Collaboration quadrants
– mapping the effects of international collaboration

STINT
The Swedish Foundation for International Cooperation in Research and Higher Education

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Preface

The mission of the Swedish Foundation for International Cooperation in Research and Higher Education, STINT, is to internationalize Swedish higher education institutions (HEIs). To this end, STINT has carried out a number of programs funding mobility and international collaborations. Moreover, STINT acts as a provider of knowledge relating to internationalisation with the purpose to encourage HEI's and public and private bodies to make wise investments in internationalisation.

The purpose of this study is to address all mentioned objectives. It informs about the value of the investments made so far in international collaborations (by HEIs, STINT and other actors), it provides knowledge that might lead to better decisions in the future and it signals the important value of internationalisation of research.

Inspired by a report covering research collaboration between EU and the USA (Elsevier, 2013), STINT asked Elsevier to carry out a similar study of Sweden and the ten largest Swedish HEIs. This led to the delivery of 11 commented 'collaboration quadrants'. After quality check at the Swedish HEIs, this report was made with the original quadrants as well as additional data.

The study adds to the literature arguing for the value of international collaboration in research. Moreover, the study illustrates large inter-university differences in their collaboration patterns and several issues meriting further research are forwarded.

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Content

Introduction

Purpose of study

STINT's mission is to internationalize Swedish higher education institutions (HEIs). To this end, STINT has carried out a number of programs funding individual's, group's and institution's mobility and international collaborations. Moreover, STINT acts as a provider of knowledge relating to internationalisation with the purpose to encourage HEIs and public and private bodies to make wise investments in internationalisation.

The purpose of this study is to address all mentioned objectives. It informs about the value of the investments made so far in international collaborations (by HEIs, STINT and other actors), it provides knowledge that might lead to better decisions in the future and it signals the important value of internationalisation of research.

Methodology

Inspired by the report covering research collaboration between EU and the USA (Elsevier, 2013), which among others indicated important benefits of extra-regional collaboration, STINT asked Elsevier if it would be possible to carry out a similar study of Sweden and the ten largest Swedish HEIs. This led to the delivery of 11 commented 'collaboration quadrants'. The higher education institutions (HEIs) were selected for their high number of full time equivalent teaching and research staff, under the assumption that these institutions would also have a high publication output which makes for a more accurate analysis.

Next step was to send the quadrants to the HEIs being studied for comments and quality check. All HEIs responded to the invitation and a number of comments and ideas for further analysis were provided.

In this report, the quadrants are presented in original version as well as in a version using the same scales to facilitate comparisons. In addition, some data on international collaboration is included. Data comes from Elsevier and Scopus. Tables and figures complementing the quadrants were compiled using Elsevier's tool SciVal (SciVal® database, Elsevier B.V., http://www.scival.com downloaded in May 2014).

One important limitation of the current study is that it only addresses research. Internationalisation of the other main missions of the HEI is

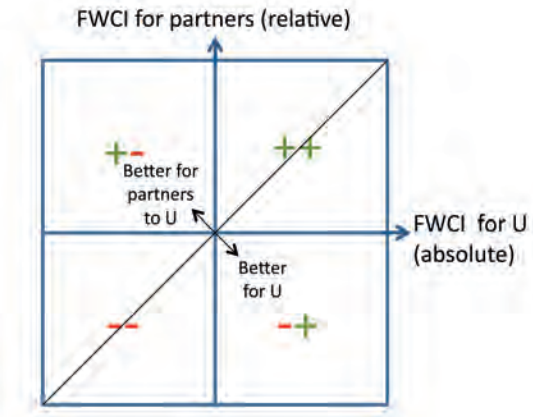
not covered. However, the existence of research collaboration between two HEIs might also indicate that there is also some type of collaboration in education or innovation.

A central indicator in this report is the field-weighted citation impact, FWCI, a proxy for research quality. It is an indicator of mean citation impact, and compares the actual number of citations received by an article with the expected number of citations for articles of the same document type (article, review or conference proceeding paper), publication year and subject field. Where the article is classified in two or more subject fields, the harmonic mean of the actual and expected citation rates is used.

The indicator is therefore always defined with reference to a global baseline of 1.0 and intrinsically accounts for differences in citation accrual over time, differences in citation rates for different document types (reviews typically attract more citations than research articles, for example) as well as subject-specific differences in citation frequencies overall and over time and document types. It is one of the most sophisticated indicators in the modern bibliometric toolkit. For a more detailed description, see Elsevier (2014).

The collaboration partners are plotted according to their effect on FWCI. The quadrants presented in this analysis reveal whether a specific collaboration is associated with a positive effect on FWCI for one partner, for the other partner, for both, or for neither, cf Figure 1.

Figure 1: **Schematic collaboration quadrant**



The x-axis represents the FWCI of the collaboration between the HEI in focus (called 'U' in Figure 1) and the other institutions. On this axis a vertical line is placed indicating the average FWCI of international collaborative publications for the HEI in focus. Therefore, if a collaborating institution appears to the right of this line, the collaboration can be considered to be beneficial to that HEI. Another vertical line indicates the average FWCI for all publications by the HEI in focus. In all cases, this line is to the left of the vertical line for international collaborative publications, which signifies that international co-publications have a higher quality when FWCI is used as an indicator.

The y-axis shows the fold increase in FWCI for each collaborating institution's average of internationally collaborative publications. To see exactly how much higher (or lower) the FWCI of collaborative papers with the HEI in focus is in relation to their own respective averages (again, of internationally collaborative papers only), a horizontal line at y=1 has been added as a benchmark.

The size of the bubbles indicates the total volume of collaborative papers. It should be mentioned beforehand that the field-weighted citation impact fluctuates more when it comes to lower volumes of publication output. A few highly-cited articles could then result in a very high field-weighted citation impact. Institutions with a larger output volume tend to have a field-weighted citation impact that is closer to, for example, the world average, as the differences between the highly-cited and uncited articles are smoothed out

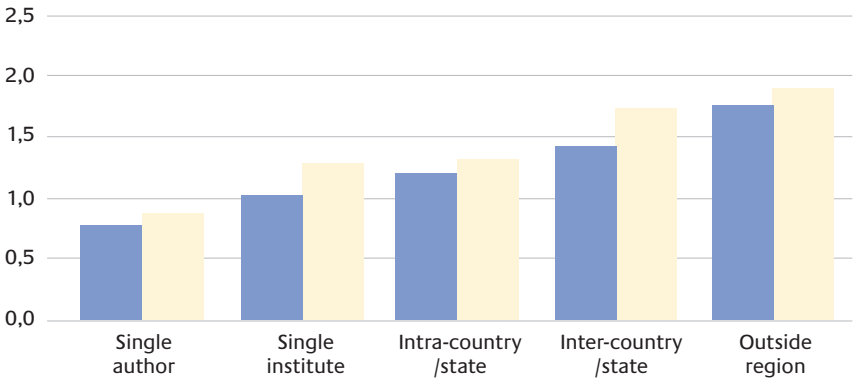
and a convergence towards the mean can be observed. This means that, as can be seen in the collaboration quadrant maps in this report, the relatively prolific collaborations more frequently show field-weighted citation impact values around the averages.

Another aspect to have in mind is that sometimes publications are the result of collaborations between large numbers of institutions and include thus hundreds of authors. Still, a publication including authors from Uppsala University and Harvard University, for example, count as one collaborative publication between these two institutions in the mapping below.

One question asked in the first review was how the number of co-authors influences the result. As the data in the quadrants builds on 'whole counts', i.e. a publication co-authored by researchers in several countries gives full credit to each country, this definitely influences the size of the bubbles: the sum of all bubbles is clearly higher than the number of publications they are based on, due to double-counting. However, as argued below, the influence on the main indicator used in this study, the FWCI, is not so strong. The alternative is fractionalisation, which means that each publication is divided by the number of authors, but this would complicate the calculation of a FWCI.

First of all, collaborative and single author papers do differ in terms of citation impact. Moreover, the distance between the co-authors also appears to have an impact. The longer distance the collaboration covers, the higher the impact, see Figure 2. The results presented in this study also tend to support this relation, even though the empirical basis is far weaker.

Figure 2: **FWCI and collaboration type (blue=EU, yellow=USA), Elsevier(2013:15)**

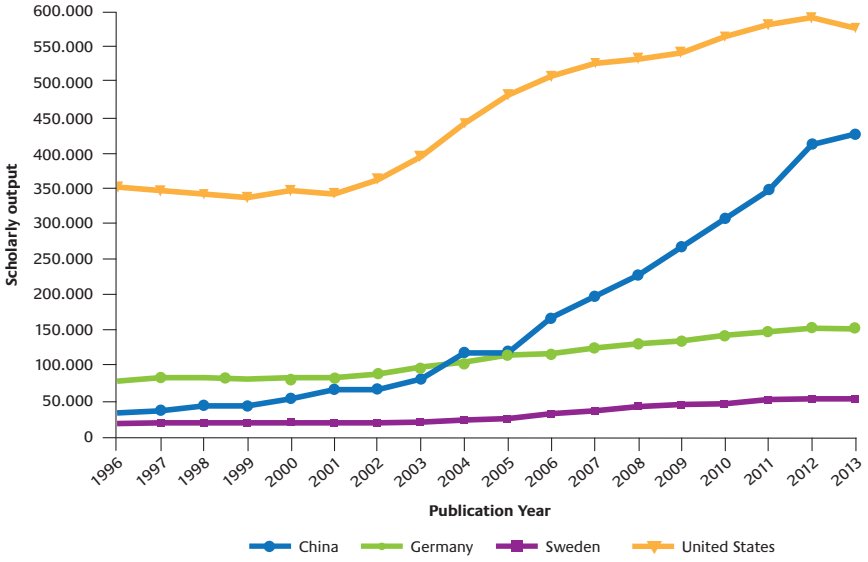


Secondly, there is not always a direct relation between the number of co-authors and the citation impact, cf. Franceschet & Costantini (2010). And finally, the calculation of the FWCI is specific for each scientific subject and each type of publication, i.e. apples are compared to apples to a large extent. If a certain subject often has hyperauthored publications, the publication still has to perform better than the average to receive a FWCI higher than one.

Sweden

The total output from Swedish universities grows annually in absolute terms. However, in relation to the total volume of scientific publications, the share diminishes slowly, as some large countries, in particular China, exhibit a rapid growth, see Figure 3.

Figure 3: **Scholarly output for Sweden and selected countries**



The share of publications with at least one Swedish and one foreign author increases, see Figure 4. Compared to other countries, Sweden has a high share of international co-publications.

In Table 1, publication data for the ten Swedish universities covered in this study is presented.

Figure 4: **Share of international co-publications for Sweden and selected countries**

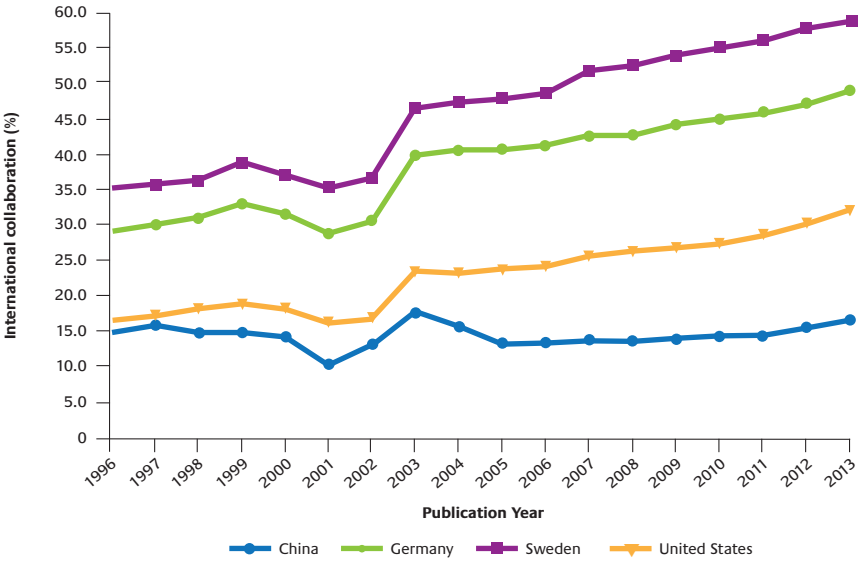


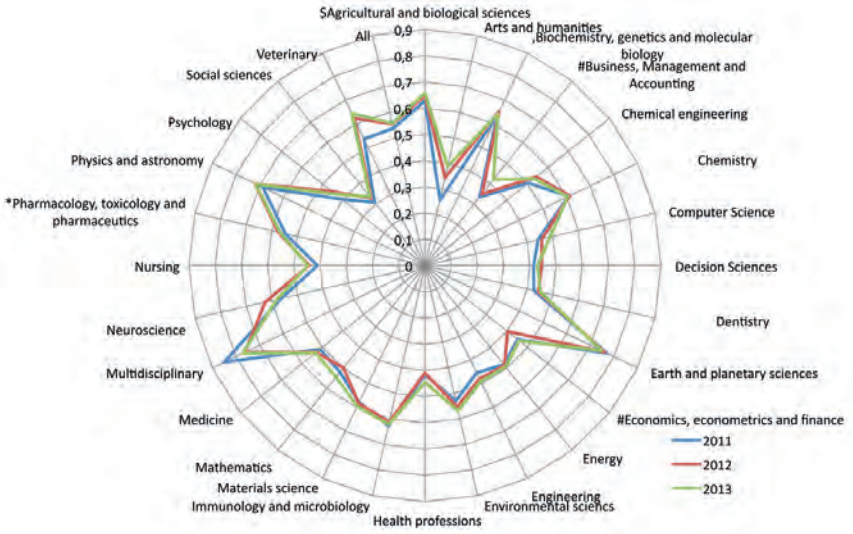
Table 1: **Key data for the ten Swedish universities covered by this study**

Description	Research and education staff[1)]	No. of publications[2)]	Share of international co-publications[2)]	FWCI overall[3)]	FWCI for international collaborations[3)]
Sweden	**28,486**	**152,795**	**57.2%**	**1,61**	**1.93**
Uppsala University	**2,955**	21,091	57.2%	1.81	2.12
Lund University	2,930	23,180	56.2%	1.78	2.12
Göteborg University	2,563	14,813	49.7%	1.80	2.20
Stockholm University	2,290	11,184	58.2%	1.85	**2.27**
Karolinska Institutet	1,928	**24,987**	58.1%	**1.86**	2.23
Umeå University	1,925	9,048	52.3%	1.62	1.92
Linköping University	1,534	10,359	43.0%	1.57	1.96
KTH Royal Institute of Technology	1,515	15,101	54.5%	1.56	1.86
Swedish University of Agricultural Sciences	1,367	6,866	**58.8%**	1.59	1.81
Chalmers University of Technology	1,122	9,542	49.3%	1.50	1.65

[1)] Key data from Swedish Higher Education Agency (2013)
[2)] Based on data for 2009 – 2013
[3)] Based on data for 2008 – 2012

It should be observed that the publication behaviour differs between academic disciplines, and it is thus not only high academic quality that leads to the high number of publications from Karolinska Institutet, as medicine research generally has high numbers of publications, compare Figure 5. The share of international co-publications is based on data for 28 universities in Sweden and their publications in the years 2011 - 2013. For example, it can be noted that the share of international co-publications in physics and astronomy (70%) is approximately twice the share in social sciences.

Figure 5: **Share of international co-publications for different scientific sectors**



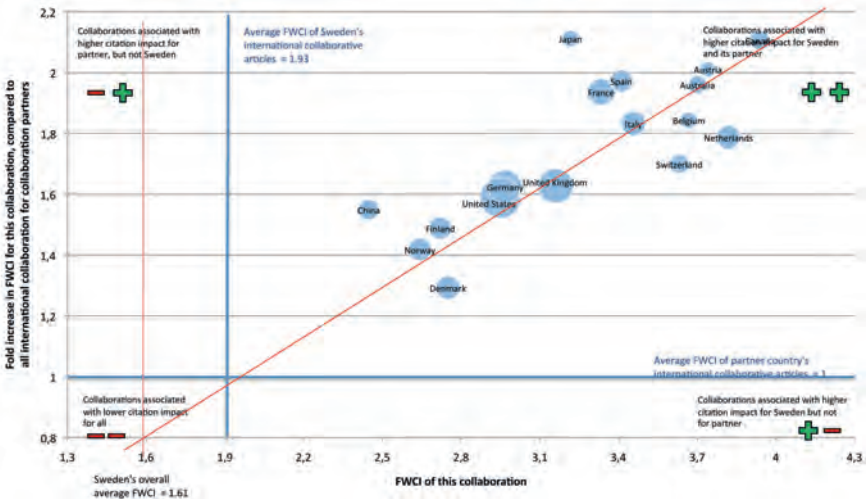
Sweden's most prolific collaboration countries are plotted in the quadrant in Figure 6. First and foremost it should be noted that all circles are located in the top right hand corner, i.e. all are beneficial for both countries in terms of FWCI. Whereas the smaller circles (countries with a lower number of co-publications with Sweden) are in different places, the larger

circles are close to the centre of the sector. Collaborations with the Nordic countries appear to be somewhat less rewarding compared to more distant countries.

For countries along the diagonal line, the benefits of collaboration are equally large. For example, the collaborative publications between Sweden and Austria resulted in almost twice the impact compared to each countries average international collaborative publication.

One question received in the first discussion with universities in Sweden was how it is possible that all listed collaborations are so far from the average. Does it imply that all other collaboration countries score very low in terms of FWCI? The reason why this is possible is that the basis for the calculations of FWCI is lower than the number of publications attributed to each country. For example, a collaborative publication between Sweden, Germany and Austria gives each country one additional publication (when calculating the size of the bubbles), but the FWCI relates to the one and only publication. This relates to the 'whole count' issue, which has also been discussed in the methodology section.

Figure 6: **Collaboration quadrant for Sweden**



Ten largest Swedish higher education institutions

Uppsala University

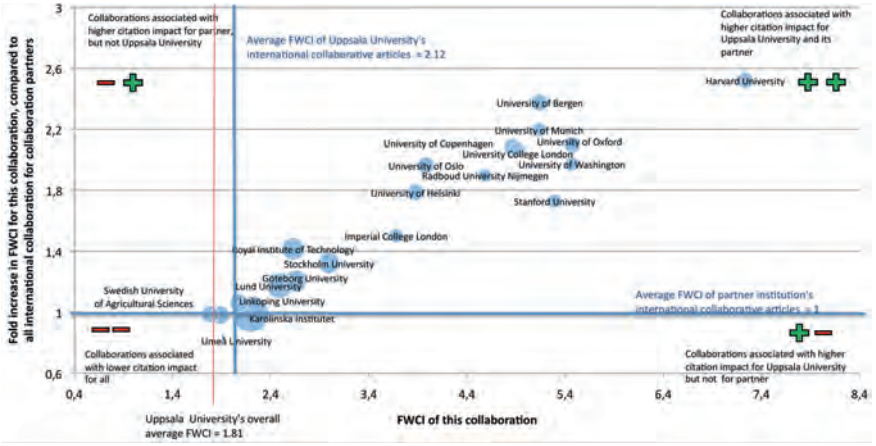
The international research partner mix of Uppsala University consists of globally leading universities and the main universities in Sweden's neighbouring countries, cf. Table 2. For the period of study, the numbers of publications are relatively similar and all these collaborations exhibit very high FWCIs.

Table 2: **Top ten international co-publishing institutions 2009-2013 for Uppsala University**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
University of Copenhagen	Denmark	701	4.75
University of Bergen	Norway	620	4.78
University of Oxford	United Kingdom	595	5.45
Harvard University	United States	590	7.03
University of Oslo	Norway	573	4.14
University of College London	United Kingdom	536	5.16
Stanford University	United States	475	4.33
University of Helsinki	Finland	471	4.95
University of Munich	Germany	462	5.32
University of Washington	United States	456	5.08

When mapping all most prolific research partners in the quadrant, the difference between distant collaborators and more local ones becomes very visible, see Figure 7. However, almost all partners land in the '++' corner, i.e. they are beneficial for both Uppsala University and the partner.

Figure 7: **Collaboration quadrant for Uppsala University**



Lund University

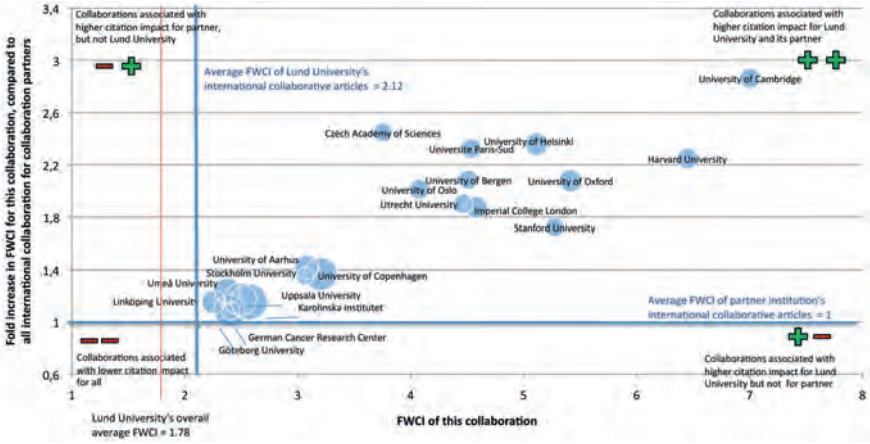
Lund University is located in southern Sweden very close to Denmark. This is also reflected in the top research collaboration partners, see Table 3. Otherwise, compared to Uppsala University, the spread between the largest and smallest partner is somewhat larger and the focus is more heavily on Europe. The clustering of all Swedish research partners and both Danish very close

Table 3: **Top ten international co-publishing institutions 2009-2013 for Lund University**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
University of Copenhagen	Denmark	1 282	3.17
University of Aarhus	Denmark	657	3.04
University of Oxford	United Kingdom	610	5.16
University of Helsinki	Finland	538	5.26
Harvard University	United States	534	6.01
Imperial College London	United Kingdom	501	4.85
University of Cambridge	United Kingdom	495	6.51
Utrecht University	Netherlands	475	4.74
University of Bergen	Norway	472	4.49
Stanford University	United States	461	4.39

to the centre illustrates clearly the distance factor for the impact of international collaboration, cf. Figure 8. A comparison of the Czech Academy of Sciences and Stanford University shows that whereas collaboration with Stanford is more beneficial for Lund than for Stanford, the opposite is valid for the Czech Academy of Sciences. However, both collaborations are clearly beneficial for all partners.

Figure 8: **Collaboration quadrant for Lund University**



Göteborg University

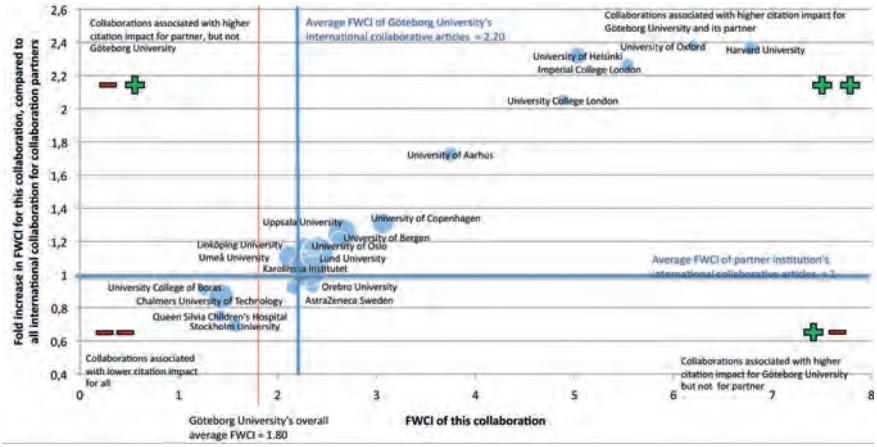
The same Scandinavian universities as in both previous cases are also in the top for Göteborg University, cf. Table 4. Apart from these institutions, one US and four UK top institutions are on the list. The collaboration with Harvard University appears extremely beneficial for both parties.

Table 4: **Top ten international co-publishing institutions 2009-2013 for Göteborg University**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
University of Copenhagen	Denmark	484	3.55
University of Oslo	Norway	354	2.52
University of Helsinki	Finland	328	5.05
University of Bergen	Norway	327	2.72
University of Aarhus	Denmark	253	3.43
Harvard University	United States	251	7.82
University College London	United Kingdom	223	5.51
Imperial College London	United Kingdom	203	5.88
University of Oxford	United Kingdom	179	6.64
University of Glasgow	United Kingdom	158	6.49

In the quadrant for Göteborg University, there are bubbles in all four sectors, even though the majority are in the '++' one, see Figure 9. Collaborations with the regional partner institutions such as Chalmers University of Technology and University College of Boras are not contributing to the involved parties' citation impact.

Figure 9: **Collaboration quadrant for Göteborg University**



Stockholm University

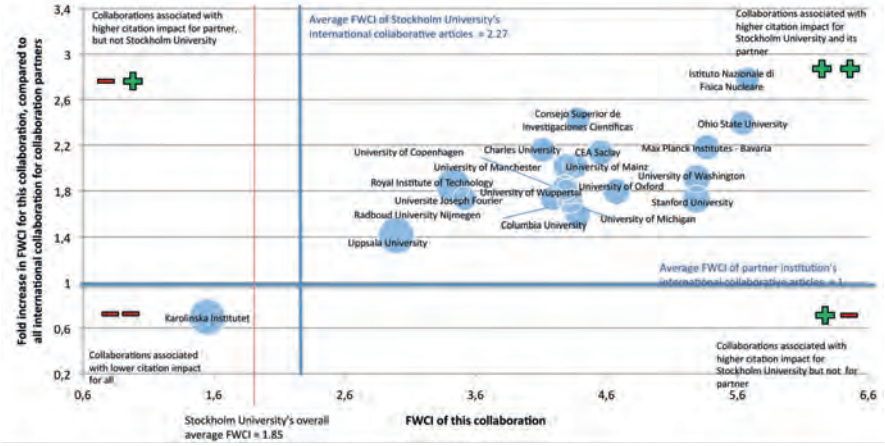
Compared to the previously discussed comprehensive Swedish universities, Stockholm University has a distinctly different mix of international research partners, cf. Table 5. Several US institutions are on the top ten list as well as partners from Italy and France. All collaborations have a similar scope in terms of co-publications.

Table 5: **Top ten international co-publishing institutions 2009-2013 for Stockholm University**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
Stanford University	United States	564	4.77
University of Washington	United States	535	5.05
University of Copenhagen	Denmark	508	4.13
University of Oxford	United Kingdom	497	4.52
Max Planck Institutes – Bavaria	Germany	493	4.82
The Ohio State of University	United States	486	5.03
Columbia University	United States	469	4.16
INFN	Italy	463	4.95
CEA Saclay	France	448	4.28
University of Manchester	United Kingdom	447	3.91

When mapping all research partners the diversity in partner institutions and countries remains and only three Swedish and one Scandinavian higher education institution are among the 20 most prolific research collaborators, cf. Figure 10. Among the Swedish partners, Karolinska Institutet and the Royal Institute of Technology (KTH) both have a clearly different scientific profiles compared to Stockholm University. Still, the citation impact of these two collaborations differs substantially.

Figure 10: **Collaboration quadrant for Stockholm University**



Karolinska Institutet

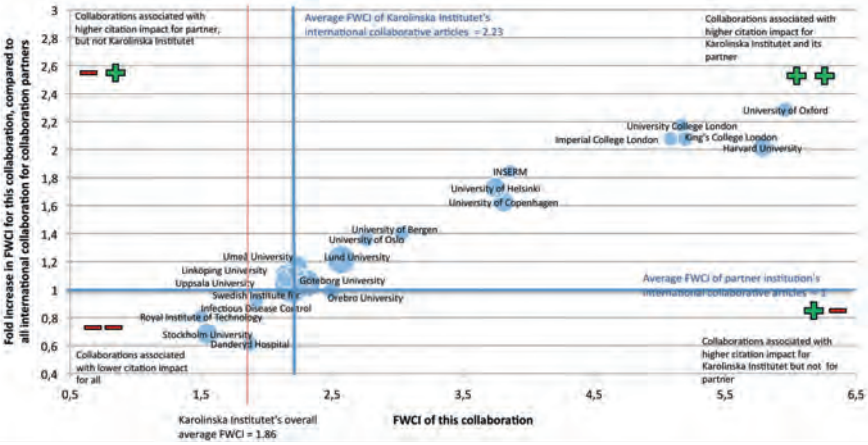
Harvard University was the second largest research partner to Karolinska Institutet during the period of study, cf. Table 6, and both the number of co-authored publications and their citation impact was very high. Otherwise, even though Karolinska Institutet has a different scientific profile compared to the other Swedish universities in this study, the main international partners remain the same.

Table 6: **Top ten international co-publishing institutions 2009-2013 for Karolinska Institutet**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
University of Copenhagen	Denmark	868	4.82
Harvard University	United States	844	6.62
University of Helsinki	Finland	822	3.94
King's College London	United Kingdom	564	6.12
University of Bergen	Norway	497	3.90
University College London	United Kingdom	495	6.53
University of Oxford	United Kingdom	491	7.24
University of Oslo	Norway	442	3.57
Imperial College London	United Kingdom	416	7.06
INSERM	France	410	4.69

There is almost a perfect correlation between the distance that the collaboration spans and the citation impact it receives, cf. Figure 11. The mapping also reveals that the national research partners are quite large in comparison to the international ones. On the one hand, a more specialized university has stronger incentives to collaborate with other institutions (national or international) to address global challenges. On the other, a more specialized university might also have better chances to become internationally attractive. In the comparison of the ten Swedish universities included in this study, Karolinska Institutet has the highest number of publications and the highest FWCI.

Figure 11: **Collaboration quadrant for Karolinska Institutet**



Umeå University

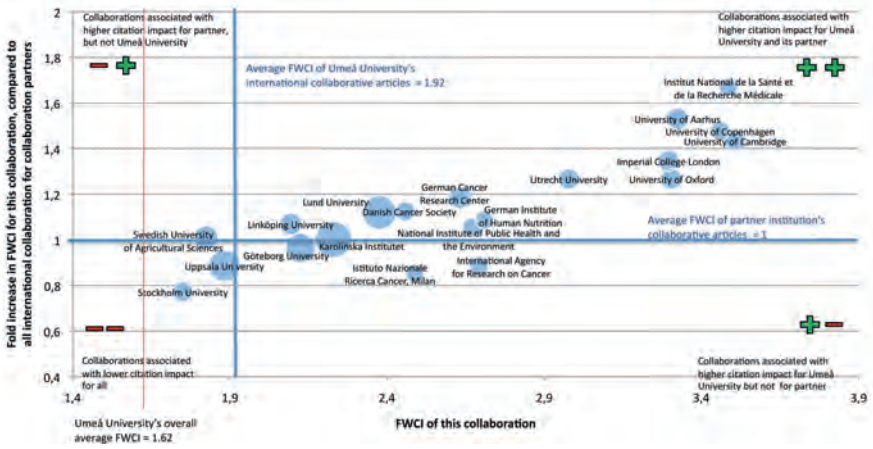
Umeå University appears to have a strong focus on cancer research, when judging from the names of the international research collaborators, cf. Table 7. Moreover, none of the top ten partners is outside Europe.

Table 7: **Top ten international co-publishing institutions 2009-2013 for Umeå University**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
German Cancer Research Center	Germany	322	2.62
University of Aarhus	Denmark	317	3.39
Imperial College London	United Kingdom	306	3.82
Utrecht University	Netherlands	306	3.29
University of Oxford	United Kingdom	298	3.53
University of Cambridge	United Kingdom	271	3.52
Danish Cancer Society	Denmark	252	2.62
University of Copenhagen	Denmark	249	3.59
INSERM	France	247	3.82
National Institute of Public and the Enviror	Netherlands	246	2.63

Among the 20 most prolific partners, 15 are beneficial for the partners, cf. Figure 12. All are beneficial for Umeå University. The mapping also indicates that there might be a need for Umeå University to extend the collaboration network outside Europe.

Figure 12: **Collaboration quadrant for Umeå University**



Linköping University

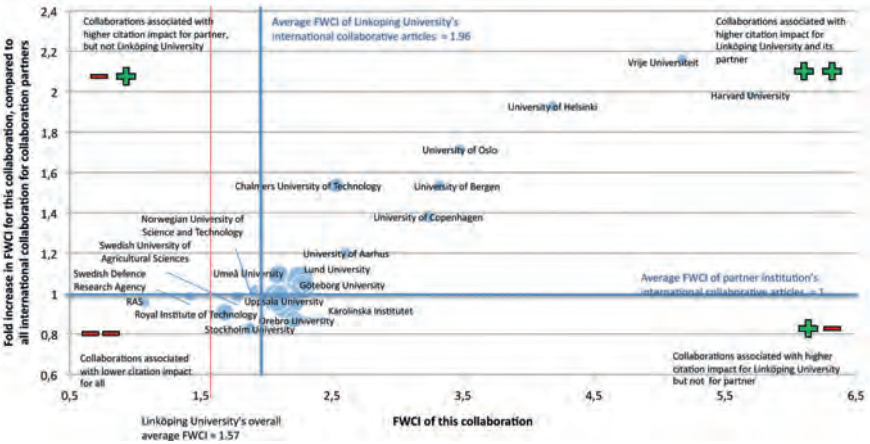
The mix of international research partners to Linköping University differs somewhat from the other universities' mix as no UK university is represented, cf. Table 8. Instead two Dutch and three Norwegian institutions are on the top ten list. It should also be noted that the number of publications is relatively low, compared to previously presented universities. Linköping University has the lowest share of international co-publications among the universities studied (43%).

Table 8: **Top ten international co-publishing institutions 2009-2013 for Linköping University**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
University of Copenhagen	Denmark	118	3.17
Vrije Universiteit	Netherlands	104	6.17
University of Aarhus	Denmark	100	2.47
University of Bergen	Norway	96	3.83
Norwegian Univ. of Science and Technology	Norway	85	1.58
Harvard University	United States	80	4.28
University of Helsinki	Finland	77	3.71
University of Oslo	Norway	76	4.18
University of California at San Diego	United States	65	2.23
University of Groningen	Netherlands	64	7.41

In Figure 13, the small size of most international research collaborations becomes visible when comparing with the bubbles for Swedish institutions. Among them, Chalmers University of Technology appears to benefit much more from collaboration with Linköping University than the others, where the collaboration is very close to neutral in terms of the citation impact. The large number of national collaborators pushes the two smallest international partners (UC San Diego and University of Groningen) out of the top 20 list.

Figure 13: **Collaboration quadrant for Linköping University**



KTH Royal Institute of Technology

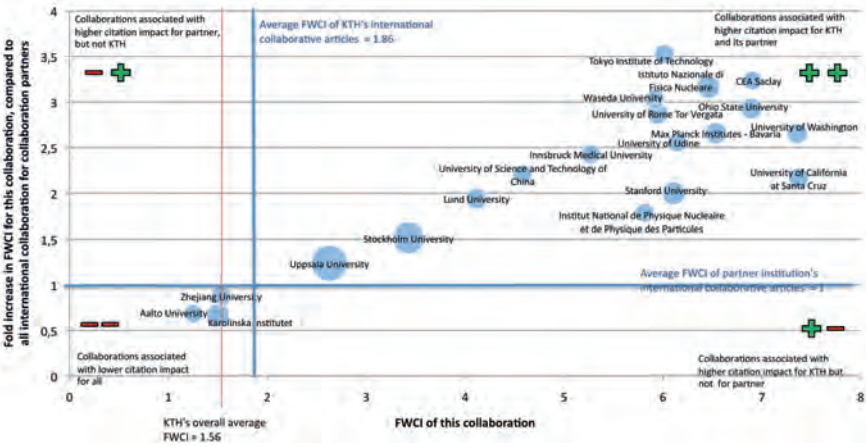
KTH is smaller than Linköping University in terms of research and education staff but much larger when looking at international co-publications, see Table 9. KTH's mix includes several distant partners, among them two in Japan. It is also notable that no Scandinavian university makes it into the top ten list.

Table 9: **Top ten international co-publishing institutions 2009-2013 for KTH Royal Institute of Technology**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
Stanford University	United States	482	5.52
INFN	United States	462	5.63
University of Rome Tor Vergata	Italy	429	4.97
Max Planck Institutes – Bavaria	Germany	407	5.97
The Ohio State University	United States	385	6.21
University of California at Santa Cruz	United States	371	6.44
University of Washington	United States	366	6.41
Waseda University	Japan	345	5.38
Innsbruck Medical University	Austria	343	4.85
Tokyo Institute of Technology	Japan	337	5.39

Four Swedish, one Finnish and one Chinese university are easily identified in the lower part of Figure 14. The remaining 14 partners cover a large part of the world. Several collaborations have a much higher citation impact than KTH's average. All bubbles except for the universities of Stockholm and Uppsala are of a similar size.

Figure 14: **Collaboration quadrant for KTH Royal Institute of Technology**



Swedish University of Agricultural Sciences (SLU)

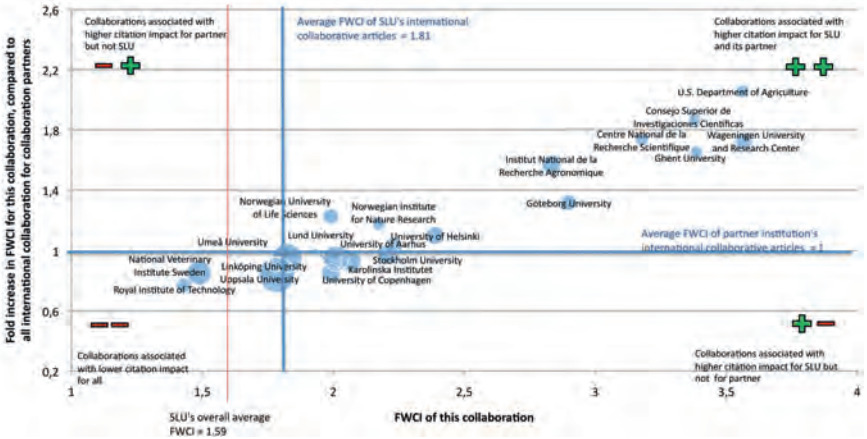
Apart from three Scandinavian universities, SLU's top ten list of international research partners includes unique institutions, compared to the other 9 Swedish universities in this study, cf. Table 10. Given SLU's distinct scientific profile, this is not surprising. There is only one non-European partner in the list.

Table 10: **Top ten international co-publishing institutions 2009-2013 for the Swedish University of Agricultural Sciences**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
University of Copenhagen	Denmark	181	2.27
INRA Institut National de La Recherche Agronomic	France	164	3.07
University of Aarhus	Denmark	163	2.47
University of Helsinki	Finland	161	2.75
Wageningen University and Research Center	Netherlands	145	3.25
Norwegian University of Life Science	Norway	108	2.29
Ghent University	Belgium	81	4.88
U.S. Department of Agriculture	United States	77	3.30
CSIC	Spain	76	3.25
Norwegian University of Nature Research	Norway	75	2.15

The bubbles in Figure 15 cluster to a large extent in correlation to the distance that the collaboration spans. Whereas the majority of the Swedish institutions collaborating with SLU do not benefit in terms of a higher citation impact, all international partners except for the largest one, University of Copenhagen, do benefit from collaborating with SLU.

Figure 15: **Collaboration quadrant for Swedish University of Agricultural Sciences**



Chalmers University of Technology

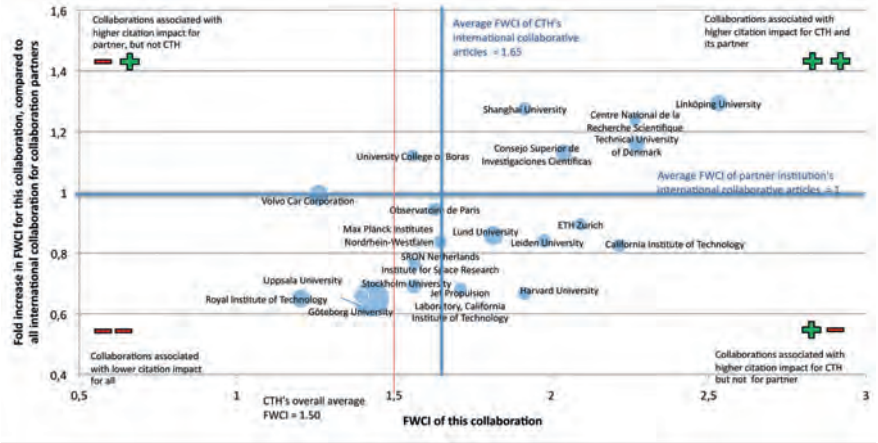
According to Table 11, Chalmers's international partners are mainly outside Scandinavia and most of them have not been listed before. As a matter of fact, the top ten of KTH, which is another university of technology, is completely different. The numbers are relatively small, both as regards the number of co-authored publications and the FWCI.

Table 11: **Top ten international co-publishing institutions 2009-2013 for Chalmers University of Technology**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
CSIC	Spain	172	1.95
Technical University of Denmark	Denmark	146	1.90
Leiden University	Netherlands	136	2.13
Max Planck Institutes – Bavaria	Germany	121	1.80
Observatoire de Paris	France	119	1.56
Harvard University	United States	114	1.43
ETH Zurich	Switzerland	110	2.09
Jet Propulsion Laboratory, California Institute of Technology	United States	105	1.71
California Institute of Technology	United States	101	2.41
SRON Netherlands Institute for Space Research	Netherlands	97	1.53

The mapping of Chalmers's most prolific collaborations differs radically from the other quadrants presented in this study, cf. Figure 16. The most rewarding collaboration is with a Swedish university (Linköping) and only six partners benefit from collaborating with Chalmers. The largest collaboration within Göteborg gives as already observed mutually lower citation impact than the averages for each university.

Figure 16: **Collaboration quadrant for Chalmers University of Technology**



Comparison of collaboration patterns

In the study of each Swedish university above, the scales for the x and y axes vary as well as the scale for the bubbles. Below in Appendix, all collaboration quadrants are provided using the same scales. Even though it makes it difficult to read the labels for each institution, it allows for a better comparison of the collaboration patterns. A diagonal is also added to see if the benefit is more on the Swedish university's side (below the line) or on the partner's side (above the line).

A comparison of the quadrants indicates that some of the large comprehensive universities have approximately the same pattern (Lund, Uppsala and Stockholm). Göteborg, Umeå and Linköping have a higher concentration of circles close to the centre of the quadrant. Among the single-faculty universities, the difference between KTH and Chalmers is striking. Whereas KTH has several mutually rewarding international collaborations all over the right hand side of the diagram, Chalmers's bubbles are concentrated to a small area close to the average citation impact.

Even though the bubbles tend to distribute close to the diagonal, there appears to be a relatively systematic pattern that particularly for collaborations with very high citation impact for the Swedish institution, the benefit is more on the Swedish side. However, both partners benefit from the collaboration.

Discussion and conclusions

Thijssen et al (2011) looked at international collaborations for different countries. Overall, the average collaboration distance increased more or less linearly from 334 kilometres in 1980 to 1,553 km in 2009. According to this and several other studies, the benefits appear to increase in relation to the distance the collaboration spans.

However, collaborations with universities of a similar quality in neighbouring countries do also yield a relatively high citation impact. A closer look at University of Copenhagen, which is on eight of the Swedish universities' top ten lists and six times even on the first place, indicates that it is bigger than the Swedish universities with a publication volume of 36,000 during the same period and it also has a slightly higher citation impact (FWCI = 1.94). Three Swedish universities are on the top list of University of Copenhagen, see Table 13. A separate study of why collaboration with the University of Copenhagen is so dominant among the Swedish universities appears to be of interest.

Table 13: **Top ten international co-publishing institutions 2009-2013 for University of Copenhagen**

Institution	Country	Co-authored publications	Field-Weighted Citation Impact
Lund University	Sweden	1 282	3.17
Harvard University	United States	1 115	6.10
University of College London	United Kingdom	926	5.34
University of Oslo	Norway	872	4.12
Karolinska Institutet	Sweden	868	4.82
University of Bergen	Norway	865	4.59
University of Cambridge	United Kingdom	732	5.89
University of Oxford	United Kingdom	716	6.89
Uppsala University	Sweden	701	4.75
University of Helsinki	Finland	636	5.03

Another topic to investigate more in detail is the large difference between KTH and Chalmers. In general, these two universities are considered fairly similar. The quadrants tell another story.

Data also indicates that the benefits are typically more on the Swedish HEI's side. Another way of interpreting this fact is that the most prolific

collaboration partners to the Swedish universities are stronger in terms of citation impact (FWCI). As lasting collaborations normally require balanced benefits, one question that remains to be answered is how the Swedish universities manage to establish collaborations with these often globally leading institutions. Do they bring in other qualities than research excellence into the collaboration?

To conclude, this study indicates that international collaboration in research is mutually beneficial. Increased international collaboration appears thus to be a promising method to improve the citation impact. This is not a new finding but it is an important reminder and this study provides additional support to this indication. A further contribution of the study are developed empirical data and analysis methods supporting the development of rewarding international collaborations in research.

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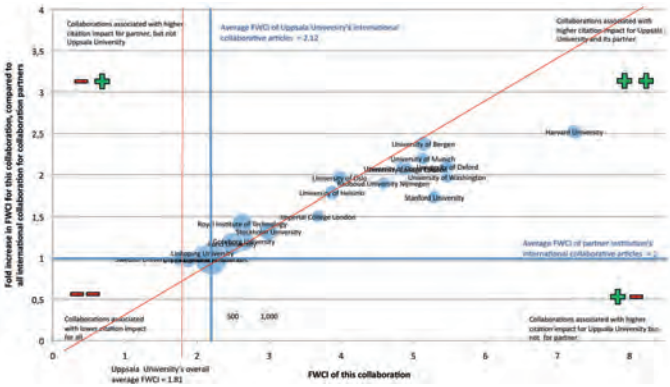
Franceschet, M. and Costantini, A. (2010) The effect of scholar collaboration on impact and quality of academic papers, *Journal of Informetrics*, 4 (4): 540-553.

Swedish Higher Education Agency (2013) Key data http://www.ukambetet.se/statistikuppfoljning/statistikdatabasomhogskolan/nyckeltal.4.575a959a141925e81d1262a.html accessed May, 2014.

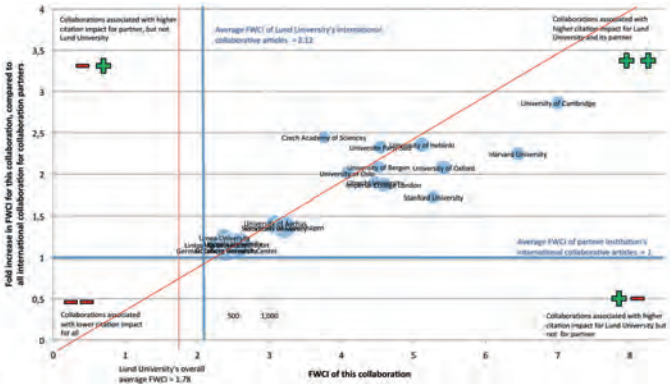
Tijssen, R, Waltman, L, and van Eck, NJ. (2011) Collaborations span 1,553 kilometres, *Nature*, 473: 154.

Appendix: **Collaboration quadrants in the same scale for ten Swedish universities**

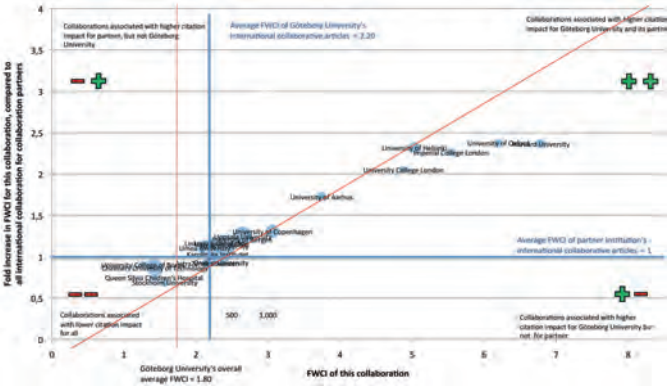
Uppsala University



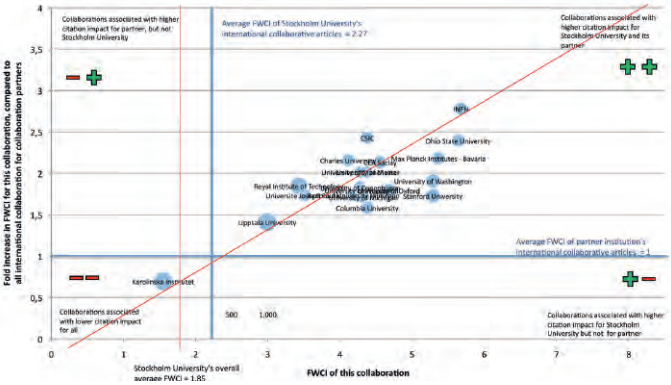
Lund University



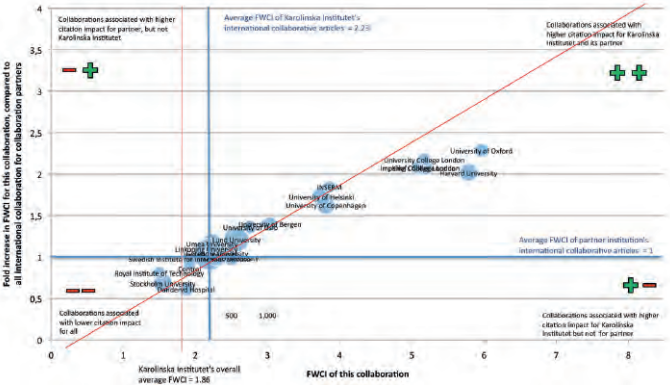
Göteborg University



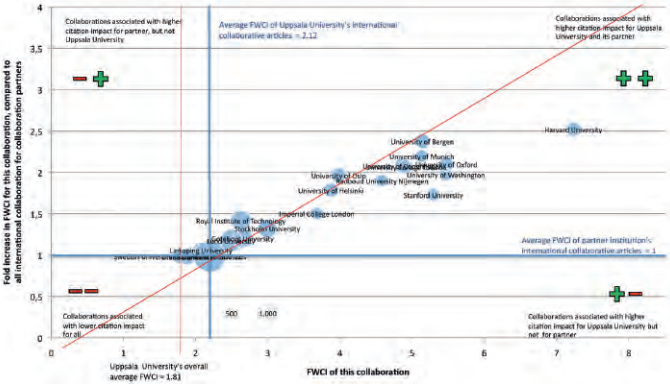
Stockholm University



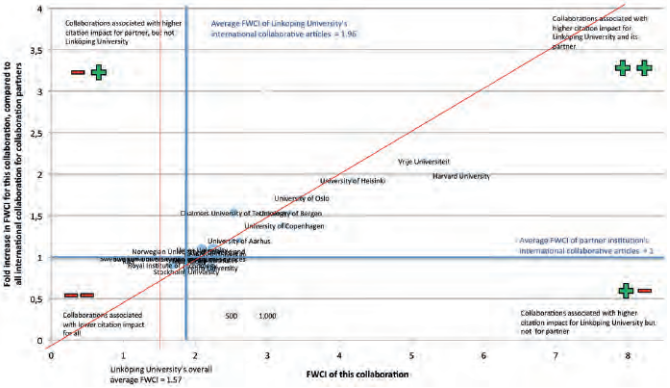
Karolinska Institutet



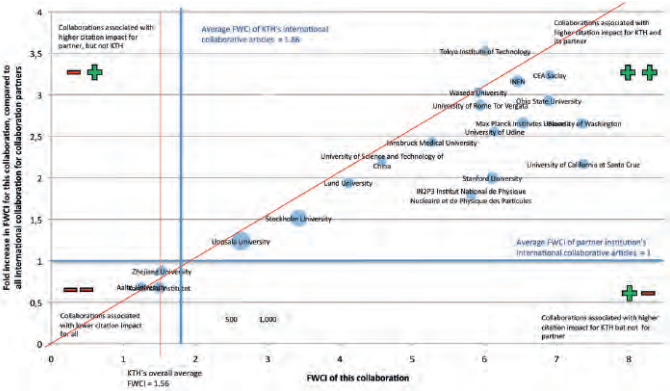
Umeå University



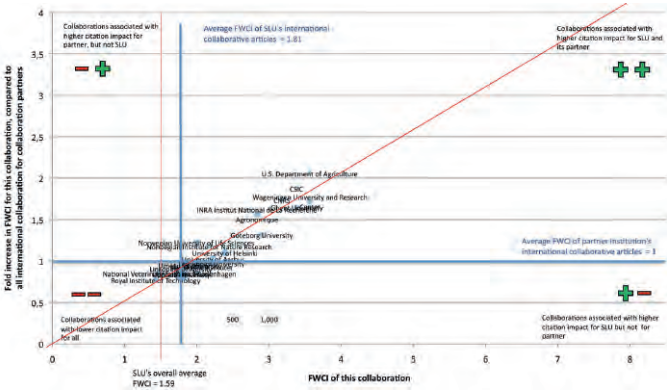
Linköping University



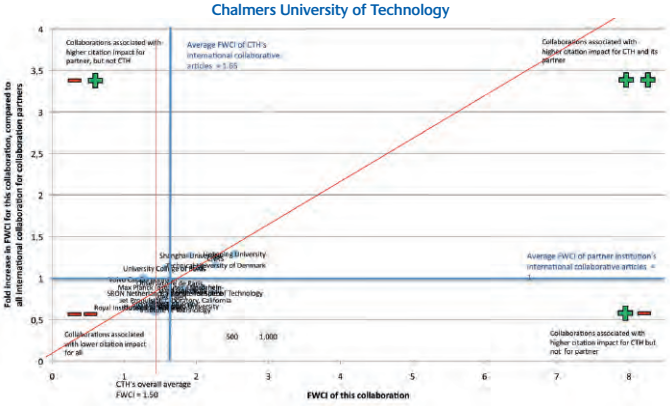
KTH Royal Institute of Technology



Swedish University of Agricultural Sciences (SLU)



Chalmers University of Technology



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STINT promotes knowledge and competence development within internationalisation and invests in internationalisation projects proposed by researchers, educators and leaderships at Swedish universities.

STINT promotes internationalisation as an instrument to:

- Enhance the quality of research and higher education
- Increase the competitiveness of universities
- Strengthen the attractiveness of Swedish universities

STINT's mission is to encourage renewal within internationalisation through new collaboration forms and new partners. For example, STINT invests in young researchers' and teachers' international collaborations. Moreover, STINT's ambition is to be a pioneer in establishing strategic cooperation with emerging countries in research and higher education.

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