Country Report – Canada

STINT
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Foreword

Recognising the importance of intelligence and analyses for the development of international strategies for higher education and research at various levels of the knowledge system, STINT has compiled a series of brief country reports focused on their academic profiles and performance.

Released as a pilot series covering 16 countries, these country reports aim to provide national overviews using current and reliable data. The selection of countries is based on STINT's existing collaborations and other criteria, not least that the selected portfolio provides an interesting illustration of developments in the academic world:

- Brazil
- Canada
- Chile
- China
- India
- Indonesia
- Japan
- Malaysia
- Kenya, Rwanda, Tanzania and Uganda
- South Africa
- South Korea
- United States of America
- Vietnam

The reports provide insight into each country's knowledge system as well as its demographic and economic context. Primarily, our intention is that both policy and decision makers, as well as practitioners within the Swedish higher education system, will utilise these reports in furthering international strategic collaboration at various levels.

Special effort has been made to include the latest available data. Data were collected in July 2020; for further details about the data and methods, see the Appendix. Several persons at STINT have been involved in the production of these reports: Erik Forsberg, Andreas Göthenberg, Niklas Kviselius, Tommy Shih and Hans Pohl, who was the project leader and developed the tables and figures.

Introduction

Canada's economy is the tenth largest in the world, relying chiefly upon its abundant natural resources in combination with well-developed international trade networks.

Canada is in fact a relatively young federation of independent provinces. Despite an overarching federal funding system for research and innovation, each province is independent regarding the thematic areas chosen and additional support it provides to certain institutions and whole industries.

Canada has one of the highest per-capita immigration rates in the world, driven mainly by its economic policy. The product of large-scale immigration from many other countries, it is one of the world's most ethnically diverse and multicultural nations. A primarily skills-based immigration policy has benefitted the academic sector. Canada ranks among the highest in international measurements of government transparency, civil liberties, quality of life, economic freedom, and education.

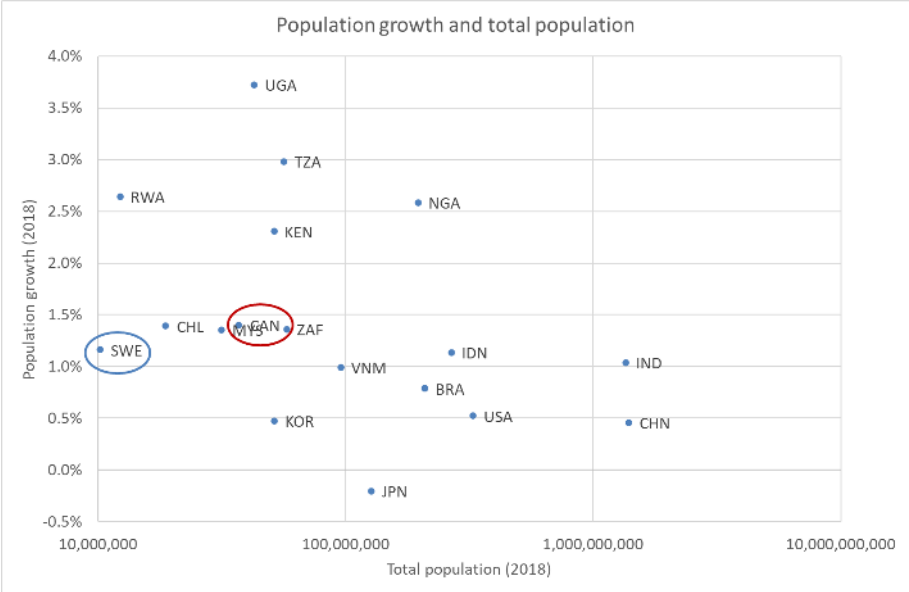
The country is an ambitious medium-sized science, technology and innovation nation. Accounting for more than CAN$30 billion in research and development (R&D) spending every year, science, technology and innovation are prioritised at all levels of Canadian government, as well as in industry and academic institutions. Business accounts for half of the R&D activities undertaken in Canada, followed by higher education institutions (HEIs) at about 40% and the federal and provincial governments at about 8%, while private non-profit organisations account for most of the remainder.

When looking at recent years' National Budgets for Science and Innovation, five broad areas emerge as both current strengths and emphases for further development: 1. Environment and Agriculture; 2. Health and Life Sciences; 3. Information and Communications Technologies; 4. Natural Resources and Energy; and 5. Advanced Manufacturing.

Population and economic development

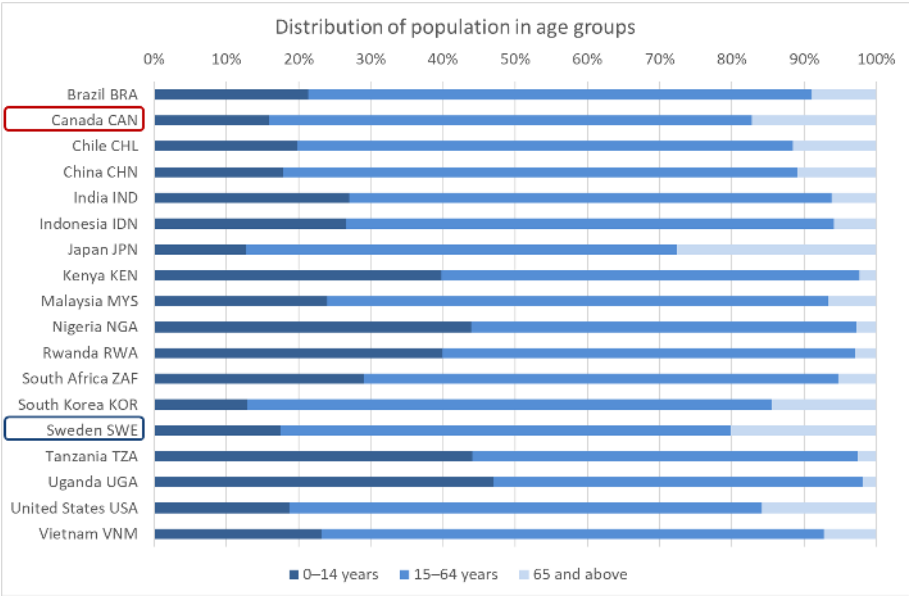
Canada's population is growing and reached 37.6 million people in 2019. This increase of over 500,000 people during the course of 2018 constitutes the country's largest population increase in a single year since Confederation. With an annual growth rate of 1.4%, Canada's population is the fastest growing among G7 countries (see Figure 1).

Figure 1: **Total population (logarithmic scale) and population growth**



Canada's population growth should be seen in the light of an active immigration policy focusing primarily on economic growth, with more than 310,000 immigrants registering in Canada in 2018–19. Natural increase accounts for less than a third of Canada's population growth and is no longer the major factor. Canada admits new permanent residents under four main categories. In 2018, 58% of new permanent residents were admitted through the economic stream, followed by 27% through family sponsorship, 14% as protected persons and refugees, and 1% for humanitarian or other reasons.

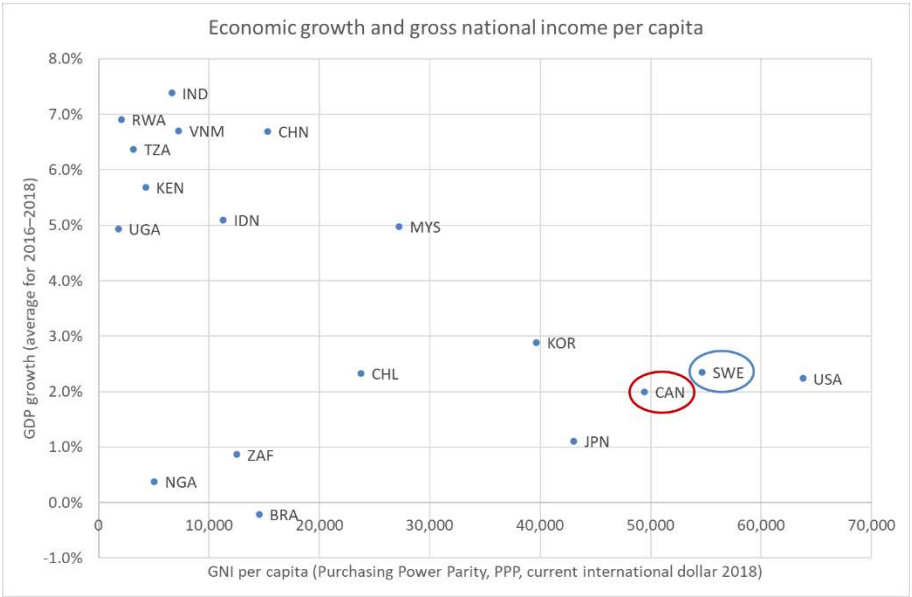
Figure 2: **The percentage of the population in each age group**



Like most industrialised countries, Canada expects an increasingly ageing population with falling birth rates. According to 2019 Canadian population data, 17% of the population are already over the age of 65 (see Figure 2). This number is growing rapidly, and population ageing will contribute to a considerable increase in future levels of government spending.

This has led to an active policy discussion about leveraging immigration even more in the decade to come, including setting more concrete targets to attract lower age groups to increase the population – perhaps as high as 100 million people – resulting in a more balanced population age profile.

Figure 3: **Gross national income (GNI) and gross domestic product (GDP) growth**

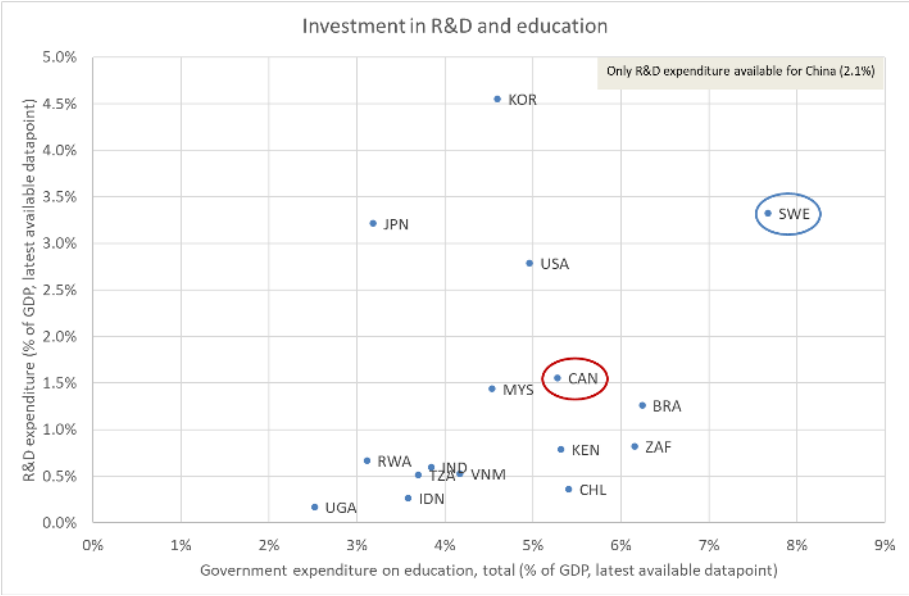


Canada has seen a healthy positive economic growth rate since the 1970s, with an annual gross domestic product (GDP) growth ranging from approximately 1 to 7% (see Figure 3), except for five distinct periods of economic recession.

Since 1970, all Canadian recessions coincided with those in the United States, showing that the two economies are highly synchronised. The Canadian economy, for example, entered the 2008–09 recession (the last before Covid-19) primarily because of problems in the US housing market.

Regional variations also occur in Canada because each province has exposure to different industries that are affected by different variables. Alberta is highly reliant on global oil and gas markets, and may therefore be affected differently than Ontario, for example, which relies more on manufacturing and services.

Figure 4: **Expenditure on education and research and development (R&D), both as a percentage of GDP; data predominantly for 2017 or 2018**



The Canadian government's expenditure on education is slightly more than 5% of GDP and that on R&D about 1.5%. Canadian government expenditure on education is slightly more in terms of a percentage of GDP than that of the neighbouring United States. However, Canadian R&D expenditure as a percentage of GDP is less than that of the United States. In comparison, Swedish expenditure is more than 7% of GDP for education and more than 3% of GDP for R&D (see Figure 4).

Higher education institutions in Canada

Canada's 96 public universities offer some 15,000 study programmes. According to the 2021 *Times Higher Education* World University Rankings, 30 Canadian institutions are counted among the best in the world, with five in the top 100 and eight in the top 200.

Canada's top two universities – the University of Toronto (Ontario) and the University of British Columbia (British Columbia) – score particularly highly for research impact. These two are followed by McGill University (Quebec), McMaster University (Ontario), and Université de Montréal (Quebec).

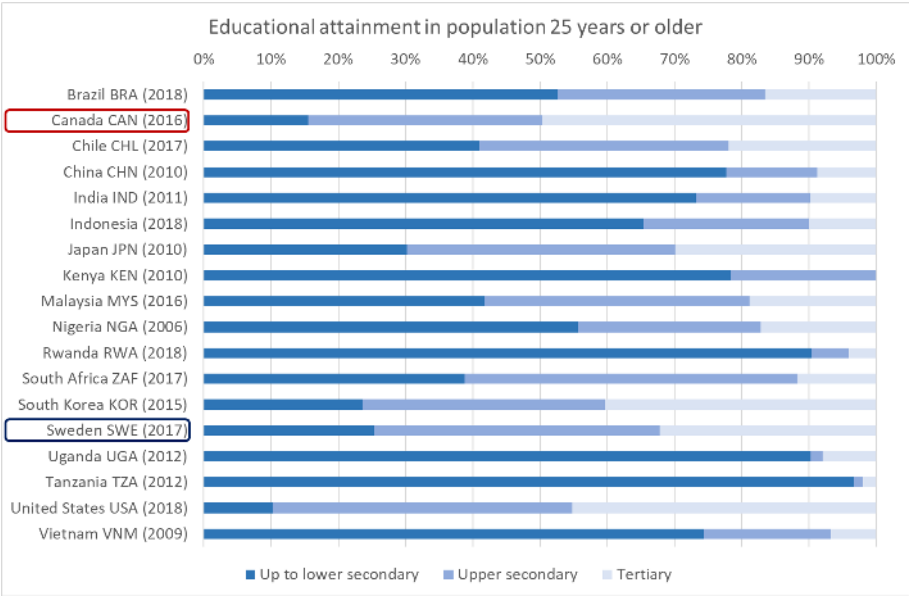
Students from around the world rank Canada as the one of the most welcoming countries for international students, and cities like Montréal, Toronto and Vancouver are perceived as study locations offering a high quality of life. The universities are in clear competition with their US counterparts for the attention of international students, and often provide cheaper study options, and strive for simpler application processes supported by greater opportunities to obtain permanent residency.

Most HEIs are members of Universities Canada, a membership organisation providing university presidents with a unified voice for higher education, research and innovation.

Universities Canada also gather statistics, for instance on student mobility, to monitor developments in the higher education sector. Universities Canada has noted that only 11% of Canadian undergraduates undertake an international mobility experience over the course of their degree, despite the clear benefits of global study to building future skills. In fact, only one in ten young Canadians crosses a provincial border to complete their university degree.

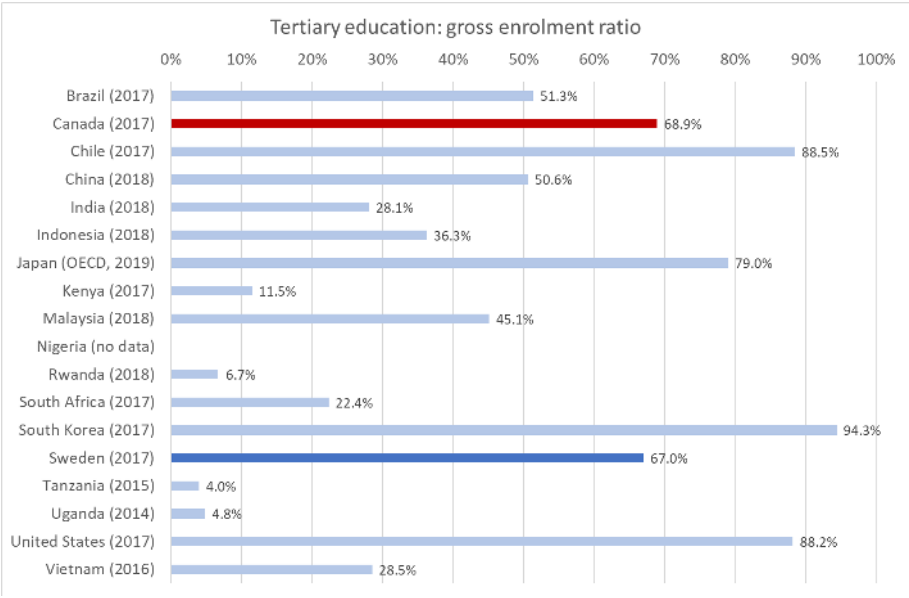
Educational attainment and student mobility

Figure 5: **Educational attainment**



By international comparison, Canada has a highly educated population. About 50% of the population (25 years or older) had attained tertiary education in 2016, which is higher than in the United States and Sweden. More than 30% of the Canadian population had attained upper secondary education. By comparison, in Sweden about 40% of the population had attained upper secondary and more than 30% tertiary education (see Figure 5).

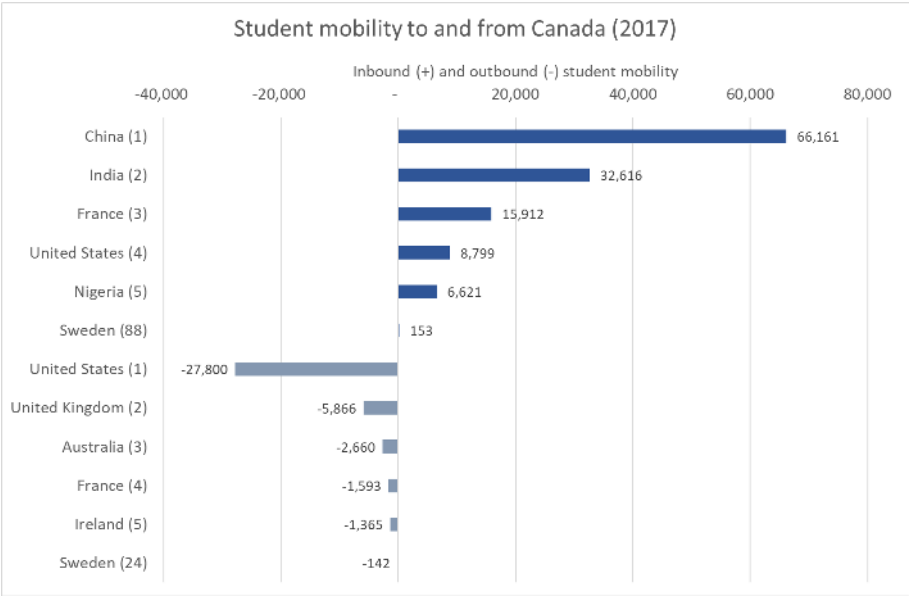
Figure 6: **Gross enrolment ratio for tertiary education**



The gross enrolment ratio (GER) for tertiary education is indicated in Figure 6. This is the ratio of students enrolled in tertiary education divided by the 5-year age group starting from the official secondary school graduation age. The GER indicates the capacity of the education system to enrol students of a particular age group.

Canada is a country quite similar to Sweden with respect to enrolment in tertiary education. In both Sweden and Canada, a little over two thirds of the student population eligible to tertiary studies were enrolled at a higher education institution in 2017.

Figure 7: **Inbound and outbound students, origins and destinations**



Canada is a popular study destination for Chinese and Indian students, the two largest groups of foreign students (see Figure 7). Together these two groups comprised almost 100,000 students in 2017. Swedish students constitute a relatively modest group; only 153 new students from Sweden went to study in Canada the same year. This number is almost on par with the number of Canadian students in Sweden, which was 142. Canadian students tend to study abroad in other English-speaking countries such as the United States (27,800), United Kingdom (5,866) and Australia (2,660). Due to the Covid-19 pandemic, the number of inbound students has decreased, especially from China. This development is likely to continue after Covid-19.

Figure 8: **Inbound and outbound students to and from Sweden per year**

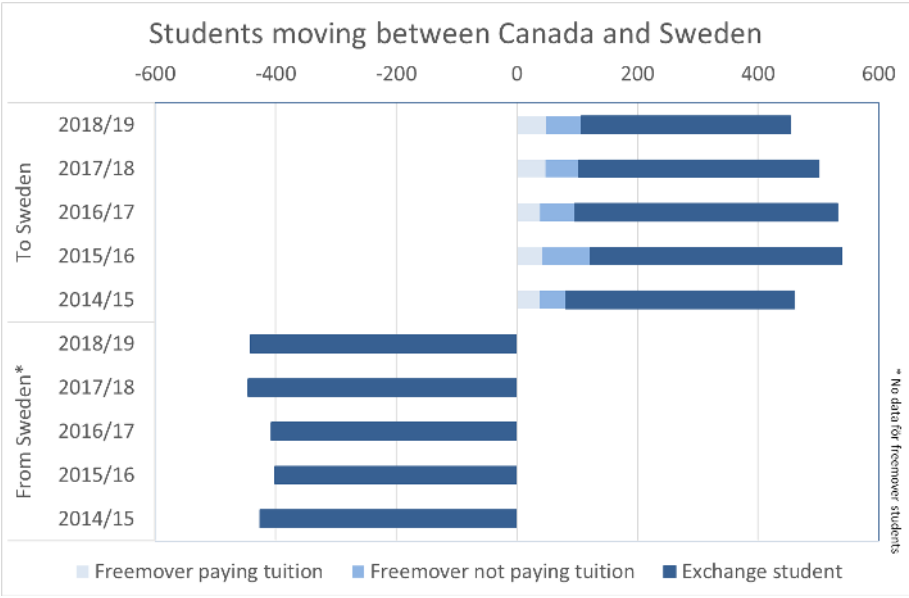
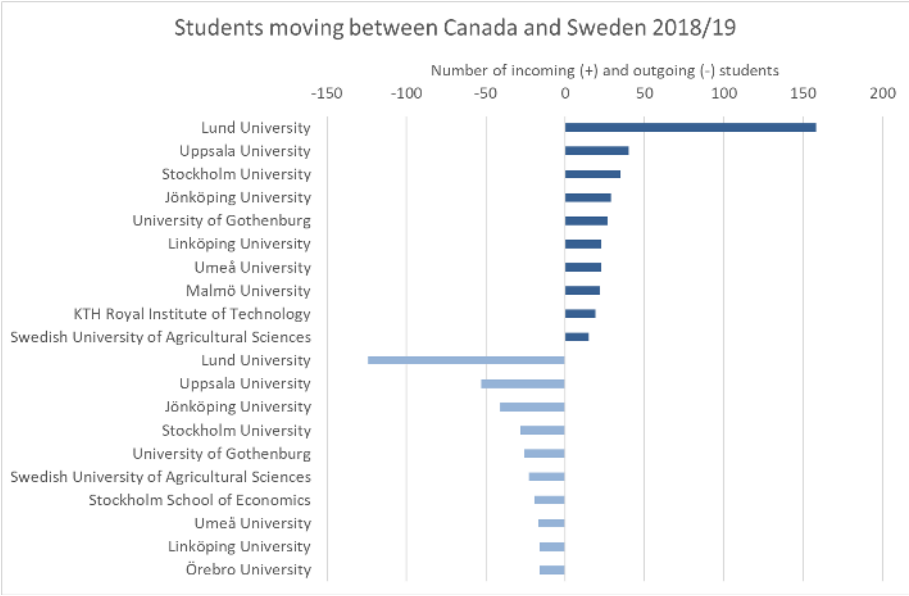


Figure 8 illustrates the inbound and outbound students to and from Sweden. Canada is a fairly popular study destination for Swedish students. Swedish data show that the number of outgoing exchange students remained constant in recent years, with roughly 400 students doing a study exchange in Canada. The exchange is balanced between the two countries, although Canada has a higher number of students than Sweden.

Figure 9: **Inbound and outbound students to and from Sweden 2018/19, per higher education institution**



In Figure 9, the exchange pattern for specific HEIs is illustrated. Lund University has by far the highest number of inbound and outbound students of all Swedish HEIs. Overall, the comprehensive universities in Sweden have larger exchange programmes.

Research and collaboration with Sweden

Canada has highly advanced science and technology capacity. The share of the country's scientific production in the world exceeds its relative size with regards to economy and population. Measured by citation impact, the quality of research output in Canada is in line with that of comparable countries, such as the United States. Canada's field-weighted citation impact (FWCI) was 1.51 between 2015 and 2019, while the corresponding number for Sweden was 1.68. With regards to international collaboration, Canada is also a fairly open country.

Table 1: **Selected publication indicators**

Based on publications 2015–2019							
Country	Annual publication volume (average)	Share of world	Annual volume growth 2015–2019	Citation impact	Share of int'l co-publ	Share of ac.-corp. co-publ.	Collaboration intensity with Sweden
		%	%	FWCI	FWIS	%	$NCII_{100}$
Brazil	79,128	2.54%	4.4%	0.90	0.79	2.1%	72%
Canada	110,493	3.55%	2.0%	1.51	1.31	4.2%	75%
Chile	13,929	0.45%	5.9%	1.22	1.42	2.0%	70%
China	559,913	17.98%	8.7%	1.02	0.55	2.4%	47%
India	164,707	5.29%	6.5%	0.82	0.43	1.2%	55%
Indonesia	24,572	0.79%	54.3%	0.92	0.58	0.7%	31%
Japan	133,011	4.27%	1.0%	0.95	0.69	5.4%	70%
Kenya	3,082	0.10%	7.2%	1.73	1.92	4.5%	124%
Malaysia	32,636	1.05%	5.8%	1.01	1.06	1.5%	30%
Nigeria	8,476	0.27%	14.0%	0.98	1.17	1.3%	36%
Rwanda	427	0.01%	11.2%	3.30	2.40	5.2%	203%
South Africa	24,423	0.78%	6.2%	1.26	1.29	2.9%	111%
South Korea	85,265	2.74%	2.0%	1.05	0.69	4.5%	35%
Sweden	42,975	1.38%	2.2%	1.68	1.55	8.3%	n/a
Tanzania	1,660	0.05%	7.8%	1.81	1.98	3.4%	178%
Uganda	1,741	0.06%	7.1%	1.76	2.04	4.8%	170%
United States	685,704	22.02%	0.9%	1.42	0.86	4.7%	74%
Viet Nam	7,649	0.25%	24.9%	1.43	1.67	2.2%	40%
World	3,113,580	100.00%	2.8%	1.00	1.00	2.6%	n/a

See the Appendix for detailed explanations of some of the indicators in Table 1.

Figure 10: **Annual co-publications per number of co-authors**

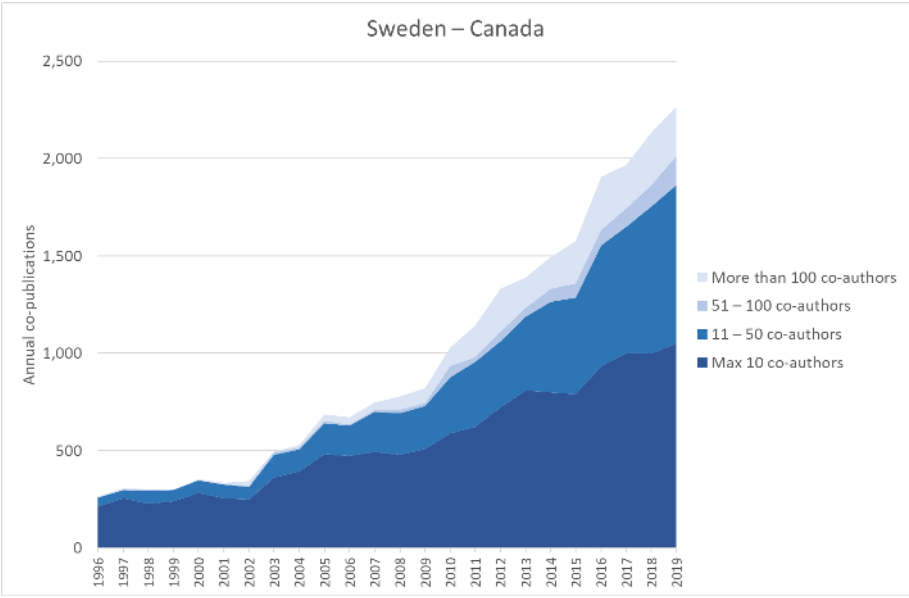
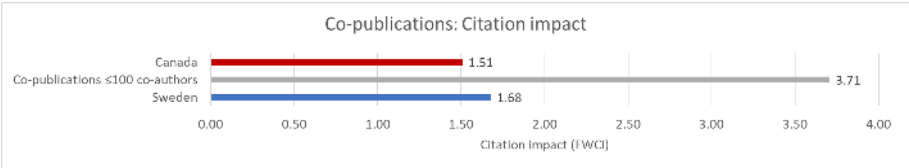
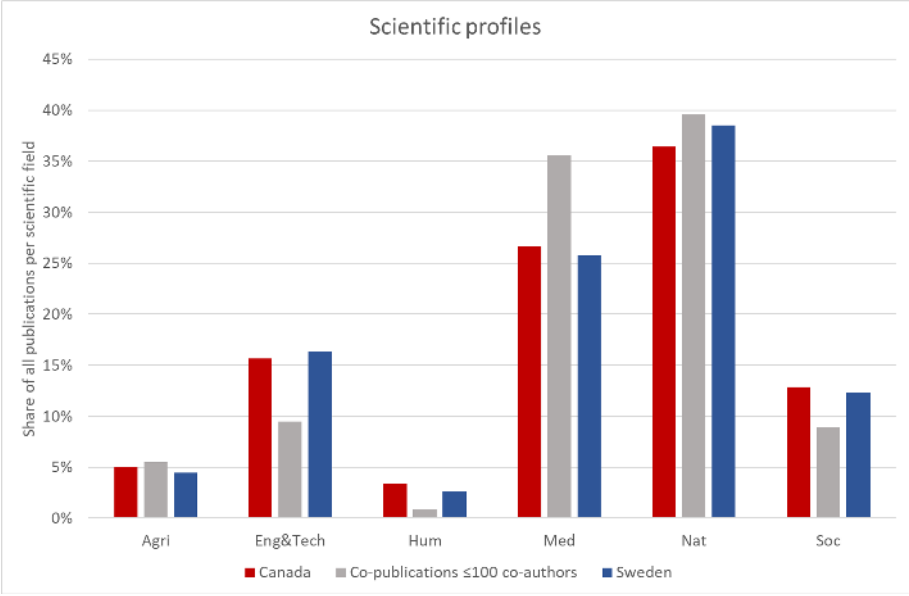


Figure 11: **Field-weighted citation impact for each country and their co-publications with ≤100 co-authors (2015–2019)**



Co-publications between Sweden and Canada are dominated by cooperations with up to ten co-authors, as indicated in Figure 10. During the last decade, there has been a drastic increase in the number of co-publications between Sweden and Canada, especially regarding medium-sized cooperations with 11–50 co-authors. Both Sweden and Canada benefit when researchers work together. As can be seen in Figure 11, co-publications (with up to 100 co-authors) have a significantly higher FWCI than that of each country.

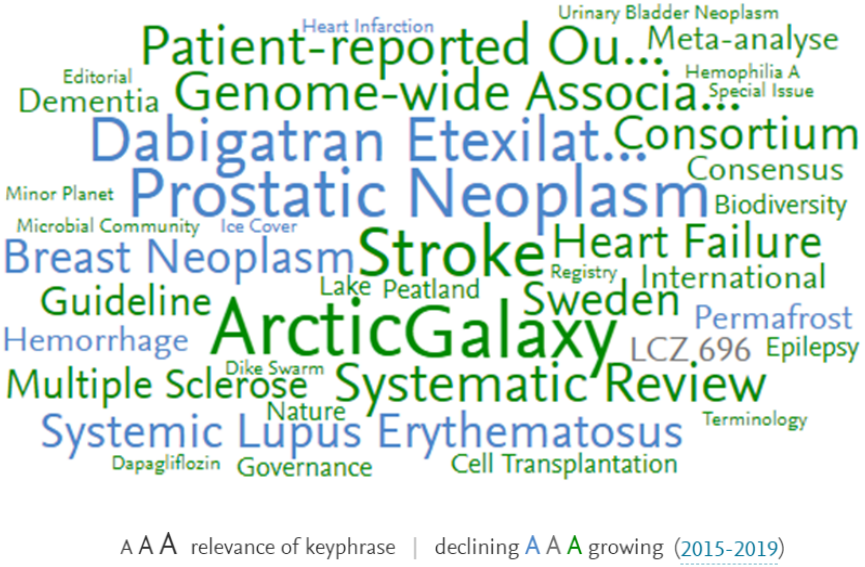
Figure 12: **Distribution of publications per scientific field (2015–2019)**



In Figure 12, the scientific profiles of research collaborations between Sweden and Canada are compared with the overall profiles of these countries in various fields. For example, approximately 5% of the publications with Canadian participation are within the agricultural sciences, and the same applies to Sweden and the co-publications between the two countries. If all scientific fields collaborated internationally to the same extent, the shares of co-publications involving both countries would typically lie between the national shares.

Engineering and technology are clearly underrepresented in Swedish–Canadian collaborations, whereas medicine is overrepresented. The humanities and social sciences are almost always underrepresented in these scientific profiles, due to the lower share of international co-publications. This argument also applies in the reverse: these fields have a low share of international co-publications as they are underrepresented in international collaborations.

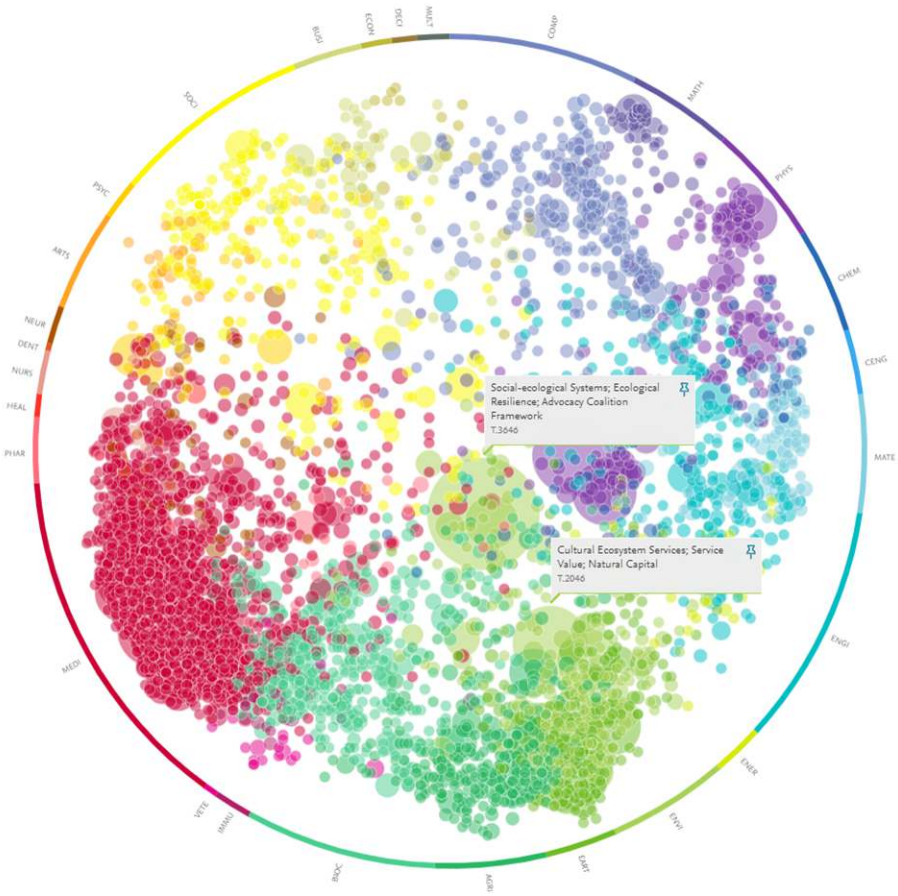
Figure 13: **Word cloud based on co-publications with ≤100 co-authors (2015–2019)**



The word cloud in Figure 13 was produced using Elsevier's Fingerprint Engine. It shows the most prominent keyphrases occurring in publications with co-authors affiliated to Swedish and Canadian institutions, based on their titles, abstracts and keywords. Large, green words signal highly relevant and growing keyphrases. Given the overall growth in co-publications between Sweden and Canada, most keyphrases are green.

Several keyphrases apparently pertain to medicine. Research pertaining to the Arctic and to astronomy has grown during this period. 'Sweden' is among the keyphrases whereas 'Canada' is not. One interpretation is that the research done in collaboration between the countries has a stronger focus on the Swedish context.

Figure 14: **Wheel of science based on co-publications with ≤100 co-authors (2015–2019)**



Publications involving Swedish and Canadian researchers cover almost all scientific fields (see Figure 14). The bubbles in the centre of the circle indicate the presence of some multidisciplinary collaborations. The high number of red bubbles confirms the high share of co-publications within medicine. The two large bubbles in the figure both represent ecological topics. Their size indicates that a high number of all the included co-publications are on these topics. A STINT report (R20:04) on research targeting the sustainable development goals (SDGs) highlighted intense collaboration between Sweden and Canada pertaining to SDG 13, Climate Action.

Table 2: **The 20 institutions in Sweden with the highest share of co-publications with ≤100 co-authors (2015–2019). Only institutions with at least 300 publications during the period are included**

Institution	Co-publications with Canada (≤100 co-authors)	Share of all publications at the Swedish institution	FWCI
Stockholm Environment Institute	61	9.05%	3.70
Royal Swedish Academy of Sciences	34	8.42%	5.29
Swedish Museum of Natural History	91	6.83%	2.27
Swedish Meteorological and Hydrological Institute	38	6.38%	3.70
Swedish University of Agricultural Sciences	534	5.87%	3.28
Karolinska Institutet	1,993	5.53%	4.47
IVL Swedish Environmental Research Institute	19	4.82%	3.25
Stockholm University	833	4.61%	3.12
University West	39	4.53%	1.66
NORDITA	40	4.37%	2.11
Luleå University of Technology	239	4.33%	1.75
Blekinge Institute of Technology	53	4.22%	2.70
University of Gothenburg	944	4.16%	5.33
Stockholm School of Economics	37	4.13%	6.65
Mid Sweden University	73	4.04%	2.27
Uppsala University	1,176	3.98%	3.96
Umeå University	469	3.87%	3.41
Örebro University	166	3.62%	4.98
Lund University	1,142	3.62%	4.01
Linköping University	406	2.86%	2.96

Table 2 ranks Swedish HEIs and research institutes based on their co-publications with Canada (with up to 100 co-authors) as a share of their total publication output. Most of the listed institutions' co-publication shares with Canada are larger than Canada's share of global publications, indicating a strong focus on Canadian collaboration. For an institution with a low total publication volume, the co-publication share is more indicative as just a few publications may have noticeable impact; several of Sweden's larger HEIs with large publication volumes also have a co-publication share significantly above Canada's share of global publications. As can be conjectured from the institutions topping the list, institutions proportionally producing a high volume of co-publications with Canada cover fields such as earth and planetary sciences as well as agricultural and environmental sciences, except, of course, in the case of Karolinska Institute.

Figure 15: **Top ten Swedish institutions with the highest number of co-publications with ≤100 co-authors (2015–2019)**

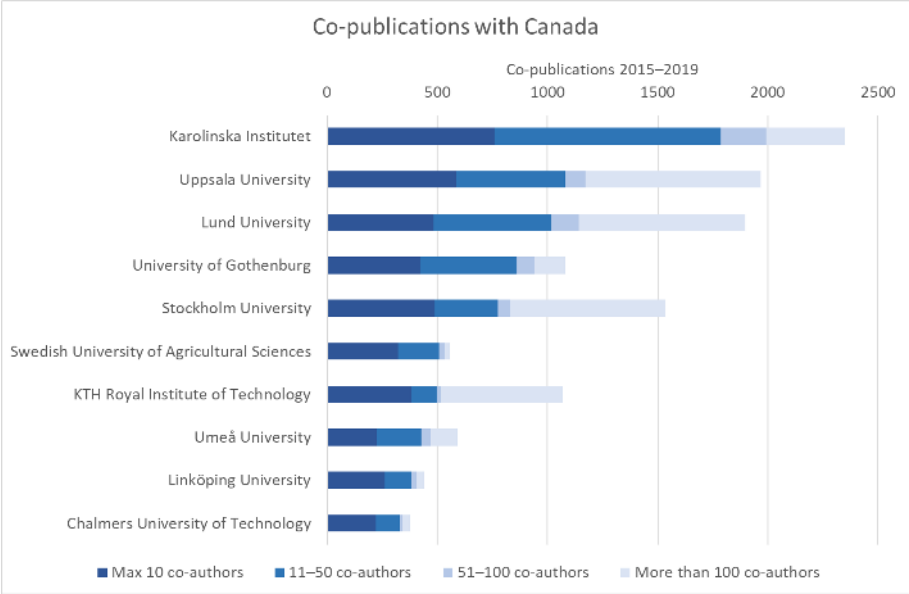


Figure 15 lists the ten Swedish universities with the most co-publications with Canada, ranked according to the number of co-publications with up to 100 co-authors. This ranking closely follows the ranking of the total number of publications by Swedish universities, with a few smaller differences. One notable exception, though, is that the largest technical universities rank lower for Canadian co-publications than in the total publication ranking, which is in line with what can be seen in Figure 12; i.e., engineering and technology are underrepresented in Swedish–Canadian research collaborations. The reason for this is on the other hand unclear.

Figure 16: **Top ten Canadian institutions with the highest number of co-publications with ≤100 co-authors (2015–2019)**

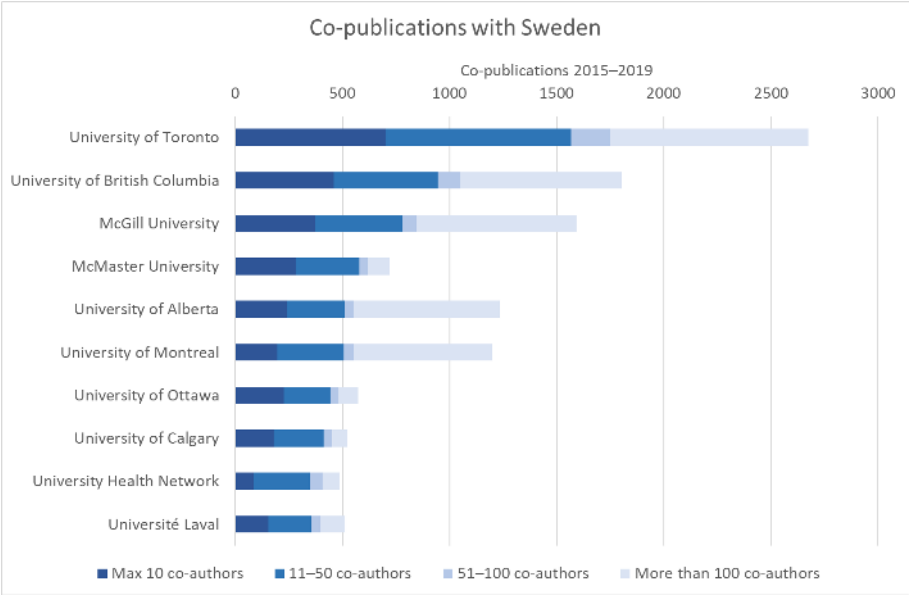


Figure 16 lists the ten Canadian universities with the highest numbers of co-publications with Sweden, ranked according to the number of co-publications with up to 100 co-authors. Most universities in the list are also the largest universities in Canada in terms of total publication volume and thus Swedish–Canadian co-publication patterns by volume by and large follow general Canadian patterns. Most of the Canadian universities on the list are also those ranked highest in international university rankings, i.e., Swedish research collaboration with Canada is focused on the top Canadian universities. Notably absent from the list in Figure 16 is Western University, which generally ranks among the top ten in Canada both in terms of publication volume and international rankings.

Table 3: **Co-publication matrix for the top ten in both countries showing the number of co-publications with ≤100 co-authors (2015–2019)**

Publications 2015–2019 with up to 100 co-authors	University of Toronto	University of British Columbia	McGill University	McMaster University	University of Alberta	University of Montreal	University of Ottawa	University of Calgary	University Health Network	Université Laval	With Canada
Karolinska Institutet	638	275	285	177	135	187	203	128	212	126	1,991
Uppsala University	212	158	97	108	109	75	75	53	45	39	1,173
Lund University	281	178	142	92	64	68	51	64	81	84	1,143
University of Gothenburg	162	128	100	131	76	127	61	50	51	57	942
Stockholm University	135	89	71	19	58	41	35	47	12	15	831
Swedish University of Agricultural Sciences	31	69	29	27	40	17	4	13	1	39	534
KTH Royal Institute of Technology	47	41	33	24	25	12	18	11	3	4	515
Umeå University	124	61	65	31	47	41	23	11	41	33	469
Linköping University	95	41	34	22	20	31	42	27	36	13	405
Chalmers University of Technology	51	47	26	9	20	1	6	11	1	4	340
With Sweden	1,750	1,050	845	619	554	551	480	450	407	395	8,595

The co-publication matrix in Table 3 shows the co-publications (with up to 100 co-authors) between the top ten collaborating institutions in Sweden and Canada and thus gives an indication of the distribution of collaborations between Swedish and Canadian HEIs and research institutes. The blue/green bars represent the ratio of the number of co-publications between two HEIs/research institutes to the total number of co-publications (for the Swedish institution). While it is clear that the top three Canadian universities, the University of Toronto, the University of British Colombia and McGill University, to a certain degree dominate Swedish–Canadian research collaborations (contributing to 20%, 12% and 10% of the total co-publications with Sweden, respectively), overall collaborations between Canada and Sweden are quite well distributed over a large range of both Swedish and Canadian HEIs and research institutes.

Appendix: Data and methods

Data

The report is based on data from the following organisations, accessed in June/July 2020:

- Population and economic data: World Bank, see https://databank.worldbank.org/home.aspx
- Educational attainment and student mobility: UNSCO, see http://data.uis.unesco.org, and the Swedish Higher Education Authority (UKÄ), see https://www.uka.se/statistik--analys/statistikdatabas-hogskolan-i-siffror.html (with one data point from the OECD for Japan)
- Research: Publication data from Scopus, the broadest available publication database, see https://www.elsevier.com/solutions/scopus?dgcid=RN_AGCM_Sourced_300005030

In some cases, there are clear differences in the student mobility data from UNESCO and UKÄ. Different reporting periods and definitions (see below) might explain some of these differences.

Methods

According to the UNESCO Institute for Statistics, an internationally mobile student is an individual who has physically crossed an international border between two countries with the objective to participate in educational activities in a destination country, where the destination country is different from his/her country of origin. For measuring international mobility in education, UNESCO, the OECD and Eurostat have agreed that the preferred definition of the country of origin should be based on students' educational careers prior to entering tertiary education. See http://uis.unesco.org/en/methodology#Q5

The research section includes several indicators and figures that might require further explanation.

Table 1, Selected publication indicators. The annual growth is calculated by using linear regression to approximate the volume development during the period 2015–2019. The field-weighted citation impact (FWCI) is a normalised indicator comparing the citations a publication receives with other publications in the same scientific field, from the same year, and in the same type of publication. If the FWCI is above one, the publication is more frequently cited than the world average, and vice versa. The field-weighted internationalisation score (FWIS) is normalised in a similar manner. A FWIS above one means that the publications are more international (include more international co-authorships) than the world average, and vice versa.[1] Academic–corporate co-publications include at least one academic and one corporate affiliation and at least two co-authors. Finally, the normalised collaboration intensity index (NCII) illustrates how the collaboration differs from a situation when Sweden (or another entity) collaborates with all countries in proportion to their share of all international co-publications globally. For example, authors with an affiliation in the United States participate in 16% of all international co-publications globally. In Sweden's international co-publications, the share of US co-authors is 11%. The NCII is calculated as the actual share divided by the 'expected' share, i.e. 11/16 = 67%, which indicates that US collaboration is underrepresented in Sweden's portfolio of international co-publications.[2]

Figure 12, Distribution of publications per scientific field (2015–2019). The scientific profile is calculated using the OECD categorisation of publications in six scientific fields: agricultural sciences, engineering and technology, humanities, medical sciences, natural sciences, and social sciences. For each field, the share of publications is calculated using the

[1] For more details, see Pohl, H., Warnan, G. and Baas, J. (2014), 'Level the playing field in scientific collaboration with the use of a new indicator: Field-weighted internationalization score', *Research Trends* 39, 3–8.

[2] For a more detailed description, see Pohl, H. (2020), 'Collaboration with countries with rapidly growing research: supporting proactive development of international research collaboration', *Scientometrics* 122(1), 287–307. https://doi.org/10.1007%2Fs11192-019-03287-6

number of publications within the field and the total number of publications in the dataset.

The **word cloud (Figure 13)** is a feature in SciVal, which uses the Elsevier Fingerprint Engine to extract distinctive keyphrases within the publication set. For more information, see https://www.elsevier.com/solutions/elsevier-fingerprint-engine

The **wheel of science (Figure 14)** is another feature directly available in SciVal. Each bubble represents a topic. The size of the bubble indicates the output of the entity on that topic. The position of the bubble is based upon the All Science Journal Classification (ASJC) categories of the journals in which the scholarly output is published. The position is related to the topic as a whole and is not affected by the entity examined. The greater influence an ASJC has over a topic, the closer the topic is dragged to its side of the wheel. As a result, the topics closer to the centre of the wheel are more likely to be multidisciplinary, compared to the topics along the edge of the wheel.

Note that a topic may be placed at the edge of the wheel, but still be considered multidisciplinary because it is equally influenced by a number of ASJCs that are located on the same side of the wheel.

STINT, the Swedish Foundation for International Cooperation in Research and Higher Education, was set up by the Swedish Government in 1994 with the mission to internationalise Swedish higher education and research.

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

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- Enhance the quality of research and higher education
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