Country Report – India

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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

India is the world's second largest country by population, the fifth largest by gross domestic product (GDP), and third when adjusted for purchasing power parity. As a parliamentary republic, India is often referred to as the world's largest democracy. India's GDP has generally been growing in the 6–7% range since the turn of the millennium, although the growth rate slowed from 2017, partly as a result of the 2016 demonetisation initiative.

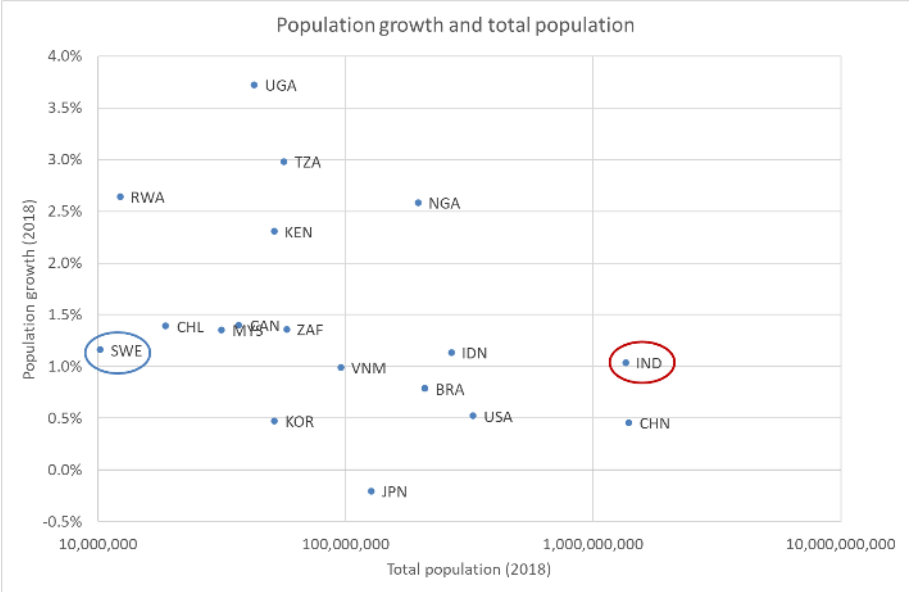
India has a developed and extensive service industry, notably including IT and business outsourcing services, which is based on its large, educated, English-speaking workforce and a deep pool of software engineers. As of 2016, the service industry accounted for about 62% of the GDP, with the industrial and agricultural sectors accounting for 23% and 15%, respectively. Agriculture remains a fixture of the Indian economy, employing some 59% of the population. India has a substantial pharmaceutical industry that produces about 20% of the global supply of generic drugs as well as more than 50% of the global output of vaccines.

India's research and development (R&D) spending is low in an international comparison and has also been steadily declining since 2008, reaching 0.65% of GDP in 2018 according to World Bank data. Furthermore, industry contributes relatively little to the country's total R&D spending. Taken together this makes India's aspiration to spend 2.2% of GDP on R&D by 2022 look unlikely to realise. Nevertheless, the country's innovation ecosystem performs reasonably well in international comparison, ranking 48th in the world in the World Intellectual Property Organization (WIPO) Global Innovation Index 2020 and thereby performing above expectations for its level of development.

Population and economic development

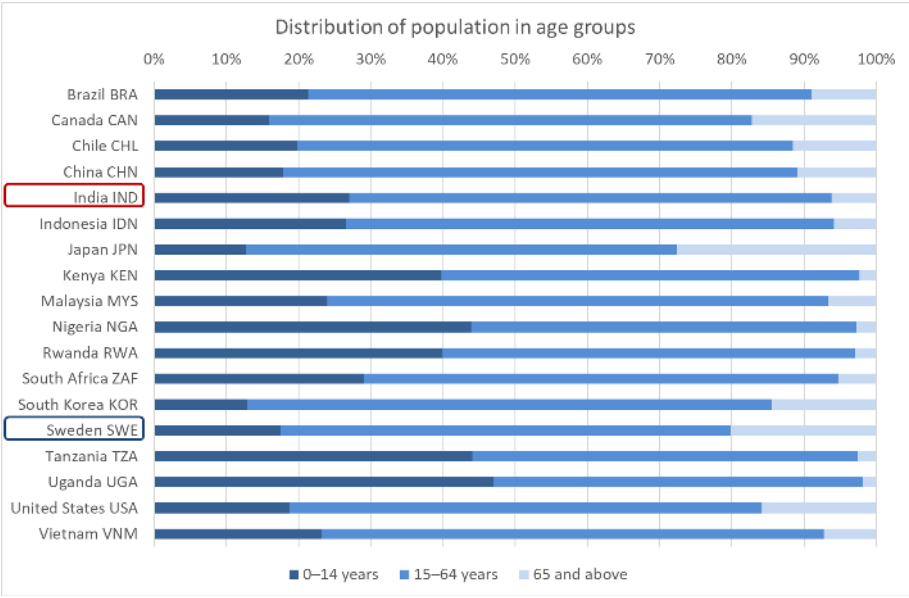
According to UN data, India's population is estimated at 1.37 billion people in 2020, comprising 18% of the total world population. This makes India the world's most populous country after China. With China's population growth flattening, India is projected to take the top position in less than a decade.

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



As in much of the rest of the world, India's population growth rate has been slowing in recent decades, a decline attributed to decreased poverty, rising education levels especially among women, and perhaps most importantly, growing urbanisation. Most Indian states are expected to hit replacement fertility levels of 2.1 children per woman by 2021. By the middle of the century, most of India's population increase will be due to demographic momentum, meaning that even as fertility rates fall below replacement levels, high numbers of young people will continue to boost the country's population.

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

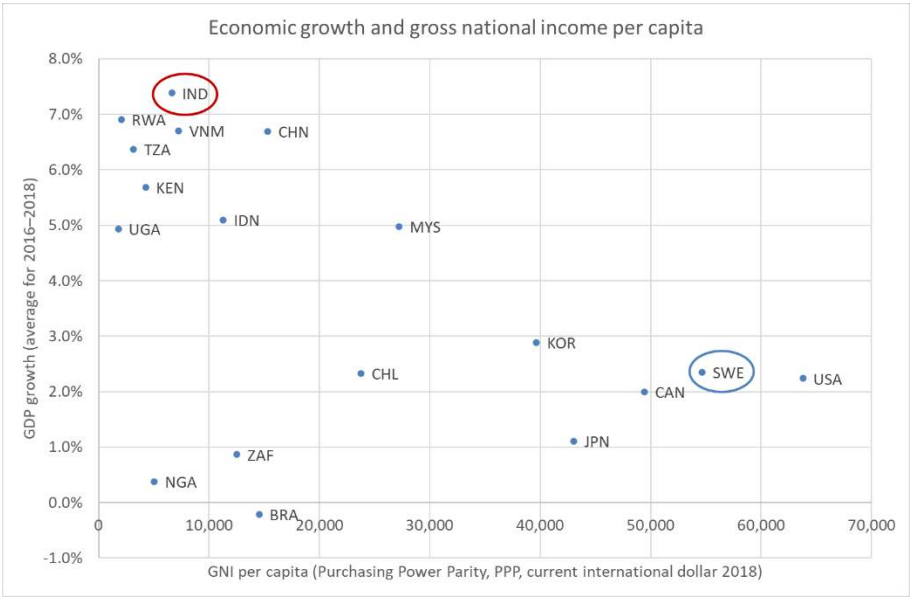


Half of India's population is under the age of 25, with two-thirds younger than 35, and they are projected to constitute the world's largest workforce by 2027. This is naturally a great resource, but robust public policy and investments are needed to ensure full benefit as the age distribution is uneven: high numbers of young people in the poorest parts of the country are the most deprived of infrastructure and social services and are disconnected from the global economy.

Women still often face forced marriages and domestic violence, and India has come to be considered one of the least safe places for women worldwide. The practice of sex-selective abortions continues to persist, despite the stringent laws enacted to counter the skewed sex distribution.

So far, India's government has failed to take full advantage by upskilling this large, male-heavy generation and putting them to productive work.

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

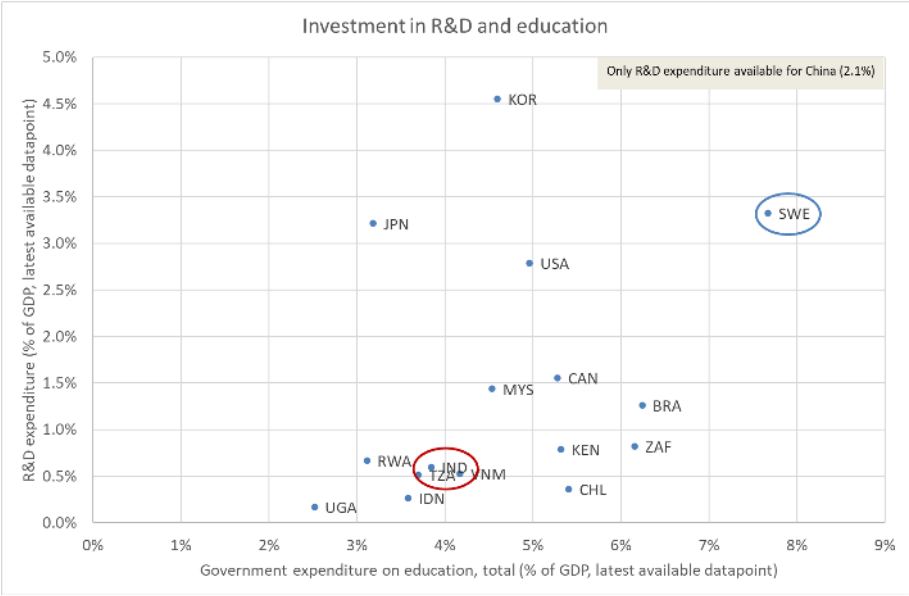


India is the world's third largest economy in purchasing parity terms. Its annual GDP growth rate averaged 5.87% from 1951 until 2020, reaching an all-time high of 11.4% in 2010. In 2019, the country lost its place as the world's fastest growing economy as its growth rate fell behind that of, for example, China and several African countries.

The last decades' growth has largely been due to the expansion of the service sector rather than manufacturing; services have for example shown a 17% compound annual growth rate during 2015–2020. The long-term growth prospects of the Indian economy remain positive due to its young population and increasing integration into the global economy.

India followed socialist-inspired politicians for most of its independent history, with state ownership of many sectors and annual per capital income growth around 1% for the first three decades after independence. Following more fundamental reforms since 1991, India has progressed towards a free market economy. Since the 2000s, India has made notable progress in reducing absolute poverty.

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



The Indian government's expenditure on education is slightly less than 4% and that on R&D about 0.5% of GDP. These are low percentages when compared internationally. For instance, Chinese expenditure on R&D is about 2% of GDP. By 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 India

India has an ancient tradition of learning dating back to Vedic times. During colonial rule an education system based on the British one was introduced, and the first Western-style universities were established. Today India has the third largest higher education system in the world.

The Indian higher education system has seen tremendous expansion during recent decades. Between 1990 and 2017, the number of universities increased almost fivefold to close to 1,000, and c. 18,000 colleges were established in 2008–2016 alone. The number of technical colleges has also rapidly grown. Private universities and colleges have markedly increased since operations were permitted in the 1980s, partially because of the lack of capacity in public universities and colleges. With the world's largest population under the age of 25, India still has a low tertiary gross enrolment ratio of about 28%, well below the global average. Further massive expansion of tertiary education is therefore deemed necessary.

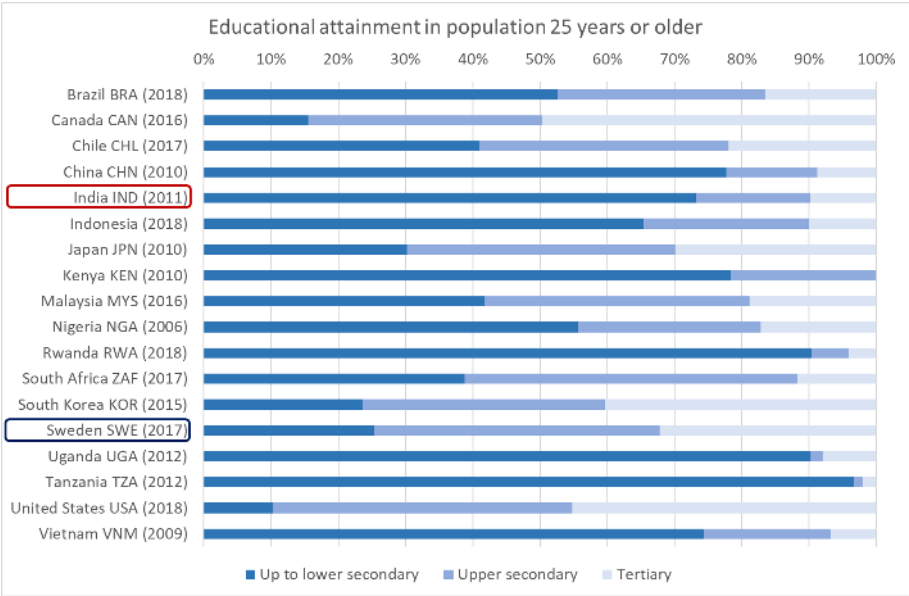
Unsurprisingly, India has the second highest number of outbound international students in the world. English-speaking countries dominate as receiving countries; however, non-traditional study destinations, such as the UAE and China, are seeing a strong increase.

Despite the large scale of the Indian higher education system, and the considerable numbers of influential Indian scientists at universities in Europe and North America, India has yet to develop any internationally top-ranked universities and the country's share of the global research output is rather low (see discussion related to Table 1).

The 23 Indian Institutes of Technology are a dominant force in the Indian research landscape, as is the Indian Institute of Science, which is typically considered the leading institution in India in terms of research quality. Although they are not among the top-ranked universities in India, Anna University and Vellore Institute of Technology lead by publication volume.

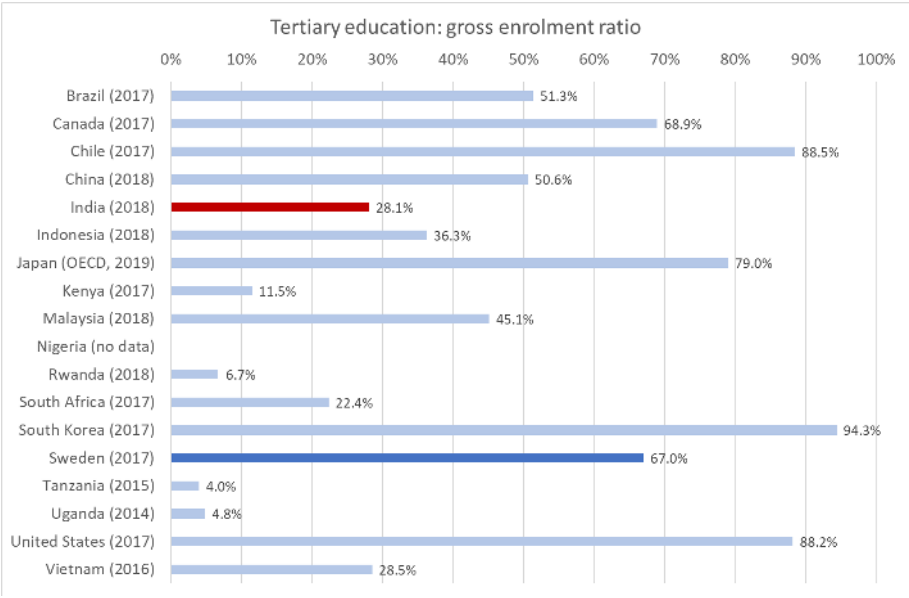
Educational attainment and student mobility

Figure 5: **Educational attainment**



There are no recent data on educational attainment for the population of India. Data from 2011 indicate that the vast majority of the population (25 years and older), close to 75%, had not attained upper secondary education or higher, which was rather similar to the situation in China. About 10% had attained tertiary education, as can be seen in Figure 5. By comparison, in Sweden about 40% of the population had attained upper secondary and more than 30% tertiary education (2017).

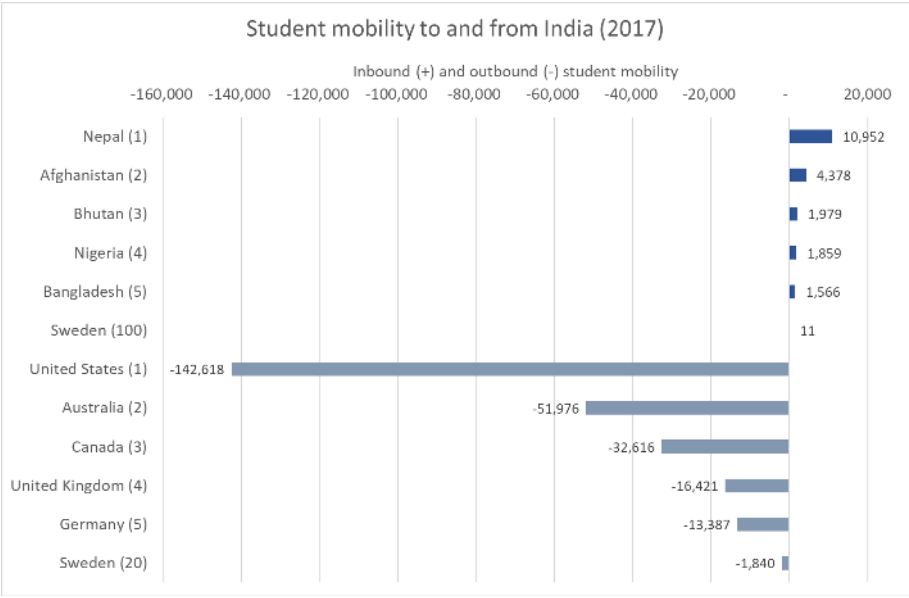
Figure 6: **Gross enrolment ratio for tertiary education**



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.

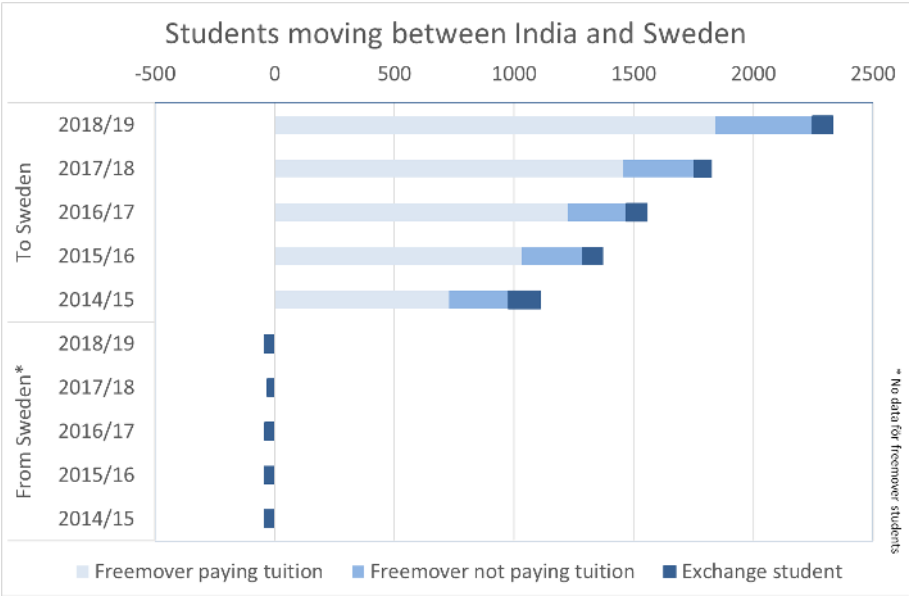
In India, the GER for tertiary education is 28.1%, which is significantly lower than China's 50.6%. The corresponding GER for Sweden is 67%.

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



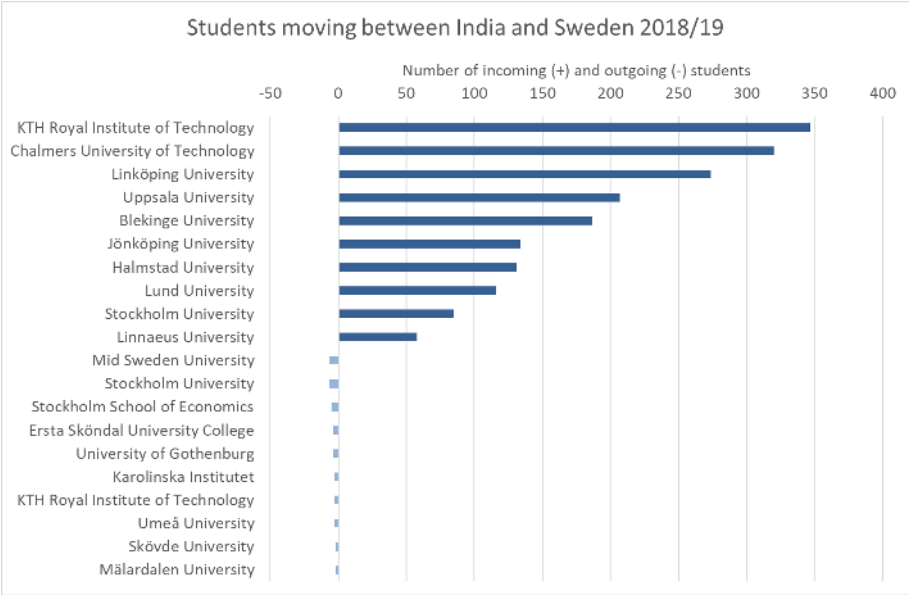
Indian students are the second largest group of foreign students in the world. As can be seen in Figure 7, the majority of outbound Indian students study in the United States, followed by other English-speaking countries such as Australia, Canada, and the United Kingdom. Sweden also receives a fairly high number of Indian students, in comparison to other foreign student groups. The number of Indian students in Sweden was 1,840 in 2017. Inbound students to India predominantly come from countries in the region such as Nepal, Afghanistan and Bhutan.

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



The number of Indian students studying abroad has increased over recent years and Sweden has seen an equivalent increase in inbound Indian students. As shown in Figure 8, the number of Indian students in Sweden consecutively increased during the five academic years 2014/15–2018/19. The greatest change has been seen in the category of tuition paying students. This group more than doubled from the academic year 2014/15 to 2018/19. A slight increase in non-tuition paying students was also seen. The number of exchange students is fairly constant in both directions. The student flows between Sweden and India are strongly asymmetric, with significantly more Indian students going to Sweden than in the other direction.

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



Some specific patterns can be seen when breaking down the inbound Indian students by the specific Swedish higher education institutions (HEIs) at which they study. HEIs with strong engineering programmes are preferred (see Figure 9). These include technical universities such as KTH Royal Institute of Technology and Chalmers University of Technology, but also smaller universities such as the ones in Blekinge, Jönköping and Halmstad. Outbound Swedish students come from a fairly mixed group of HEIs, including large universities such as KTH, Karolinska Institute, Stockholm University, and the University of Gothenburg, as well as newer universities such as Mid Sweden University, Linnaeus University, and smaller HEIs such as the Stockholm School of Economics and Ersta Sköndal Bräcke University College. The absolute student numbers from each of these are however small, making it difficult to draw any specific conclusions.

Research and collaboration with Sweden

Indian scientific production constitutes 5.29% of the world total, while India's share of the world population is almost 18%. The annual growth of publications (2015–2019) is comparable to that of other emerging countries, but greater than that of advanced science nations. The field-weighted citation impact (FWCI) is 0.82, which is slightly below that of other emerging economies. Indian publications are fairly local; the share of international co-publications, as measured by the field-weighted internationalisation score (FWIS), is only 0.43.

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**

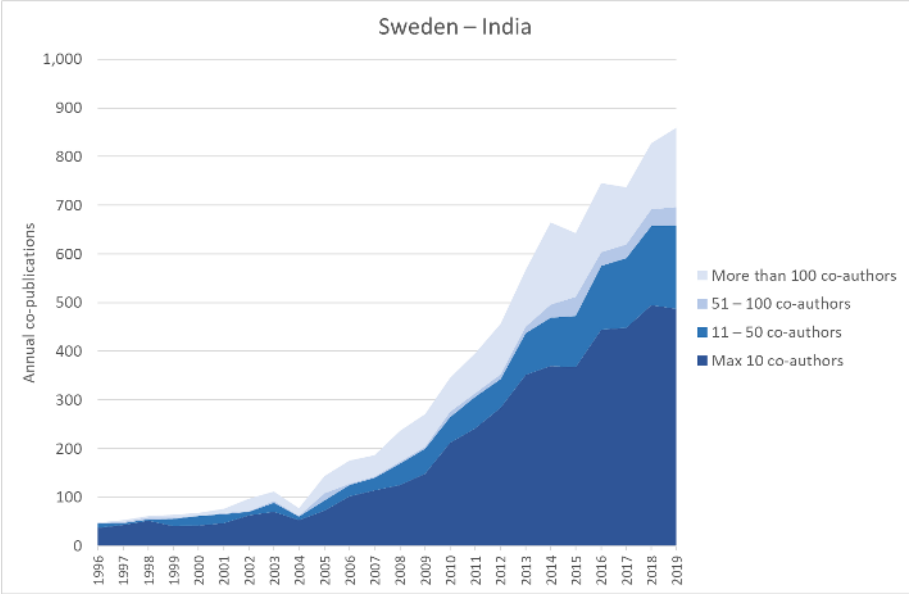
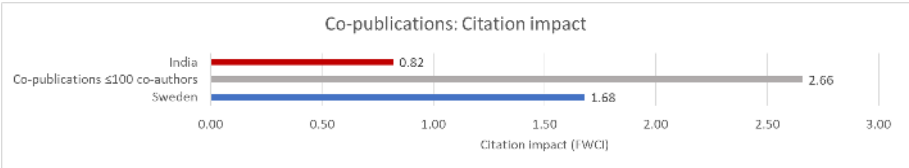
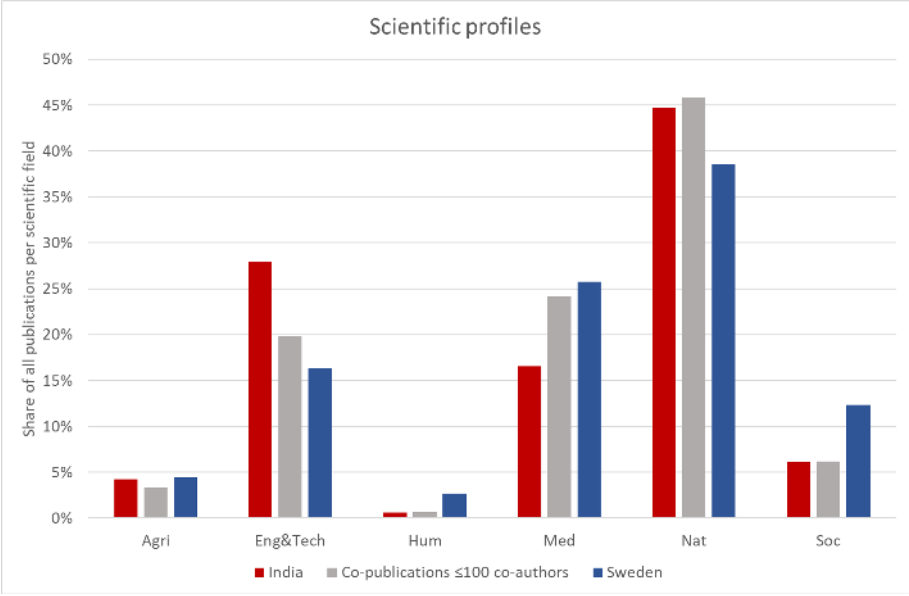


Figure 11: **Field-weighted citation impact for each country and their co-publications with ≤100 co-authors (2015–2019)**



Co-publications between Sweden and India 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 India, and especially in small cooperations with up to ten co-authors. 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, i.e., collaborations increase the quality of both Swedish and Indian research.

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



In Figure 12, the scientific profiles of research collaborations between Sweden and India are compared with the overall profiles of these countries in various fields. For example, approximately 28% of the publications with Indian participation are within engineering and technology. In Sweden, the share is clearly lower at 17%. 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 for engineering and technology and medicine. The natural sciences are slightly overrepresented, while the agricultural sciences are slightly underrepresented in Swedish–Indian co-publications.

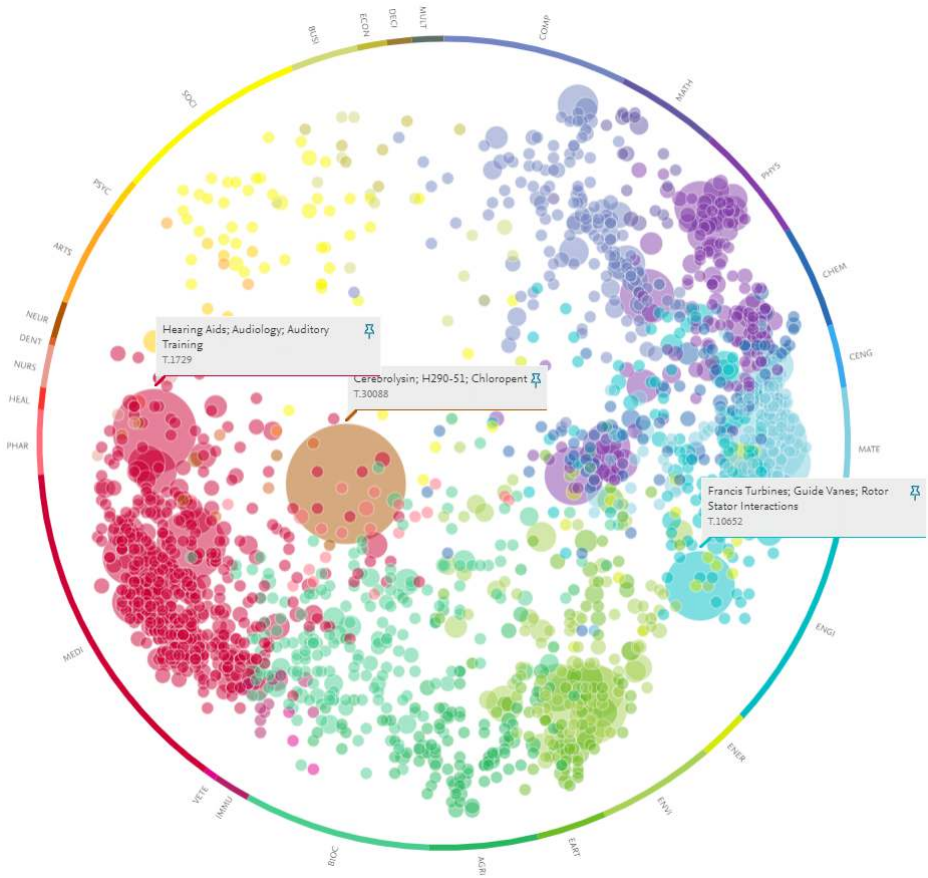
The HEIs with high numbers of Swedish–Indian co-publications are listed below. Given the comparatively even distribution of such co-publications over scientific fields, a broad mix of institutions are involved, as could be expected.

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 Indian 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 India, most keyphrases are green.

'India' is a prominent keyphrase whereas 'Sweden' is not. One interpretation is that the research done in collaboration between the countries has a stronger, yet declining, focus on the Indian context. Keyphrases pertaining to medicine are somewhat more prominent, even though some of the most prominent green (i.e., growing) keyphrases pertain to the physical sciences: 'neutrino' and 'supernova' span the range from one of the smallest entities in the physical world to one of the largest.

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



Publications involving Swedish and Indian researchers cover almost all scientific fields, see Figure 14. The largest bubble is relatively close to the centre, indicating that it includes multidisciplinary collaborations. Its size indicates that a high number of included co-publications are on this topic.

Medicine, environmental sciences, and materials sciences appear to be three fields with particularly strong collaborations. There are fewer yellow bubbles, indicating limited collaborative research in the social sciences.

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 India (≤100 co-authors)	Share of all publications at the Swedish institution	FWCI
University West	45	5.2%	1.67
NORDITA	37	4.0%	1.13
Stockholm Environment Institute	21	3.1%	6.21
Luleå University of Technology	151	2.7%	1.75
Swedish Meteorological and Hydrological	12	2.0%	1.97
ABB Corporate Research	18	2.0%	1.31
University of Borås	20	2.0%	1.09
Uppsala University	580	2.0%	2.09
KTH Royal Institute of Technology	422	1.9%	1.64
Sandvik AB	7	1.8%	1.39
University of Gävle	22	1.8%	0.38
Linköping University	231	1.6%	1.88
Mälardalen University	39	1.6%	1.12
Swedish Museum of Natural History	20	1.5%	3.35
Royal Swedish Academy of Sciences	6	1.5%	63.34
Stockholm University	263	1.5%	3.49
Karolinska Institutet	508	1.4%	3.97
Swedish University of Agricultural Science	127	1.4%	2.09
University of Skövde	15	1.3%	0.72
Umeå University	151	1.2%	2.43

Table 2 ranks Swedish HEIs and research institutes based on their co-publications with India (with up to 100 co-authors) as a share of their total publication output. With the exception of University West, all Swedish institutions listed have a co-publication share below, and for most significantly below, India's global publication share. This underscores the fact that Sweden's research collaboration with India can be classified as underdeveloped, India's collaboration intensity with Sweden is only 55% (see Table 1). This does not necessarily represent a failure of Swedish institutions to focus on collaborations with India, as India's FWIS of 0.43 is quite low (with 1 being the global average), but it does indicate ample opportunity for enhanced collaboration.

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

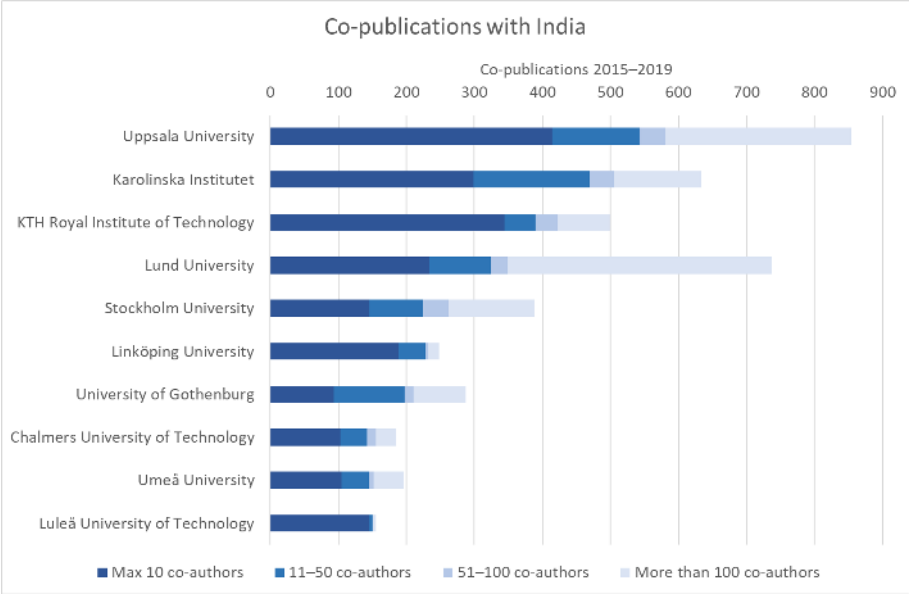


Figure 15 lists the ten Swedish universities with the highest numbers of co-publications with India, ranked according to the number of co-publications with up to 100 co-authors. With the exception of Luleå University of Technology, these are also the top ten Swedish universities by overall publication volume, with some differences in the ranking order. A significant proportion of the largest comprehensive universities' co-publications with India have more than 100 co-authors, especially for Lund University and Uppsala University. For the most part, these are in the field of particle physics, in which publications with very high numbers of co-authors are common (the exception here is the University of Gothenburg).

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

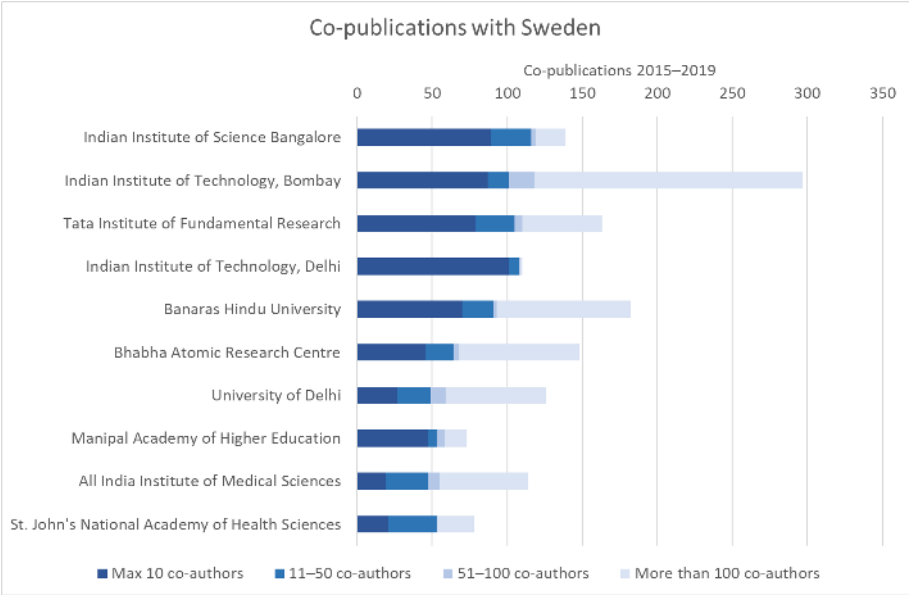


Figure 16 lists the ten Indian universities with the highest numbers of co-publications with Sweden, ranked according to the number of co-publications with up to 100 co-authors. The list neither correlates well with a ranking of Indian institutions by overall publication volume, nor with international rankings of Indian HEIs and research institutes. Combined with the generally modest number of co-publications with Sweden per institution, it is challenging to draw any general conclusions about collaboration patterns between Swedish and Indian HEIs and research institutes.

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	Indian Institute of Science Bangalore	Indian Institute of Technology, Bombay	Tata Institute of Fundamental Research	Indian Institute of Technology, Delhi	Banaras Hindu University	Bhabha Atomic Research Centre	University of Delhi	Manipal Academy of Higher Education	All India Institute of Medical Sciences	St. John's National Academy of Health Sciences	With India
Uppsala University	39	26	12	22	37	12	9	6	11	12	580
Karolinska Institutet	5	3	8	6	11	13	10	29	23	21	505
KTH Royal Institute of Technology	39	27	36	29	3	7	3	9	1	-	422
Lund University	10	3	14	6	14	17	9	1	10	-	349
Stockholm University	16	14	37	4	3	6	4	2	2	-	262
Linköping University	9	5	-	8	3	2	2	15	-	3	231
University of Gothenburg	3	-	5	10	8	2	-	2	10	20	210
Chalmers University of Technology	7	3	16	12	2	5	3	-	-	-	155
Umeå University	-	-	-	2	3	-	1	-	1	-	152
Luleå University of Technology	-	16	-	1	11	1	3	1	1	-	151
With Sweden	119	118	110	109	93	68	59	58	55	53	3,118

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 India and thus gives an indication of the distribution of collaborations between Swedish and Indian 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). The matrix indicates very well-distributed research collaborations between India and Sweden. None of the top ten Indian collaborators contribute to above 5% of the total number of co-publications with Sweden. For the Swedish universities, with the exception of Umeå University, the top ten Indian collaborators contribute to about 25–35% of their total co-publications with India.

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.

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.

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