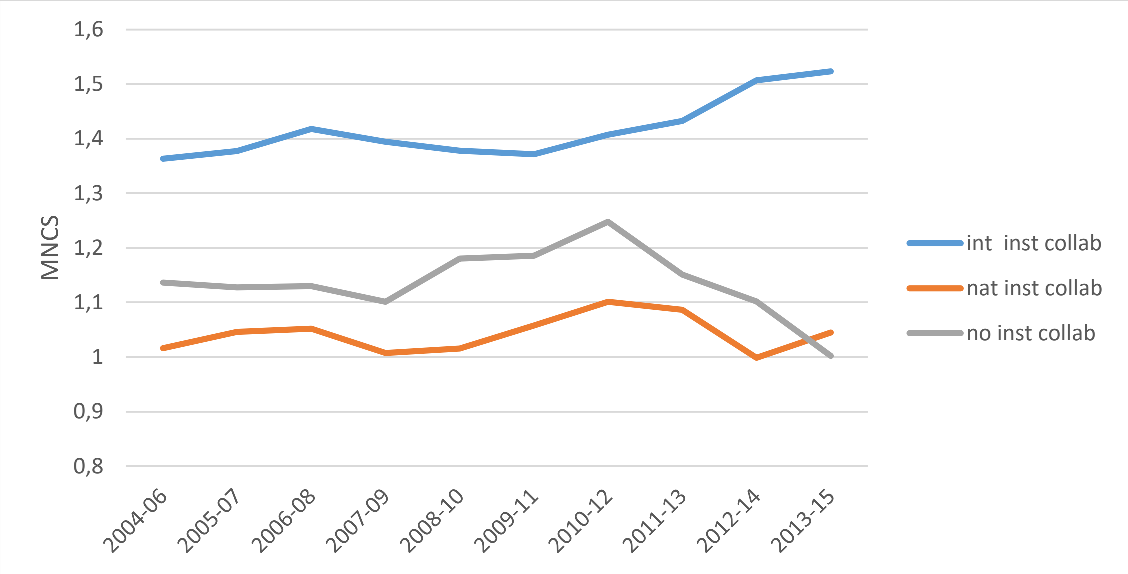

Figure 19. Citation impact for Danish publications according to collaboration type measured with the mean normalized citation score (MNCS).

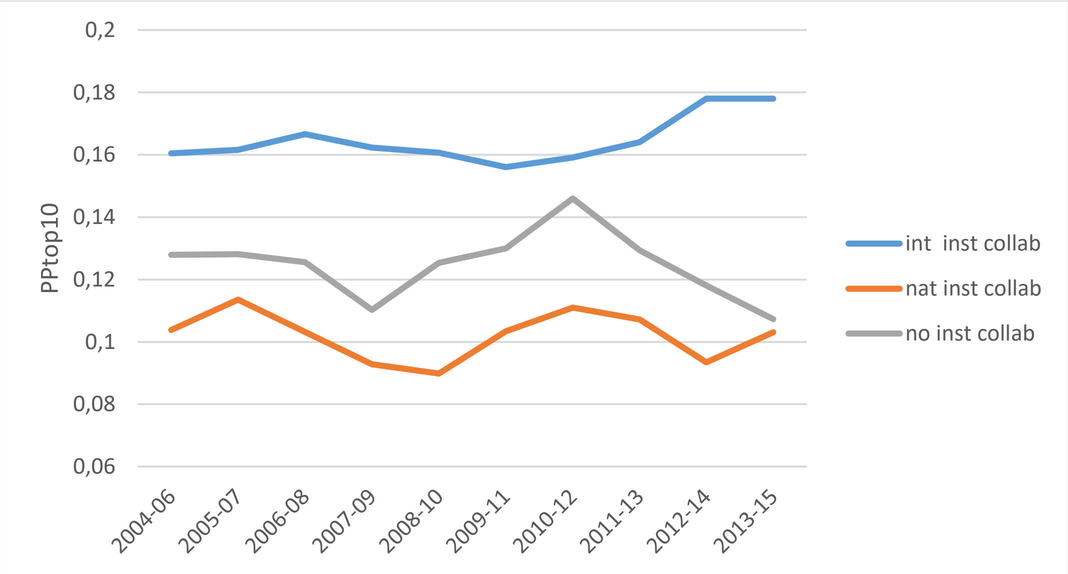

Figure 20. Citation impact for Danish publications according to collaboration types measured as the proportion of publications among the 10% most cited (PPtop10%).

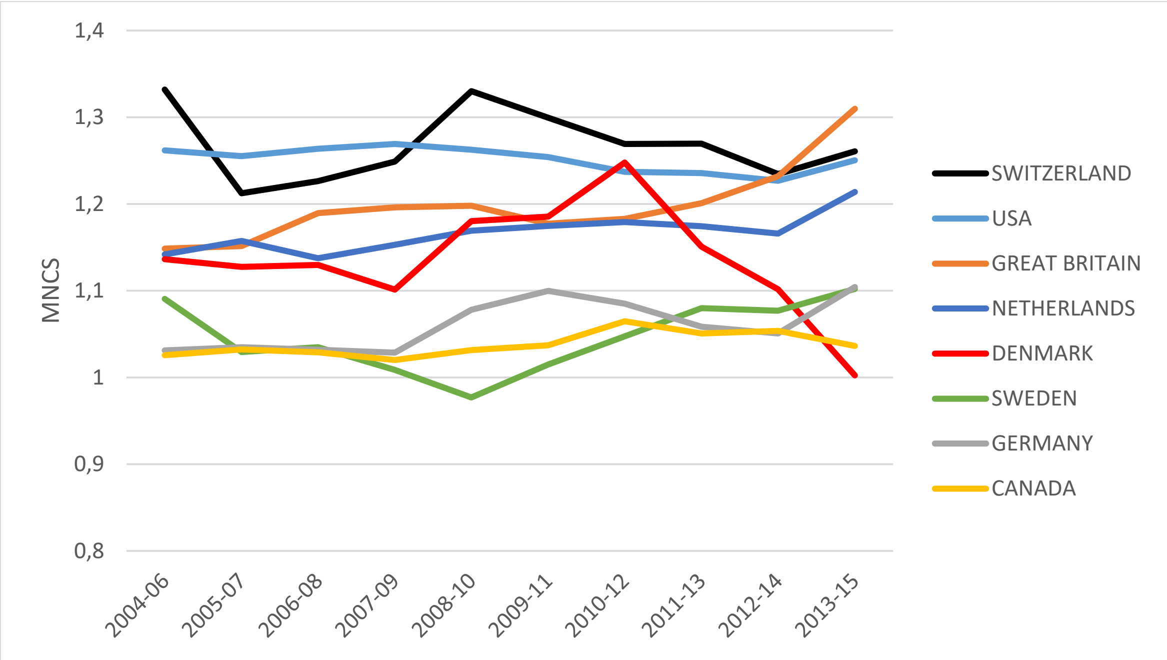

Figure 21. Country citation impact for publications with <u>no inter-institutional collaboration</u> measured with the mean normalized citation score (MNCS).

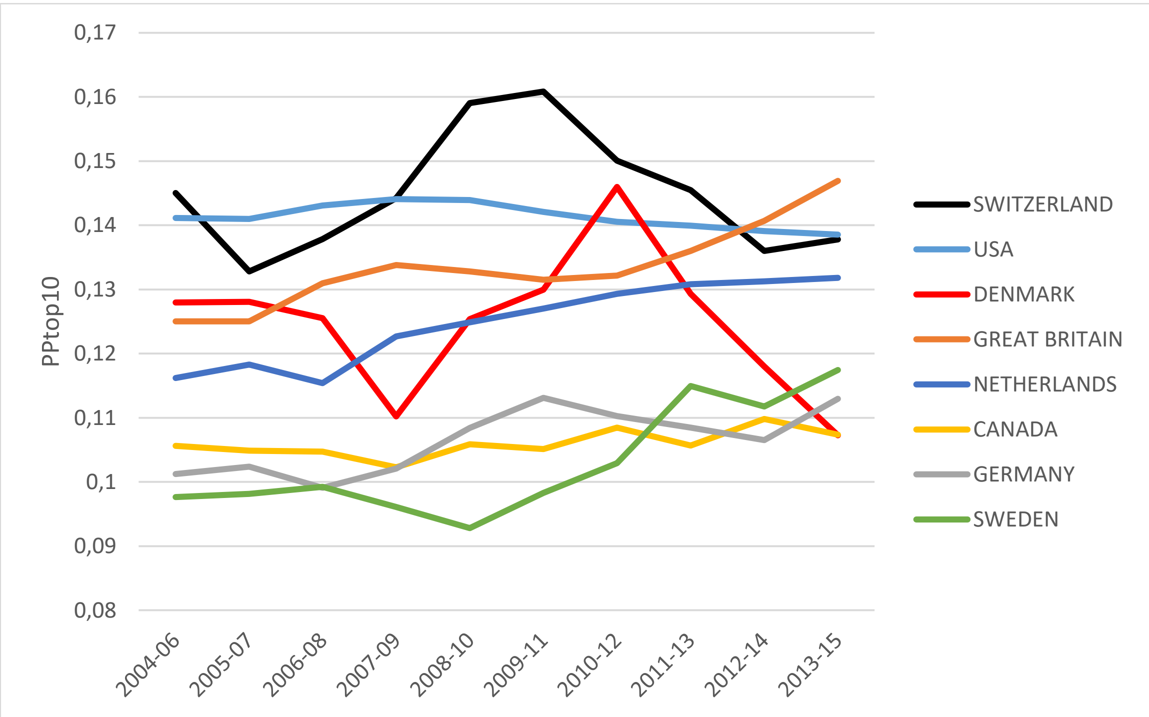

Figure 22. Country citation impact for with <u>no inter-institutional collaboration</u> measured as the proportion of publications among the 10% most cited (PPtop10%).

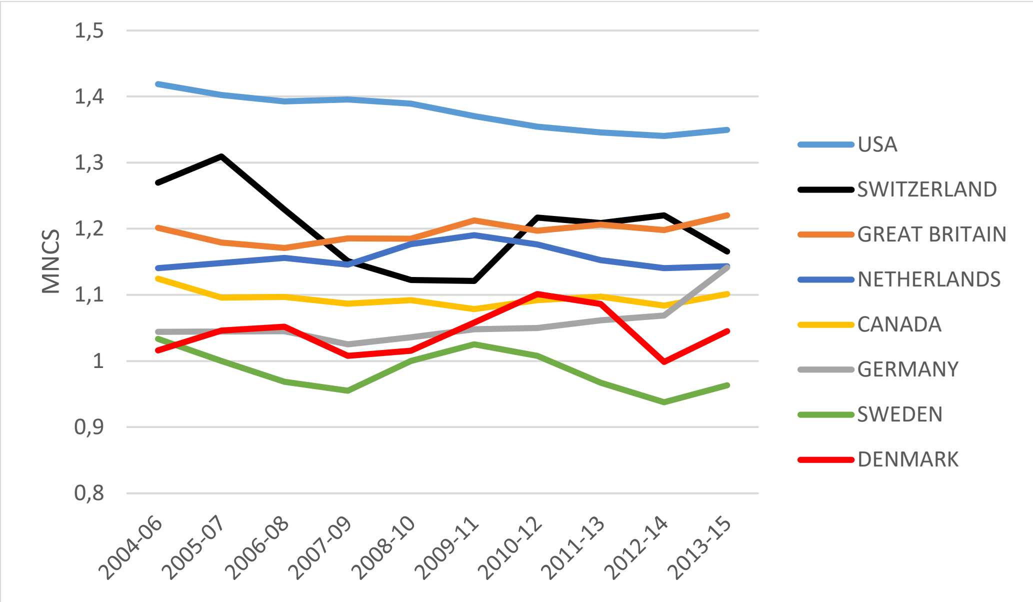

Figure 23. Country citation impact for publications with <u>national inter-institutional collaboration</u> measured with the mean normalized citation score (MNCS).

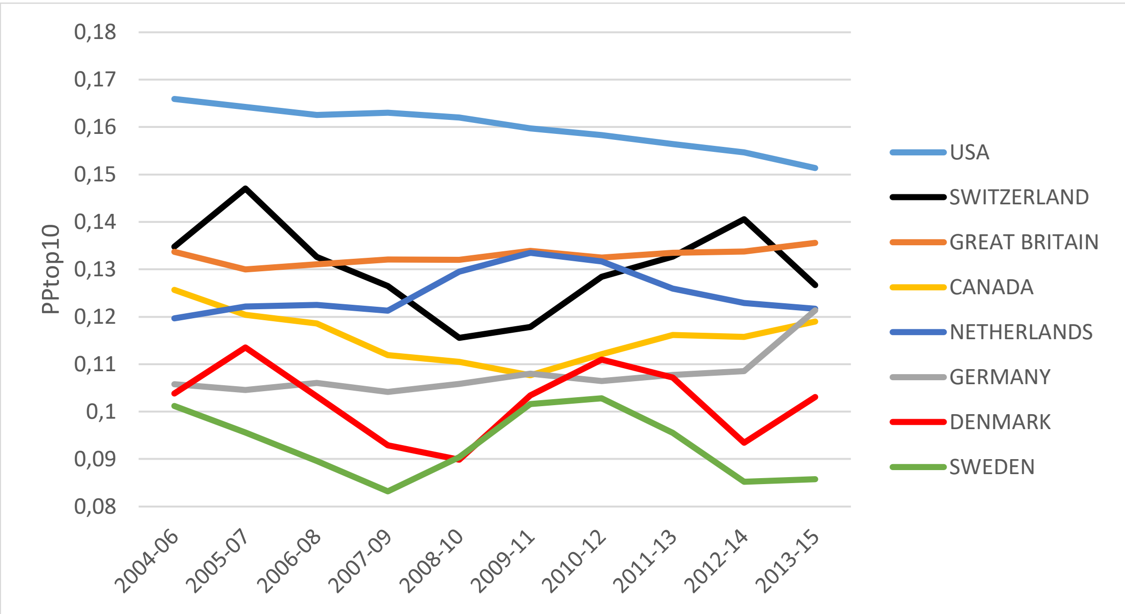

Figure 24. Country citation impact for publications with <u>national inter-institutional collaboration</u> measured as the proportion of publications among the 10% most cited (PPtop10%).

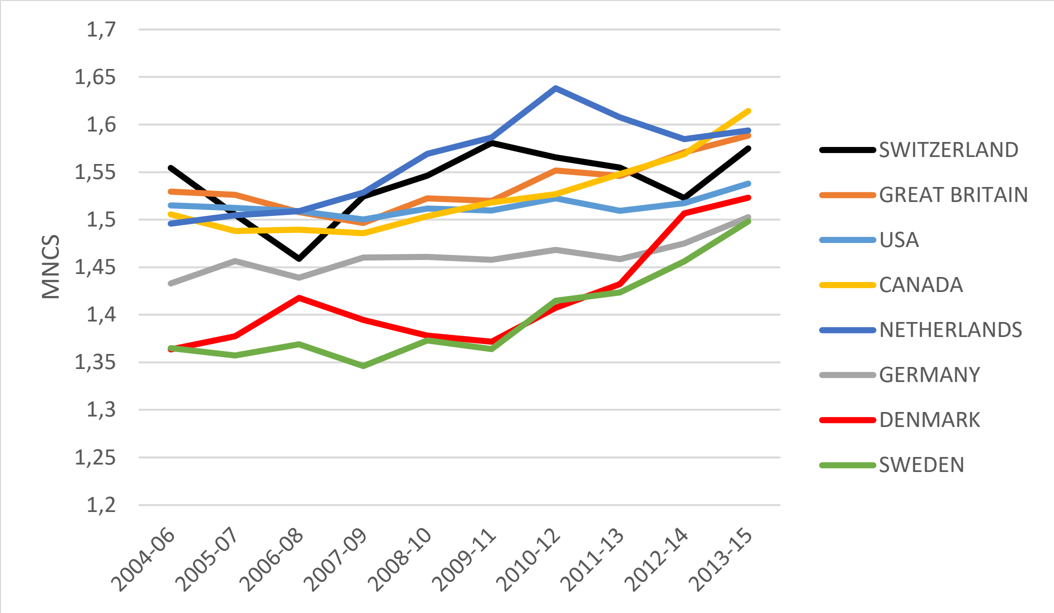

Figure 25. Country citation impact for publications with <u>international collaboration</u> measured with the mean normalized citation score (MNCS).

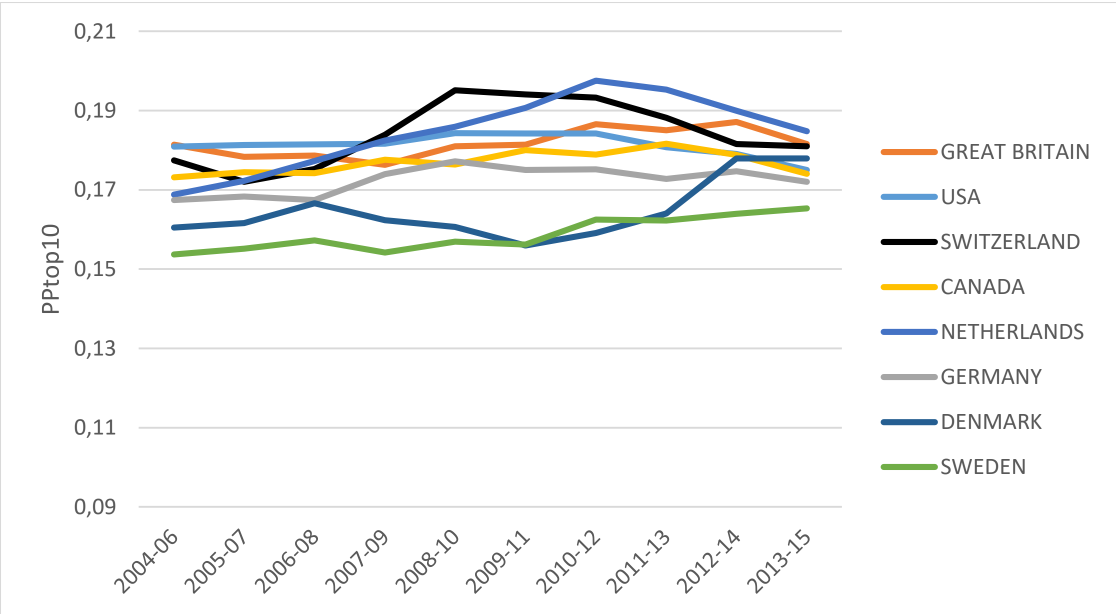

Figure 26. Country citation impact for publication with <u>international collaboration</u> measured as the proportion of publications among the 10% most cited (PPtop10%).

Main observations:

- We see well-known patterns. International co-authored publications on average have higher impact, compared to publications with national collaboration or no collaboration.
- Likewise, it is compatible with a well-known pattern that Danish publications with no collaboration between national institutions on average have higher impact than publications resulting from such national collaborations.
- However, the most interesting finding is that from 2010-12 and onwards, the impact of the Danish publications with no collaboration drops quite substantially. We have scrutinized the data and the results seem genuine.
- It is interesting because the Danish no collaboration publications generally have relatively high impact scores compared to the other countries, yet this seems to evaporate in the latest period.
- Also, the impact of the Danish national collaboration papers is generally among the lowest for the eight countries.

5. Analyses of Danish regional institutions

In order to perform analyses of Danish regional institutions, we have manually refined and disambiguated the address fields of the 20601 publications with at least one Danish country address. Especially hospital names can be difficult to handle and we caution that even after our manual refinement, data are still not accurate. There will be both false positive and negatives in the set. We are however, comfortable that the main findings and the trends are robust.

We include four 'regional institutions' each comprising a university and affiliated local university hospitals. The four universities are Copenhagen, University of Southern Denmark, Aarhus and Aalborg. Notice, Aalborg University is treated as an independent unit despite that Aalborg University Hospital has been affiliated with Aarhus University in the entire period examined, and that Aalborg University only recently established a medical faculty.

Below we present three tables that show the publication output of the ten most active Danish institutional units in the specially constructed dataset. Besides the four regional units centered at the universities, six others are included: The Danish Cancer Society, H. Lundbeck A/S, Neurosearch A/S[4], Novo Nordisk A/S, the State Serum Institute and the Danish Technical University. We provide publication counts for these ten institutional units but we only include six of them in the citation analyses. The three-year cumulated publication outputs form the Danish Cancer Society, Neurosearch A/S, Novo Nordisk A/S and the State Serum Institute are too low to allow for a robust citation analyses.

5.1. Publication analyses for Danish regional institutions

In Tables 8, 9 and 10 we present institutional publication counts, both full counts, fractional counts at the institutional level and fractional counts at the author level. The institutions are ranked according to the publication output in the first period 2004-06.

Table 8. Publication counts, full counts.

Institutions	2004-06	2005-07	2006-08	2007-09	2008-10	2009-11	2010-12	2011-13	2012-14	2013-15
Copenhagen	1714	1809	1952	2175	2455	2708	2971	3170	3445	3629
Aarhus	919	963	1046	1202	1352	1508	1648	1819	1920	1970
Uni South Den	431	452	525	588	666	740	803	931	1078	1180
Aalborg	288	313	315	333	365	398	419	458	560	684
H. Lundbeck	118	123	119	116	121	129	127	122	135	146
Tech Uni	100	122	128	139	130	144	171	213	234	238
State Serum Inst	81	74	72	61	61	67	92	104	116	95
Dan Cancer Soc	67	73	79	91	102	127	127	122	105	122
Neurosearch	67	76	74	69	70	65	62	47	35	19
Novo Nordisk	50	58	51	57	50	49	47	44	52	59
Grand Total	3835	4063	4361	4831	5372	5935	6467	7030	7680	8142

[4] Notice, since 2012 Neurosearch A/S has been in the process of being dissolved.

Table 9. Publication counts, fractionalized for unique institutional participations.

Institutions	2004-06	2005-07	2006-08	2007-09	2008-10	2009-11	2010-12	2011-13	2012-14	2013-15
Copenhagen	859.4	873.3	931.3	1014.0	1137.3	1230.4	1314.7	1383.4	1475.4	1505.4
Aarhus	440.8	449.7	485.1	552.0	596.3	651.8	683.1	746.8	759.6	768.1
Uni South Den	192.0	204.3	231.6	247.4	268.0	281.8	291.8	325.3	374.5	397.5
Aalborg	142.4	148.3	141.9	144.8	159.8	172.2	174.3	177.7	204.9	246.8
Lundbeck	57.1	54.6	50.3	49.3	52.6	56.1	53.5	46.9	50.9	52.1
Tech Uni	50.5	57.6	56.8	64.7	57.1	68.0	74.9	92.9	96.6	92.6
Neuroserach	37.5	41.9	37.9	36.1	34.5	30.1	26.6	19.0	13.7	5.2
State Serum Inst	34.9	31.1	30.2	25.0	22.8	20.4	28.4	33.0	34.5	26.5
Dan Cancer Soc	23.7	26.6	32.0	35.0	32.9	35.2	34.5	34.6	29.8	34.1
Novo Nordisk	21.6	22.7	18.3	18.6	17.1	17.9	17.4	15.6	17.4	18.2
Grand Total	1859.9	1910.2	2015.5	2186.8	2378.5	2563.8	2699.1	2875.2	3057.5	3146.5

Table 10. Publication counts, fractionalized for author participations.

Institutions	2004-06	2005-07	2006-08	2007-09	2008-10	2009-11	2010-12	2011-13	2012-14	2013-15
Copenhagen	439.9	442.2	471.6	507.1	570.9	617.5	659.1	671.8	705.5	715.0
Aarhus	243.5	247.3	264.1	305.1	332.4	363.3	377.2	408.6	410.5	405.8
Uni South Den	105.7	106.6	122.3	133.8	149.1	159.4	165.9	189.2	220.0	235.3
Aalborg	74.8	78.5	78.2	81.6	89.5	97.0	100.3	102.3	118.6	144.1
Lundbeck	32.5	31.1	30.2	26.4	26.3	26.3	24.7	23.5	23.9	25.5
Tech Uni	27.9	32.9	32.8	35.6	30.6	36.6	42.3	52.4	52.6	51.1
Neuroserach	17.8	18.4	16.4	15.5	15.9	14.5	11.8	7.3	5.1	2.4
State Serum Inst	17.4	16.0	15.3	12.1	11.5	10.5	13.8	16.0	18.1	14.6
Dan Cancer Soc	12.3	12.8	14.1	16.6	15.8	18.3	17.0	16.8	15.8	18.8
Novo Nordisk	8.5	11.1	11.3	13.0	11.7	10.0	8.8	6.8	8.3	8.7
Grand Total	980.3	996.8	1056.2	1146.8	1253.5	1353.4	1420.9	1494.8	1578.4	1621.2

Main observations:

- The size difference between the four regional units is stable over the period. Copenhagen has the largest output, almost twice as many publications as Aarhus ranked second. Aarhus then has approximately twice as many publications as University of Southern Denmark ranked third, while the gap between Aalborg and University of Southern Denmark is somewhat smaller.
- It is interesting that three pharmaceutical companies are among the ten institutions, as well as the Technical University, the latter having no medical faculty.

5.1.1. Publication profiles for Danish regional institutions according to journals

In this sub-section we compare the regional institutions' journal publication profiles measured with MNJS. In principle, if an institution's publications on average are published in journals with higher impact factors, then there MNJS score will be above one. Notice, this indicator is not a measure of own citations, but instead a measure of publication profile. Nevertheless, the MNJS and mean normalized citation score for individual publications are strongly correlated, so a strong publication profile measured with the MNJS will most likely also mean a relatively high citation indicator.

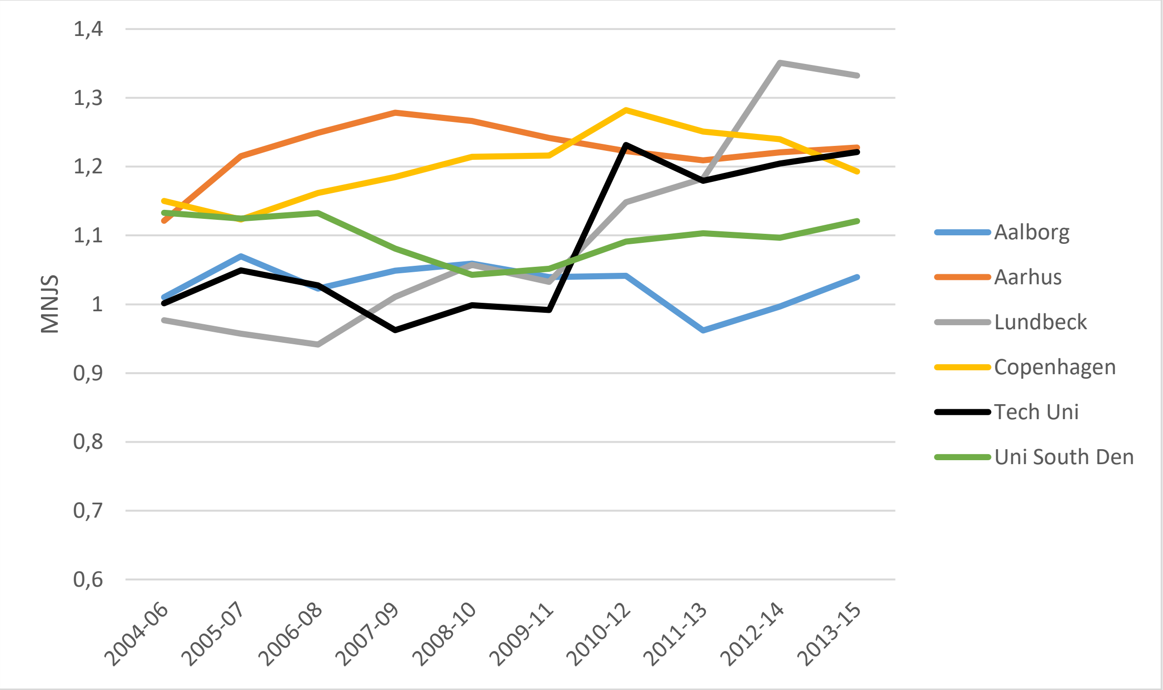

Figure 27. Publication profiles for Danish regional institutions according to journal impact measured with the mean normalized journal score (MNJS).

Main observations:

- Compared to the country analyses, the publication outputs are substantially lower which means that fluctuations become more likely. Indeed, the trends for both the Technical University and H.Lundbeck A/S increase steeply from 2009-11 to 2010-12, and for H.Lundbeck A/S it continues into the period 2012-14.
- The largest institutions, Copenhagen and Aarhus have comparable profiles, and until 2009-11 they have the most visible journal publication profiles among the six institutions examined.

5.2. Collaboration analyses for Danish regional institutions

The following three maps (Figures 28-30) illustrate the collaboration networks for all Danish neuroscience research split into the periods 2004-2007, 2008-2011 and 2012-2015. All maps (figures) are created and reported at the same zoom levels. Especially, Figure 30 may seem to be at a different level but this is not the case, rather it is an effect of more publications and a denser network. Notice, comparison of absolute distances on maps generated on different network data are nonsensical, regardless of zoom level, as there is no scale for the distance. Smaller institutions are not shown in the figures, as they make the maps less readable. However, in Appendix 3 we demonstrate how the maps can be interactively examined using the vosviewer software (www.vosviewer.com) on the map and network files provided with this report; it is hereby possible to examine all institutions by zooming the maps. Danish institutions have been cleaned more extensively than international ones. Overlap between institutions prevents some institutions from being shown, e.g. Aarhus University, which is large but with hardly visible label in the first maps and no label in the last. The amount of institutions with at least 30 links to other institutions increases from 494 in the early period, to 2,663 in the late period.

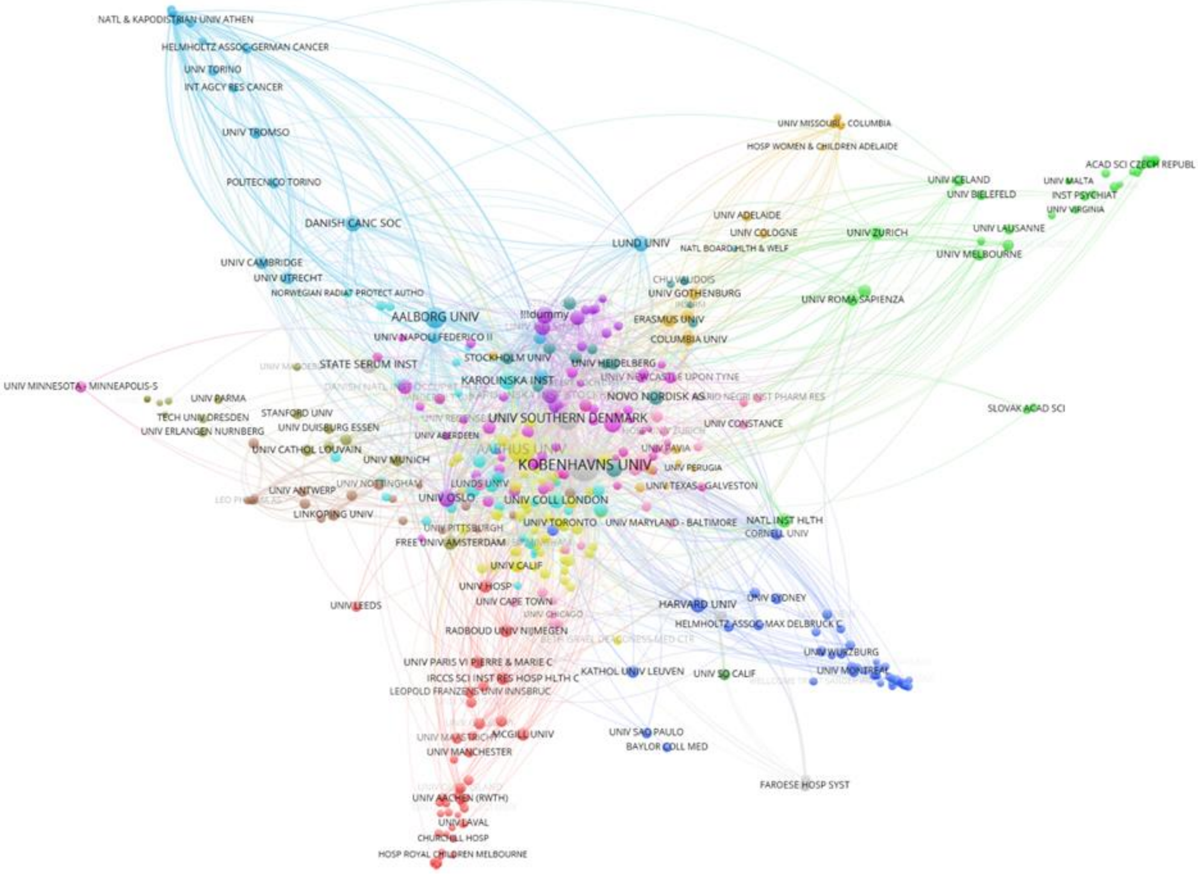

Figure 28. Collaboration network for Danish neuroscience, 2004-2007. Collaborating universities with link strengths below 30 not shown.

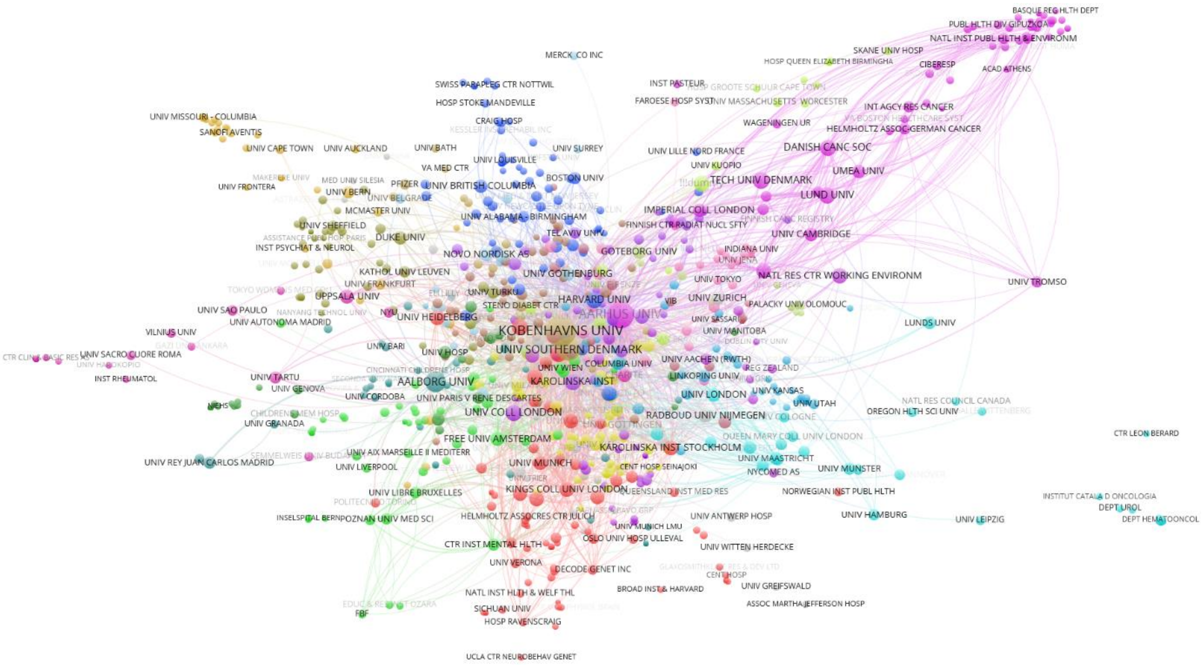

Figure 29. Collaboration network for Danish neuroscience, 2008-2011. Collaborating universities with link strengths below 30 not shown.

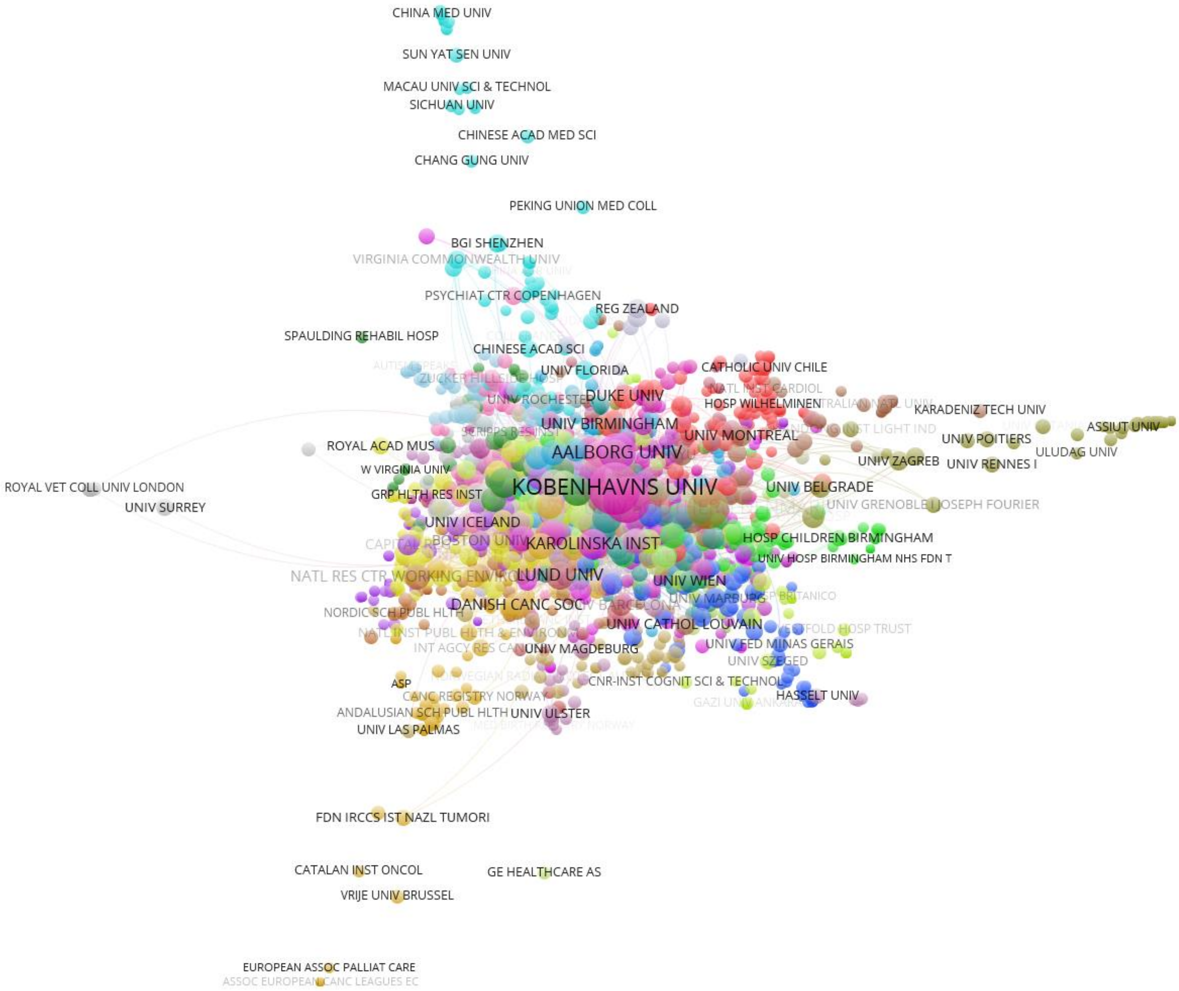

Figure 30. Collaboration network for Danish neuroscience, 2012-2015. Collaborating universities with link strengths below 30 not shown.

Main observations:

- Large increase in international, collaborative partners creates denser networks in the later periods.
- Chinese collaborators become visible in the latest period only. European and North American collaborators move, comparatively towards the core. However, clear clusters of these collaborators are visible throughout the entire period of analysis.

5.3. Citation analyses for Danish regional institutions

This section presents trends in citation impact for the Danish regional institutions based on the specially constructed set of ‘neuroscience’ publications 2004 – 2015. Two complimentary indicators are used: The mean normalized citation Score (MNCS) and the proportion of publications among the 10% (PPtop10) percent most cited in the database. We refer to Chapter 3 for clarification and Section 4.3 for cautions. Most importantly, the publication sets linked to the four universities are considerably smaller than the country sets and we can therefore expect more volatility from one period to the next and also less robustness.

Notice, compared to the analyses at the country level, the publication output for the Danish regional institutes are considerably lower. With fewer publications the underlying distributions become less robust (i.e. they are highly skewed) which means that fluctuations in the trends become more visible.

First, we present the overall trends in citation impact and subsequently we provide provides stability intervals for the MNCS and PPtop10 indicators.

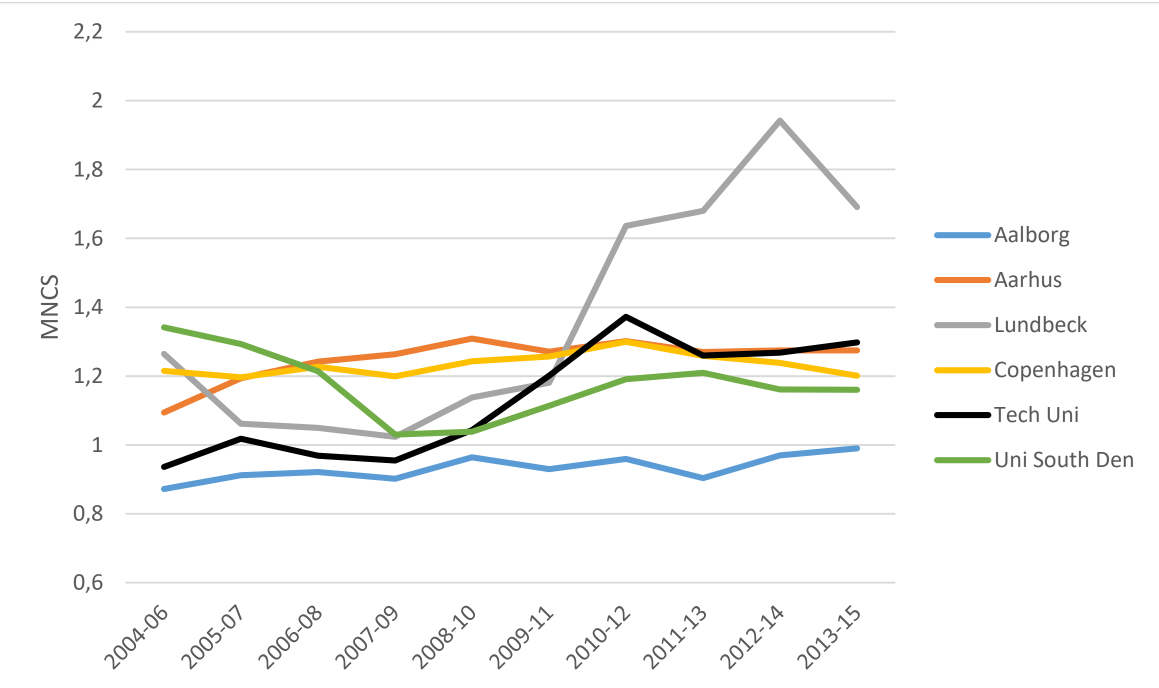

Figure 31. Citation impact for Danish regional institutions measured with the mean normalized citation score (MNCS).

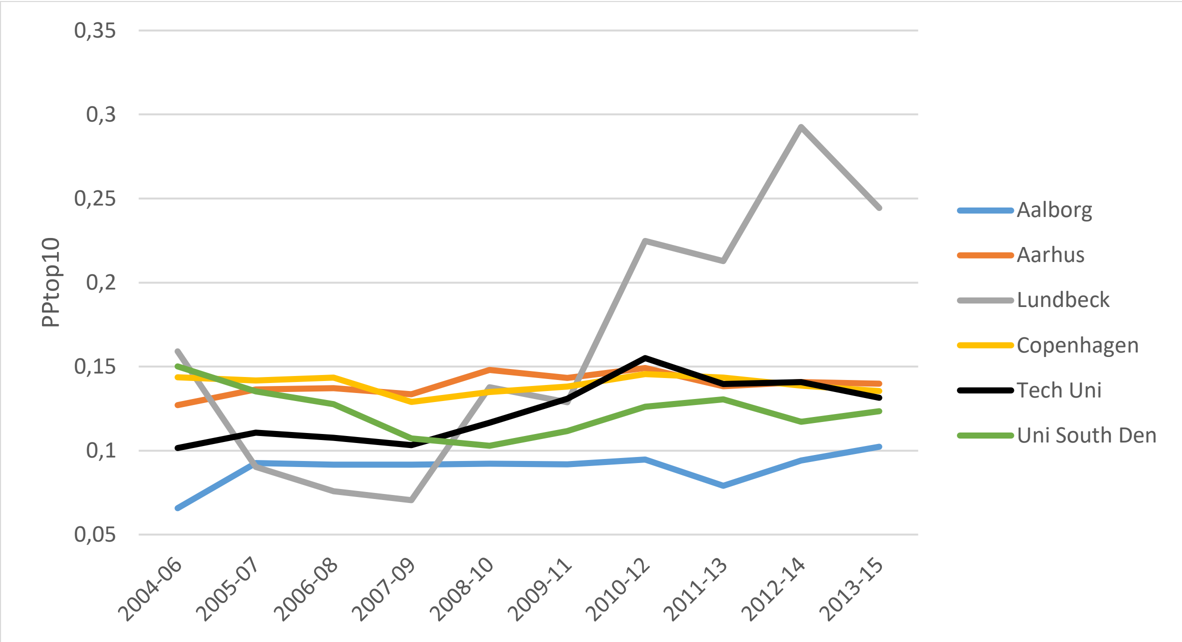

Figure 32. Citation impact for Danish regional institutions according to the proportion of publications among the 10% most cited (PPtop10%).

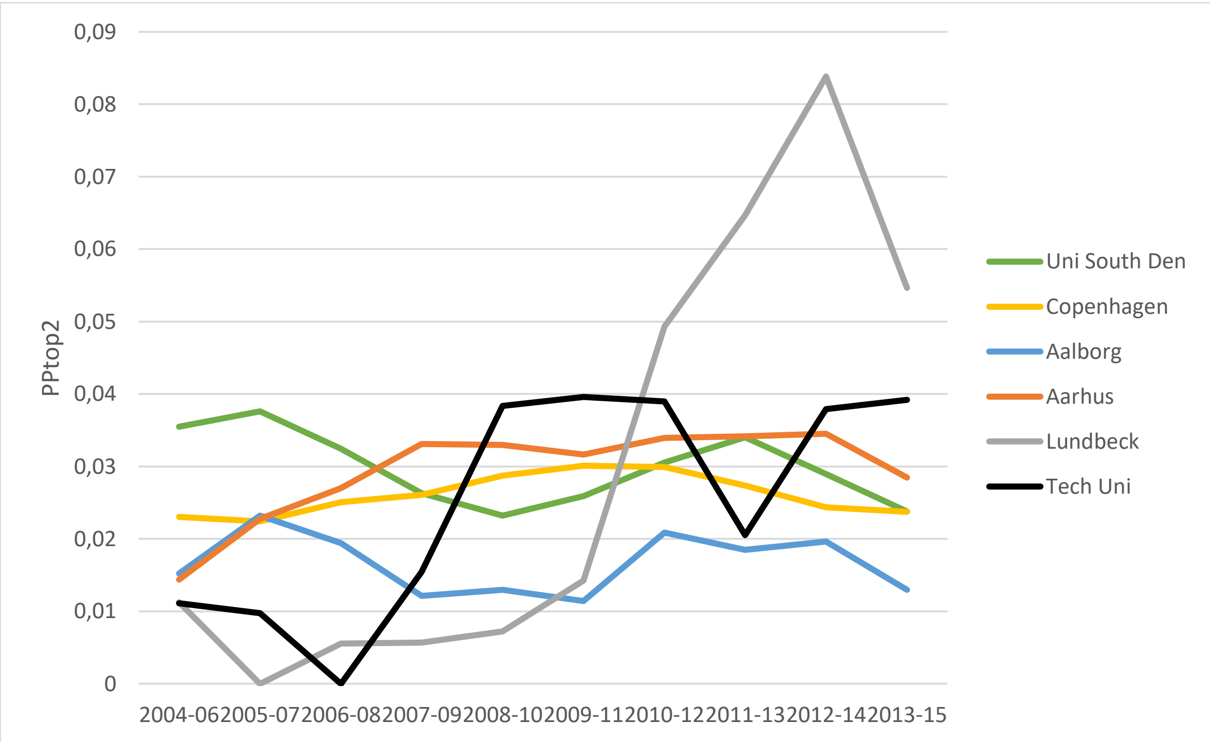

Figure 33. Citation impact for Danish regional institutions according to the proportion of publications among the 2% most cited (PPtop2%).

Main observations:

- The MNCS and PPtop10 indicators show a stable performance for Copenhagen, Aarhus and University of Southern Denmark. The performance for the Technical University is lower in the first period but catches up in with the others in the latter periods.
- The most striking trend is the sudden steep rise in impact for the set of publications linked to H.Lundbeck A/S, this can most probably be ascribed to some very highly cited papers as demonstrated in the PPtop2 indicator.

5.3.1. Stability intervals

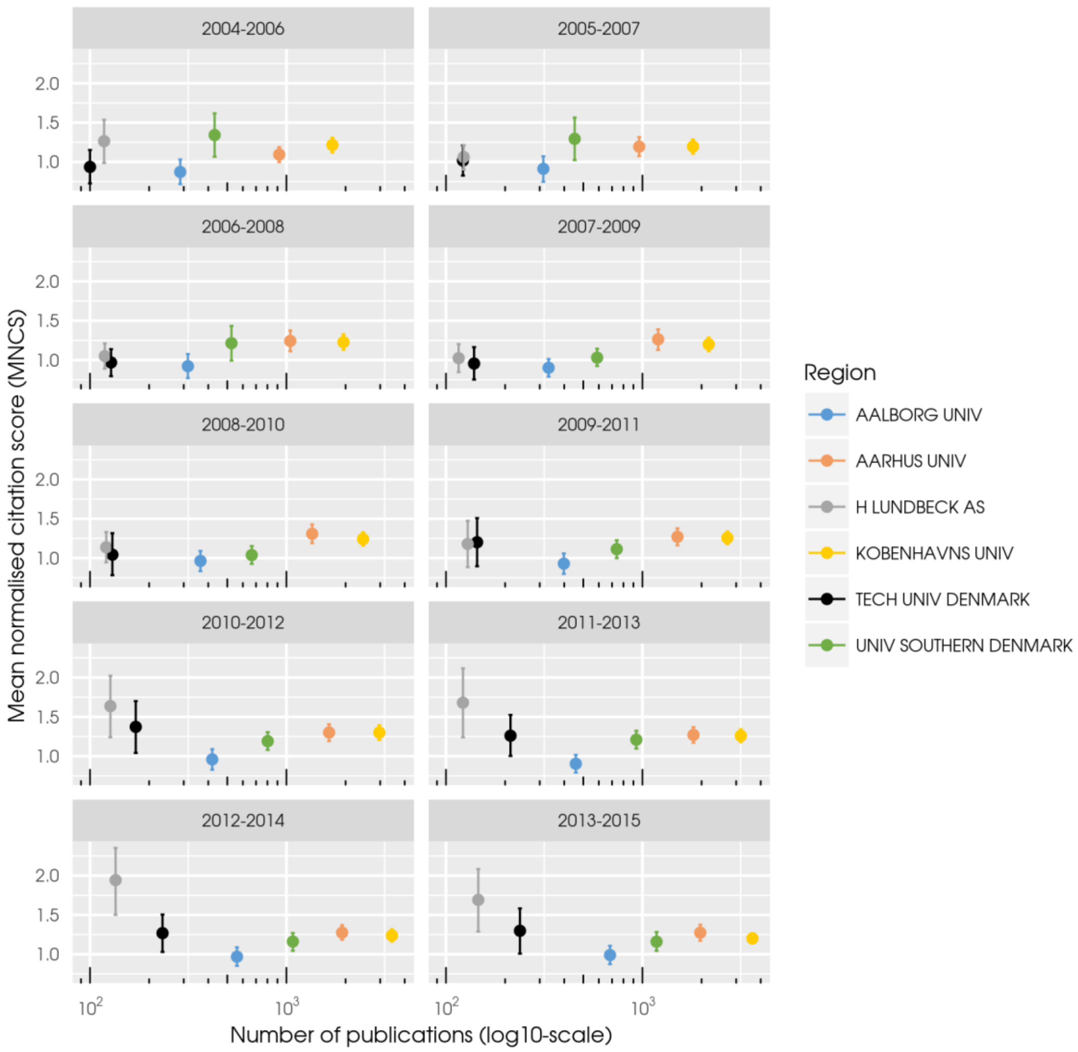

Figure 34. 95% stability intervals for the MNCS indicators; 1000 resamples.

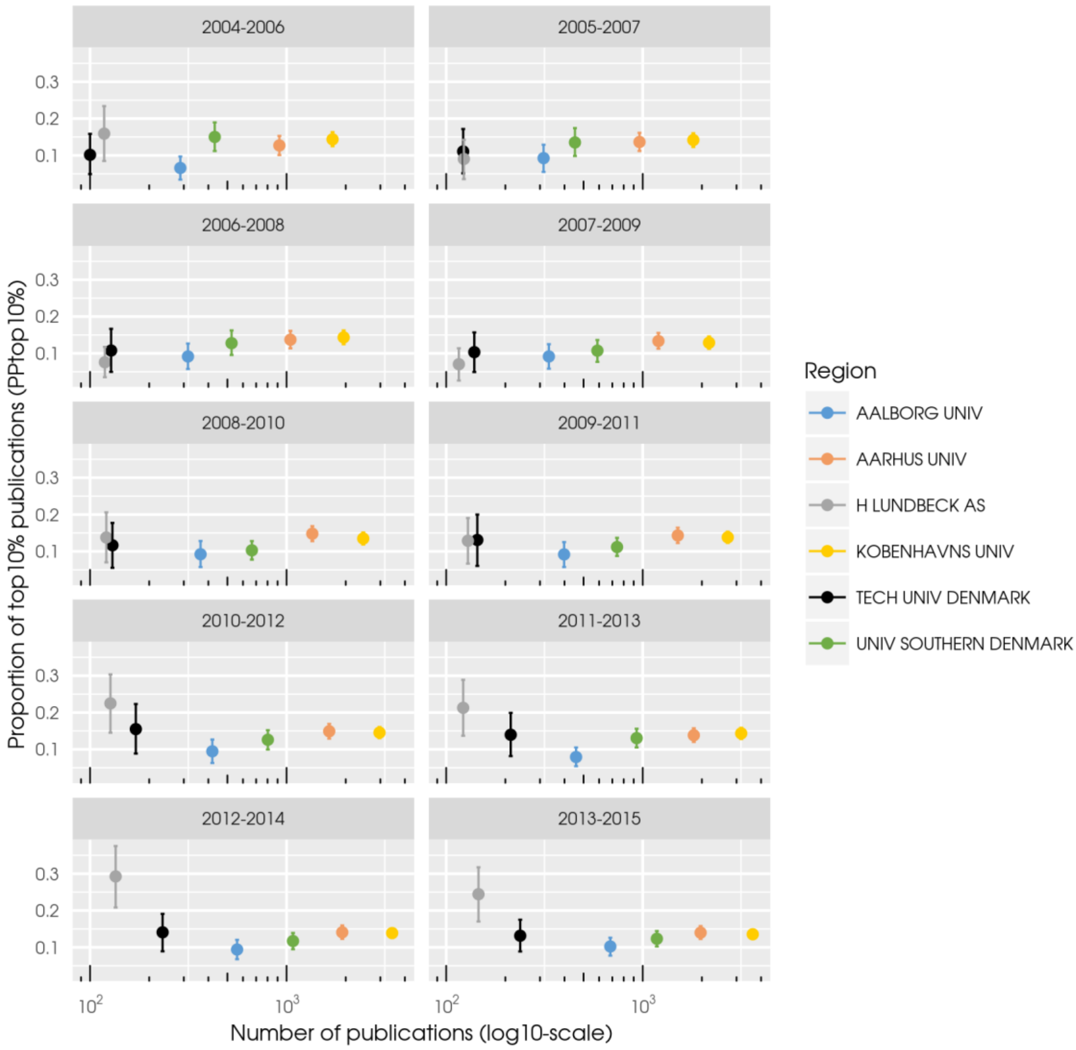

Figure 35. 95% stability intervals for the PPtop10 indicators; 1000 resamples.

Figures 34 and 35 provide the stability intervals for the MNCS and PPtop10 indicators. For each publication window in the time series, we have plotted the institutions' indicator value as a function of their publication output (on a log scale) and then provided the indicator values with stability intervals. It is clear from the plots that the intervals become smaller as the publication volume rises. Hence, a larger publication output makes the underlying distribution more robust. We remind the reader that the indicator values are population parameters and not sample estimates. We refer to section 3.3.4 for clarification and for warnings on how not to interpret the stability intervals.

6. Advanced scientometric analyses

In this chapter, we present five different scientometric analyses. First, we examine industry related publications in the set of Danish publications. Second, we examine the funding acknowledgements in the Danish set of publications from 2009-2015. Third, we examine the research profiles of the four main regional institutions. Fourth, we examine the degree of interdisciplinarity of the four regional institutions, and finally we examine the 'hot topics' in neuroscience.

6.1. Industry publications

The first analysis utilizes a special coding in the CWTS database where 'industry publications' are identified. Notice, that the CWTS algorithm is known to underestimate the results, however, we have plenty of evidence that comparisons of patterns between countries are reliable albeit the proportions may be underestimated. First we present the proportion of industry publications for the countries. These proportions include both publications from industry alone and collaborations between industry and research institutions. Second, for the Danish set of regional institutional publications we present the trends in the collaboration between industry and the universities and/or hospitals.

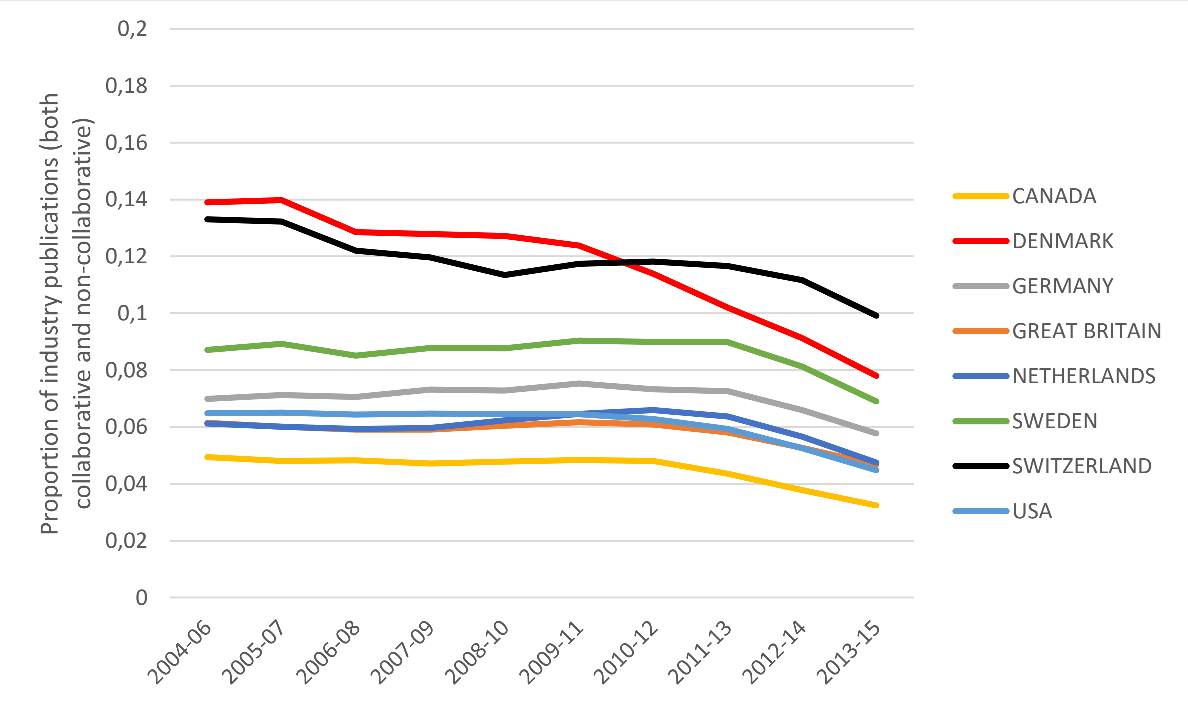

Figure 36. Proportion of industry full-count publications for countries (collaborative and non-collaborative).

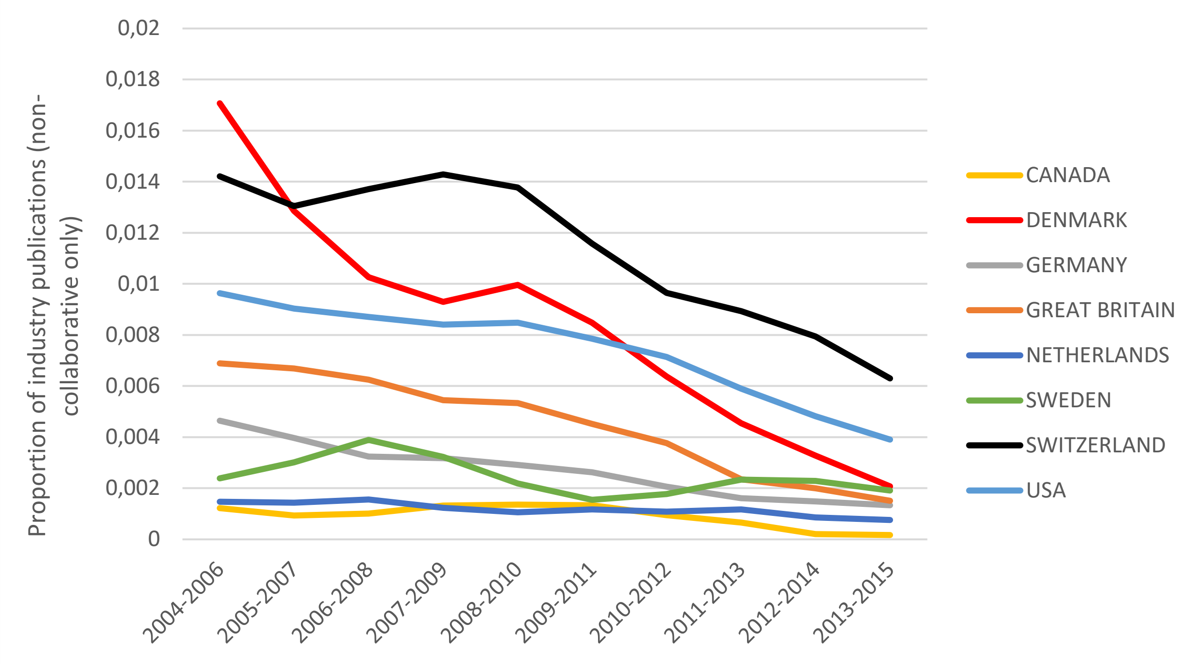

Figure 37. Proportion of industry full-count publications for countries (non-collaborative only).

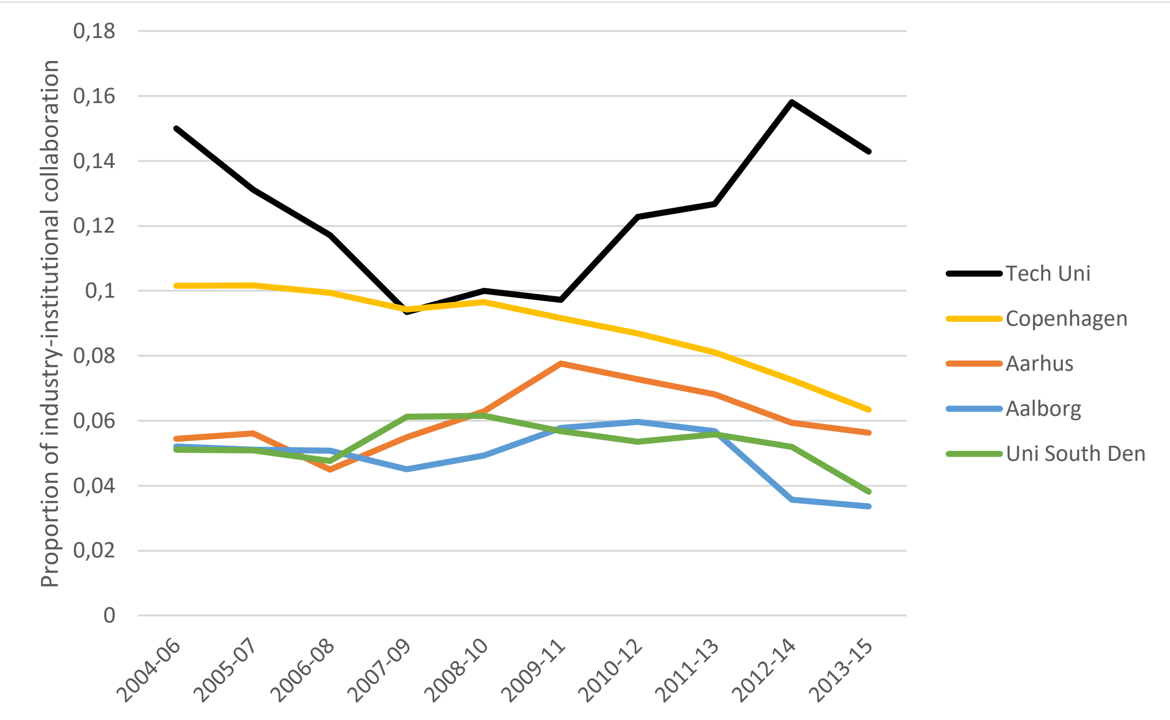

Figure 38. Proportion of industry full-count co-publications for regional institutions (Lundbeck A/S is excluded, as the proportion is equal to 1[5]).

[5] We are not able to algorithmically discern between several potential "industry" units co-authoring a publication. Hence, publications with Lundbeck A/S in the author affiliation will be binary coded as "industry" irrespective of how many other industry units are involved.

Main observations:

- In Figures 36 and 37, we see a general trend, not exclusive for neuroscience or medical publications, of decline in industry publications after the financial crisis.
- Also visible from Figures 36 and 37, are the strong pharmaceutical sectors in Denmark and Switzerland, yet in the latter period especially the Danish trends in output drop markedly.
- In Figure 38, the trends in collaborations are shown. The Technical University has the largest proportion of collaborative publications, yet the trends fluctuate substantially due to the relative low publication output.
- Copenhagen has had the largest collaboration with industry measured through co-publications, but the trend has dropped considerably over time.

6.2. Funding analyses

In this section, we explore the funding acknowledgements among the Danish publications in the specially constructed neuroscience publication set. Since late 2008, WoS has extracted and indexed funding institutions and grant numbers from the publications included in the database. The algorithms are certainly not perfect and in order to be useful for analyses, substantial manual data cleaning has been done in order to handle name ambiguities.

We provide two network maps of the relations between the funding sources in the set of publications from 2009 to 2015. The first map is an overview of the whole network and the second map zooms in on Lundbeckfonden. Finally, we provide a table with indicator values for the publications linked to the most prolific funding sources. Only funding sources with more than 50 fractionalized publications are included.

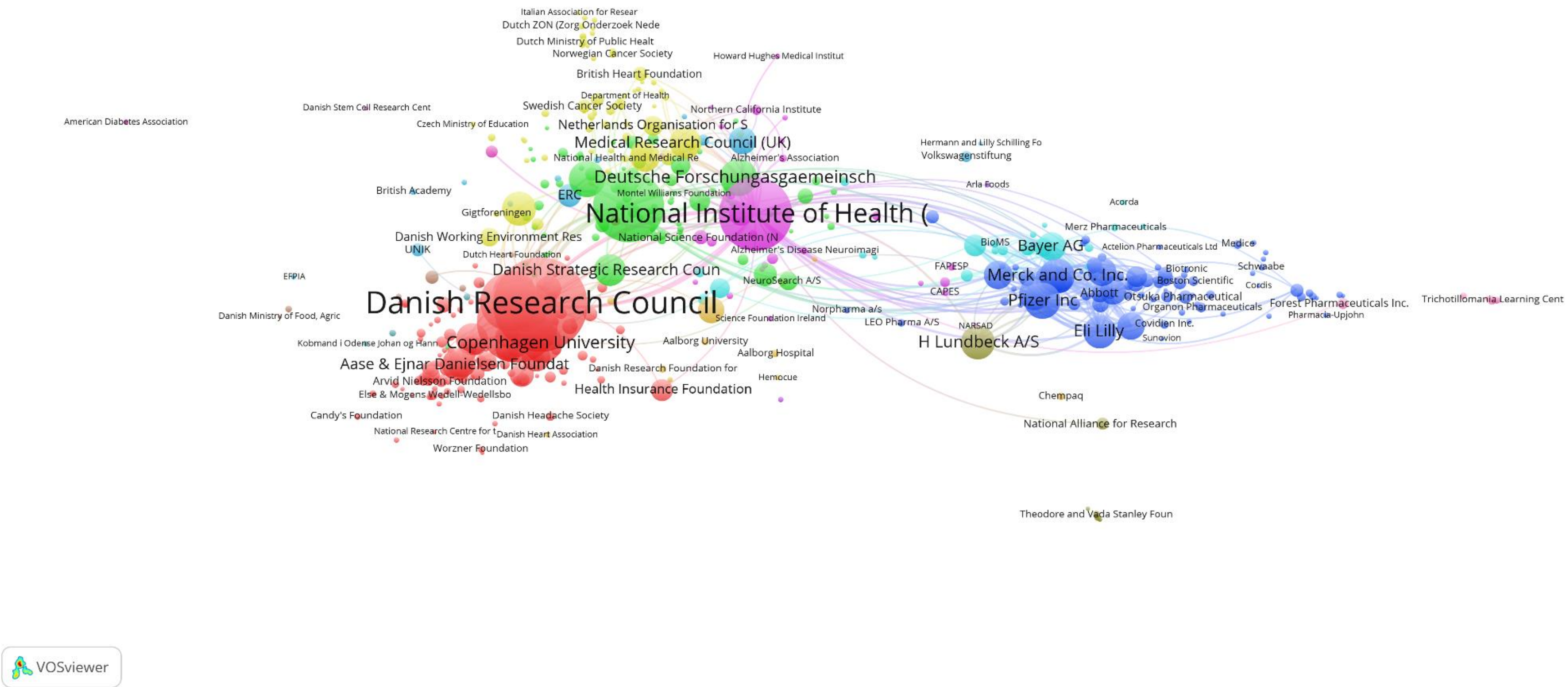

Figure 39. Network of acknowledged funding institutions from 2009 to 2015 in the specially constructed Danish set of neuroscience WoS-publication, overview map.

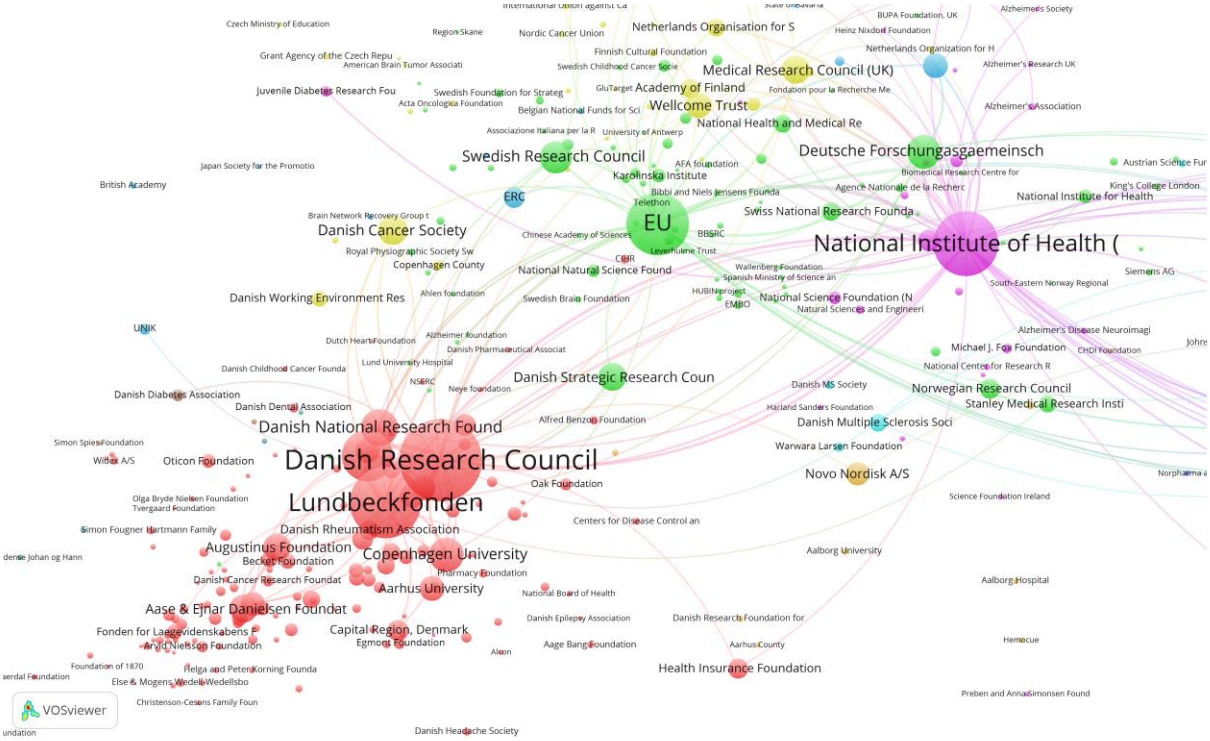

Figure 40. Network of acknowledged funding institutions from 2009 to 2015 in the specially constructed Danish set of neuroscience WoS-publication, zoom in on the cluster of Danish funding institutions.

Notice, the size of circles indicates the volume of acknowledgements in publications and the colors indicate clusters of funding sources. Clusters are created based on the strength of the co-acknowledgements

Table 11. The eight most prolific funding sources acknowledged in the Danish set of publications and the aggregate impact of the publications they are acknowledged in.

Funding institutions	Publications	MNCS	PPtop10
Danish Research Council*	426.7	1.35	0.152
Lundbeckfonden	297.9	1.29	0.146
EU	169.9	1.87	0.231
Novo Nordic Foundation	148.3	1.53	0.163
National Institute of Health (NIH)	145.8	1.90	0.222
Danish National Research Foundation**	89.0	2.24	0.271
Copenhagen University***	71.1	1.22	0.123
H. Lundbeck A/S	50.4	2.01	0.278

*Det Frie Forskningsråd (in principle all 5 subject councils)
**Various kinds of funding from Copenhagen University
***Grundforskningsfonden

Main observations:

- The overall map reveals some interesting but perhaps not surprising patterns. There seems to be four main clusters. To the right a cluster of pharmaceutical companies; in the center of the map the NIH; above and to the right of NIH a cluster of European funding sources both EU and national funding agencies; and finally to the lower right a cluster of Danish funding sources (including Lundbeckfonden) both public and private.
- The most prolific Danish funding sources are the Danish Research Council (DFF) and Lundbeckfonden. This is visible when we zoom in on the Danish cluster in Figure 39, i.e.the zoom is shown in Figure 40.
- It is also visible that the NIH is a major hub between the private industry and the Danish funding sources.
- Likewise, there is a strong relation between the Danish research Council, Lundbeckfonden and the Danish National Research Foundation, which means that these funding sources very often are acknowledged together in the same publications.
- The impact values in Table 11 fluctuates and are somewhat vulnerable due to the rather small number of publications. Nevertheless, impact scores are generally high or very high for these publication sets.

6.3. Analyses of research specialties in neuroscience

In the following maps we show the MeSH topicality of the Danish set of publications as well as the subsets affiliated to the four major universities and their affiliated hospitals. The closeness between descriptors indicates to which degree they are used together, their size the frequency of use and the color identifies the topical cluster they have been assigned to. The layout of the individual maps is identical, only the sizes/frequencies vary according to the profile of the individual universities, thereby showing which topics are more prominent at the universities. Only those keywords with at least 200 occurrences in the Danish set are included, to allow computation as well as ease visual interpretation. Again we refer to the vosviewer software and the provided map and network files for interactive examination of the maps.

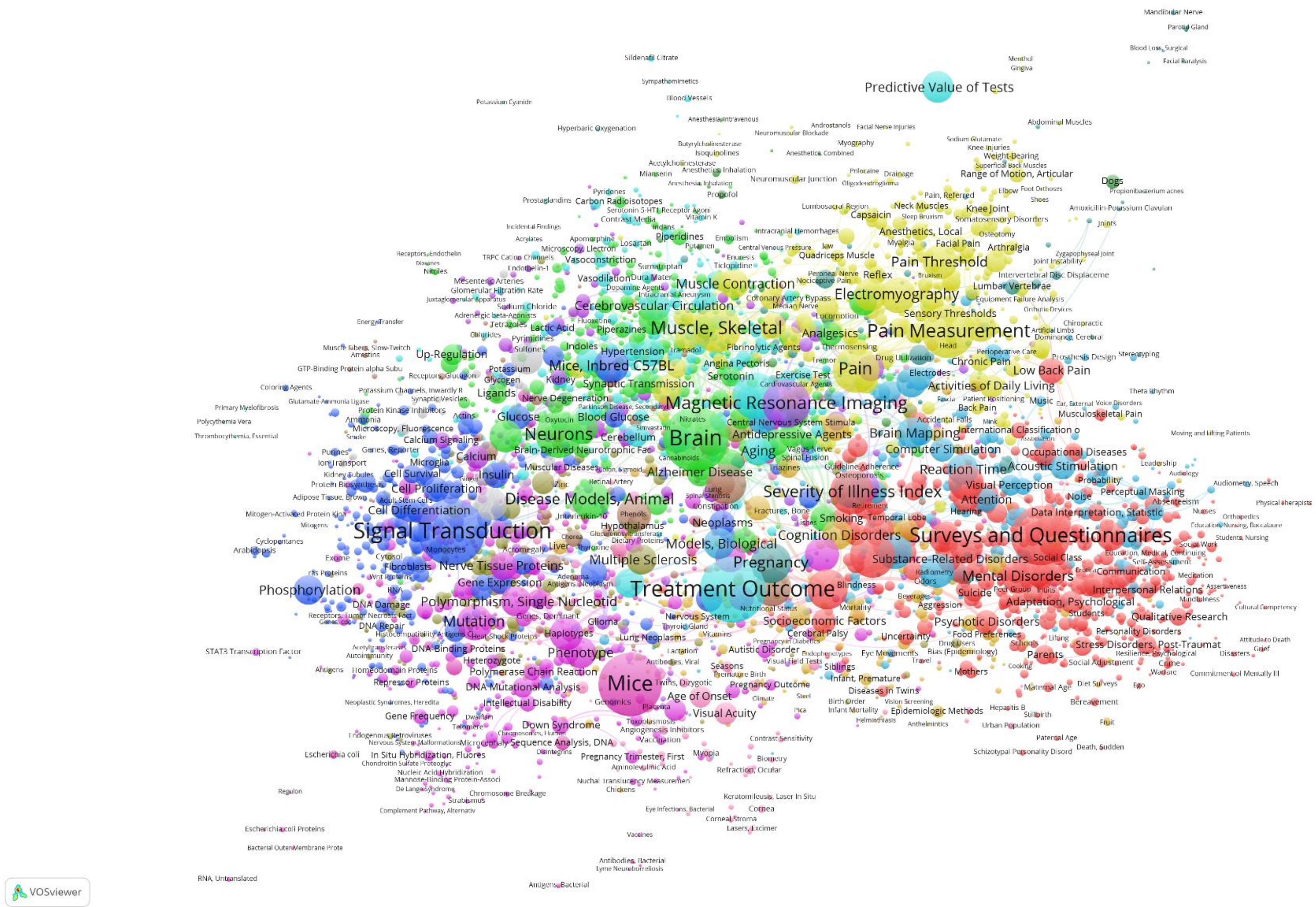

Figure 41. MeSH co-occurence map of all Danish papers.

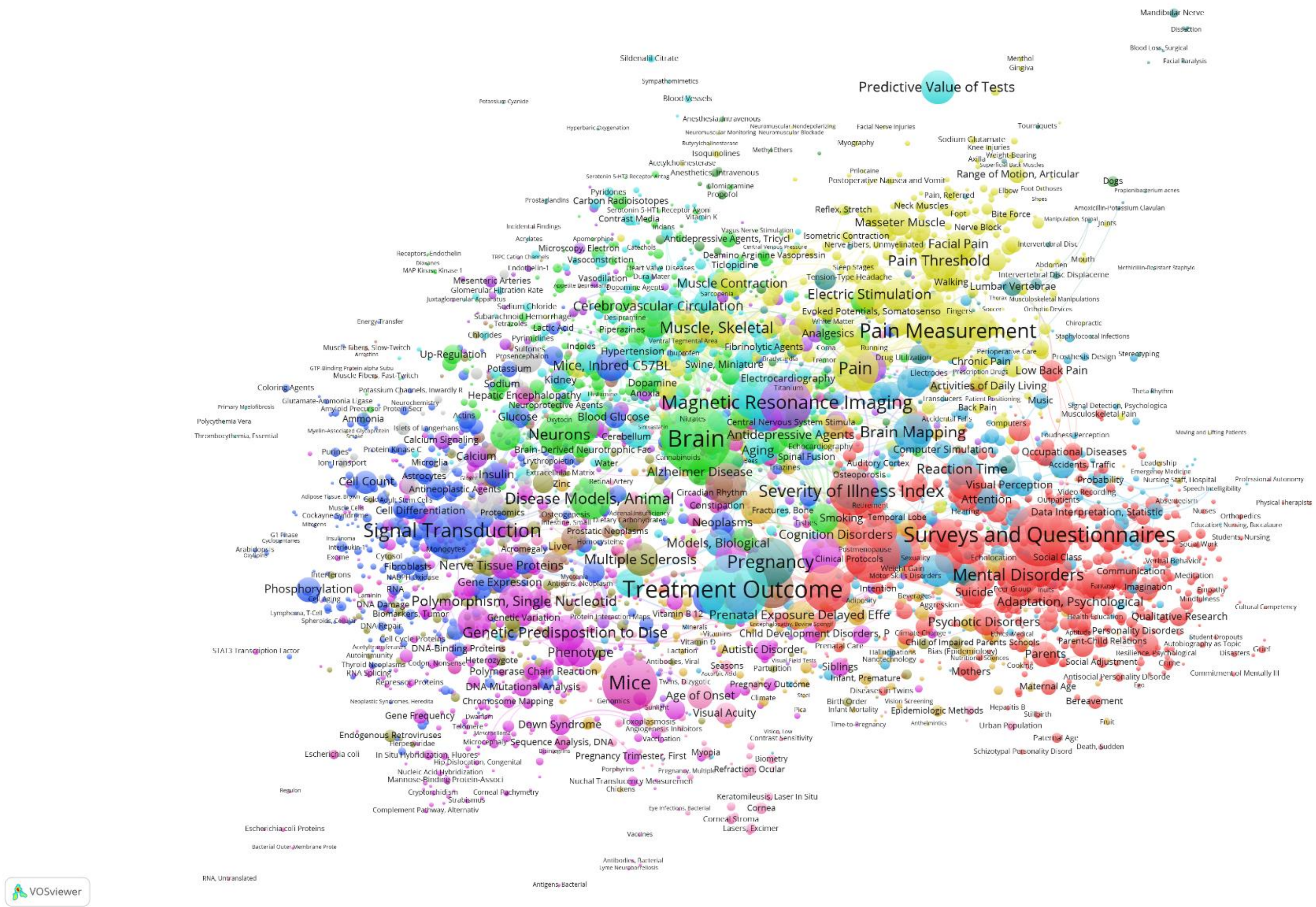

Figure 42. MeSH co-occurence map of all Aarhus University papers.

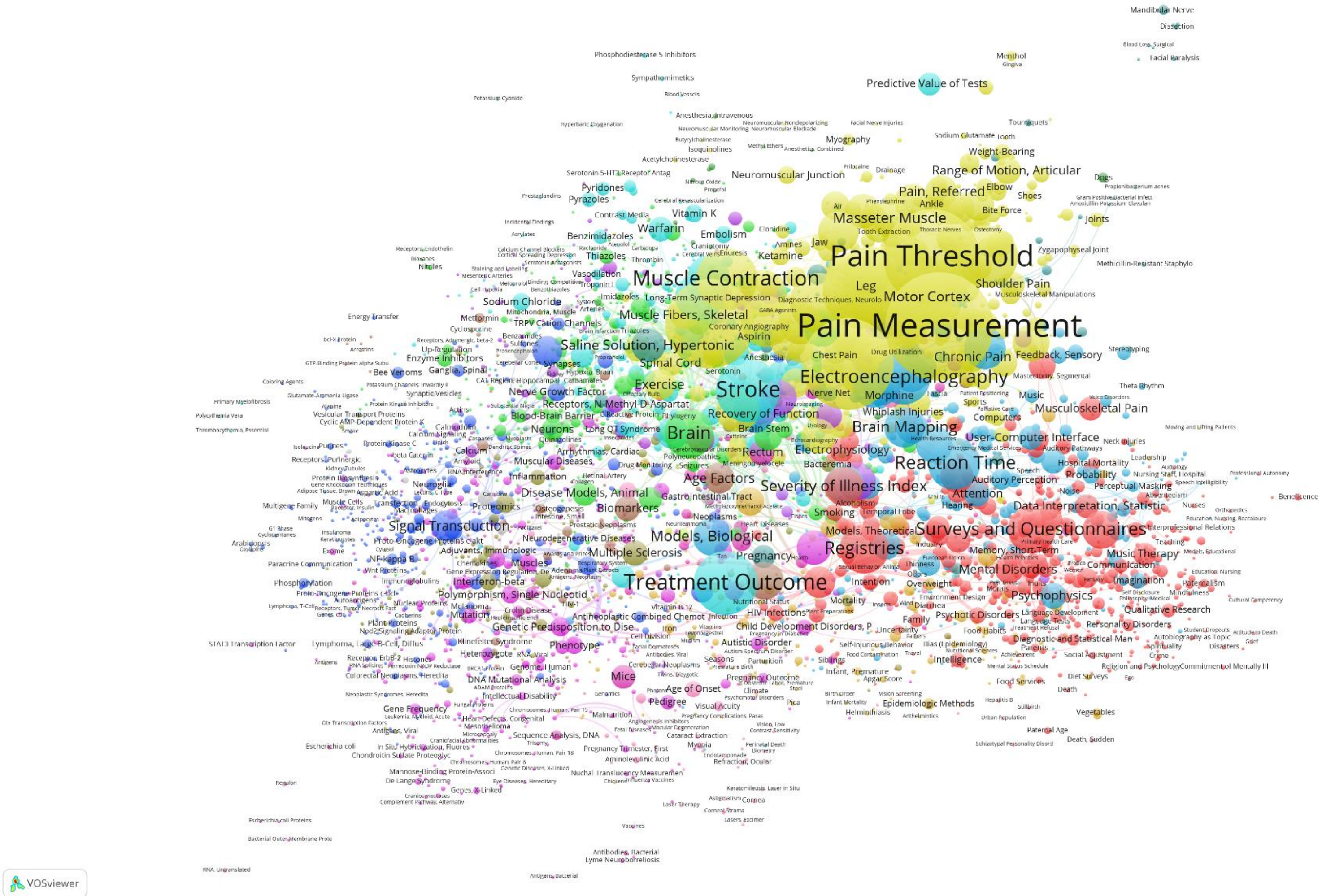

Figure 43. MeSH co-occurence map of all Aalborg University papers.

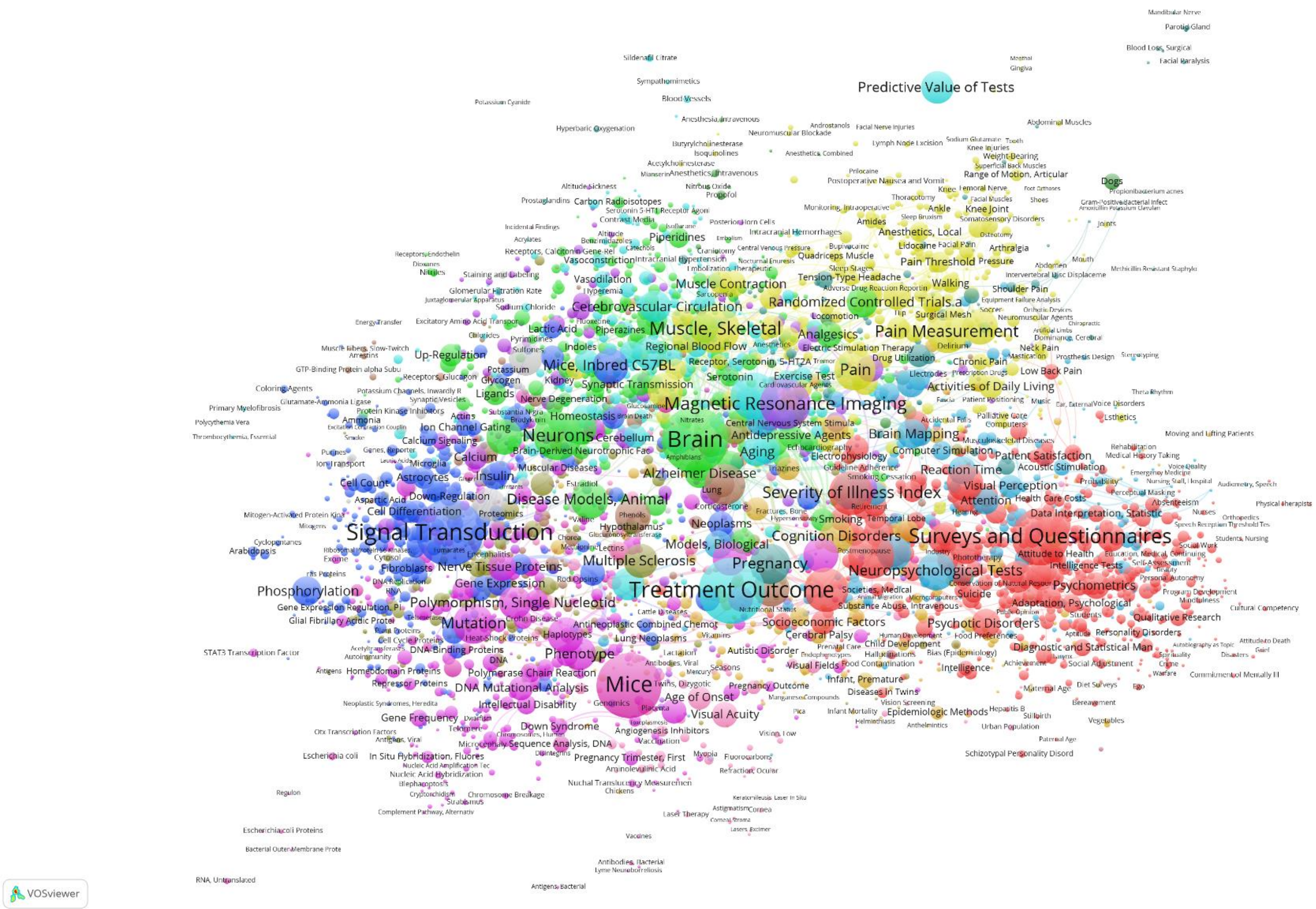

Figure 44. MeSH co-occurence map of all Copenhagen University papers.

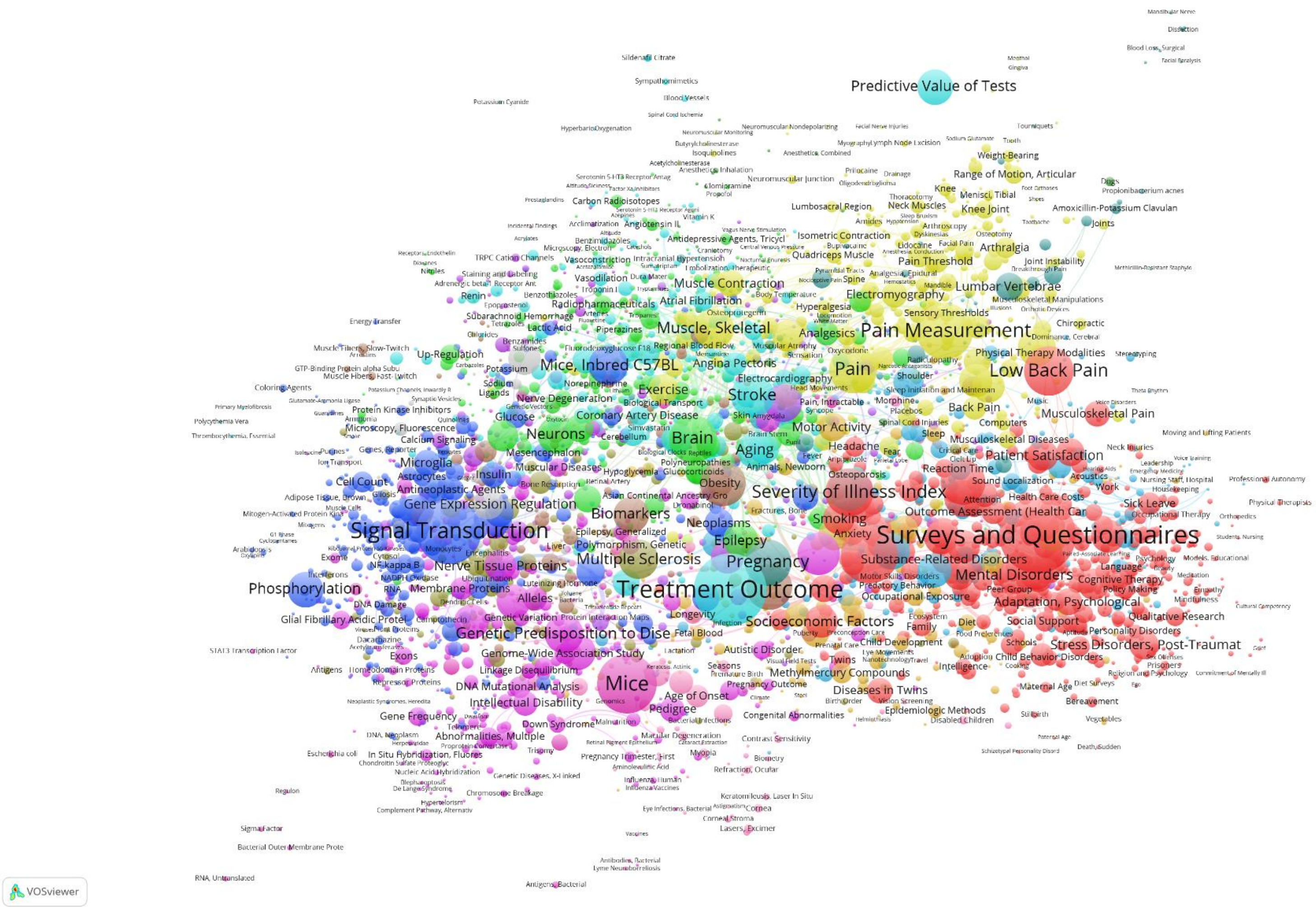

Figure 45. MeSH co-occurence map of all University of Southern Denmark papers.

Main observations:

- For all universities the term “Surveys and Questionnaires” is highly frequent, as are several closely linked terms mostly related to mental disorders, although with greater variation.
- Aarhus University’s topical profile resembles that of Denmark, with marginal differences only, indicating a broad research profile.
- Aalborg University has a clear focus on pain research (Sensory-Motor Interaction Centre), with less emphasis on basic research.
- Copenhagen University on the contrary has a greater focus on basic research.
- The University of Southern Denmark has a broad profile. The cluster surrounding “Surveys and Questionnaires” has more frequent terms relating to Quality-of-life, patient factors and patient social factors, than could be found in other university maps. This is likely related to health economics research at the University of Southern Denmark.

6.4. Analyses of knowledge dissemination and interdisciplinarity

All scientific publishing is knowledge dissemination, but if work is used outside the field in which it is published, it can be said to have a wider reach. In this section we analyze the degree to which Danish neuroscience research is based on interdisciplinary references and if it is cited outside their own areas. We use article-level classifications on the meso-level to determine if a reference or citation originates from the same domain as the individual papers. In the figures below, we report the average proportions of each of these aspects for each of the major regions. Figure 46 shows the development in the proportion of references, in the set of Danish neuroscience publications, to publications outside of "neuroscience" as operationalized in this report. Figure 47 shows the development in the proportion of citations to the set of Danish neuroscience publications coming from papers outside of "neuroscience" as operationalized in this report.

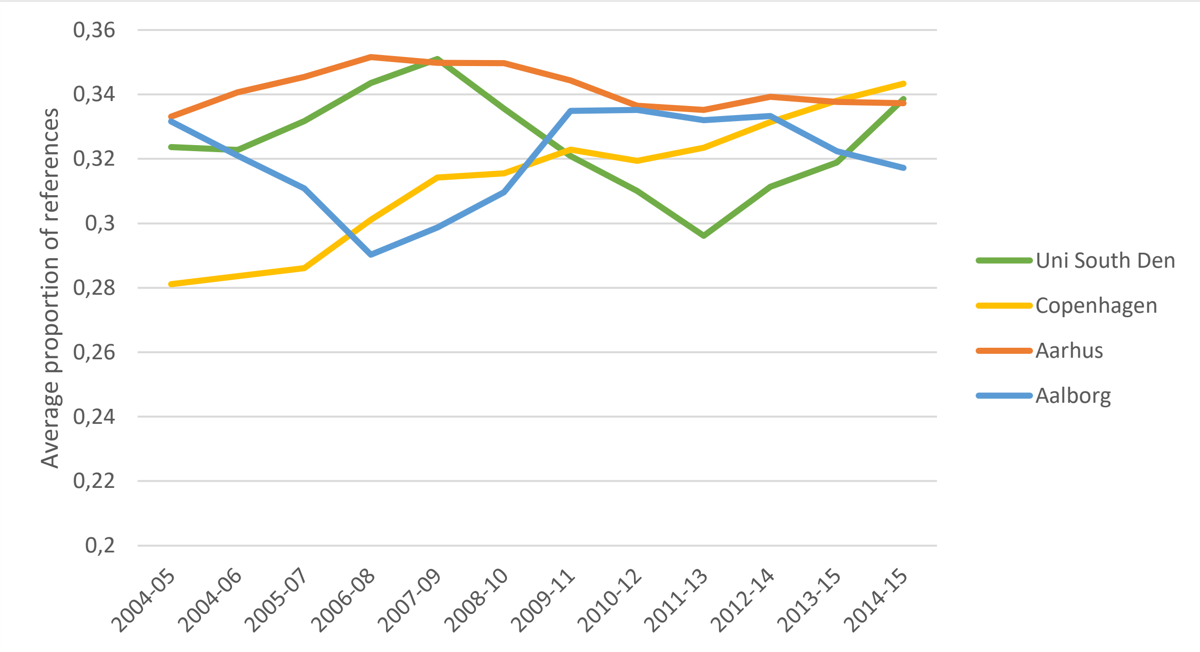

Figure 46. Average proportion of references per paper found outside own domain (at the meso-level).

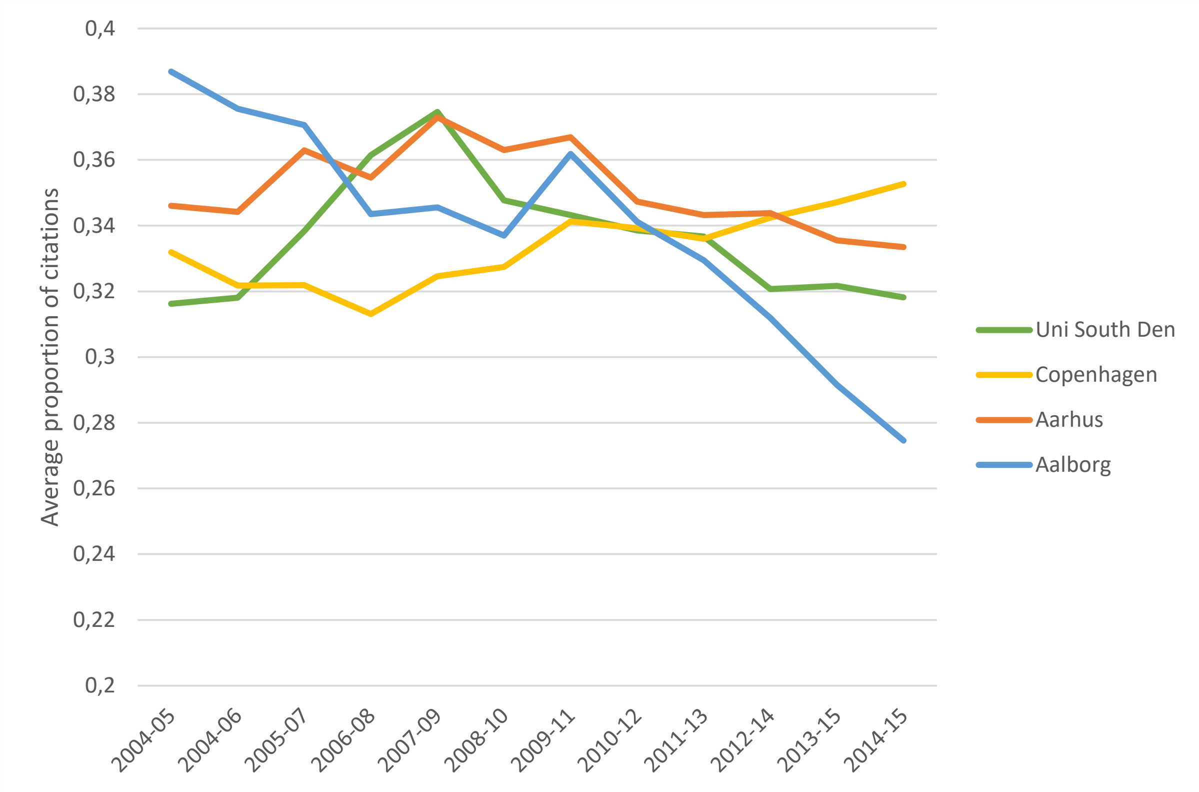

Figure 47. Average proportion of received citations per paper found outside own domain (at the meso-level).

Main observations:

- The overall proportions of both references and citations outside the original domain is stable for most units of analysis over the entire period, at around 32-36%. The exceptions are:
- Aalborg University appears to become more specialised, with a drop from 39% to 27% of citations coming from outside their own areas.
- Copenhagen University becomes more interdisciplinary with an increase from 28% to 34% in the proportion of references from outside their own areas.

6.5. “Hot topics” – recent research areas with high impact

For the analysis of hot topics, we selected only the top 2% highest cited publications in 2013-2015. The idea is to examine only the highest cited papers for this period because they are the ones that immediately get cited after publication and they are more distinctive when it comes to number of citations than for example top 10% due to the relative short citation window. A total of 2,806 papers out of 85,381 for the period were extracted, around 3.3%, signifying an overall high ratio of high impact papers for the dataset, compared to the overall research on related topics. For the Danish part of the dataset, the proportion is 58 of 7,107 or just 0.8%.

To illustrate which topics are particularly highly cited, MeSH descriptors and keywords were extracted from the complete set as well as the Danish set. The resulting co-MeSH descriptor and keyword maps are shown in Figure 48 to 51, where the keyword maps (Figures 49 and 51) are show as heat maps. Again, these maps can be scrutinized using the vosviewer software and the provided map and network files.

Main observations:

- Very few (58) Danish papers are placed in the top 2% in the most recent period. Compared to global neuroscientific research, Denmark should have had four times as many papers in the top 2%. It should be noted that a very strict criterion was used, excluding those papers with ties around the $98^{th}/99^{th}$ percentile, which makes the indicator very sensitive. For a small country like Denmark, this can have a large effect in the negative direction. An inclusion of these ties would have had too large an effect in the opposite direction, however, detracting from the “hotness” of the set.
- In the overall set, especially the basic research in genetics and cell biology is dominant, but also specific diseases such as Alzheimer’s and Parkinson’s disease are significant in their presence. Also cancer research stands out.
- The Danish set somewhat resembles the overall, however, with less emphasis on cancer, more on depression, postoperative pain, several cardiovascular topics and consensus recommendations/guidelines.

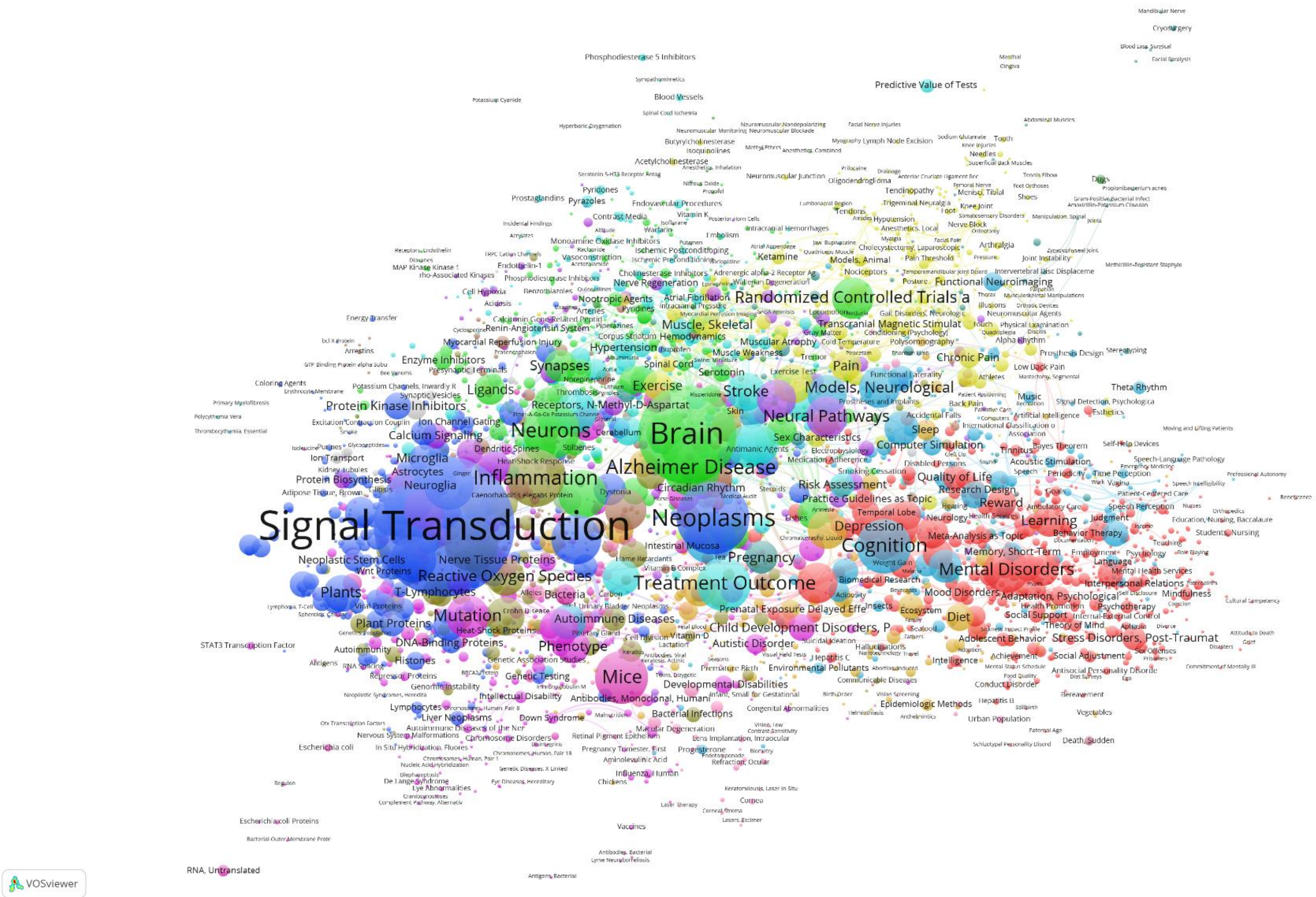

Figure 48. Co-MeSH descriptor network of the 2% most highly cited publications in 2013-2015 (all publications).

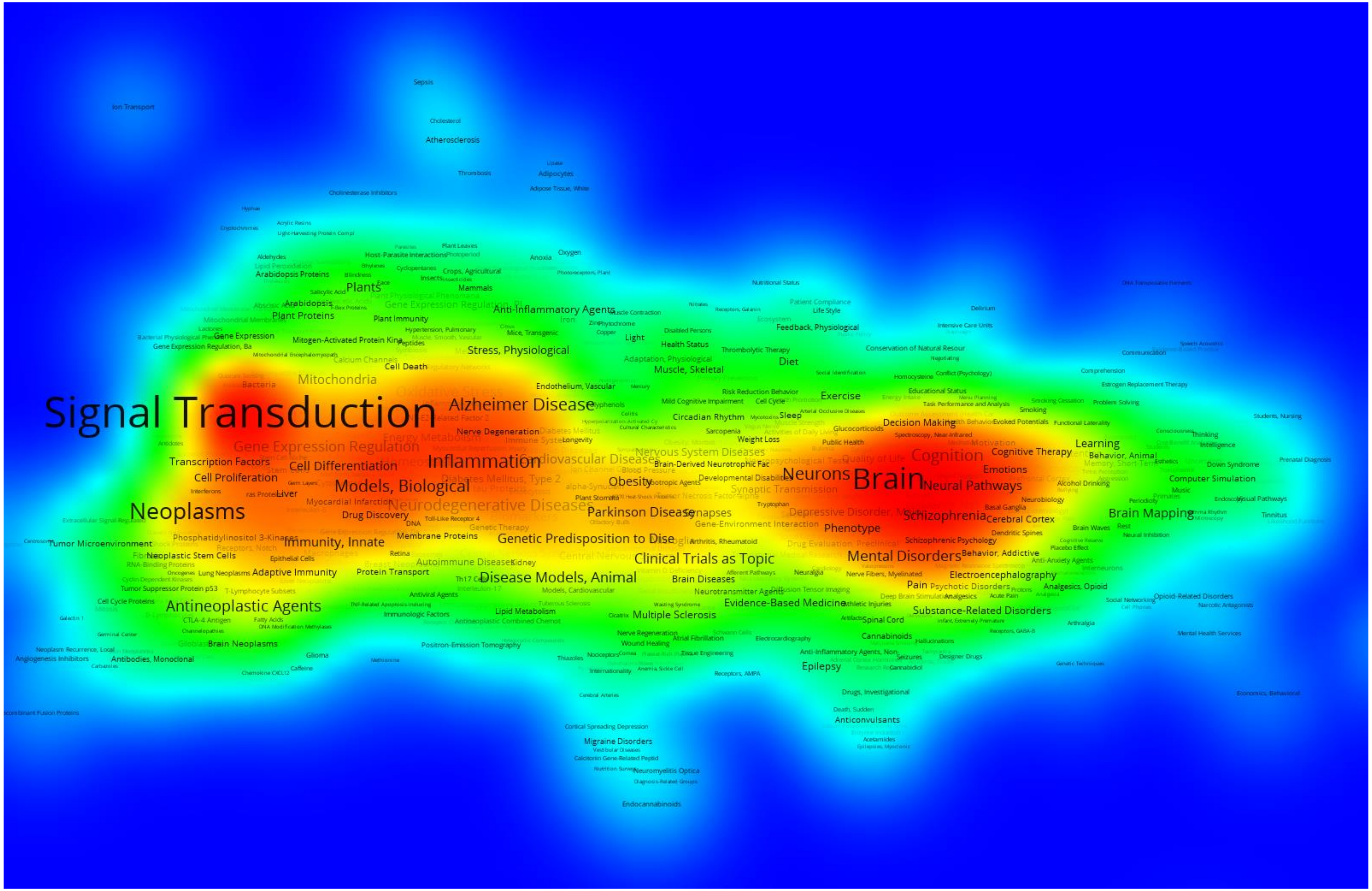

Figure 49. Heat map of the most frequent keywords among the 2% most cited publications in 2013-15.

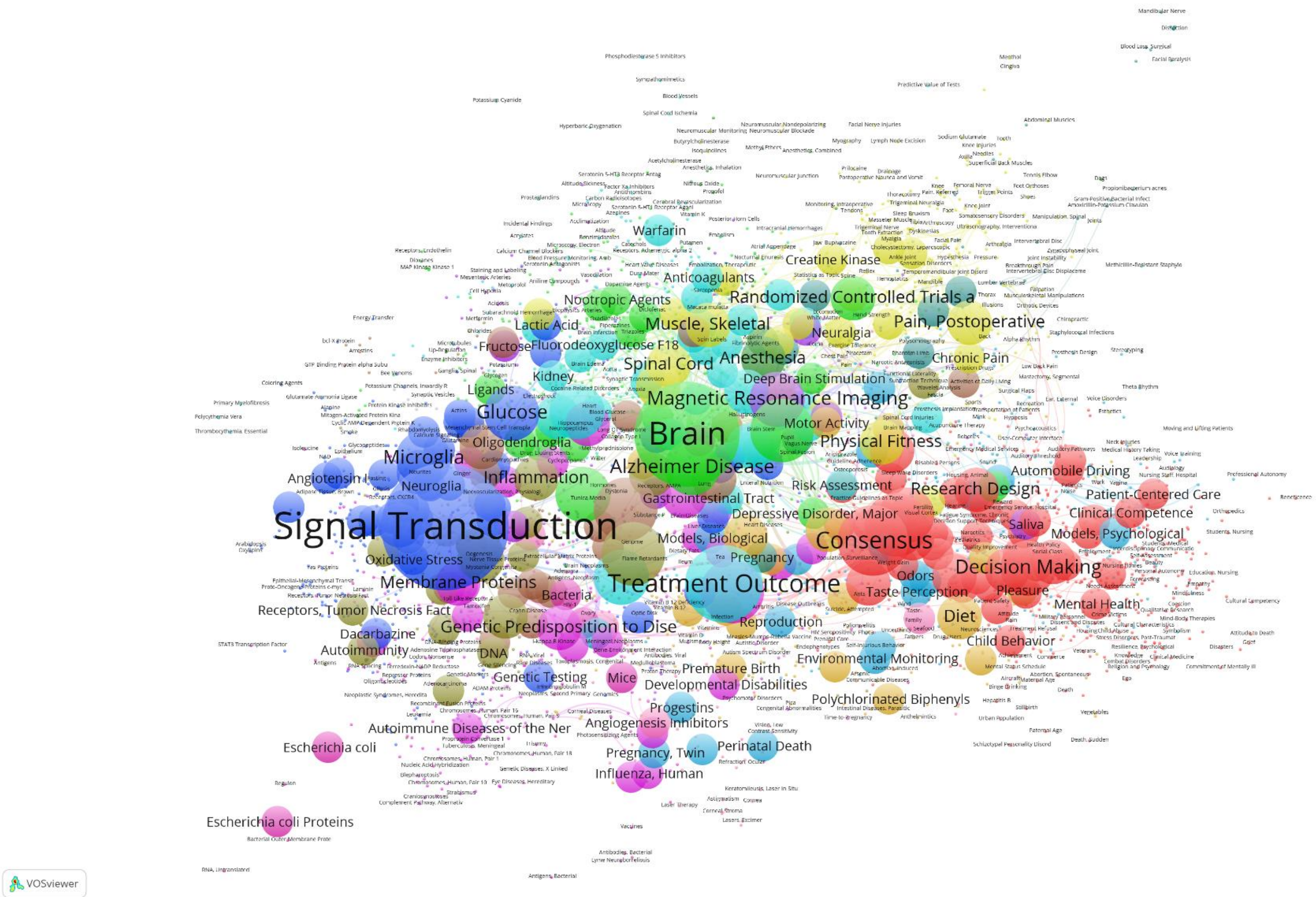

Figure 50. Co-MeSH descriptor network of the Danish publications among the 2% most highly cited in 2013-2015 (Danish publications).

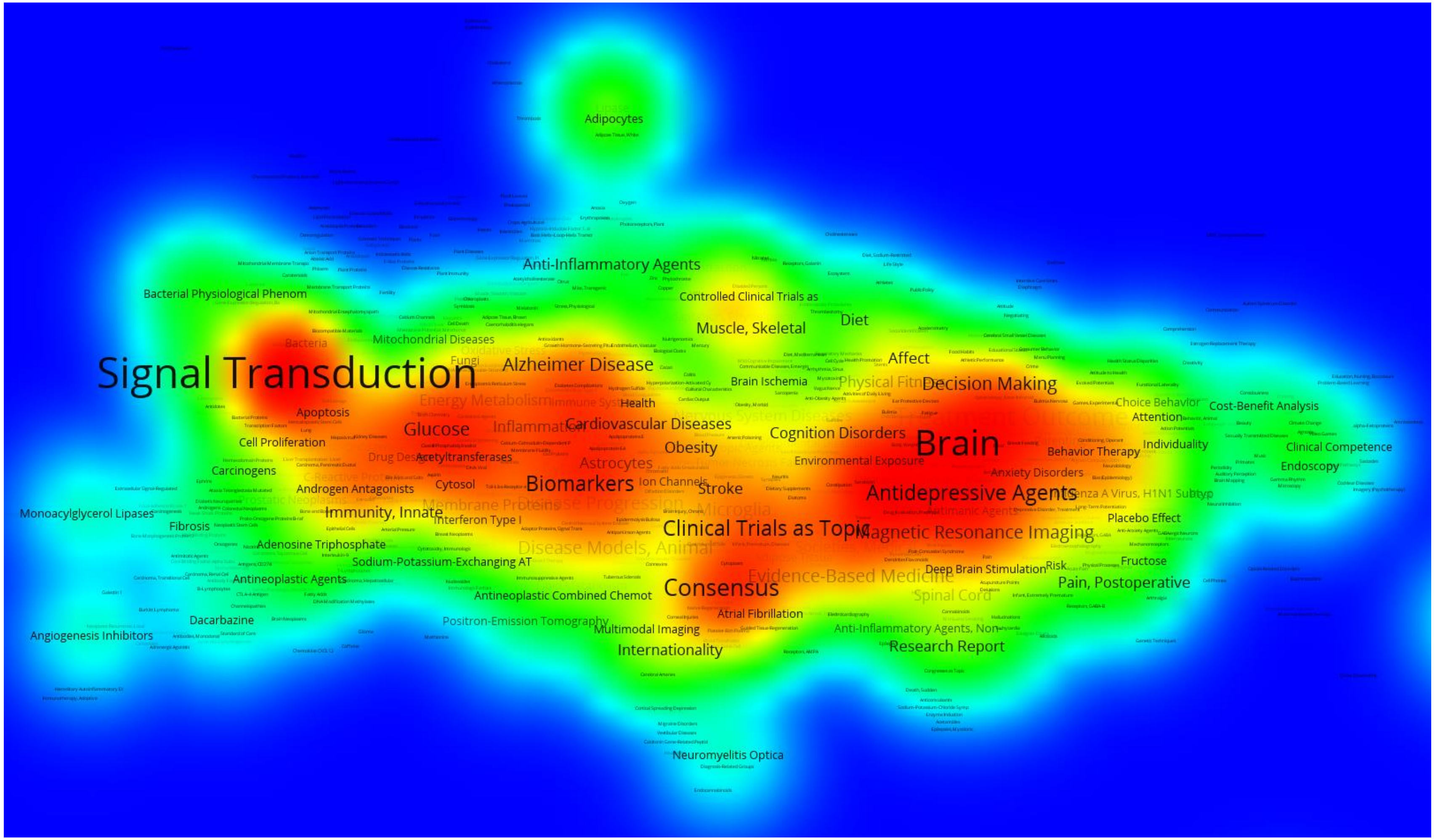

Figure 51. Heat map of the most frequent keywords among the Danish publications in the set of 2% most cited publications in 2013-15.

7. References

Hicks, D., Wouters, P., Waltman, L., de Rijcke, S., & Rafols, I. (2015). The Leiden Manifesto for research metrics. *Nature*, 520, 429-431.

Schneider, J. W. (2013). Caveats for using statistical significance tests in research assessments. *Journal of Informetrics*, 7(1), 50-62.

Schneider, J. W. (2015). Null hypothesis significance tests. A mix-up of two different theories: the basis for widespread confusion and numerous misinterpretations. *Scientometrics*, 102(1), 411-432.

8. Appendix 1: Impact analyses based on Web of Science journal subject categories

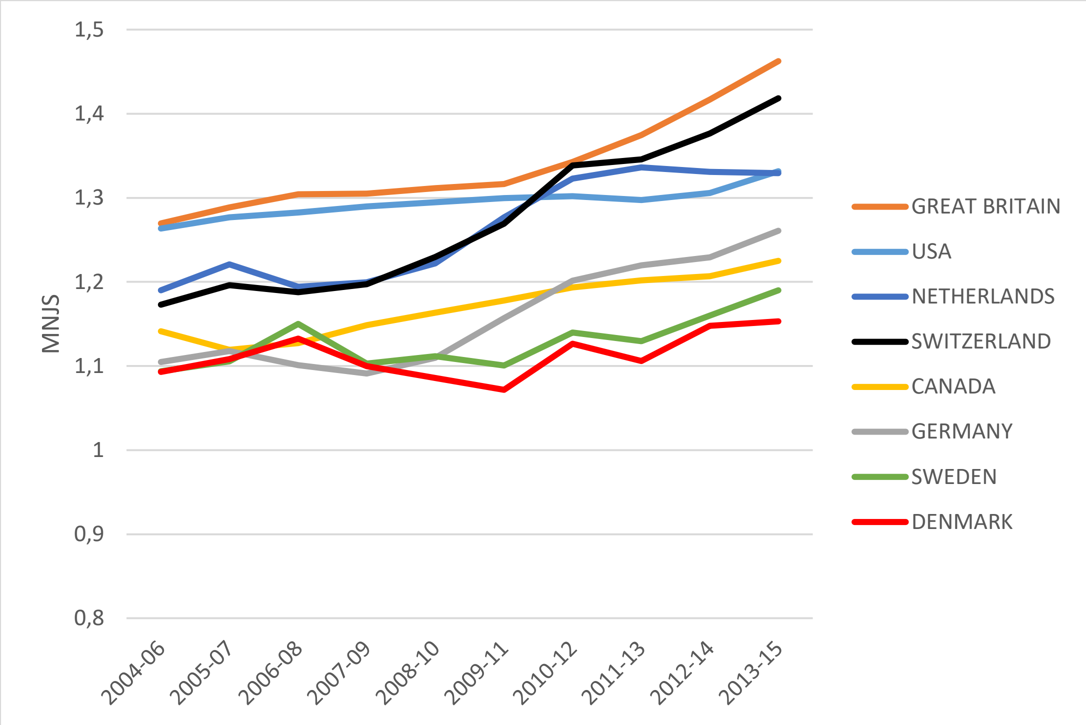

Figure 52. Publication profiles in the Web of Science journal subject category <u>neuroscience</u> according to journal impact measured with the mean normalized journal score (MNJS).

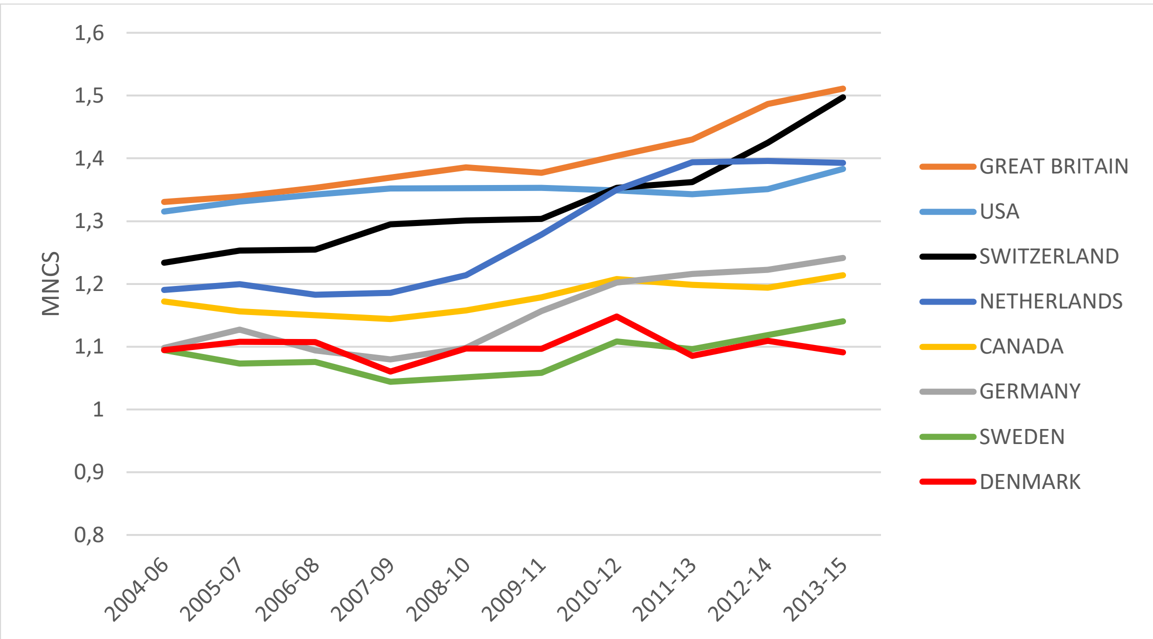

Figure 53. Country citation impact in the Web of Science journal subject category <u>neuroscience</u> measured with the mean normalized citation score (MNCS).

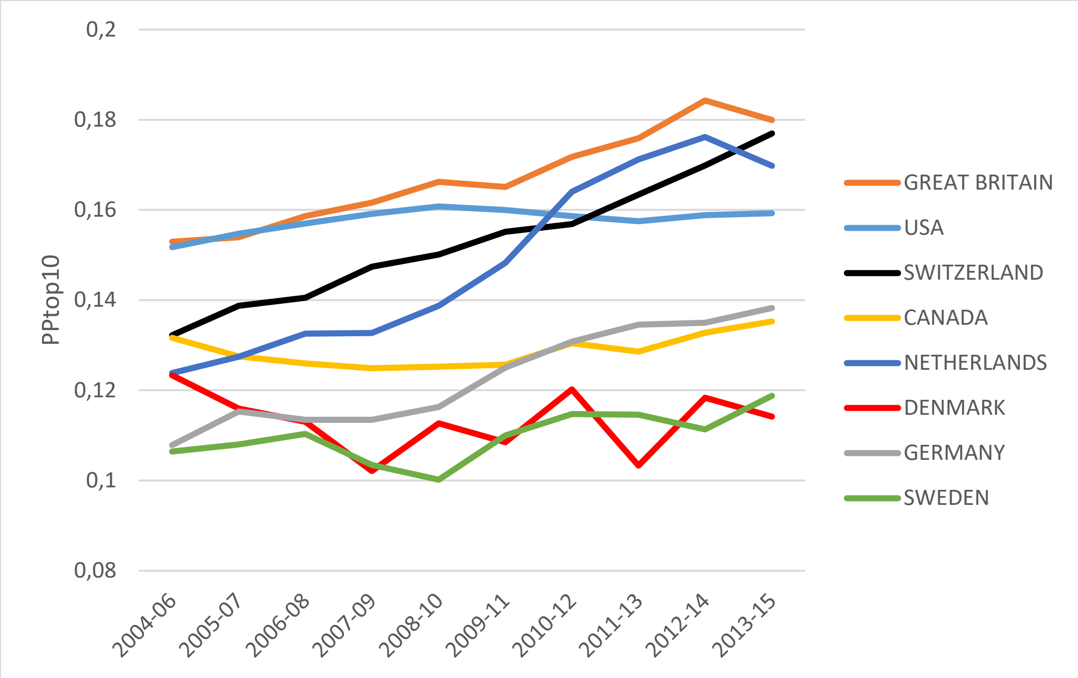

Figure 54. Country citation impact in the Web of Science journal subject category neuroscience according to the proportion of publications among the 10% most cited (PPtop10%).

8.1. Impact analyses based on Web of Science journal subject categories according to collaboration types

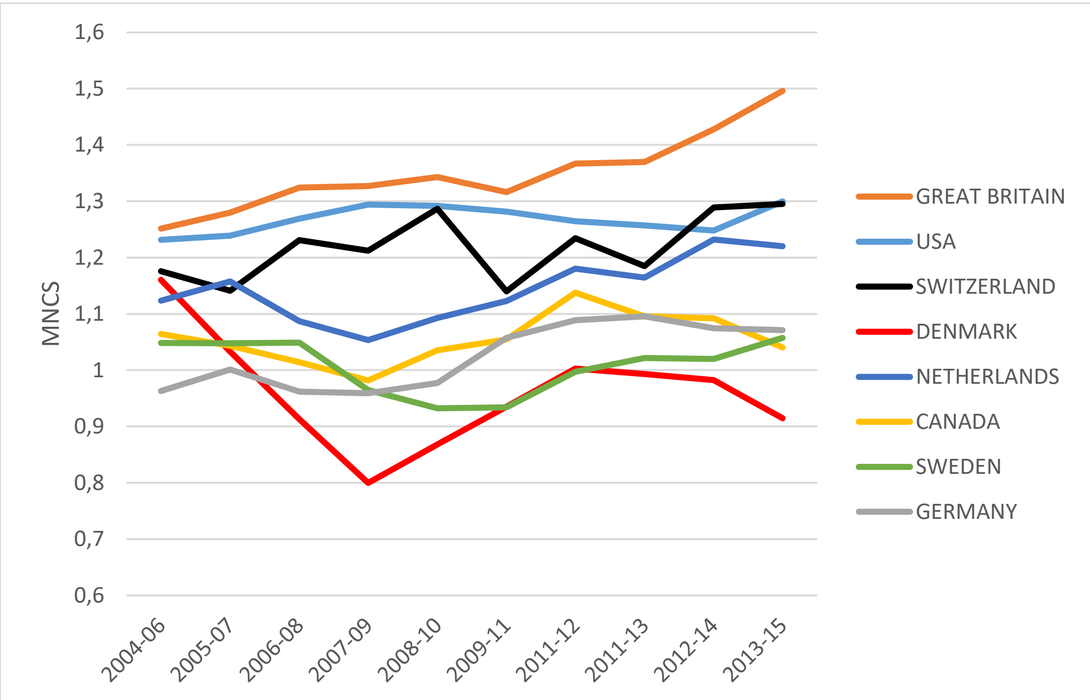

Figure 55. Country citation impact for publications in the WoS subject category neuroscience for publications with <u>no inter-institutional collaboration</u> measured with the mean normalized citation score (MNCS).

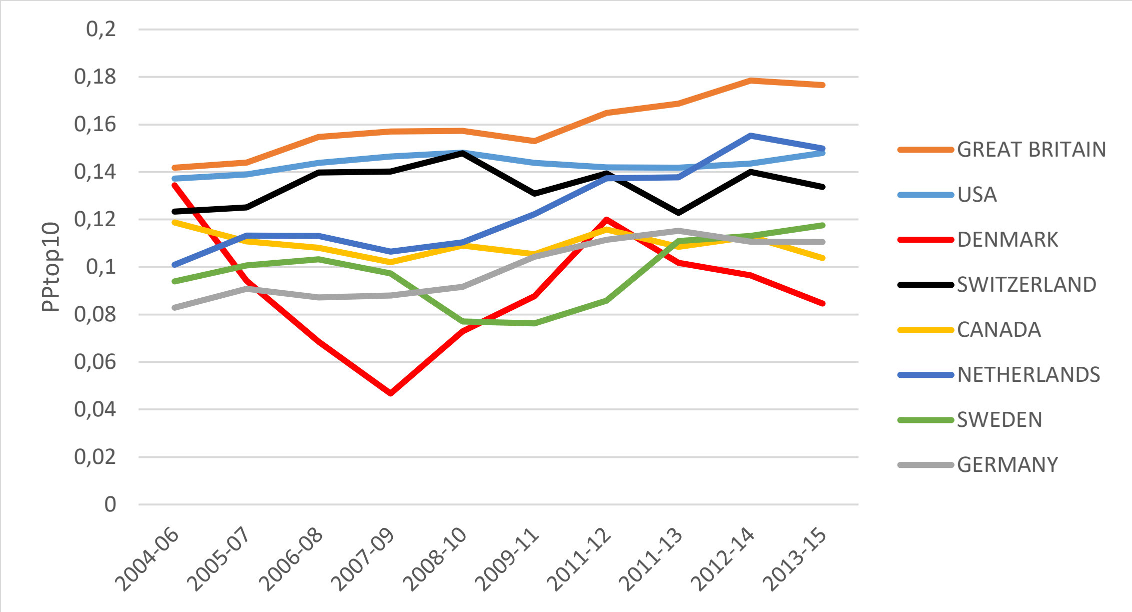

Figure 56. Country citation impact for publications in the WoS subject category for publications with <u>no inter-institutional collaboration</u> measured with the proportion of the 10% most highly cited publications (PPtop10%).

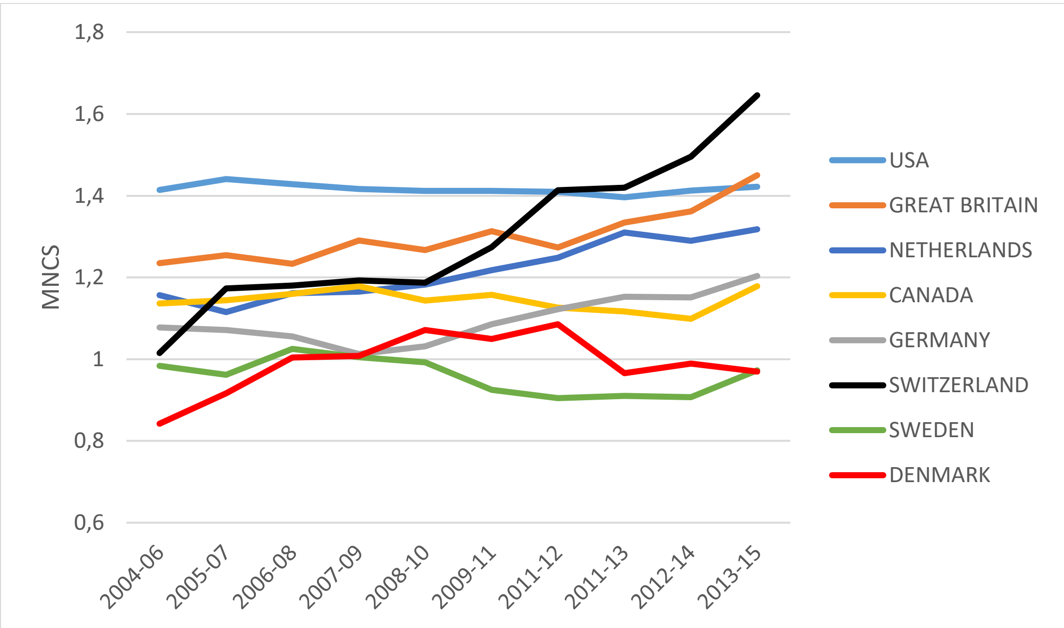

Figure 57. Country citation impact for publications in the WoS subject category neuroscience with <u>inter-institutional collaboration</u> measured with the mean normalized citation score (MNCS).

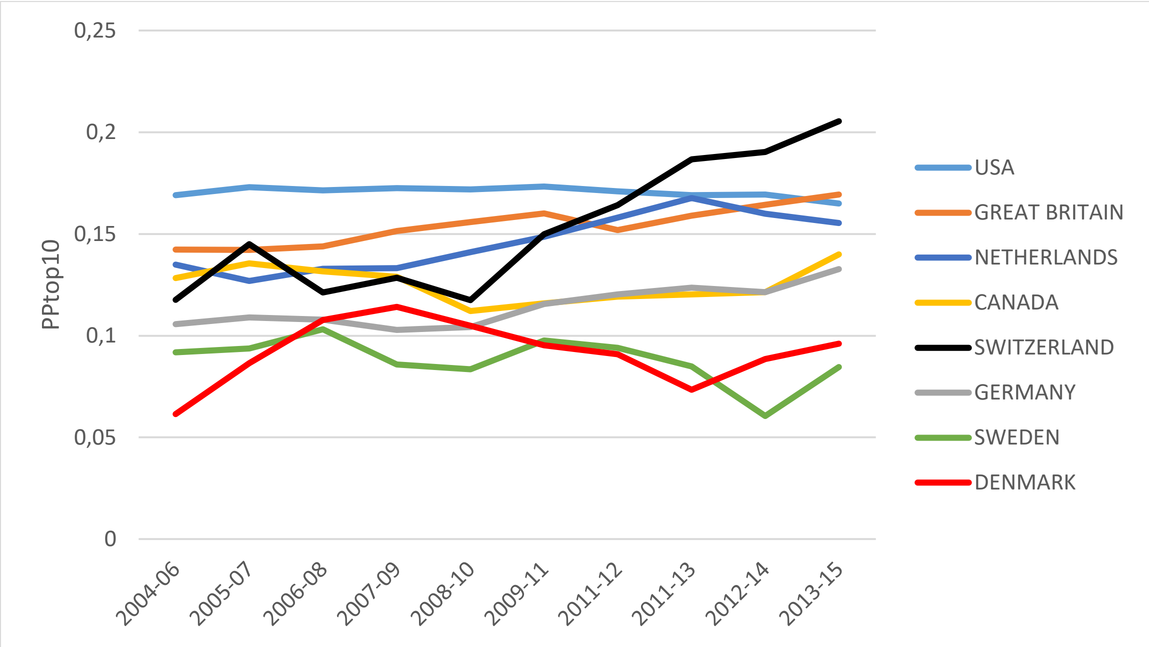

Figure 58. Country citation impact for publications in the WoS subject category for publications with <u>inter-institutional collaboration</u> measured with the proportion of the 10% most highly cited publications (PPtop10%).

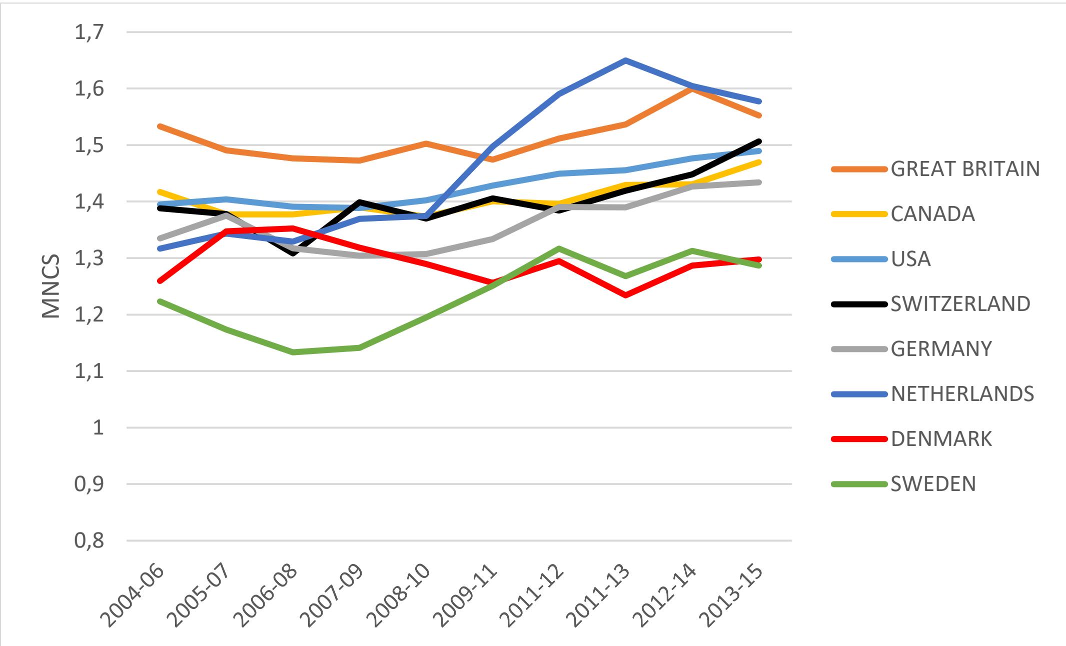

Figure 59. Country citation impact for publications in the WoS subject category neuroscience with <u>international collaboration</u> measured with the mean normalized citation score (MNCS).

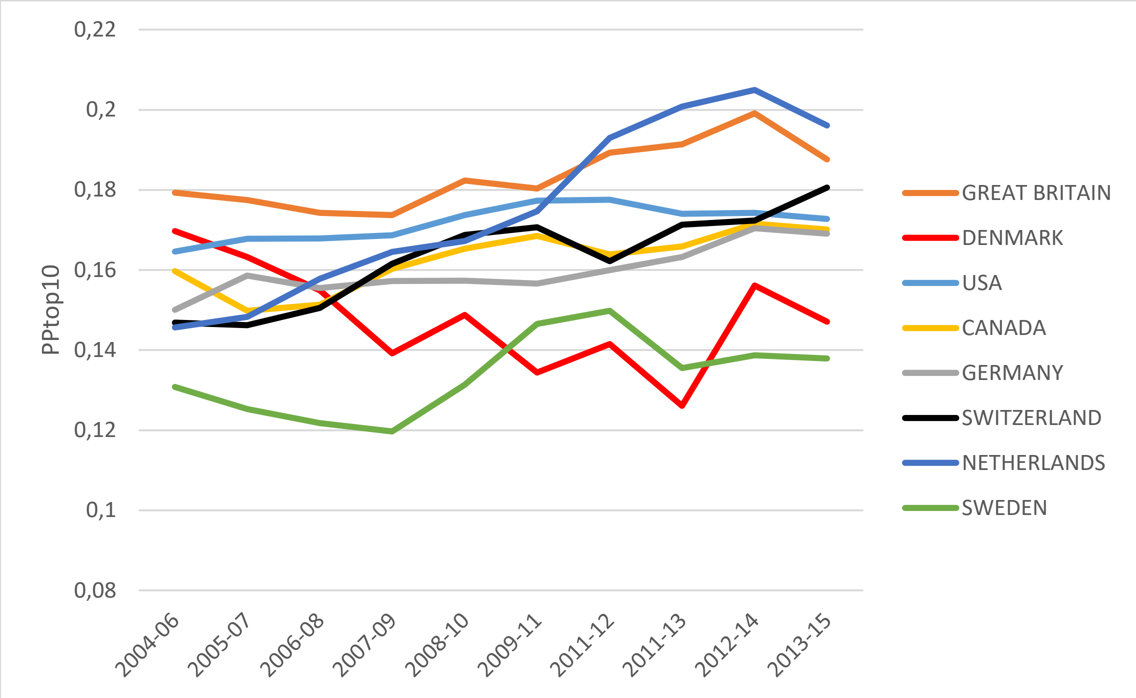

Figure 60. Country citation impact for publications in the WoS subject category for publications with <u>international collaboration</u> measured with the proportion of the 10% most highly cited publications (PPtop10%).

9. Appendix 2: Search documentation

9.1. FACET A Search terms

1. Nervous System Diseases[Mesh] OR
2. Nervous System/physiology[Mesh] OR
3. Nervous System/etiology[Mesh] OR
4. Nervous System/drug effects[Mesh] OR
5. Nervous System/pharmacology[Mesh] OR
6. Nervous System/pathology[Mesh] OR
7. Nervous System/genetics[Mesh] OR
8. Nervous System/physiopathology[Mesh] OR
9. Nervous System/cytology[Mesh] OR
10. Nervous System/enzymology[Mesh] OR
11. Nervous System/biosynthesis[Mesh] OR
12. Nervous System/pharmacokinetics[Mesh] OR
13. Nervous System[Mesh] AND Animals[Mesh] OR
14. Mental Disorders[Mesh] OR
15. Signal transduction[Mesh] OR
16. Mental processes[Mesh] OR
17. Neurology[Mesh] OR
18. Neurosciences[Mesh] OR
19. Brain mapping[mesh]

9.1.1. PubMed Search string

Nervous System Diseases[Mesh] OR Nervous System/physiology[Mesh] OR Nervous System/etiology[Mesh] OR Nervous System/drug effects[Mesh] OR Nervous System/pharmacology[Mesh] OR Nervous System/pathology[Mesh] OR Nervous System/genetics[Mesh] OR Nervous System/physiopathology[Mesh] OR Nervous System/cytology[Mesh] OR Nervous System/enzymology[Mesh] OR Nervous System/biosynthesis[Mesh] OR Nervous System/pharmacokinetics[Mesh] OR Nervous System[Mesh] AND Animals[Mesh] OR Mental Disorders[Mesh] OR Signal transduction[Mesh] OR Mental processes[Mesh] OR Neurology[Mesh] OR Neurosciences[Mesh] OR Brain mapping[mesh]

9.2. FACET B Search terms

1. (arteritis[tw] OR vasculitis[tw]) AND nervous system[tw] OR
2. (central nervous system[tw] OR peripheral nervous system[tw]) AND (cyst*[tw] OR malformation*[tw] OR cancer[tw] OR neoplasm*[tw]) OR
3. Acoustic Neuroma[tw] OR
4. Acrocallosal Syndrome*[tw] OR
5. adie syndrome*[tw] OR
6. Adjustment disorder*[tw] OR
7. Adrenergic*[tw] OR
8. Affective disorder*[tw] OR
9. Agoraphobi*[tw] OR
10. Agraphia[tw] OR
11. Aicardi Syndrome*[tw] OR
12. AIDS Dementia Complex[tw] OR
13. akathisia[tw] OR
14. Akinetic Mutism[tw] OR

15. Alcohol Withdrawal Delirium[tw] OR
16. Alcohol Withdrawal Seizures[tw] OR
17. Alcoholic Intoxication[tw] OR
18. Alcohol-Induced disorder*[tw] OR
19. Alcoholism[tw] OR
20. Alcohol-Related disorder*[tw] OR
21. Alexia[tw] OR
22. Alstrom Syndrome*[tw] OR
23. Alzheimer Disease[tw] OR
24. Amblyopia[tw] OR
25. Amnesia[tw] OR
26. Amphetamine-Related disorder*[tw] OR
27. Anencephaly[tw] OR
28. Angelman Syndrome*[tw] OR
29. Anomia[tw] OR
30. Anorexia Nervosa[tw] OR
31. Antidepressive*[tw] OR
32. Anti-obesity*[tw] OR
33. Antiparkinson*[tw] OR
34. Antipsychotic Agents[tw] OR
35. Antipsychotic* [tw] OR
36. Antisocial Personality Disorder[tw] OR
37. Anxiety[tw] OR
38. Aphasia[tw] OR
39. Arachnoid Cyst*[tw] OR
40. Arachnoiditis[tw] OR
41. Arnold-Chiari Malformation*[tw] OR
42. Asperger Syndrome[tw] OR
43. Asthenia[tw] OR
44. ataxia telangiectas*[tw] OR
45. Attention Deficit and Disruptive Behavior disorder*[tw] OR
46. Auditory Perceptual disorder*[tw] OR
47. Autism Spectrum Disorder[tw] OR
48. Autistic Disorder[tw] OR
49. Bardet-Biedl Syndrome*[tw] OR
50. Battered Child Syndrome[tw] OR
51. Binge Drinking[tw] OR
52. Binge-Eating Disorder[tw] OR
53. Bipolar[tw] OR
54. Body Dysmorphic disorder*[tw] OR
55. Borderline Personality Disorder[tw] OR
56. botulism[tw] OR
57. Brain Concussion*[tw] OR
58. brain death[tw] OR
59. Brain Edema*[tw] OR
60. brain Hypoxia*[tw] OR
61. brain injur*[tw] OR
62. Brain Ischemia[tw] OR
63. Brain Neoplasm*[tw] OR
64. Bulimia Nervosa[tw] OR
65. CADASIL[tw] OR
66. Cannabinoid*[tw] OR
67. Capgras Syndrome[tw] OR

68. Cataplex*[tw] OR
69. Causalgia[tw] OR
70. Cerebellar Neoplasm*[tw] OR
71. cerebral palsy[tw] OR
72. cerebral toxoplasmos*[tw] OR
73. Cerebral Ventricle Neoplasm*[tw] OR
74. Cerebral Ventriculitis[tw] OR
75. Charcot-Marie-Tooth Disease[tw] OR
76. Child Behavior disorder*[tw] OR
77. Child Development disorder*[tw] OR
78. Cholinergic*[tw] OR
79. Chorea[tw] OR
80. Cocaine-Related disorder*[tw] OR
81. Cognition disorder*[tw] OR
82. Colloid Cyst*[tw] OR
83. Combat disorder*[tw] OR
84. Communication disorder*[tw] OR
85. Compulsive Personality Disorder[tw] OR
86. Congenital nystagmus[tw] OR
87. Consciousness disorder*[tw] OR
88. Conversion Disorder[tw] OR
89. cranial nerve cancer*[tw] OR
90. cranial nerve neoplasm*[tw] OR
91. Creutzfeldt-Jakob Syndrome[tw] OR
92. Creutzfeldt-Jakob Syndrome*[tw] OR
93. Cyclothymic Disorder[tw] OR
94. Cytochrome*[tw] OR
95. dandy-walker[tw] OR
96. Delirium[tw] OR
97. Delusional Parasitosis[tw] OR
98. Dementia[tw] OR
99. Demyelin*[tw] OR
100. Dependent Personality Disorder[tw] OR
101. Depressi*[tw] OR
102. Developmental Disabilit*[tw] OR
103. Diffuse Neurofibrillary Tangles with Calcification[tw] OR
104. Dissociative disorder*[tw] OR
105. Dopamine* [tw] OR
106. Duane Retraction Syndrome*[tw] OR
107. dysautonomi*[tw] OR
108. Dyscalculia[tw] OR
109. Dyskinesias[tw] OR
110. Dyslexia[tw] OR
111. Dyspareunia/psychology[tw] OR
112. dysreflexia[tw] OR
113. Dyssomnia*[tw] OR
114. Dysthymic Disorder[tw] OR
115. Dystonia Musculorum Deformans[tw] OR
116. Dystonic Disorder*[tw] OR
117. Elimination disorder*[tw] OR
118. Encephalocele[tw] OR
119. encephalomyelitis[tw] OR
120. Encopresis[tw] OR

121. Enuresis[tw] OR
122. Epidural Neoplasm*[tw] OR
123. epilepsy[tw] OR
124. epilept*[tw] OR
125. Erectile Dysfunction/psychology[tw] OR
126. Esotropia*[tw] OR
127. Essential Tremor*[tw] OR
128. Exhibitionism[tw] OR
129. Exotropia*[tw] OR
130. Factitious disorder*[tw] OR
131. fatigue syndrome*[tw] OR
132. Feeding and Eating disorder*[tw] OR
133. Female Athlete Triad Syndrome[tw] OR
134. Fetal Alcohol Spectrum disorder*[tw] OR
135. Fetishism[tw] OR
136. Firesetting[tw] OR
137. Frontotemporal Dementia[tw] OR
138. Frontotemporal Lobar Degeneration[tw] OR
139. Gambling[tw] OR
140. Gender Dysphoria/psychology[tw] OR
141. Giant Axonal Neuropathy[tw] OR
142. Guillain-Barre Syndrome*[tw] OR
143. gustatory sweating[tw] OR
144. Hallucinogens[tw] OR
145. Heroin Dependence[tw] OR
146. hippel-lindau syndrome*[tw] OR
147. Histrionic Personality Disorder[tw] OR
148. Hoarding Disorder[tw] OR
149. Holoprosencephaly[tw] OR
150. horner syndrome*[tw] OR
151. huntington[tw] OR
152. Huntington Disease[tw] OR
153. hydranecephal*[tw] OR
154. Hydrocephalus[tw] OR
155. Hypertensive Encephalopathy[tw] OR
156. Hypnotics and Sedatives[tw] OR
157. Hypochondriasis[tw] OR
158. Hypothalamic Neoplasm*[tw] OR
159. Hysteria[tw] OR
160. Infratentorial Neoplasm*[tw] OR
161. Inhalant Abuse[tw] OR
162. insomnia[tw] OR
163. Intellectual Disabilit*[tw] OR
164. Intracranial Arteriovenous Malformation*[tw] OR
165. Intracranial Hypertension[tw] OR
166. Intracranial Hypotension[tw] OR
167. jet lag syndrome*[tw] OR
168. kernicterus[tw] OR
169. Kluver-Bucy Syndrome[tw] OR
170. Kluver-Bucy Syndrome*[tw] OR
171. Landau-Kleffner Syndrome*[tw] OR
172. Language Development disorder*[tw] OR
173. Language disorder*[tw] OR

174. Laurence-Moon Syndrome*[tw] OR Learning disorder*[tw] OR
175. Lennox Gastaut Syndrome*[tw] OR
176. leukoencephalopath*[tw] OR
177. Lewy Body Disease[tw] OR
178. Lissencephaly[tw] OR
179. marchiafava-bignami[tw] OR
180. Marijuana Abuse[tw] OR
181. Masochism[tw] OR
182. Megalencephaly[tw] OR
183. meige syndrome*[tw] OR
184. Meningeal Carcinomatosis[tw] OR
185. Meningeal Neoplasm*[tw] OR
186. Meningioma[tw] OR
187. meningit*[tw] OR
188. Meningocele[tw] OR
189. Meningoencephalitis[tw] OR
190. Meningomyelocele[tw] OR
191. Microcephaly[tw] OR
192. migraine[tw] OR
193. Mild Cognitive Impairment[tw] OR
194. Miller Fisher Syndrome*[tw] OR
195. Mood disorder*[tw] OR
196. Morgellons Disease[tw] OR
197. Morphine Dependence[tw] OR
198. Motor disorder*[tw] OR
199. Motor Skills disorder*[tw] OR
200. movement disorder*[tw] OR
201. Multiple Personality Disorder*[tw] OR
202. Multiple System Atroph*[tw] OR
203. Munchausen Syndrome[tw] OR
204. Mutism[tw] OR
205. myastheni*[tw] OR
206. myelinolysis[tw] OR
207. myelitis[tw] OR
208. Narcolepsy[tw] OR
209. Neonatal Abstinence Syndrome[tw] OR
210. nerve disease*[tw] OR
211. nerve injur*[tw] OR
212. Nerve Sheath Neoplasm*[tw] OR
213. neural tube defect*[tw] OR
214. Neurasthenia[tw] OR
215. Neurocognitive disorder*[tw] OR
216. Neurocytoma*[tw] OR
217. Neurodevelopmental disorder*[tw] OR
218. Neurofibroma[tw] OR
219. neurofibromatos*[tw] OR
220. neurological syndrome*[tw] OR
221. neuron disease*[tw] OR
222. neuropath*[tw] OR
223. Neurotic[tw] OR
224. Neurotic disorder*[tw] OR
225. Night Terror*[tw] OR
226. Nocturnal Myoclonus Syndrome*[tw] OR

227. Nocturnal Paroxysmal Dystonia[tw] OR
228. Obsessive Hoarding[tw] OR
229. Obsessive-Compulsive[tw] OR
230. occular motility[tw] OR
231. Oculomotor Nerve Disease*[tw] OR
232. Oculomotor Nerve Injur*[tw] OR
233. Olivopontocerebellar Atroph*[tw] OR
234. Ophthalmoplegia[tw] OR
235. Ophthalmoplegic Migraine[tw] OR
236. Opioid-Related disorder*[tw] OR
237. Opsoclonus-Myoclonus Syndrome*[tw] OR
238. Optic Nerve Glioma[tw] OR
239. Optic Nerve Neoplasm*[tw] OR
240. Orthostatic Intolerance*[tw] OR
241. pain syndrome*[tw] OR
242. Panic[tw] OR
243. paralys*[tw] OR
244. Paranoi*[tw] OR
245. Paranoid Personality Disorder[tw] OR
246. Paraphilic disorder*[tw] OR
247. Parasomnia*[tw] OR
248. paresis[tw] OR
249. parkinson*[tw] OR
250. Passive-Aggressive Personality Disorder[tw] OR
251. Pathologic Nystagmus[tw] OR
252. Pedophilia[tw] OR
253. Pentalogy of Cantrell[tw] OR
254. persistent vegetative[tw] OR
255. Personality disorder*[tw] OR
256. Phencyclidine Abuse[tw] OR
257. Phobic disorder*[tw] OR
258. Phosphodiesterase Inhibitors[tw] OR
259. Pick Disease of the Brain[tw] OR
260. Pinealoma[tw] OR
261. Pinealoma*[tw] OR
262. Pituitary Disease*[tw] OR
263. pneumocephal*[tw] OR
264. Pneumocephalus[tw] OR
265. poliomyeliti*[tw] OR
266. Polymicrogyria[tw] OR
267. Porencephaly[tw] OR
268. Premature Ejaculation/psychology[tw] OR
269. Premenstrual Dysphoric Disorder[tw] OR
270. Primary Progressive Nonfluent Aphasia[tw] OR
271. Pseudotumor Cerebri[tw] OR
272. Psychological Trauma[tw] OR
273. Psychoses[tw] OR
274. Psychosis[tw] OR
275. Psychotic[tw] OR
276. Psychotropic Drugs[tw] OR
277. Reactive Attachment Disorder*[tw] OR
278. Reflex Sympathetic Dystroph*[tw] OR
279. Refsum Disease*[tw] OR

280. restless legs syndrome*[tw] OR
281. Reye Syndrome*[tw] OR
282. Sadism[tw] OR
283. Schizencephaly[tw] OR
284. Schizoid Personality Disorder[tw] OR
285. Schizophreni*[tw] OR
286. Schizophrenia[tw] OR
287. Schizotypal Personality Disorder[tw] OR
288. sclerosis[tw] OR
289. Seasonal Affective Disorder[tw] OR
290. seizure*[tw] OR
291. septo-optic dyspla*[tw] OR
292. Serotonin*[tw] OR
293. Sexual and Gender disorder*[tw] OR
294. Shared Paranoid Disorder[tw] OR
295. Shy-Drager Syndrome*[tw] OR
296. Sinus Pericranii[tw] OR
297. Sleep Arousal Disorder*[tw] OR
298. Sleep Bruxism[tw] OR
299. Sleep Deprivation[tw] OR
300. sleep disorder*[tw] OR
301. Sleep Paralysis[tw] OR
302. Sleep Wake disorder*[tw] OR
303. smith-magenis[tw] OR
304. Sneddon Syndrome*[tw] OR
305. Somatoform disorder*[tw] OR
306. Somnambulism[tw] OR
307. Spastic Paraplegia[tw] OR
308. Speech disorder*[tw] OR
309. Spina Bifida Cystica[tw] OR
310. Spina Bifida Occulta[tw] OR
311. spinal cord disease*[tw] OR
312. Spinal Cord Neoplasm*[tw] OR
313. Spinal Dysraphism[tw] OR
314. Stereotypic Movement Disorder[tw] OR
315. stiff-person[tw] OR
316. Strabismus[tw] OR
317. Stress disorder*[tw] OR
318. Striatonigral Degeneration*[tw] OR
319. stroke*[tw] OR
320. sturge-weber syndrome*[tw] OR
321. Substance Abuse[tw] OR
322. Substance Withdrawal Syndrome[tw] OR
323. Substance-Related disorder*[tw] OR
324. supranuclear palsy[tw] OR
325. Supratentorial Neoplasm*[tw] OR
326. Susac Syndrome*[tw] OR
327. Tic disorder*[tw] OR
328. Tobacco Use Disorder[tw] OR
329. Tolosa-Hunt Syndrome*[tw] OR
330. Torticollis[tw] OR
331. Tourette Syndrome[tw] OR
332. tourette* syndrome*[tw] OR

333. Transsexualism[tw] OR
334. Transvestism[tw] OR
335. Trichotillomania[tw] OR
336. tuberous sclerosis[tw] OR
337. Uveomeningoencephalitic Syndrome[tw] OR
338. Vaginismus[tw] OR
339. Vascular Headache*[tw] OR
340. Vein of Galen Malformation*[tw] OR
341. vertigo[tw] OR
342. Voyeurism[tw] OR
343. Wernicke Encephalopathy[tw]

9.2.1. PubMed Search string

((arteritis[tw] OR vasculitis[tw]) AND nervous system[tw]) OR ((central nervous system[tw] OR peripheral nervous system[tw]) AND (cyst*[tw] OR malformation*[tw] OR cancer[tw] OR neoplasm*[tw])) OR Acoustic Neuroma[tw] OR Acrocallosal Syndrome*[tw] OR adie syndrome*[tw] OR Adjustment disorder*[tw] OR Adrenergic*[tw] OR Affective disorder*[tw] OR Agoraphobi*[tw] OR Agraphia[tw] OR Aicardi Syndrome*[tw] OR AIDS Dementia Complex[tw] OR akathisia[tw] OR Akinetic Mutism[tw] OR Alcohol Withdrawal Delirium[tw] OR Alcohol Withdrawal Seizures[tw] OR Alcoholic Intoxication[tw] OR Alcohol-Induced disorder*[tw] OR Alcoholism[tw] OR Alcohol-Related disorder*[tw] OR Alexia[tw] OR Alstrom Syndrome*[tw] OR Alzheimer Disease[tw] OR Amblyopia[tw] OR Amnesia[tw] OR Amphetamine-Related disorder*[tw] OR Anencephaly[tw] OR Angelman Syndrome*[tw] OR Anomia[tw] OR Anorexia Nervosa[tw] OR Antidepressive*[tw] OR Anti-obesity*[tw] OR Antiparkinson*[tw] OR Antipsychotic Agents[tw] OR Antipsychotic* [tw] OR Antisocial Personality Disorder[tw] OR Anxiety[tw] OR Aphasia[tw] OR Arachnoid Cyst*[tw] OR Arachnoiditis[tw] OR Arnold-Chiari Malformation*[tw] OR Asperger Syndrome[tw] OR Asthenia[tw] OR ataxia telangiectas*[tw] OR Attention Deficit and Disruptive Behavior disorder*[tw] OR Auditory Perceptual disorder*[tw] OR Autism Spectrum Disorder[tw] OR Autistic Disorder[tw] OR Bardet-Biedl Syndrome*[tw] OR Battered Child Syndrome[tw] OR Binge Drinking[tw] OR Binge-Eating Disorder[tw] OR Bipolar[tw] OR Body Dysmorphic disorder*[tw] OR Borderline Personality Disorder[tw] OR botulism[tw] OR Brain Concussion*[tw] OR brain death[tw] OR Brain Edema*[tw] OR brain Hypoxia*[tw] OR brain injur*[tw] OR Brain Ischemia[tw] OR Brain Neoplasm*[tw] OR Bulimia Nervosa[tw] OR CADASIL[tw] OR Cannabinoid*[tw] OR Capgras Syndrome[tw] OR Cataplex*[tw] OR Causalgia[tw] OR Cerebellar Neoplasm*[tw] OR cerebral palsy[tw] OR cerebral toxoplasmos*[tw] OR Cerebral Ventricle Neoplasm*[tw] OR Cerebral Ventriculitis[tw] OR Charcot-Marie-Tooth Disease[tw] OR Child Behavior disorder*[tw] OR Child Development disorder*[tw] OR Cholinergic*[tw] OR Chorea[tw] OR Cocaine-Related disorder*[tw] OR Cognition disorder*[tw] OR Colloid Cyst*[tw] OR Combat disorder*[tw] OR Communication disorder*[tw] OR Compulsive Personality Disorder[tw] OR Congenital nystagmus[tw] OR Consciousness disorder*[tw] OR Conversion Disorder[tw] OR cranial nerve cancer*[tw] OR cranial nerve neoplasm*[tw] OR Creutzfeldt-Jakob Syndrome[tw] OR Creutzfeldt-Jakob Syndrome*[tw] OR Cyclothymic Disorder[tw] OR Cytochrome*[tw] OR dandy-walker[tw] OR Delirium[tw] OR Delusional Parasitosis[tw] OR Dementia[tw] OR Demyelin*[tw] OR Dependent Personality Disorder[tw] OR Depressi*[tw] OR Developmental Disabilit*[tw] OR Diffuse Neurofibrillary Tangles with Calcification[tw] OR Dissociative disorder*[tw] OR Dopamine* [tw] OR Duane Retraction Syndrome*[tw] OR dysautonomi*[tw] OR Dyscalculia[tw] OR Dyskinesias[tw] OR Dyslexia[tw] OR Dyspareunia/psychology[tw] OR dysreflexia[tw] OR Dyssomnia*[tw] OR Dysthymic Disorder[tw] OR Dystonia Musculorum Deformans[tw] OR Dystonic Disorder*[tw] OR Elimination disorder*[tw] OR Encephalocele[tw] OR encephalomyelitis[tw] OR Encopresis[tw] OR Enuresis[tw] OR Epidural Neoplasm*[tw] OR epilepsy[tw] OR epilept*[tw] OR Erectile Dysfunction/psychology[tw] OR Esotropia*[tw] OR Essential Tremor*[tw] OR Exhibitionism[tw] OR Exotropia*[tw] OR Factitious disorder*[tw] OR fatigue syndrome*[tw] OR Feeding and Eating disorder*[tw] OR Female Athlete Triad Syndrome[tw] OR Fetal Alcohol Spectrum disorder*[tw] OR

Fetishism[tw] OR Firesetting[tw] OR Frontotemporal Dementia[tw] OR Frontotemporal Lobar Degeneration[tw] OR Gambling[tw] OR Gender Dysphoria/psychology[tw] OR Giant Axonal Neuropathy[tw] OR Guillain-Barre Syndrome*[tw] OR gustatory sweating[tw] OR Hallucinogens[tw] OR Heroin Dependence[tw] OR hippel-lindau syndrome*[tw] OR Histrionic Personality Disorder[tw] OR Hoarding Disorder[tw] OR Holoprosencephaly[tw] OR horner syndrome*[tw] OR huntington[tw] OR Huntington Disease[tw] OR hydranecephal*[tw] OR Hydrocephalus[tw] OR Hypertensive Encephalopathy[tw] OR Hypnotics and Sedatives[tw] OR Hypochondriasis[tw] OR Hypothalamic Neoplasm*[tw] OR Hysteria[tw] OR Infratentorial Neoplasm*[tw] OR Inhalant Abuse[tw] OR insomnia[tw] OR Intellectual Disabilit*[tw] OR Intracranial Arteriovenous Malformation*[tw] OR Intracranial Hypertension[tw] OR Intracranial Hypotension[tw] OR jet lag syndrome*[tw] OR kernicterus[tw] OR Kluver-Bucy Syndrome[tw] OR Kluver-Bucy Syndrome*[tw] OR Landau-Kleffner Syndrome*[tw] OR Language Development disorder*[tw] OR Language disorder*[tw] OR Laurence-Moon Syndrome*[tw] OR Learning disorder*[tw] OR Lennox Gastaut Syndrome*[tw] OR leukoencephalopath*[tw] OR Lewy Body Disease[tw] OR Lissencephaly[tw] OR marchiafava-bignami[tw] OR Marijuana Abuse[tw] OR Masochism[tw] OR Megalencephaly[tw] OR meige syndrome*[tw] OR Meningeal Carcinomatosis[tw] OR Meningeal Neoplasm*[tw] OR Meningioma[tw] OR meningit*[tw] OR Meningocele[tw] OR Meningoencephalitis[tw] OR Meningomyelocele[tw] OR Microcephaly[tw] OR migraine[tw] OR Mild Cognitive Impairment[tw] OR Miller Fisher Syndrome*[tw] OR Mood disorder*[tw] OR Morgellons Disease[tw] OR Morphine Dependence[tw] OR Motor disorder*[tw] OR Motor Skills disorder*[tw] OR movement disorder*[tw] OR Multiple Personality Disorder*[tw] OR Multiple System Atroph*[tw] OR Munchausen Syndrome[tw] OR Mutism[tw] OR myastheni*[tw] OR myelinolysis[tw] OR myelitis[tw] OR Narcolepsy[tw] OR Neonatal Abstinence Syndrome[tw] OR nerve disease*[tw] OR nerve injur*[tw] OR Nerve Sheath Neoplasm*[tw] OR neural tube defect*[tw] OR Neurasthenia[tw] OR Neurocognitive disorder*[tw] OR Neurocytoma*[tw] OR Neurodevelopmental disorder*[tw] OR Neurofibroma[tw] OR neurofibromatos*[tw] OR neurological syndrome*[tw] OR neuron disease*[tw] OR neuropath*[tw] OR Neurotic[tw] OR Neurotic disorder*[tw] OR Night Terror*[tw] OR Nocturnal Myoclonus Syndrome*[tw] OR Nocturnal Paroxysmal Dystonia[tw] OR Obsessive Hoarding[tw] OR Obsessive-Compulsive[tw] OR occular motility[tw] OR Oculomotor Nerve Disease*[tw] OR Oculomotor Nerve Injur*[tw] OR Olivopontocerebellar Atroph*[tw] OR Ophthalmoplegia[tw] OR Ophthalmoplegic Migraine[tw] OR Opioid-Related disorder*[tw] OR Opsoclonus-Myoclonus Syndrome*[tw] OR Optic Nerve Glioma[tw] OR Optic Nerve Neoplasm*[tw] OR Orthostatic Intolerance*[tw] OR pain syndrome*[tw] OR Panic[tw] OR paralys*[tw] OR Paranoi*[tw] OR Paranoid Personality Disorder[tw] OR Paraphilic disorder*[tw] OR Parasomnia*[tw] OR paresis[tw] OR parkinson*[tw] OR Passive-Aggressive Personality Disorder[tw] OR Pathologic Nystagmus[tw] OR Pedophilia[tw] OR Pentalogy of Cantrell[tw] OR persistent vegetative[tw] OR Personality disorder*[tw] OR Phencyclidine Abuse[tw] OR Phobic disorder*[tw] OR Phosphodiesterase Inhibitors[tw] OR Pick Disease of the Brain[tw] OR Pinealoma[tw] OR Pinealoma*[tw] OR Pituitary Disease*[tw] OR pneumocephal*[tw] OR Pneumocephalus[tw] OR poliomyeliti*[tw] OR Polymicrogyria[tw] OR Porencephaly[tw] OR Premature Ejaculation/psychology[tw] OR Premenstrual Dysphoric Disorder[tw] OR Primary Progressive Nonfluent Aphasia[tw] OR Pseudotumor Cerebri[tw] OR Psychological Trauma[tw] OR Psychoses[tw] OR Psychosis[tw] OR Psychotic[tw] OR Psychotropic Drugs[tw] OR Reactive Attachment Disorder*[tw] OR Reflex Sympathetic Dystroph*[tw] OR Refsum Disease*[tw] OR restless legs syndrome*[tw] OR Reye Syndrome*[tw] OR Sadism[tw] OR Schizencephaly[tw] OR Schizoid Personality Disorder[tw] OR Schizophreni*[tw] OR Schizophrenia[tw] OR Schizotypal Personality Disorder[tw] OR sclerosis[tw] OR Seasonal Affective Disorder[tw] OR seizure*[tw] OR septo-optic dyspla*[tw] OR Serotonin*[tw] OR Sexual and Gender disorder*[tw] OR Shared Paranoid Disorder[tw] OR Shy-Drager Syndrome*[tw] OR Sinus Pericranii[tw] OR Sleep Arousal Disorder*[tw] OR Sleep Bruxism[tw] OR Sleep Deprivation[tw] OR sleep disorder*[tw] OR Sleep Paralysis[tw] OR Sleep Wake disorder*[tw] OR smith-magenis[tw] OR Sneddon Syndrome*[tw] OR Somatoform disorder*[tw] OR Somnambulism[tw] OR Spastic Paraplegia[tw] OR Speech disorder*[tw] OR Spina Bifida Cystica[tw] OR Spina Bifida Occulta[tw] OR spinal cord disease*[tw] OR Spinal Cord Neoplasm*[tw] OR Spinal Dysraphism[tw] OR Stereotypic Movement Disorder[tw] OR stiff-person[tw] OR Strabismus[tw] OR Stress disorder*[tw] OR Striatonigral Degeneration*[tw] OR stroke*[tw] OR sturge-weber syndrome*[tw] OR Substance Abuse[tw] OR Substance Withdrawal Syndrome[tw] OR Substance-Related disorder*[tw] OR supranuclear palsy[tw] OR Supratentorial Neoplasm*[tw] OR Susac Syndrome*[tw] OR Tic disorder*[tw] OR Tobacco Use Disorder[tw] OR Tolosa-Hunt Syndrome*[tw] OR Torticollis[tw] OR Tourette Syndrome[tw] OR tourette* syndrome*[tw] OR Transsexualism[tw] OR Transvestism[tw] OR Trichotillomania[tw] OR tuberous sclerosis[tw] OR Uveomeningoencephalitic Syndrome[tw] OR Vaginismus[tw] OR Vascular Headache*[tw] OR Vein of Galen Malformation*[tw] OR vertigo[tw] OR Voyeurism[tw] OR Wernicke Encephalopathy[tw]

9.3. FACET C Search terms

This search covers the following journals:

Used search term	PubMed translated search term
0065-1400[ta]	"Acta Neurobiol Exp (Wars)"[Journal]
0001-6268[ta]	"Acta Neurochir (Wien)"[Journal]
0300-9009[ta]	"Acta Neurol Belg"[Journal]
0001-6314[ta]	"Acta Neurol Scand"[Journal]
0001-6322[ta]	"Acta Neuropathol"[Journal]
0365-558X[ta]	"Acta Psychiatr Neurol"[Journal]
0360-1293[ta]	"Acupunct Electrother Res"[Journal]
0091-3960[ta]	"Am J Acupunct"[Journal]
0195-6108[ta]	"AJNR Am J Neuroradiol"[Journal]
0364-5134[ta]	"Ann Neurol"[Journal]
0302-2773[ta]	"Appl Neurophysiol"[Journal]
0003-9829[ta]	"Arch Ital Biol"[Journal]
0003-9942[ta]	"Arch Neurol"[Journal]
0004-0576[ta]	"Arch Neurobiol (Madr)"[Journal]
0140-525X[ta]	"Behav Brain Sci"[Journal]
0163-1047[ta]	"Behav Neural Biol"[Journal]
0166-4328[ta]	"Behav Brain Res"[Journal]
0340-1200[ta]	"Biol Cybern"[Journal]
0006-3223[ta]	"Biol Psychiatry"[Journal]
0006-8950[ta]	"Brain"[Journal]
0093-934X[ta]	"Brain Lang"[Journal]
0006-8977[ta]	"Brain Behav Evol"[Journal]
0006-8993[ta]	"Brain Res"[Journal]
0361-9230[ta]	"Brain Res Bull"[Journal]
0165-0173[ta]	"Brain Res Rev"[Journal] OR "Brain Res Brain Res Rev"[Journal]
0317-1671[ta]	"Can J Neurol Sci"[Journal]
0379-864X[ta]	"Chem Senses"[Journal]
0302-2803[ta]	"Childs Brain"[Journal]
0009-9155[ta]	"Clin Electroencephalogr"[Journal]
0303-8467[ta]	"Clin Neurol Neurosurg"[Journal]
0010-9452[ta]	"Cortex"[Journal]
0149-936X[ta]	"J Comput Tomogr"[Journal]
0012-1622[ta]	"Dev Med Child Neurol"[Journal]
0378-5866[ta]	"Dev Neurosci"[Journal]
0012-3714[ta]	"Dis Nerv Syst"[Journal]
0012-7590[ta]	"EEG EMG Z Elektroenzephalogr Elektromyogr Verwandte Geb"[Journal]
0013-4694[ta]	"Electroencephalogr Clin Neurophysiol"[Journal]
0301-150X[ta]	"Electromyogr Clin Neurophysiol"[Journal]
0013-7006[ta]	"Encephale"[Journal]
0013-9580[ta]	"Epilepsia"[Journal]

0014-3022[ta]	"Eur Neurol"[Journal]
0014-4819[ta]	"Exp Brain Res"[Journal]
0014-4886[ta]	"Exp Neurol"[Journal]
0015-5721[ta]	"Folia Psychiatr Neurol Jpn"[Journal]
0720-4299[ta]	"Fortschr Neurol Psychiatr"[Journal]
0015-8194[ta]	"Fortschr Neurol Psychiatr Grenzgeb"[Journal]
0017-8748[ta]	"Headache"[Journal]
0378-5955[ta]	"Hear Res"[Journal]
0020-7454[ta]	"Int J Neurosci"[Journal]
0392-0461[ta]	"Ital J Neurol Sci"[Journal]
0021-8359[ta]	"J Hirnforsch"[Journal]
0165-0327[ta]	"J Affect Disord"[Journal]
0144-1795[ta]	"J Auton Pharmacol"[Journal]
0021-9967[ta]	"J Comp Neurol"[Journal]
0022-264X[ta]	"J Ment Defic Res"[Journal]
0022-3018[ta]	"J Nerv Ment Dis"[Journal]
0300-9564[ta]	"J Neural Transm (Vienna)"[Journal]
0022-3034[ta]	"J Neurobiol"[Journal]
0022-3042[ta]	"J Neurochem"[Journal]
0300-4864[ta]	"J Neurocytol"[Journal]
0340-5354[ta]	"J Neurol"[Journal]
0022-3050[ta]	"J Neurol Neurosurg Psychiatry"[Journal]
0022-3069[ta]	"J Neuropathol Exp Neurol"[Journal]
0022-3077[ta]	"J Neurophysiol"[Journal]
0150-9861[ta]	"J Neuroradiol"[Journal]
0165-0270[ta]	"J Neurosci Methods"[Journal]
0360-4012[ta]	"J Neurosci Res"[Journal]
0022-3085[ta]	"J Neurosurg"[Journal]
0022-3751[ta]	"J Physiol"[Journal]
0165-1838[ta]	"J Auton Nerv Syst"[Journal]
0022-510X[ta]	"J Neurol Sci"[Journal]
0148-639X[ta]	"Muscle Nerve"[Journal]
0028-2804[ta]	"Nervenarzt"[Journal]
0197-4580[ta]	"Neurobiol Aging"[Journal]
0364-3190[ta]	"Neurochem Res"[Journal]
0028-3819[ta]	"Neurochirurgia (Stuttg)"[Journal]
0028-3770[ta]	"Neurochirurgie"[Journal]
0028-3835[ta]	"Neuroendocrinology"[Journal]
0028-3878[ta]	"Neurology"[Journal]
0305-1846[ta]	"Neuropathol Appl Neurobiol"[Journal]
0174-304X[ta]	"Neuropediatrics"[Journal]
0143-4179[ta]	"Neuropeptides"[Journal]
0028-3908[ta]	"Neuropharmacology"[Journal]
0090-2977[ta]	"Neurophysiology"[Journal]
0028-3932[ta]	"Neuropsychologia"[Journal]
0028-3940[ta]	"Neuroradiology"[Journal]
0306-4522[ta]	"Neuroscience"[Journal]
0149-7634[ta]	"Neurosci Biobehav Rev"[Journal]
0304-3940[ta]	"Neurosci Lett"[Journal]
0028-3967[ta]	"Neurosci Res Program Bull"[Journal]
0148-396X[ta]	"Neurosurgery"[Journal]
0161-813X[ta]	"Neurotoxicology"[Journal]
0304-3959[ta]	"Pain"[Journal]
0031-1758[ta]	"Paraplegia"[Journal]
0091-3057[ta]	"Pharmacol Biochem Behav"[Journal]

0301-0082[ta]	"Prog Neurobiol"[Journal]
0364-7722[ta]	"Prog Neuropsychopharmacol"[Journal]
0306-4530[ta]	"Psychoneuroendocrinology"[Journal]
0033-3158[ta]	"Psychopharmacology (Berl)"[Journal]
0048-5772[ta]	"Psychophysiology"[Journal]
0035-3787[ta]	"Rev Neurol (Paris)"[Journal]
0161-8105[ta]	"Sleep"[Journal]
0362-2436[ta]	"Spine (Phila Pa 1976)"[Journal]
0039-2499[ta]	"Stroke"[Journal]
0166-2236[ta]	"Trends Neurosci"[Journal]
0042-6989[ta]	"Vision Res"[Journal]
0044-4677[ta]	"Zh Vyssh Nerv Deiat Im I P Pavlova"[Journal]
0387-7604[ta]	"Brain Dev"[Journal]
0272-4340[ta]	"Cell Mol Neurobiol"[Journal]
0333-1024[ta]	"Cephalalgia"[Journal]
0165-3806[ta]	"Brain Res Dev Brain Res"[Journal]
0271-678X[ta]	"J Cereb Blood Flow Metab"[Journal]
0272-846X[ta]	"J Clin Neuroophthalmol"[Journal]
0165-5728[ta]	"J Neuroimmunol"[Journal]
0270-6474[ta]	"J Neurosci"[Journal]
0275-1380[ta]	"Neurobehav Toxicol Teratol"[Journal]
0172-780X[ta]	"Neuro Endocrinol Lett"[Journal]
0165-8107[ta]	"Neuroophthalmology"[Journal]
0065-9479[ta]	"Trans Am Neurol Assoc"[Journal]
0722-5091[ta]	"Clin Neuropathol"[Journal]
0362-5664[ta]	"Clin Neuropharmacol"[Journal]
0069-4827[ta]	"Clin Neurosurg"[Journal]
0091-3022[ta]	"Front Neuroendocrinol"[Journal]
0165-0475[ta]	"J Clin Neuropsychol"[Journal]
0197-0186[ta]	"Neurochem Int"[Journal]
0278-5846[ta]	"Prog Neuropsychopharmacol Biol Psychiatry"[Journal]
0271-8235[ta]	"Semin Neurol"[Journal]
0735-7044[ta]	"Behav Neurosci"[Journal]
0278-2626[ta]	"Brain Cogn"[Journal]
0940-1334[ta]	"Eur Arch Psychiatry Clin Neurosci"[Journal]
0742-3098[ta]	"J Pineal Res"[Journal]
0736-0258[ta]	"J Clin Neurophysiol"[Journal]
0721-9075[ta]	"Hum Neurobiol"[Journal]
0167-594X[ta]	"J Neurooncol"[Journal]
0733-8619[ta]	"Neurol Clin"[Journal]
0736-5748[ta]	"Int J Dev Neurosci"[Journal]
0742-941X[ta]	"CRC Crit Rev Clin Neurobiol"[Journal]
0734-600X[ta]	"Neurochem Pathol"[Journal]
0256-7040[ta]	"Childs Nerv Syst"[Journal]
0167-7063[ta]	"J Neurogenet"[Journal]
0344-5607[ta]	"Neurosurg Rev"[Journal]
0912-2036[ta]	"Jpn J Psychiatry Neurol"[Journal]
0169-328X[ta]	"Brain Res Mol Brain Res"[Journal]
0883-0738[ta]	"J Child Neurol"[Journal]
0885-7490[ta]	"Metab Brain Dis"[Journal]
0892-0915[ta]	"Crit Rev Neurobiol"[Journal]
0251-5350[ta]	"Neuroepidemiology"[Journal]
0893-133X[ta]	"Neuropsychopharmacology"[Journal]
0340-7594[ta]	"J Comp Physiol A Neuroethol Sens Neural Behav Physiol"[Journal]
0920-1211[ta]	"Epilepsy Res"[Journal]

0168-0102[ta]	"Neurosci Res"[Journal]
0887-8994[ta]	"Pediatr Neurol"[Journal]
0887-4476[ta]	"Synapse"[Journal]
0893-7648[ta]	"Mol Neurobiol"[Journal]
0885-3185[ta]	"Mov Disord"[Journal]
0892-0362[ta]	"Neurotoxicol Teratol"[Journal]
0952-5238[ta]	"Vis Neurosci"[Journal]
0749-8047[ta]	"Clin J Pain"[Journal]
0894-1491[ta]	"Glia"[Journal]
0893-6080[ta]	"Neural Netw"[Journal]
0896-6273[ta]	"Neuron"[Journal]
0899-0220[ta]	"Somatosens Mot Res"[Journal]
0951-7383[ta]	"Curr Opin Neurol Neurosurg"[Journal]
0268-7038[ta]	"Aphasiology"[Journal]
0893-6609[ta]	"Neurosci Res Commun"[Journal]
1011-6125[ta]	"Stereotact Funct Neurosurg"[Journal]
0895-8696[ta]	"J Mol Neurosci"[Journal]

9.3.1. PubMed Search string

0065-1400[ta] OR 0001-6268[ta] OR 0300-9009[ta] OR 0300-9009[ta] OR 0001-6314[ta] OR 0001-6322[ta] OR 0001-6322[ta] OR 0365-558X[ta] OR 0001-6314[ta] OR 0360-1293[ta] OR 0302-4350[ta] OR 0302-4350[ta] OR 0091-3960[ta] OR 0195-6108[ta] OR 0195-6108[ta] OR 0364-5134[ta] OR 0364-5134[ta] OR 0302-2773[ta] OR 0003-9829[ta] OR 0003-9942[ta] OR 0004-0576[ta] OR 0140-525X[ta] OR 0163-1047[ta] OR 0166-4328[ta] OR 0340-1200[ta] OR 0006-3223[ta] OR 0006-8950[ta] OR 0006-8950[ta] OR 0093-934X[ta] OR 0006-8977[ta] OR 0006-8993[ta] OR 0361-9230[ta] OR 0165-0173[ta] OR 0317-1671[ta] OR 0379-864X[ta] OR 0302-2471[ta] OR 0302-2803[ta] OR 0009-9155[ta] OR 0303-8467[ta] OR 0010-9452[ta] OR 0149-936X[ta] OR 0012-1622[ta] OR 0378-5866[ta] OR 0012-3714[ta] OR 0012-7590[ta] OR 0013-4694[ta] OR 0301-150X[ta] OR 0013-7006[ta] OR 0013-9580[ta] OR 0014-3022[ta] OR 0014-3022[ta] OR 0014-4819[ta] OR 0014-4886[ta] OR 0015-5721[ta] OR 0720-4299[ta] OR 0015-8194[ta] OR 0017-8748[ta] OR 0378-5955[ta] OR 0020-7454[ta] OR 0392-0461[ta] OR 0392-0461[ta] OR 0021-8359[ta] OR 0165-0327[ta] OR 0144-1795[ta] OR 0021-9967[ta] OR 0022-264X[ta] OR 0022-3018[ta] OR 0300-9564[ta] OR 0300-9564[ta] OR 0022-3034[ta] OR 0022-3042[ta] OR 0300-4864[ta] OR 0340-5354[ta] OR 0022-3050[ta] OR 0022-3069[ta] OR 0022-3069[ta] OR 0022-3077[ta] OR 0150-9861[ta] OR 0150-9861[ta] OR 0165-0270[ta] OR 0360-4012[ta] OR 0022-3085[ta] OR 0022-3751[ta] OR 0165-1838[ta] OR 0022-510X[ta] OR 0022-510X[ta] OR 0148-639X[ta] OR 0148-639X[ta] OR 0028-2804[ta] OR 0197-4580[ta] OR 0364-3190[ta] OR 0028-3819[ta] OR 0028-3770[ta] OR 0028-3835[ta] OR 0028-3878[ta] OR 0305-1846[ta] OR 0305-1846[ta] OR 0174-304X[ta] OR 0143-4179[ta] OR 0028-3908[ta] OR 0090-2977[ta] OR 0028-3932[ta] OR 0028-3940[ta] OR 0028-3940[ta] OR 0306-4522[ta] OR 0149-7634[ta] OR 0304-3940[ta] OR 0028-3967[ta] OR 0148-396X[ta] OR 0161-813X[ta] OR 0304-3959[ta] OR 0304-3959[ta] OR 0031-1758[ta] OR 0091-3057[ta] OR 0301-0082[ta] OR 0364-7722[ta] OR 0306-4530[ta] OR 0033-3158[ta] OR 0048-5772[ta] OR 0035-1857[ta] OR 0035-3787[ta] OR 0161-8105[ta] OR 0161-8105[ta] OR 0362-2436[ta] OR 0039-2499[ta] OR 0166-2236[ta] OR 0042-6989[ta] OR 0044-4677[ta] OR 0387-7604[ta] OR 0272-4340[ta] OR 0333-1024[ta] OR 0333-1024[ta] OR 0165-3806[ta] OR 0165-7003[ta] OR 0271-678X[ta] OR 0272-846X[ta] OR 0165-5728[ta] OR 0270-6474[ta] OR 0275-1380[ta] OR 0172-780X[ta] OR 0165-8107[ta] OR 0065-9479[ta] OR 0722-5091[ta] OR 0362-5664[ta] OR 0069-4827[ta] OR 0069-4827[ta] OR 0091-3022[ta] OR 0165-0475[ta] OR 0197-0186[ta] OR 0278-5846[ta] OR 0278-5846[ta] OR 0271-8235[ta] OR 0735-7044[ta] OR 0278-2626[ta] OR 0722-1541[ta] OR 0378-4045[ta] OR 0940-1334[ta] OR 0742-3098[ta] OR 0736-0258[ta] OR 0736-0258[ta] OR 0721-9075[ta] OR 0167-594X[ta] OR 0733-8619[ta] OR 0733-8619[ta] OR 0736-5748[ta] OR 0742-941X[ta] OR 0197-3681[ta] OR 0734-600X[ta] OR 0256-7040[ta] OR 0167-7063[ta] OR 0344-5607[ta] OR 0727-761X[ta] OR 0361-0209[ta] OR 0887-6169[ta] OR 0912-2036[ta] OR 0169-328X[ta] OR 0883-0738[ta] OR 0885-7490[ta] OR 0892-0915[ta] OR 0251-5350[ta] OR 0893-133X[ta] OR 0340-

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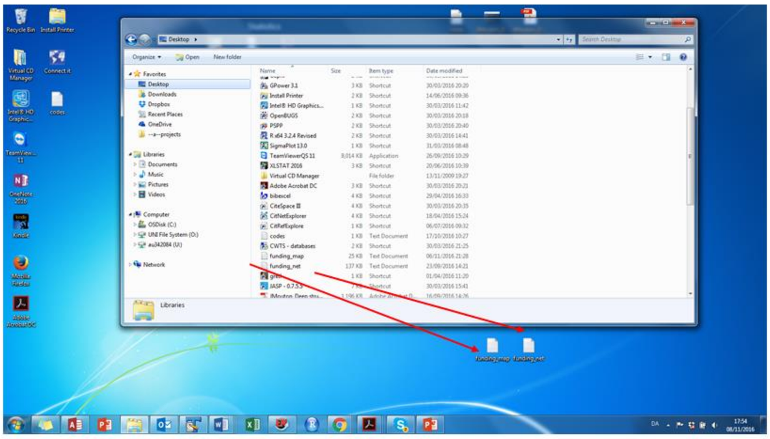
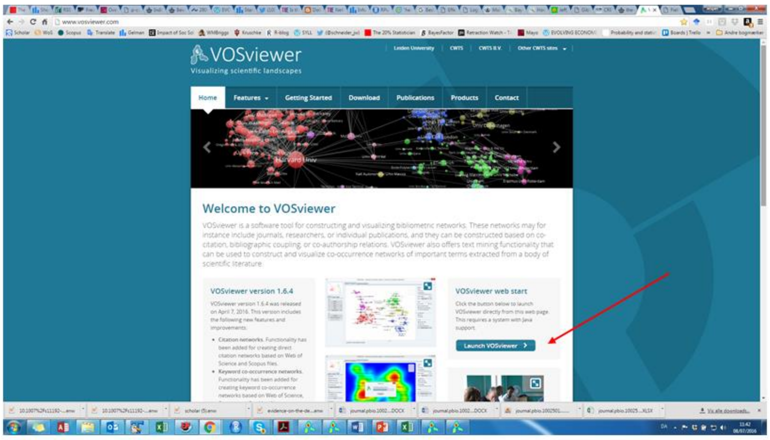
10. Appendix 3: Instructions for using vosviewer

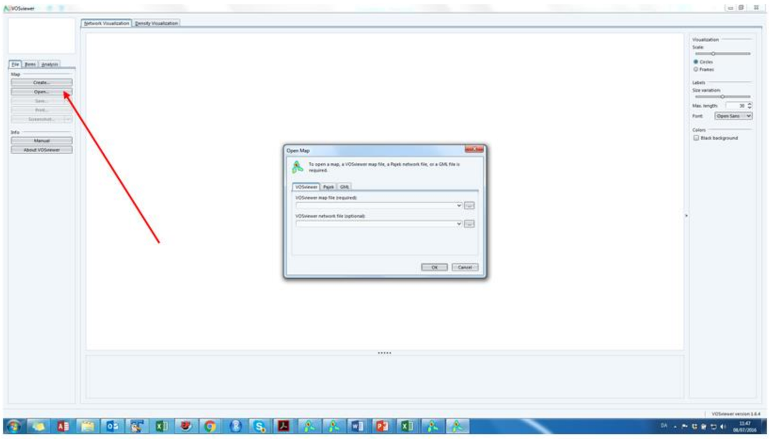
Save the two files: funding_map and funding_net somewhere on your computer, e.g. the desktop



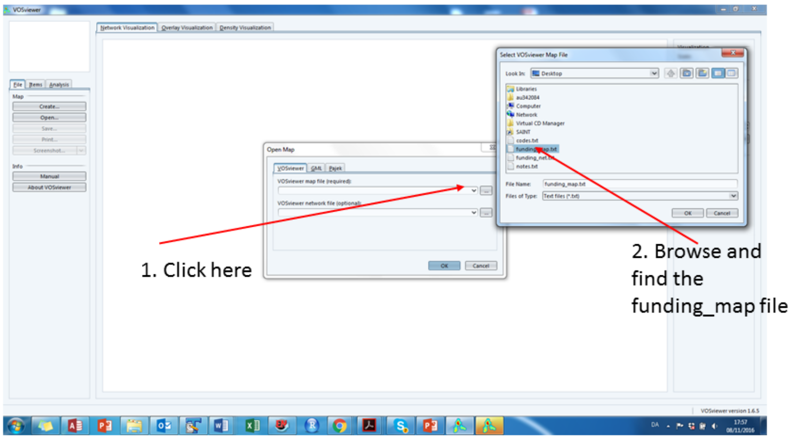
Go to www.vosvier.com and click ”launch VOSviewer



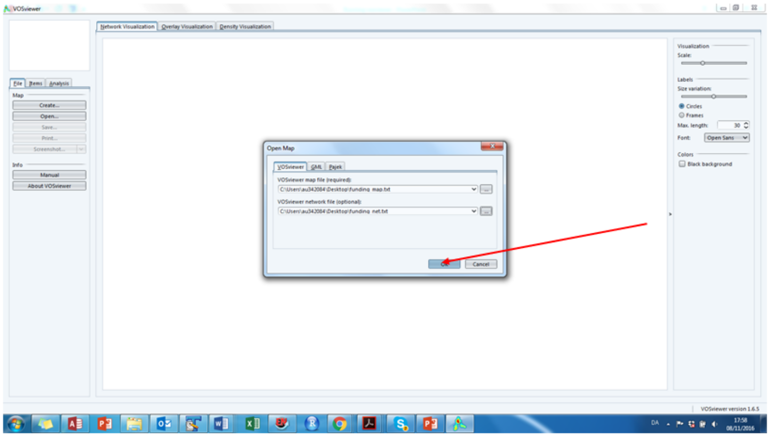
When vosviewer is running, click ”Open”



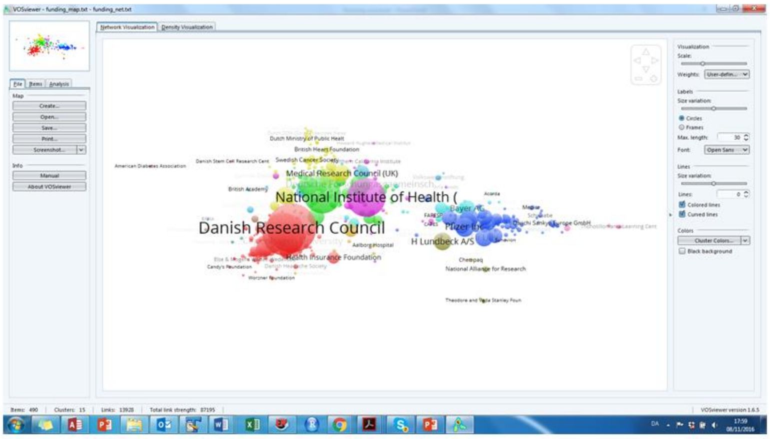
Find the two files, first find vosviewer **map** file and thereafter the **net**work file



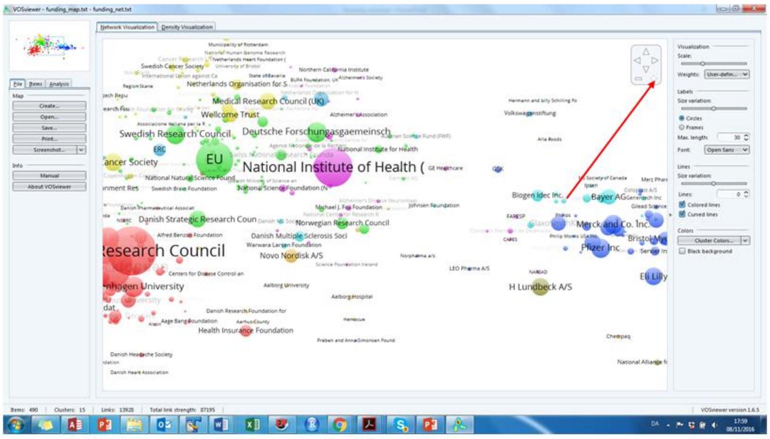
Do the same for the network file and click ”ok”



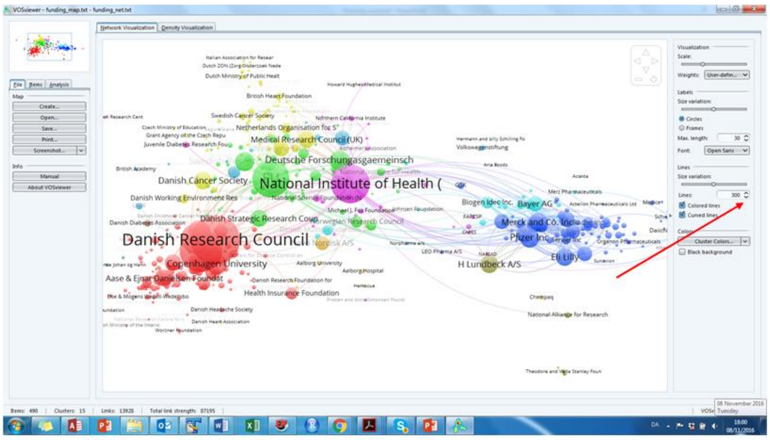
Voila – the base map



Zoom – use the mouse or as indicated below



Insert links and control the strength



Look for institutions – remember there are 3 clusters: Green (the institutes), red (other Norwegian institutions, and blue (foreign institutions)