



Country Report – Japan



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

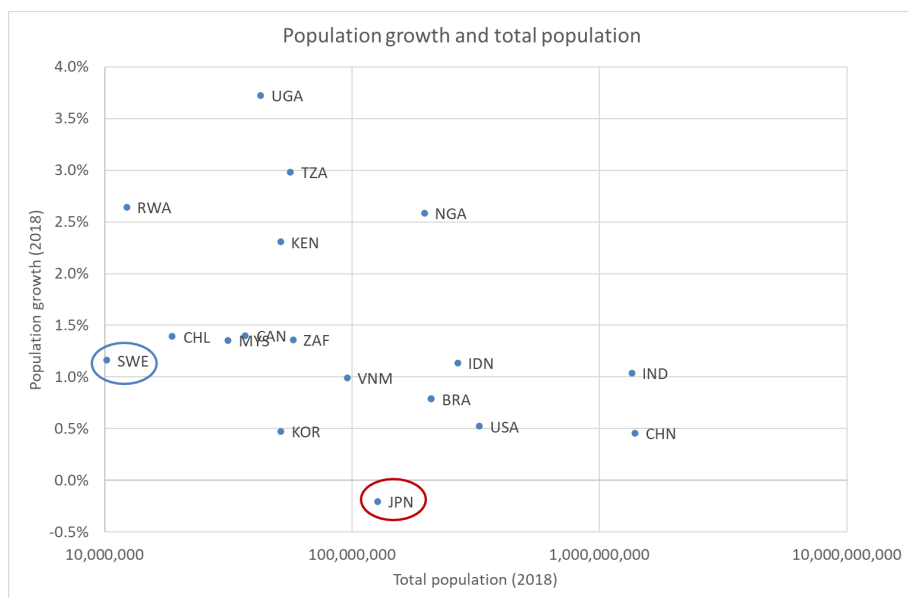
Japan caught up with more technologically advanced nations between the 1960s and 1980s, and government-initiated research programmes played an important part in this success. As many industries reached the technological frontier in the 1980s, the need for changes in science, technology, and innovation (STI) policies became apparent. In its search for a novel growth model, the Japanese government has since the 1990s emphasised the need to promote domestic science and technology. The 1995 enactment of the Science and Technology Basic Law symbolised a firm commitment towards the promotion of research and development (R&D), determined its basic principles, and required the Japanese administration to raise spending on science and technology spending. The Basic Law further requires the Japanese government to develop and implement a five-year Science and Technology Basic Plan. A new approach initiated the preparation of the recent Fifth Basic Plan, as shared guiding principles were identified. Fuelled by digital transformation, the world is at an unprecedented and accelerating pace becoming more interconnected beyond traditional borders. Preparedness for this unforeseeable near future was therefore identified as the most fundamental challenge to be addressed by the Basic Plan. The capacity to design future industry and society will be instrumental, and to this end, investing in people and providing the space to test their ideas will be key. This marks a clear shift from a traditional, technology-driven innovation policy to a more society-centred, challenge-driven policy. Four pillars have been identified: 1. preparing the next generation: future industry and society; 2. addressing socioeconomic and global challenges; 3. investing in people and excellence; and 4. developing better-functioning STI systems.¹

¹ For more details, see R. Carraz and Y. Harayama, Japan's Innovation Systems at the Crossroads: Society 5.0, Digital Asia, Konrad Adenauer Stiftung, pp. 45–57, 02/2018, Singapore, 2019

Population and economic development

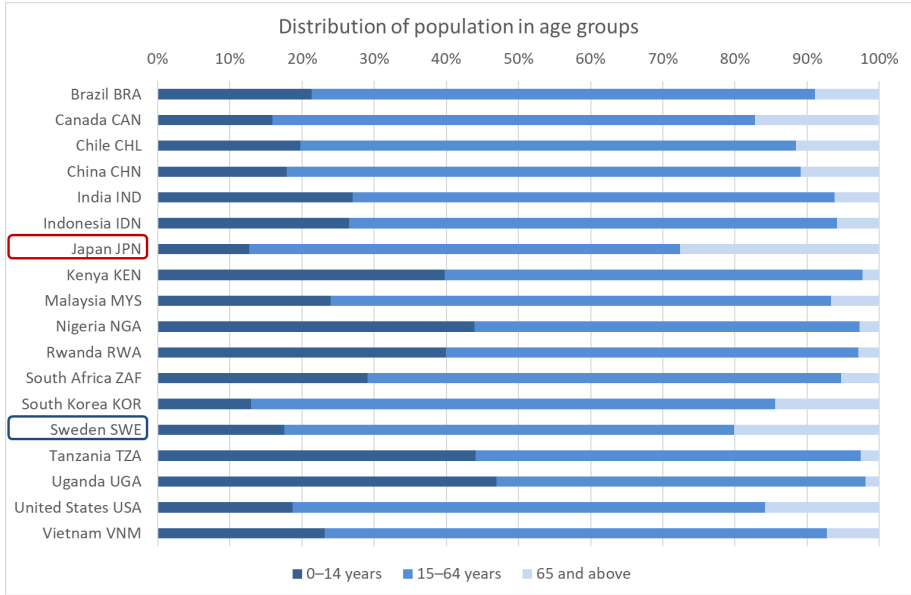
Japan's 2020 population is 126 million, making it the eleventh most populous country in the world. Japan reached its peak population of 128 million in 2010 and has since then seen an accelerating population decline, despite having one of the highest life expectancies in the world, due to falling birth rates and minimal immigration. Current projections leave Japan with a population of around 70 million by 2060 and 42 million by the early 22nd century.

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



Japan's low birth rates and disinterest in bringing in migrant workers from abroad make the nation one of the most culturally and ethnically homogeneous countries on earth.

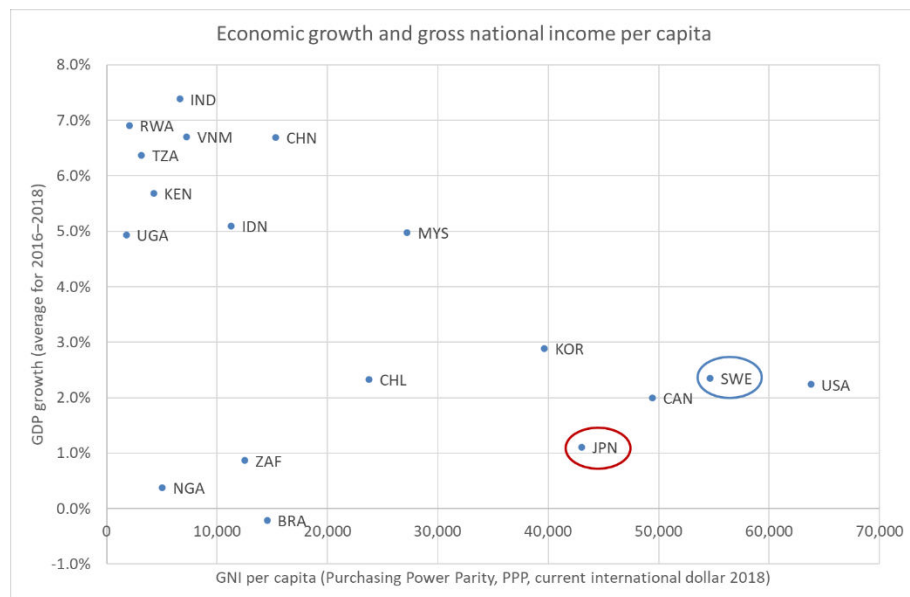
Figure 2: The percentage of the population in each age group



As shown in Figure 2, more than 20% of the population is over the age of 65, and this number is expected to rise to 40% by 2060. A number of variables may explain Japan's low birth rates. There are fewer full-time job opportunities for young people, especially for young men, which results in young people increasingly choosing to put off marriage and childbearing. Women are encouraged to participate on the labour market, but the country has weak support systems for dual-earner families.

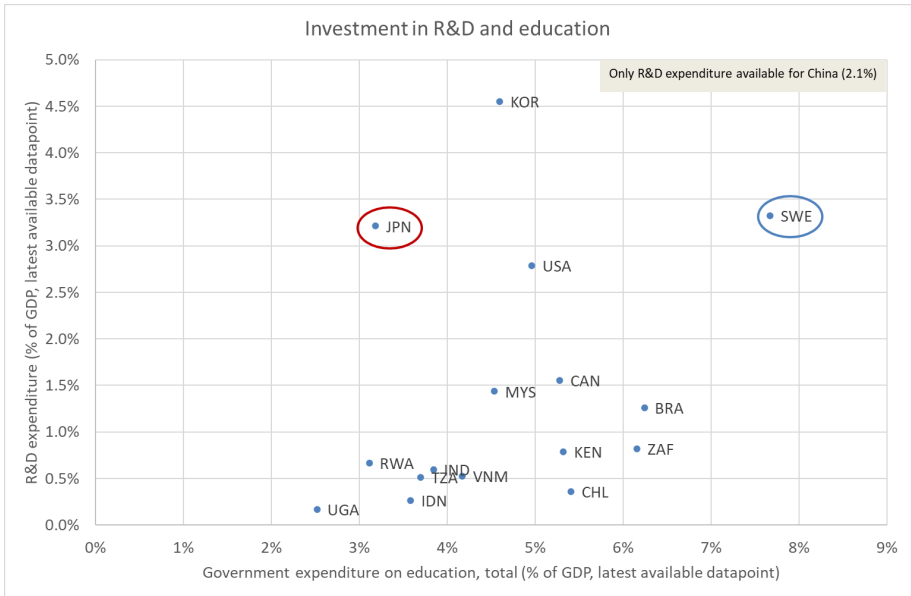
The impact of the population decline on daily life and social structures is profound, especially outside the urban centres. Schools are closing and whole areas are being depopulated. Additionally, much current innovation comes from and is the most quickly adopted by young people, while older people have difficulty adapting. A deficit of dynamic, fresh-thinking young people might make companies less nimble or open to new ideas.

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



Japan has a highly developed free-market economy, the third largest in the world, and has risen spectacularly from the ruins of the Second World War. Japan's asset price bubble collapsed in 1991 and led to a period of economic stagnation known as the "lost decade," now extended to the "lost 20 years." Japan also has the highest ratio of public debt to gross domestic product (GDP) of any developed nation. On the one hand, Japan demonstrates that a shrinking population does not automatically impoverish a country. Its population is slowly declining, yet income per capita has continued to rise as productivity grows and more women enter the workforce. Still, a rapidly ageing population affects Japan's economic performance by increasing the financial burden of social security and benefits, and the shrinking labour force is at the same time hampering growth. The International Monetary Fund has calculated that the impact of ageing could drag down Japan's average annual GDP growth by one percentage point over the next three decades. As Japan's population has levelled off, its economy has slipped into a seemingly permanent state of deflation or near deflation.

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



The Japanese government’s expenditure on education is slightly more than 3% of GDP, which is low internationally. However, expenditure on R&D is more than 3% of GDP, which is similar to that of Sweden and more than in the United States. Japanese government spending on education, as well as R&D, is lower than that of neighbouring South Korea in terms of a percentage of GDP (see Figure 4).

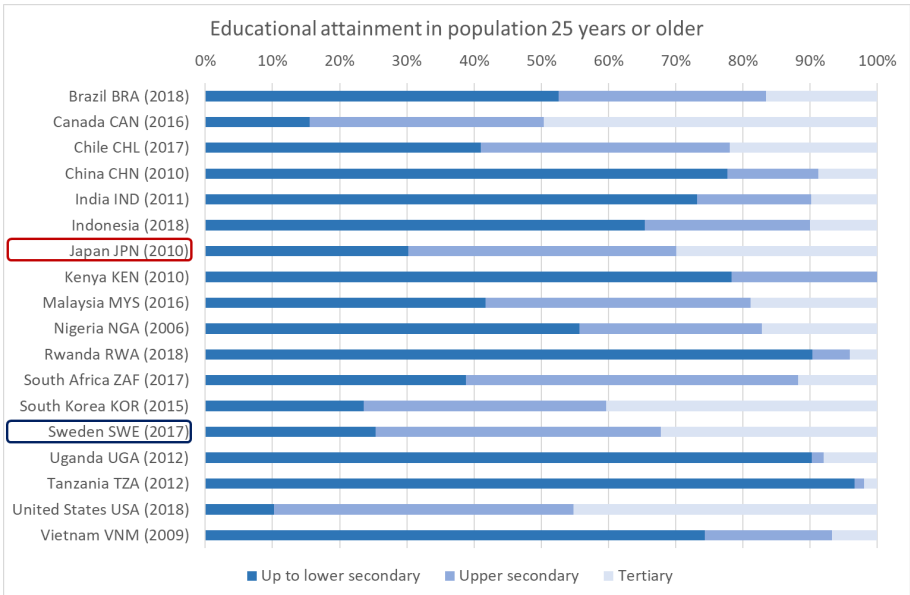
Higher education institutions in Japan

Japan has a well-developed tertiary education system and one of the largest higher education sectors in the world. However, its students are rather homogenous with relatively low shares of adult and international students compared to other OECD countries. Three categories of universities exist in Japan: national universities, established by the national government; public universities, established by prefectures and municipalities; and private universities, established by educational corporations. The country has a high proportion of private higher education institutions (HEIs). However, despite making up the majority of Japanese HEIs, private universities are often considered less prestigious than their national and public counterparts. National and public universities typically rank higher on domestic and international league tables and are responsible for the bulk of Japan's academic research output. Of the eleven universities comprising RU11, a consortium of Japan's top research universities, only two are private: Keio University and Waseda University. Even more prestigious are the National Seven Universities, the oldest and most prestigious of which is the University of Tokyo. The National University Corporation Act, implemented in 2004, reorganised this HEI category, which had previously been managed directly by the Japanese Ministry of Education, Culture, Sports, Science and Technology, thereby transforming national universities into public corporations. This move expanded their autonomy in academic, budgetary, and other matters. Still, despite its size and diversity, the higher education sector in Japan remains challenged. Problems include quality concerns, growing inequality, and shrinking enrolment. Japan's population decline has meant that fewer students graduate from senior high school and that fewer are eligible to enrol in universities. The decline has prompted the Japanese government, universities, and higher education associations to look overseas for students.²

² For more details see Education at a Glance, OECD, 2019, and S. Chawala, Education in Japan, World Education News, February 18, 2021.

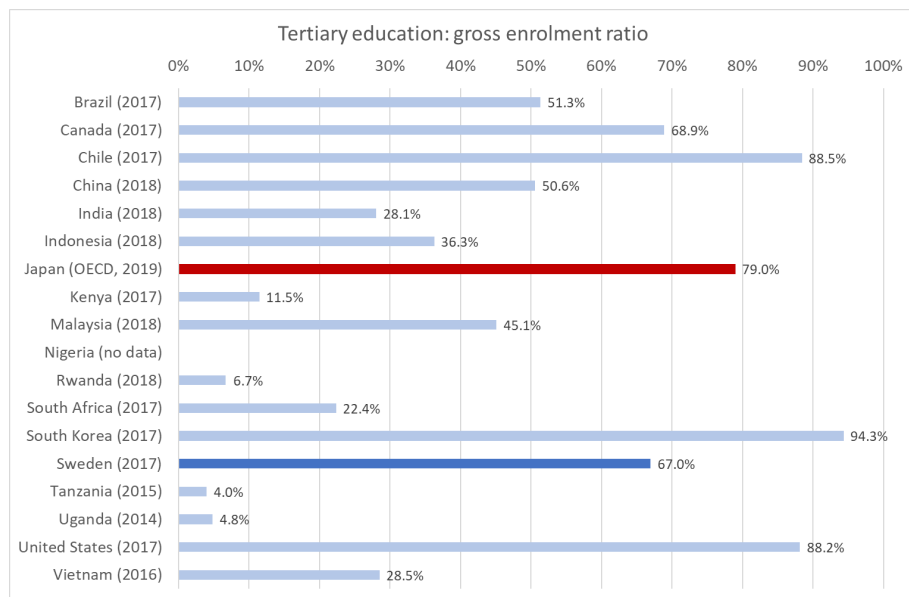
Educational attainment and student mobility

Figure 5: Educational attainment



There are no recent data on educational attainment for the population of Japan. About 40% of the population (25 years or older) had attained upper secondary education in 2010. Tertiary education was attained by 30%, as seen in Figure 5. By comparison, in South Korea about 40% of the population had attained tertiary education in 2015 and in Sweden slightly more than 30% in 2017.

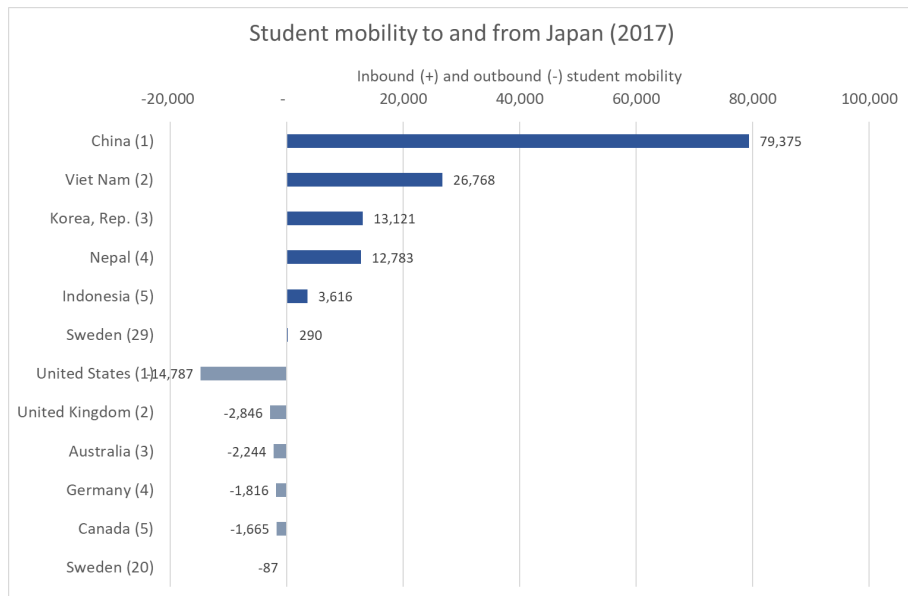
Figure 6: **Gross enrolment ratio for tertiary education**



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.

In Japan, the GER for tertiary education is rather high at 79%, but still significantly lower compared to that of South Korea at 94%. The corresponding GER for Sweden is 67%.

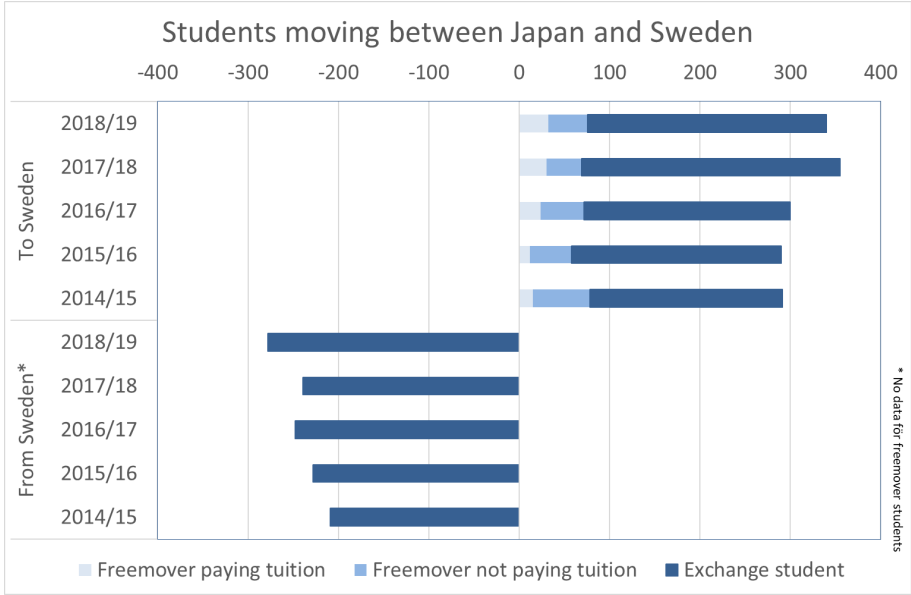
Figure 7: Inbound and outbound students, origins and destinations



In 2017, inbound students to Japan mainly comprised students from China, followed by Vietnam, South Korea, and Nepal. Swedish students constituted a relatively modest group (290 students).

The most popular study destinations for students from Japan were the United States and the United Kingdom. The data from UNESCO, on which Figure 7 is based, appear incorrect regarding inbound Japanese students to Sweden. As seen on the following pages, this number is clearly higher.

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



The number of exchange students between the two countries has remained fairly balanced and consistent over the period shown in Figure 8 (2014–2019). The indicated number of outbound students from Sweden to Japan only comprises exchange students. Roughly 200–300 students from each country participate in an exchange programme annually. A moderate number of freemoving students from Japan attend higher education in Sweden. This number has been fairly constant in recent years and does not exceed 100 students.

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

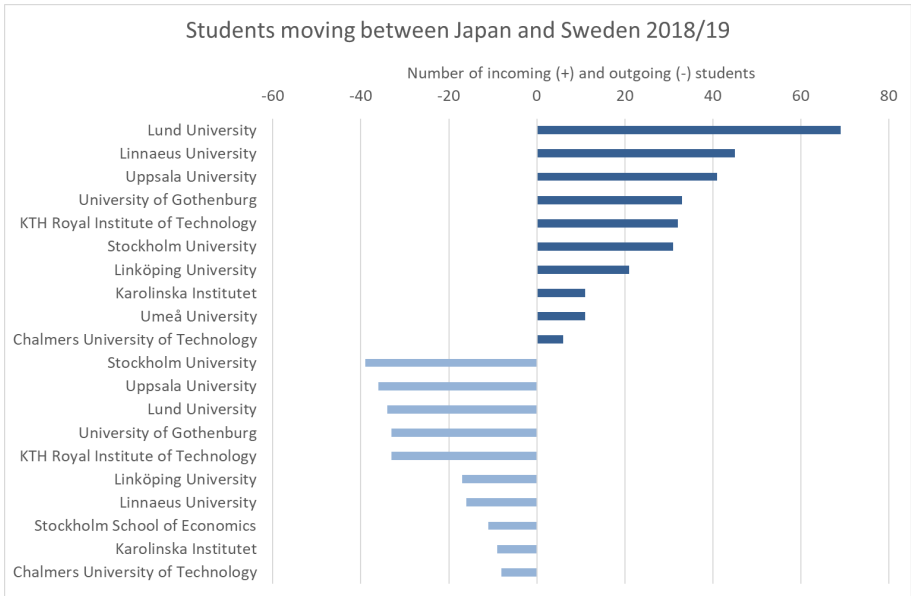


Figure 9 illustrates the inbound students from Japan to specific Swedish HEIs. By far the highest number of students study at Lund University, followed by Linnaeus University, which is interesting to note as it is a smaller and newer university. Overall, students from Japan usually study at the larger universities in Sweden. The outbound students, comprising exchange students from Swedish HEIs, mainly come from the larger Swedish universities in Stockholm, Uppsala, Lund and Gothenburg.

Research and collaboration with Sweden

Japan is a relatively strong and mature science nation and produces over 4% of the world's scientific publications. However, the growth of scientific production is weak. The average citation impact is also lower than the world average. The field-weighted citation impact (FWCI) is 0.95, which is comparable to that of countries such as Indonesia and Nigeria (although Japan has a much larger research output than these nations). International collaboration among researchers in Japan is also relatively weak, especially compared to the total number of publications.

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

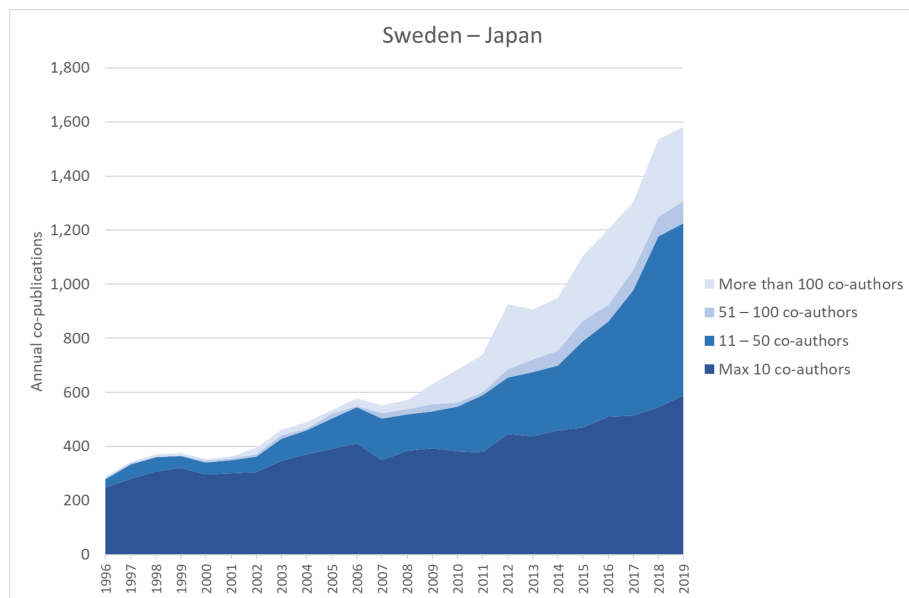
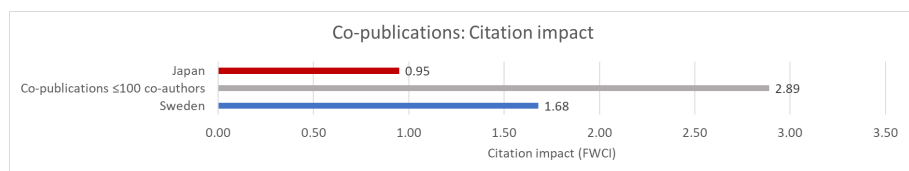


Figure 11: Field-weighted citation impact for each country and their co-publications with ≤100 co-authors (2015–2019)

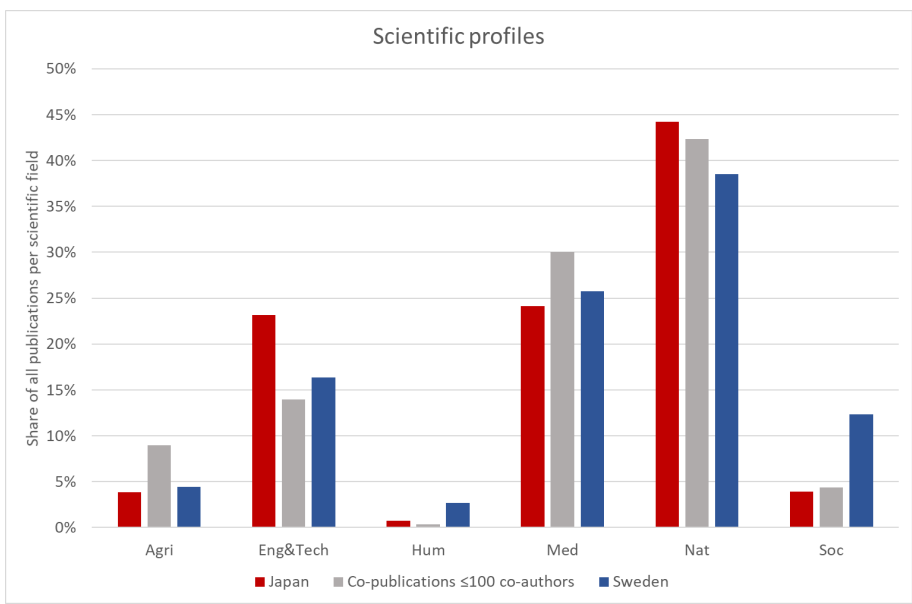


Co-publications between Sweden and Japan are dominated by cooperations with up to 50 co-authors, as indicated in Figure 10. During the last decade there has been a drastic increase in the number of co-publications between Sweden and Japan, especially regarding medium-sized cooperations with 11–50 co-authors.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

In 2015, STINT together with the Embassy of Sweden and Nagoya University organised a university presidents’ summit to promote academic cooperation between the countries. One outcome of the summit is that

several Swedish and Japanese universities have formed the Mirai network, funded by STINT.

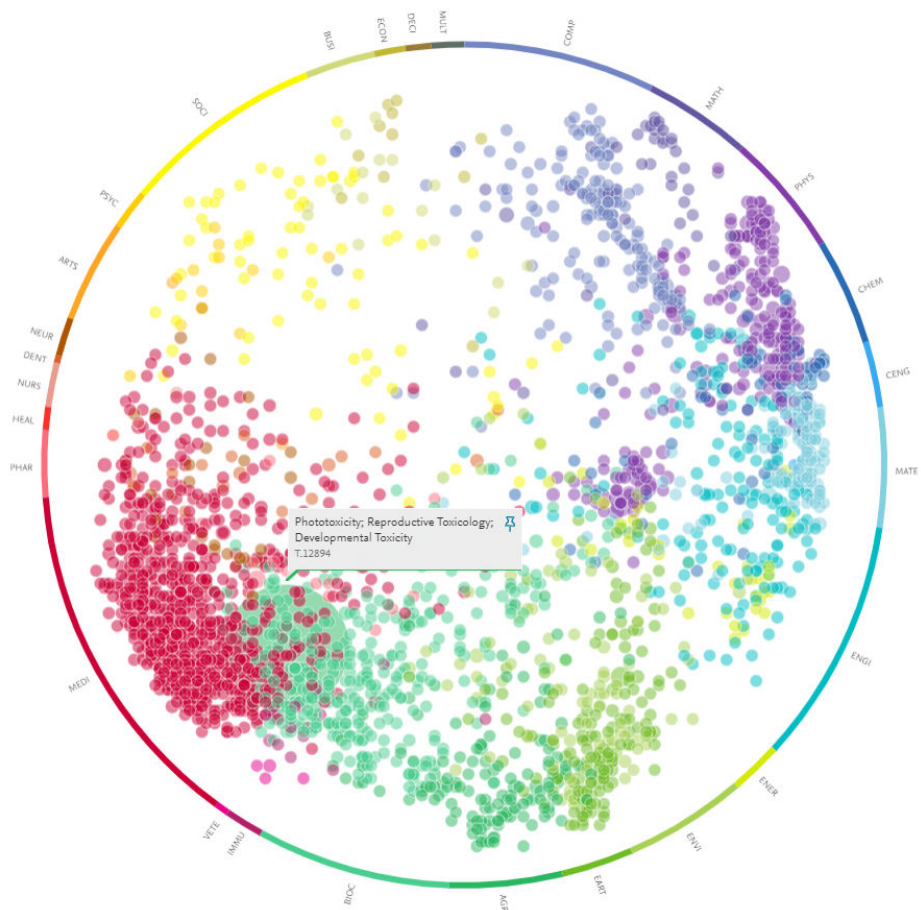
Figure 12: Distribution of publications per scientific field (2015–2019)



In Figure 12, the scientific profiles of research collaborations between Sweden and Japan are compared with the overall profiles of these countries in various fields. For example, approximately 23% of the publications with Japanese participation are within engineering and technology. In Sweden, the share is clearly lower at 16%. 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, as is the case in the natural and social sciences. The agricultural sciences and medicine are overrepresented in Swedish–Japanese collaborations, whereas engineering and technology and the humanities are underrepresented.

The relatively high share of co-publications within the agricultural sciences is surprising. A closer look at these co-publications reveals that 347 are in the same journal, *Food and Chemical Toxicology*, and concern the safety assessment registration of different fragrances. Lund University is involved in this research.

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



Publications involving Swedish and Japanese researchers are predominantly in the field of medicine (see Figure 14). One large bubble represents the toxicology publications. Its size indicates that a high share of all included co-publications are on this topic. There are bubbles all over the wheel of science and they tend to cluster towards the side of the wheel, indicating that they pertain to single disciplines. However, multidisciplinary publications located in the centre of the wheel are also present.

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 Japan (≤100 co-authors)	Share of all publications at the Swedish institution	FWCI
Södertörn University	75	7.8%	1.18
NORDITA	42	4.6%	1.98
Royal Swedish Academy of Sciences	18	4.5%	3.51
Lund University	1133	3.6%	2.20
Swedish Meteorological and Hydrological	19	3.2%	4.60
Stockholm University	564	3.1%	2.36
Karolinska Institutet	1035	2.9%	4.51
KTH Royal Institute of Technology	632	2.9%	1.75
Uppsala University	821	2.8%	3.45
Chalmers University of Technology	395	2.7%	1.96
Stockholm Environment Institute	17	2.5%	3.73
Swedish Museum of Natural History	32	2.4%	2.28
IVL Swedish Environmental Research Inst	9	2.3%	4.32
University West	18	2.1%	1.74
Ericsson AB	41	2.0%	2.78
SP Technical Research Institute of Swede	13	1.9%	0.85
Karlstad University	38	1.9%	1.63
University of Gothenburg	422	1.9%	4.62
Swedish University of Agricultural Science	167	1.8%	3.46
Sandvik AB	7	1.8%	0.77

Table 2 ranks Swedish HEIs and research institutes in Sweden based on their co-publications with Japan (with up to 100 co-authors) as a share of their total publication output. Large and research-intensive Swedish universities' shares of co-publications with Japan are lower than Japan's share of the global publication volume (4.27%), explaining Japan's research intensity with Sweden of 70%. The collaborations of NORDITA and the Royal Swedish Academy of Sciences, whose co-publication shares are slightly higher than Japan's share of the global output, are focused on particle physics and astronomy. Södertörn University's high co-publication share is due to one prolific scientist with dual affiliations at Södertörn University and the University of Tokyo.

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

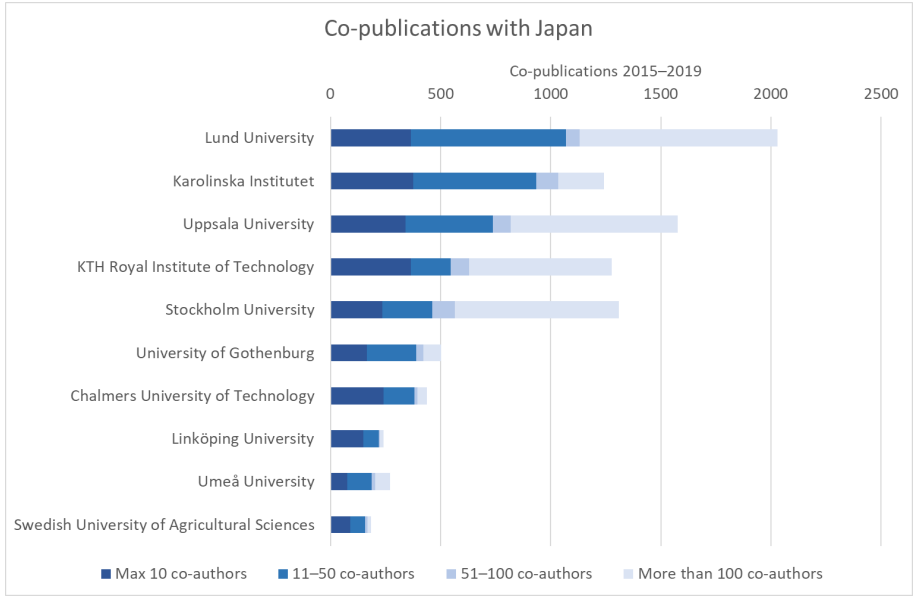


Figure 15 lists the ten Swedish universities with the highest numbers of co-publications with Japan, ranked according to the number of co-publications with up to 100 co-authors. These are more or less identical to the top ten Swedish universities by overall publication volume. Lund University ranks one place higher in the number of Japanese co-publications and the University of Gothenburg a few places lower, otherwise the order is exactly the same as that of the overall ranking of Swedish universities by publication numbers. Thus, while there are some variations in the weight of the various scientific fields in Japanese–Swedish research collaborations compared to the overall numbers (see Figure 12), co-publication patterns by and large follow the general publication patterns in Sweden.

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

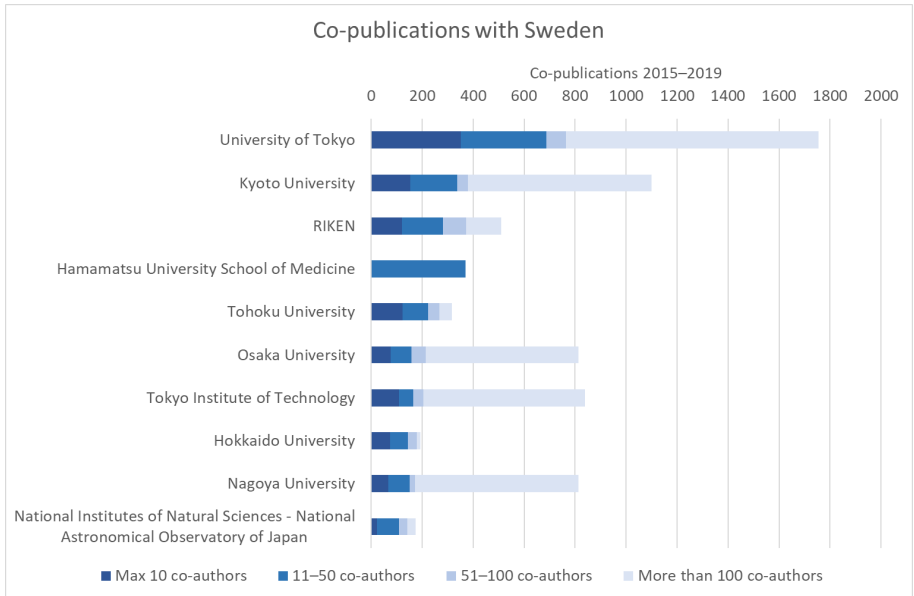


Figure 16 lists the ten Japanese universities with the highest numbers of co-publications with Sweden, ranked according to the number of co-publications with up to 100 co-authors. With the exception of Kyushu University, the list includes all of the National Seven Universities,³ which, together with the Tokyo Institute of Technology, are the largest universities in Japan by publication volume. RIKEN’s collaboration with Sweden is clearly strong, placing it close to the top of the list above several universities with significantly greater overall publication volumes. Hamamatsu University School of Medicine’s co-publications with Sweden present a special case: almost all result from the safety assessment registration of different fragrances previously discussed in relation to Figures 12–14.

³ The University of Tokyo, Kyoto University, Tohoku University, Kyushu University, Hokkaido University, Osaka University and Nagoya University.

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 Tokyo	Kyoto University	RIKEN	Hamamatsu University School of Medicine	Tohoku University	Osaka University	Tokyo Institute of Technology	Hokkaido University	Nagoya University	National Institutes of Natural Sciences - National Astronomical Observatory of Japan	With Japan
Lund University	99	105	73	366	40	45	20	16	22	8	1,130
Karolinska Institutet	87	61	83	-	48	55	8	32	35	-	1,035
Uppsala University	123	60	68	3	43	43	21	26	33	16	819
KTH Royal Institute of Technology	158	42	98	-	63	43	48	33	29	42	630
Stockholm University	195	55	63	-	37	22	35	65	36	63	564
University of Gothenburg	35	25	29	-	38	13	4	15	15	-	421
Chalmers University of Technology	65	30	31	-	12	24	45	3	27	75	394
Linköping University	26	6	3	-	11	5	3	7	4	-	226
Umeå University	8	15	12	-	6	13	2	9	4	-	203
Swedish University of Agricultural Sciences	17	20	5	-	7	2	7	17	4	-	167
With Sweden	765	379	372	371	267	213	204	179	172	142	5,384

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 Japan and thus gives an indication of the distribution of collaborations between Swedish and Japanese 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). Discounting the high number of co-publications between Lund University and Hamamatsu University School of Medicine on fragrance ingredient safety assessments (as discussed in relation to Figures 12–14), it is clear that research collaboration between Japan and Sweden is quite well spread over a large range of both Swedish and Japanese HEIs and research institutes. The University of Tokyo is the largest partner for most Swedish universities, but still contributes to no more than 14% of all Swedish–Japanese co-publications. The co-publication matrix also shows that the reason why the National Astronomical Observatory of Japan ranks as one of the top ten Japanese institutions regarding their number of co-publications with Sweden (Figure 16), namely a particularly strong collaboration with Chalmers University of Technology.

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: UNESCO, 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.⁴ 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.⁵

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

⁴ 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.

⁵ 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.

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. STINT for example 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.



STINT

Stiftelsen för internationalisering av
högre utbildning och forskning

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