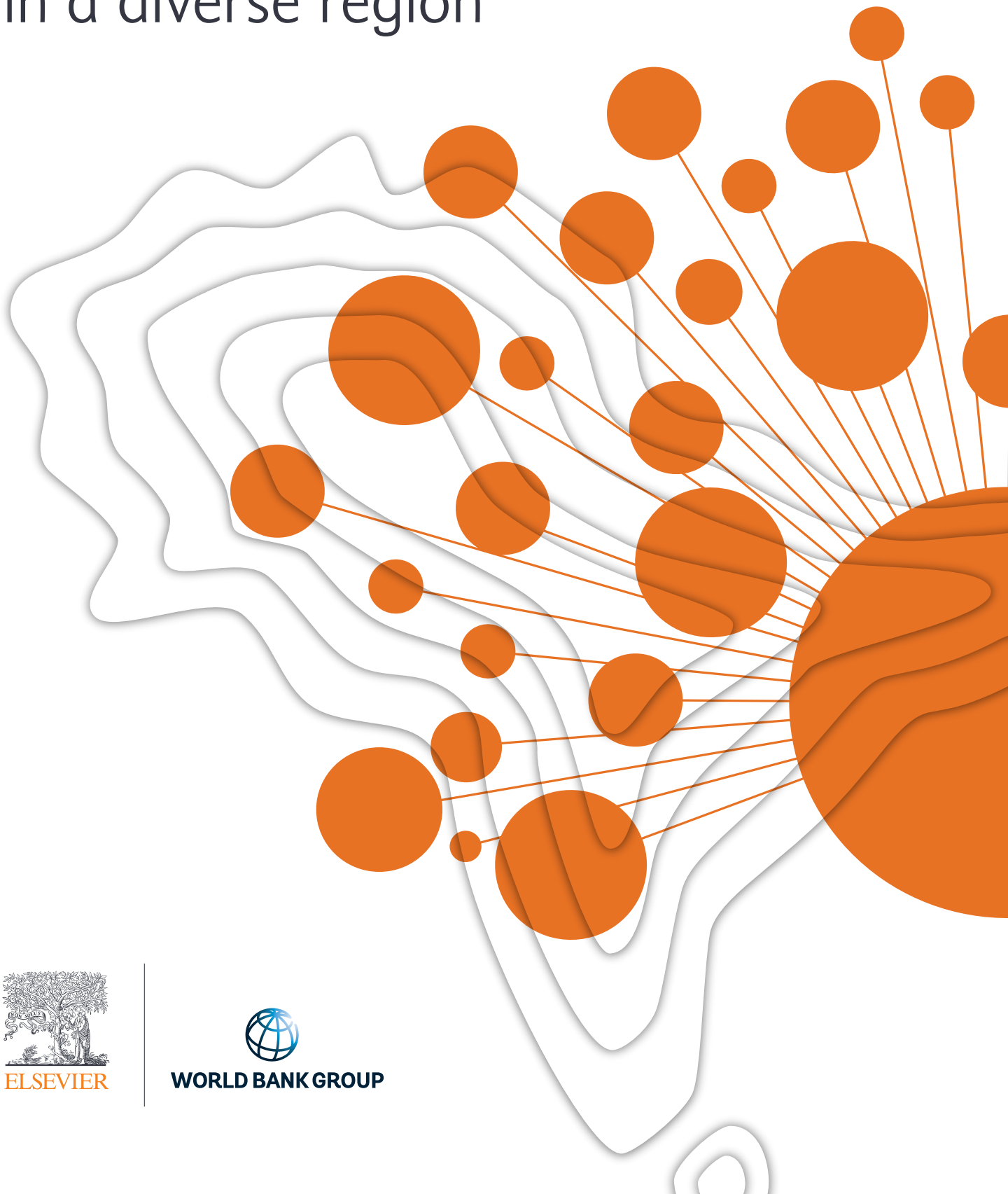
South Asia: Challenges and benefits of research collaboration in a diverse region



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South Asia: Challenges and benefits of research collaboration in a diverse region

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The World Bank wishes to acknowledge the following contributors:

Francisco Marmolejo (Lead Education Specialist)

Yoko Nagashima (Sr. Education Specialist)

Sean Lothrop (Editor)

Sandra Alborta (Program Assistant)
under the guidance of Cristian Aedo (Practice Manager, Education Global Practice, South Asia Region),

Keiko Miwa (Director, Education Global Practice)

The team is grateful for the advice from peer reviewers Roberta Malee Bassett (Sr. Education Specialist, Global Lead for Tertiary Education), Harsha Aturupane (Lead Economist), and Andreas Blom (Lead Economist).

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Maria de Kleijn (Senior Vice President Analytical Services)

Sarah Huggett (Head of Analytical Services Asia-Pacific)

Basak Candemir (Head of Analytical Services Europe & Emergia)

Eleonora Palmaro (Product Manager Funding Solutions)

Noelle Gracy (Head of Collaboration Office)

Josine Stallinga (Director of Business Development for Research Management)

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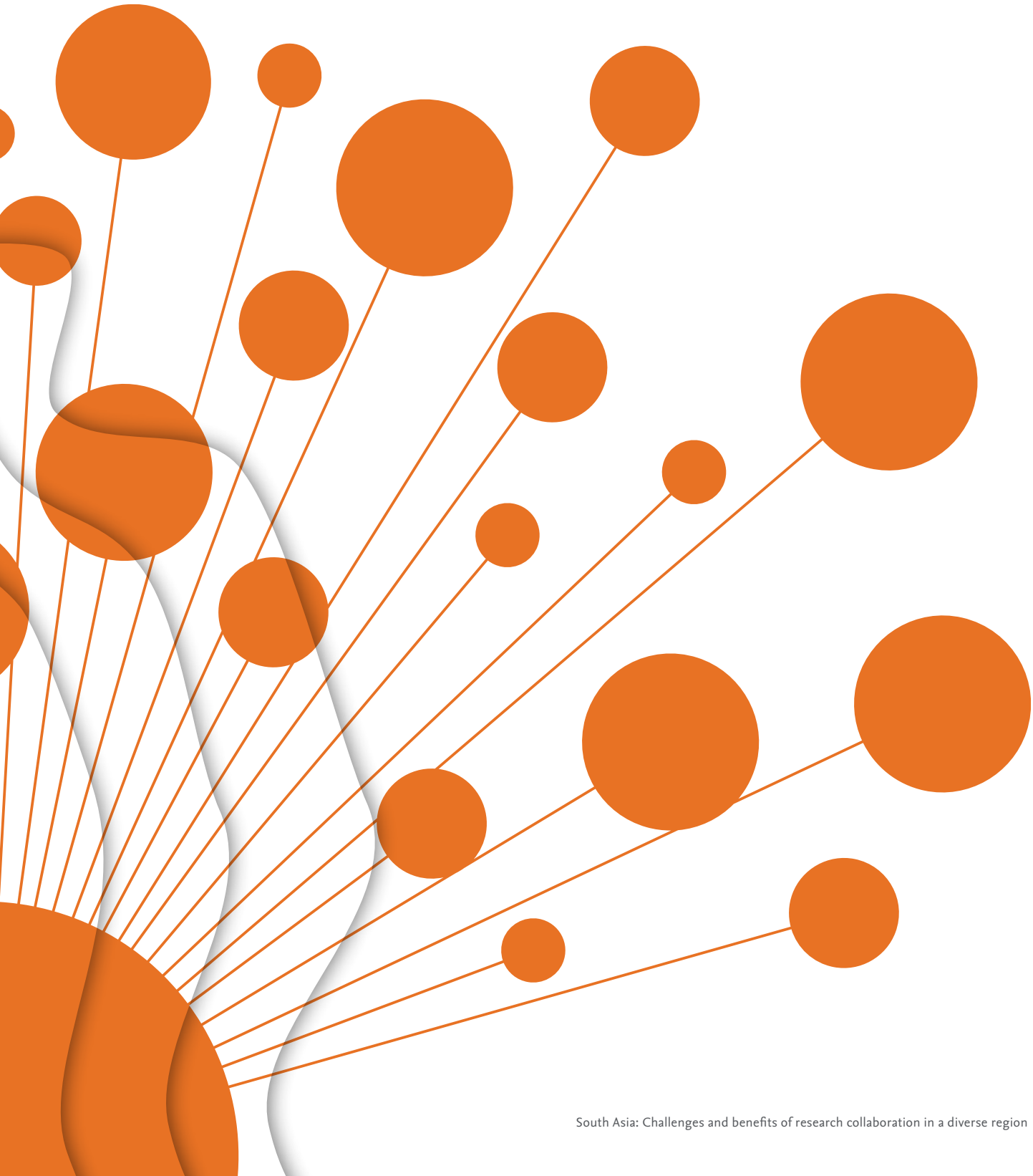
Contents

Executive summary



Introduction

Collaboration is vital to scientific innovation, as it facilitates the exchange of ideas and expands the range of perspectives on a given subject.[1] South Asian economies and societies are rapidly evolving, and knowledge production, innovation, and technological adaptation are becoming increasingly vital to the sustained growth and competitiveness of firms and sectors across the region. South Asia's regional economy may still depend on low-skilled, labor-intensive production, but high-tech, knowledge-intensive industrial and service sectors are also emerging. Meanwhile, developing countries worldwide compete for shares of the global production, technology, and value chains.

Scholarly research is at the leading edge of national efforts to sharpen competitive advantages and explore emerging fields and sectors,[2] but exploiting the benefits of new technologies requires an enabling environment for innovation and adaptation to be created, which in turn demands research and development (R&D) capacity that may exceed the domestic resources of developing countries. The extent to which developing countries succeed in supporting technological innovation has critical implications for employment and income dynamics, as "the pace of innovation will determine whether new sectors or tasks emerge to counterbalance the decline of old sectors and routine jobs as technology costs decline."[3]

In this context, international scholarly collaboration can greatly benefit countries with lower levels of gross domestic product (GDP) and gross expenditure on research and development (GERD), by enabling them to leverage and complement the resources of countries with more developed research bases. International research collaboration is increasingly common worldwide, as reflected in the rising number of collaborative publications involving authors from multiple countries. Analyzing trends in the co-authorship of scholarly publications can shed light on the volume and focus of research collaboration, facilitating comparisons between countries and regions.

This report measures scholarly output between 2012 and 2016 in terms of the total number of peer-reviewed scholarly publications (including research papers, systematic reviews, and conference proceedings) compiled in the Scopus®[4] database. Scholarly output for each country is defined as the number of published papers with at least one author from that country. Papers produced through international collaboration count toward the total output of each country, as well as the output of the region as a whole.

Discussion points:

1. What factors significantly influence research output in South Asia?
2. How could greater intraregional scholarly collaboration be encouraged?
3. How can extra-regional scholarly collaboration maximize its local impact?
4. What role can development partners, including the World Bank, play in supporting these initiatives?

1. de Beaver, 2013. The Many Faces of Collaboration and Teamwork in Scientific Research: Updated Reflections on Scientific Collaboration, *COLLNET Journal of Scientometrics and Information Management*, 7:1, 45-54, DOI: 10.1080/09737766.2013.802629
2. World Bank, 2019, *World Development Report: The Changing Nature of Work*. Washington, DC: The World Bank. p.2.
3. Ibid. p.12
4. Scopus® is the world's largest curated abstract and citation database of peer reviewed literature, comprising| 71 million documents from more than 23,700 active journals, book series, and conference-proceeding papers, published by 5,000 publishers.

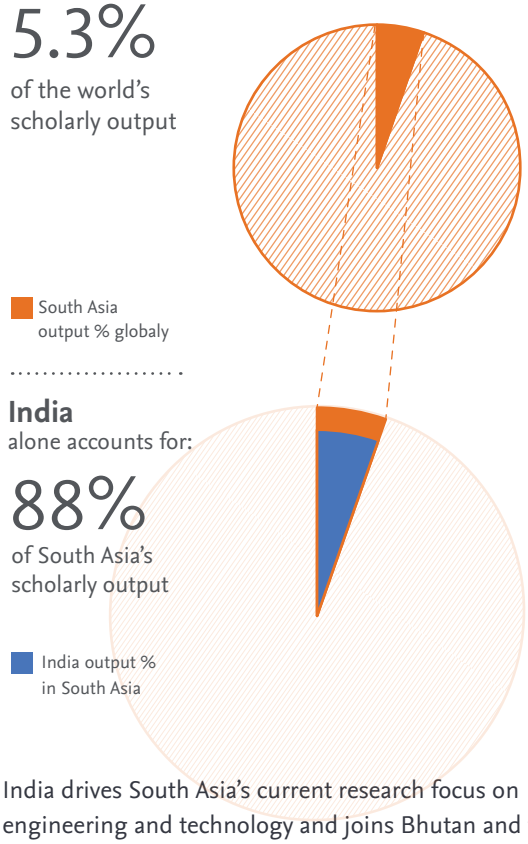
Key findings and policy recommendations

Presented here are key findings about South Asia's research input, output, and impact.

1

South Asia is a diverse region, encompassing countries of vastly different sizes and development levels, and with widely varying degrees of scholarly output and citation impact. The eight countries that comprise the South Asia region collectively published just under 700,000 works of scholarship between 2012 and 2016, representing 5.3 percent of the world's scholarly output during the period. India alone accounted for 88 percent of South Asia's scholarly publications, strongly influencing aggregated indicators for the region.

5.3%
of the world's scholarly output



India alone accounts for:

88%
of South Asia's scholarly output

India drives South Asia's current research focus on engineering and technology and joins Bhutan and the Maldives in devoting significant attention to the natural sciences. The agricultural sciences are a core focus of all South Asian countries, with the exception of India. The region's citation impact is closest to the world average in the fields of engineering and technology.

2

Although modest by global standards, South Asia's scholarly output is growing rapidly. Between 2012 and 2016, South Asia's share in global scholarly output rose by 8 percent annually, reflecting a broad increase in publications among South Asian countries. In India, Pakistan, Nepal, Bhutan, and the South Asia region as a whole, the number of scholarly publications relative to GDP exceeds the global average. Pakistan and Sri Lanka have especially high levels of scholarly output relative to their gross investment in research and development, while India, Sri Lanka, and the South Asia region publish more papers per researcher than the world average. These findings suggest that South Asian research generates an unusually high return on investment and that South Asian researchers are especially productive. However, the data do not account for the impact of international research collaboration, which enables South Asian countries to leverage additional financial and human resources. Furthermore, all South Asian countries have relatively low levels of scholarly output relative to their population size.

3

While the overall citation impact of South Asian research is below the global average, the citation impact of research produced in Bangladesh, Sri Lanka, Nepal, Afghanistan, Bhutan, and the Maldives exceeds the global average. These countries magnify the impact of their limited research bases by participating in large-scale collaborative projects, such as hyper-collaborated physics papers and internationally relevant medical research, including clinical guidelines, World Health Organization studies, and publications resulting from the Global Burden of Disease program. With the exceptions of India and Pakistan, most South Asian countries depend heavily on international collaborations, which are the basis for at least 50 percent of their publications. Most of these collaborations involve institutions outside of South Asia, and intraregional collaboration is relatively rare.

4

Just under 20 percent of South Asian publications are attributed to international collaboration, and India's relatively low rate of international collaboration reduces the regional average. Among South Asian countries, the level of research output appears to be inversely correlated with the frequency of international collaboration, as countries with the smallest research bases are the most likely to leverage international networks. In all South Asian countries, most international collaborations include at least one researcher outside the region. The proportion of papers produced through purely intraregional collaboration is very low, ranging from 0.15 percent in both India and the region as a whole, to 5-10 percent in Nepal, Afghanistan, Bhutan, and the Maldives.

The proportion of papers resulting from international collaboration within South Asia ranges

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To
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for countries like Nepal, Afghanistan, Bhutan, and the Maldives.

Papers produced through extra-regional collaboration tend to have a much greater citation impact than those produced through purely intraregional collaboration, but the latter may be more effective in addressing local challenges. The difference in citation impact is smaller for the agricultural sciences, the natural sciences, and the social sciences than for other subject areas, highlighting the strong regional relevance of these fields to South Asia's development challenges.

5

South Asia lacks a unified collaboration framework, with each country using different, independent systems to establish academic and scientific partnerships. Consequently, South Asian countries are scattered across the global international collaboration network. Within South Asia, India and Pakistan have the strongest collaborative ties, and these two countries form the nexus of intraregional collaboration. Bangladesh, Nepal, and Sri Lanka also regularly engage with India and/or Pakistan, while Afghanistan, Bhutan, and the Maldives are on the fringe of the regional network. Examining intraregional collaboration as a share of each country pair's collaborative research reveals that Pakistan has especially strong research collaboration ties with Bangladesh and Sri Lanka; Nepal has strong ties with Bangladesh and Sri Lanka; and Bhutan has strong ties with the Maldives.

6

Collaborations between academic institutions and the private sector account for just 1.3 percent of South Asia's scholarly output, roughly half the global average.

Across South Asian countries and their global comparators, academic-corporate collaborations tend to have a high citation impact, which is enhanced through large-scale collaborations such as the Global Burden of Disease studies. Relative to its scholarly output, South Asia tends to have fewer patent citations than the world average, a trend which is also consistent with comparator countries outside the region. While this may be partly attributed to the coverage of the World Intellectual Property Organization database, it could also indicate an opportunity to enhance knowledge transfer and promote the dissemination of technologies through greater academic-corporate collaboration.

Overcoming two key challenges linked to funding could greatly expand research collaboration in South Asia.

The first challenge is to secure adequate funding, as few resources are specifically dedicated to supporting international scholarly collaboration, especially within the South Asia region. Increasing national investment in research and development could encourage greater domestic, intraregional, and extra-regional collaboration while also broadening collaborative efforts to encompass a more diverse range of researchers and institutions. The second challenge is to enhance the quality of research collaboration by developing competitive funding mechanisms, with the aim of strengthening peer review processes and building the capacity of regional scholars to draft high quality research proposals.

Policy Recommendations

It is recognized that South Asian countries need to effectively leverage their research sectors in order to tackle critical development priorities, contribute to economic productivity, and increase their competitiveness. The following measures have been identified to address this:

- Increase the quantity and improve the quality of tertiary education, with a focus on science, technology, engineering, and mathematics;
- Develop criteria to determine priority research areas at national level;
- Establish financial and administrative incentives to boost the production of high quality research in priority areas, which could be measured by number of publications, their citation impact, and number of patents applications;
- Build the capacity of researchers to develop high quality proposals, expand competitive-funding mechanisms, and raise the standards of peer review processes; and
- Strengthen the ties between academic institutions and the private sector by funding academic-corporate collaborations to improve the market relevance of research and enhance its contribution to economic productivity and competitiveness.

It is also acknowledged that targeted reforms could greatly increase the benefits of research collaboration in South Asia. The following opportunities have been identified:

- Expand the network of intra and extra-regional collaboration to generate substantial gains across South Asia. Increasing this extra-regional collaboration network could enable South Asian countries to maximize the value of their relatively modest research bases and augment limited domestic resources. This is particularly relevant for research collaborations supported by multilateral financial institutions, promoting extra-regional and intraregional initiatives.
- Increase intraregional collaboration to encourage South Asian countries to focus their research on common priorities, in areas such as agriculture and public health. South Asian countries face unique challenges that are not necessarily shared by countries elsewhere in the world, therefore intraregional collaboration provides a forum to address regional priorities.

South Asian countries need to effectively leverage their research sectors in order to tackle critical development priorities, contribute to economic productivity, and increase their competitiveness.

- Encourage national governments, as well as regional higher education and research associations, to develop programs and funding schemes specifically designed to stimulate intraregional collaboration. These include scholarships and postdoctoral fellowship programs focused on academic exchange and grants for projects that address region-wide challenges. Greater intraregional collaboration has the potential to alleviate capacity constraints among national tertiary education institutions, encourage the exchange of knowledge across borders, and expand the academic and professional development opportunities available to South Asian students and researchers.
- Build the capacity of patent offices, establish Technology Transfer Offices (TTOs) in academic institutions, and provide training in intellectual property literacy to encourage academic institutions to produce more market-relevant research. Connecting scholars with private firms and entrepreneurs and providing legal advice on registering patents could significantly increase the economic impact of regional research. Many South Asian countries lack a strong legal framework for safeguarding intellectual property rights and reforms that ensure researchers can directly profit from their innovations could provide a powerful incentive to pursue marketable research. Increased intraregional collaboration could also leverage synergies between national research sectors and accelerate intraregional technology transfer.

The South Asia region

The vast South Asia region stretches from the Persian Gulf to the Bay of Bengal, and from the Himalayas to the Indian Ocean. It encompasses Afghanistan, Bhutan, India, the Maldives, Nepal, Pakistan, and Sri Lanka. In 1985, these countries formed the South Asian Association for Regional Cooperation (SAARC) and collectively, they represent 3.8 percent of the global economy.

Despite wide variations in their economic, demographic, and cultural characteristics, the SAARC member countries share the common objectives outlined in the SAARC Charter:

i to promote social welfare and cultural understanding.
ii to accelerate economic growth through intraregional cooperation.

Knowledge transfer, as well as technical and scientific assistance, are identified as key tools for advancing regional development. However, research collaboration within the South Asia region remains limited across countries and disciplines.

Intraregional knowledge transfer is a process of social communication. Its success is influenced by the effectiveness of national and institutional cooperation strategies, and the willingness of individual researchers to engage in collaboration.[5] South Asia is a complex geopolitical environment with multifaceted social and cultural characteristics, which creates barriers to collaboration at national, institutional, and individual level. In this challenging context, regional and international stakeholders must develop effective strategies to galvanize support for the joint production of scholarly work with region-wide relevance.

At a national level, promoting educational equality can boost scholarly output and foster collaboration. Gender disparities play a particularly significant role in driving educational inequality in the region and have been shown to negatively impact scholarly output.[6] To maximize scholarly output and enhance its global impact, increased interregional collaboration must be accompanied by the diversification of scholar networks in each country. Greater public investment in research and development could catalyze this process, while highlighting the regional benefits of increased scholarly output and cross-country collaboration.[7]

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5. Haque et al., 2015. Factors affecting knowledge sharing on innovation in the higher education institutions (HEIs). Asian Research Publishing Network (ARPN). VOL. 10, NO. 23. *Journal of Engineering and Applied Sciences.* Department of Information Systems, Kulliyyah of Information and Communication Technology, International Islamic University Malaysia, Kuala Lumpur

6. Thomas et al., 2001. Measuring education inequality - Gini coefficients of education (English). Policy, Research working paper; no. WPS 2525. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/361761468761690314/Measuring-education-inequality-Gini-coefficients-of-education

7. Jamjoom et al., 2016. Impact of country-specific characteristics on scientific productivity in clinical neurology research. *eNeurologicalSci* . Vol 4 (1-3). https://www.ens-journal.com/article/S2405-6502(16)30013-2/fulltext

Knowledge production and economic development in South Asia

South Asian economies are rapidly evolving, and knowledge production, innovation, and technological adaptation are becoming increasingly vital to the sustained growth and competitiveness of firms and sectors across the region. While much of South Asia's regional economy remains focused on low-skilled, labor-intensive production models—especially in agriculture and manufacturing—an ongoing process of structural transformation is driving the emergence of high-tech, knowledge-intensive industrial and service sectors. Meanwhile, the globalization of production patterns and the diffusion of technologies across borders intensifies competition among developing countries worldwide, as they strive to capture increasingly advanced segments of international value chains.

The World Bank's 2019 *World Development Report: The Changing Nature of Work*, emphasizes the pivotal role of technological innovation in creating high-quality employment, facilitating diversification, and boosting output at individual, firm, and national level. The report observes that "technology provides opportunities to create new jobs, increase productivity, and deliver effective public services. Through innovation, technology generates new sectors and new tasks."[8] However, for new technologies to thrive and their benefits to spread, innovation and adaptation necessitate sufficient research and development efforts. For developing countries, these requirements may exceed resources and capabilities. The extent to which developing countries succeed in creating an enabling environment for technological innovation has critical implications for employment and income dynamics, as "the pace of innovation will determine whether new sectors or tasks emerge to counterbalance the decline of old sectors and routine jobs as technology costs decline."[9]

Knowledge transfer in a diverse region can help broaden the scope of research and increase the amount of information produced in each subject area.[10] However, successful knowledge transfer requires active collaboration between countries and institutions, and between academia and the private sector.[11] Investments in collaborative research can stimulate innovation, reduce income inequality,[12] and improve labor market outcomes.[13] Intraregional academic and scientific collaboration can also ease political tensions between South Asian countries, as well as encourage economic cooperation and cultural exchange. Collaborative scholarly output is vital in diverse regions, because it allows countries to jointly address common challenges such as natural disasters, high levels of income inequality, inadequate access to healthcare and sanitation, and low education quality.

Knowledge is produced by innovative research, and citation impact measures the global reach of a research publication. Because relevant, applicable research is shared and referred to by other researchers in subsequent publications, the more frequently a publication is cited, the greater its impact on the production of knowledge. Because South Asian countries vary in population and economic size, it is challenging to directly compare their scholarly output and impact. The Field-Weighted Citation Impact (FWCI) indicator can control for differences in citation activity by subject area, document type, and publication year. Given the huge variations in economic size between South Asian countries and their diverse policy priorities, normalizing publication data by GDP and GERD can facilitate cross-country comparisons. Normalizations by population size and number of researchers also make it possible to comparatively examine countries with varying population and research workforce.

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8. World Bank, 2019. *World Development Report: The Changing Nature of Work*. Washington, DC: The World Bank. p.2.

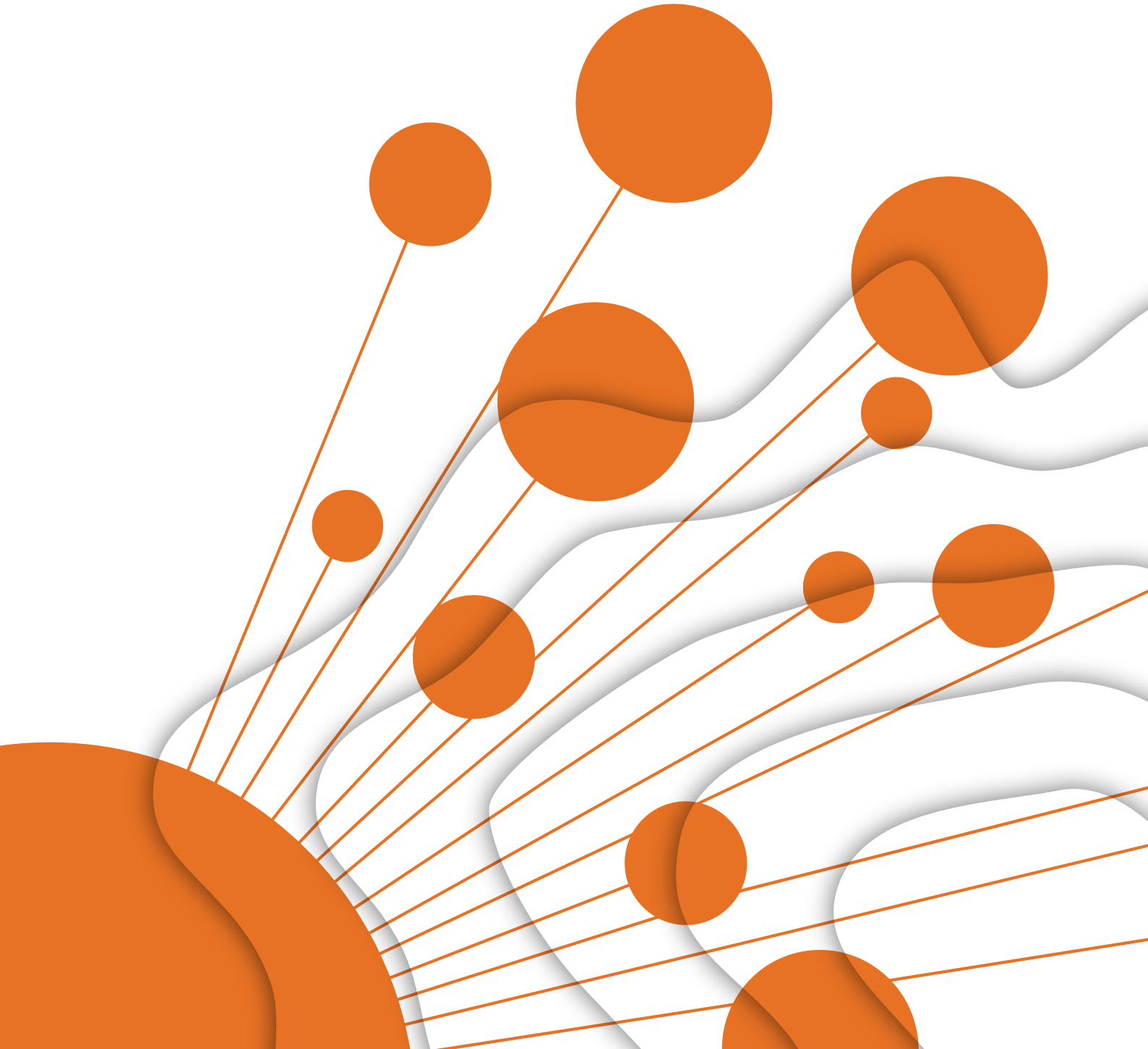
9. Ibid. p.12

10. de Beaver, 2013. The Many Faces of Collaboration and Teamwork in Scientific Research: Updated Reflections on Scientific Collaboration, *COLLNET Journal of Scientometrics and Information Management*, 7:1, 45-54, DOI: 10.1080/09737766.2013.802629

11. Parker, 1992. Industry - university collaboration in developed and developing countries (English). Population and Human Resources Department. Education and Employment Division background paper series; no. PHREE 92/64. Washington, D.C.: The World Bank. http://documents.worldbank.org/curated/en/675261468740666204/Industry-university-collaboration-in-developed-and-developing-countries

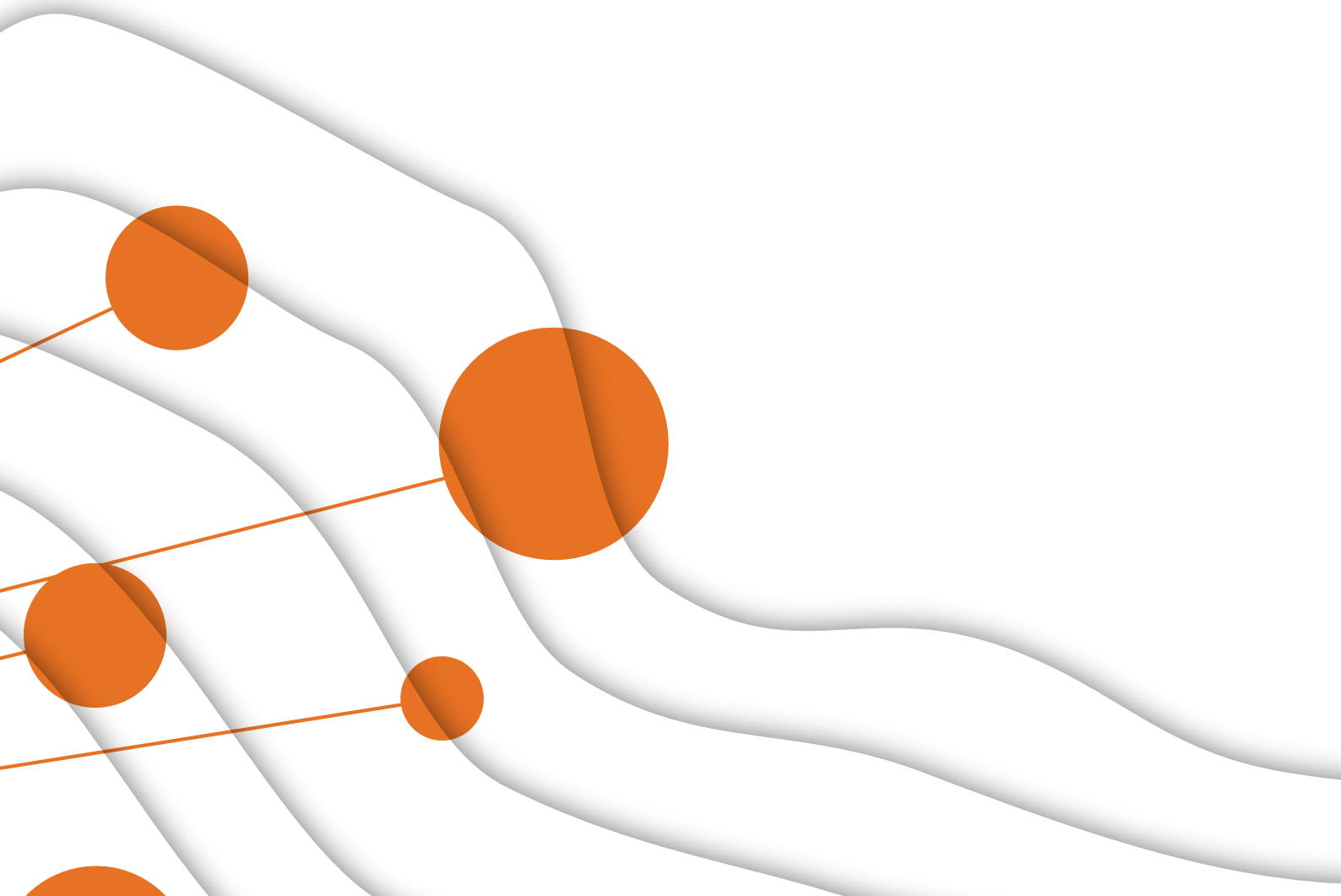
12. World Bank and Elsevier, 2014. *A decade of development in sub-Saharan African science, technology, engineering and mathematics research* (English). Washington, DC: World Bank Group and Elsevier. http://documents.worldbank.org/curated/en/237371468204551128/A-decade-of-development-in-sub-Saharan-African-science-technology-engineering-and-mathematics-research; https://www.elsevier.com/research-intelligence/research-initiatives/world-bank-2014

13. Global Economic Prospects, 2018. "Special Focus 2: Education Prospects and Global Inequality." The World Bank Group. http://pubdocs.worldbank.org/en/703271512412244412/Global-Economic-Prospects-Jan-2018-Topical-Issue-education-demographics.pdf



Chapter 1

South Asia: a diverse region



1.1 Dimensions of diversity: economic, fiscal, and demographic

South Asia is a highly diverse region. Its eight countries—Afghanistan, Bangladesh, Bhutan, India, Nepal, the Maldives, Pakistan, and Sri Lanka—vary enormously in terms of their population size, economic output, geographic features, natural resources, cultural characteristics, and development priorities.[14] These factors, along with national education and research policies, influence the amount of scholarly output produced by each country and its global impact.[15]

South Asia's complexity, diversity, and deep social cleavages are also present within individual countries. A 2015 World Bank report, *Addressing Inequality in South Asia*,[16] explains that while traditional economic indicators suggest that inequality in South Asia is relatively modest, a deeper analysis reveals vast disparities in opportunity by gender, location, and caste. Reducing inequality of opportunity at country level can improve research performance both directly, by engaging a broader range of talented researchers, and indirectly, by encouraging economic participation and accelerated growth.[17]

Investing in research and development, breaking down barriers to inclusion, and promoting a culture of regional and international collaboration can enable South Asian countries to increase their scholarly output, enhancing their contribution to national development objectives.

This report examines the scholarly output of South Asian countries at national and regional levels. The analysis evaluates national policies, examines regional trends, and benchmarks the research performance of South Asian countries against global comparators such as Brazil, China, Indonesia, Malaysia, Thailand, and Vietnam (*Figure 1*). In this report, scholarly output refers to the number of scholarly publications produced by a country and indexed in Scopus®, including work by domestic academics as well as international collaborations.

Reducing inequality of opportunity at country level can improve research performance both directly, by engaging a broader range of talented researchers, and indirectly, by encouraging economic participation and accelerated growth.

14. World Bank, 2017. *South Asia Economic Focus, Fall 2017: Growth Out of the Blue*. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/28397 SAARC, 2011, *SAARC Statistical Yearbook*, http://www.saarcstat.org/sites/default/files/publications/SAARC%20YEAR%20BOOK%202011.pdf

15. Thomas, et al., 2001. Measuring education inequality - Gini coefficients of education (English). Policy, Research working paper; no. WPS 2525. Washington, DC: World Bank. http://documents.worldbank.org/curated/en/361761468761690314/Measuring-education-inequality-Gini-coefficients-of-education

16. Rama et al., 2015. *Addressing Inequality in South Asia*. South Asia Development Forum. World Bank Group, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/20395

17. Global Economic Prospects, 2018. Special Focus 2: Education prospects and Global Inequality. The World Bank Group. http://pubdocs.worldbank.org/en/703271512412244412/Global-Economic-Prospects-Jan-2018-Topical-Issue-education-demographics.pdf

Between 2012 and 2016, South Asia published 679,571 papers, accounting for 5.3 percent of the world's scholarly output and increasing the region's share of global scholarly output by 1.7 percent. The diversity of South Asian countries in terms of their economic size and research policies results in large variations in their respective level of scholarly output. For example, researchers based in India produced almost 600,000 papers between 2012 and 2016, while researchers in the Maldives produced less than 100. To generate useful cross-country comparisons, the analysis presented in *Figure 2* normalizes scholarly output by economic size (as measured by GDP) and investment in research (as measured by GERD). The analysis also controls for other relevant factors, such as population size and the number of researchers in each country in *Figure 4*.

Scopus®— a comprehensive source of bibliometrics data

Scopus is the world's largest curated abstract and citation database of peer reviewed literature, comprising over 71 million documents from more than 23,700 active journals, book series, and conference-proceeding papers by over 5,000 publishers. The Scopus database is multilingual and its coverage is global; approximately 46 percent of Scopus titles are either published in languages other than English, or published in both English and another language. In addition, more than half of Scopus content originates outside North America, and many of its publications come from Europe, Latin America, Africa, and the Asia-Pacific region. Scopus encompasses all major research fields, with 12,569 titles in the physical sciences, 14,001 in the health sciences, 6,960 in the life sciences, and 11,211 in the social sciences. Most titles are serial publications, such as academic and trade journals, book series, and conference materials. However, the database also includes standalone books and proceedings volumes that consolidate a large number of conference papers: a preferred mechanism for knowledge dissemination in fields such as the computer sciences.

Figure 1
South Asian (orange) and comparator (blue) countries in this report

South Asian countries

1 AFG | Afghanistan
2 PAK | Pakistan
3 IND | India
4 NPL | Nepal
5 BTN | Bhutan
6 BGD | Bangladesh
7 LKA | Sri Lanka
8 MDV | Maldives

Comparator countries

9 CHN | China
10 THA | Thailand
11 VNM | Vietnam
12 MYS | Malaysia
13 IDN | Indonesia
14 BRA | Brazil

It is observed in *Figure 3* that within South Asia and among comparator countries, GDP appears to be directly correlated with the number of scholarly publications. However, research output per unit of GDP varies considerably by country. Malaysia, for example, publishes more scholarly papers than its GDP level would predict, while the opposite correlation is shown for Indonesia. Between 2012 and 2016, GERD represented 2.5 percent of Malaysia's GDP, compared to just 0.2 percent of Indonesia's. Malaysia's strong performance is likely to reflect its significant investment of public funds in research and development. The Malaysian government has also consistently invested in knowledge generation, and the "Soaring Upwards" slogan championed by the country's Ministry of Higher Education has been supported by increased funding.

Figure 2 reveals that relative to GDP, the scholarly output of India, Pakistan, and Nepal is in line with the regional average, and higher than the global average. Bhutan also exceeds the global average but is below South Asia's average. Globally, however, Malaysia outperforms all South Asian countries, and its scholarly output relative to GDP is nearly 2.5 times the world average.[18]

Figure 3 shows that among South Asian countries and comparators, GERD appears to be positively correlated with scholarly output, but as with GDP, scholarly output varies significantly by country even when GERD is taken into account. For example, India and Brazil have similar GERD levels, yet India publishes a greater number of scholarly papers. With *Figure 2*, we see that within South Asia, both Pakistan and Sri Lanka produce a large number of scholarly papers relative to their level of GERD, with Sri Lanka leading the region. India ranks third among South Asian countries and performs relatively well against global comparators, publishing fewer papers per unit of GERD than either Indonesia or Malaysia, but more than Vietnam, Thailand, Brazil, and China. The high publication rate of South Asian countries relative to their economic size and research budgets may suggest that regional research generates a particularly positive return on investment. However, the available data do not account for additional financial resources leveraged through international collaboration. Consequently, countries that utilize external resources effectively have the potential to generate a high level of research output relative to their GDP or GERD.

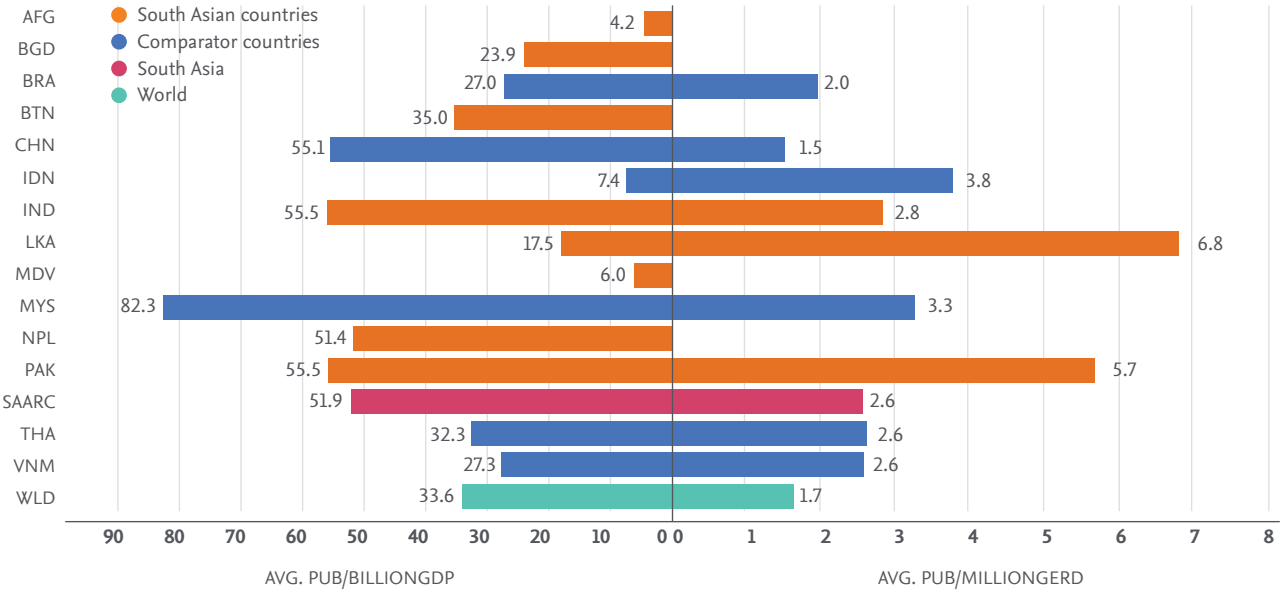


Figure 2

Number of scholarly publications per unit GDP (lhs) and GERD (rhs), South Asian countries and global comparator countries, 2012-2016. Sources: World Bank, UNESCO, and Scopus®

18. Ranai, M., 2017, 'Soaring Upwards' Budget will keep MoHE on a roll.

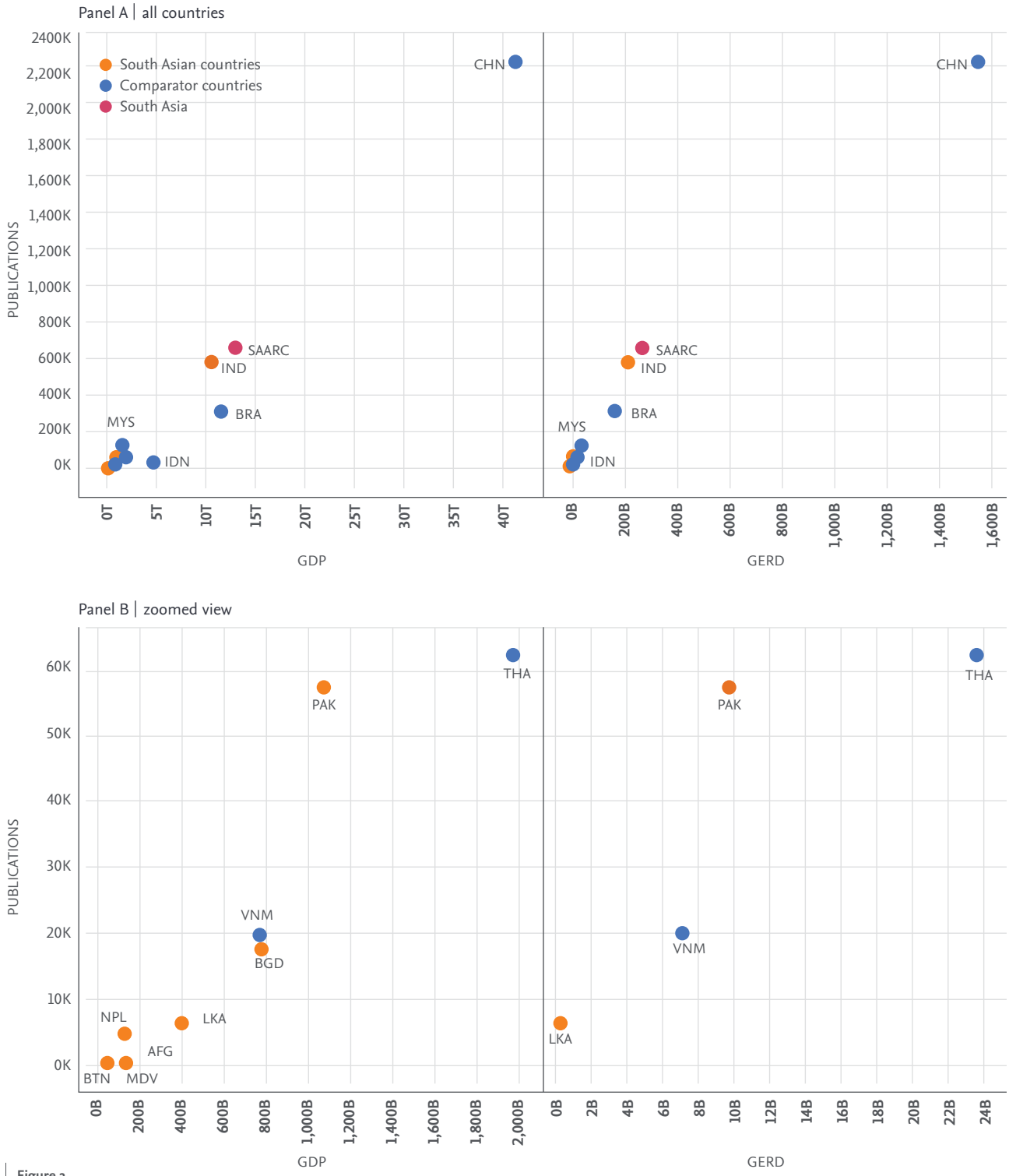


Figure 3

Number of scholarly publications versus GDP (lhs) and GERD (rhs), South Asian countries and global comparator countries, 2012-2016. Sources: World Bank, UNESCO, and Scopus®

In addition to economic size and research investment, each country's scholarly output is influenced by population size and total number of researchers *(see Figure 5)*. As illustrated in *Figure 4*, all South Asian countries have relatively low levels of scholarly output per capita, as their populations tend to be large in relation to the size of their research bases. Bhutan leads the region in scholarly output per capita, followed by India. Among global comparators, Malaysia produces an exceptional number of papers per capita, followed by China, Brazil, and Thailand.

A different pattern emerges when scholarly output is normalized by the number of full-time equivalent (FTE) researchers. *Figure 4* reveals that Sri Lanka produces more papers per FTE researcher than any other South Asian or comparator country. While China is on a par with the world average, it is observed that Sri Lanka, India, the South Asia region, and Malaysia all exceed the global average for scholarly papers per FTE researcher. However, as with research investment, these figures do not account for the potential impact of international collaboration on productivity per FTE researcher.

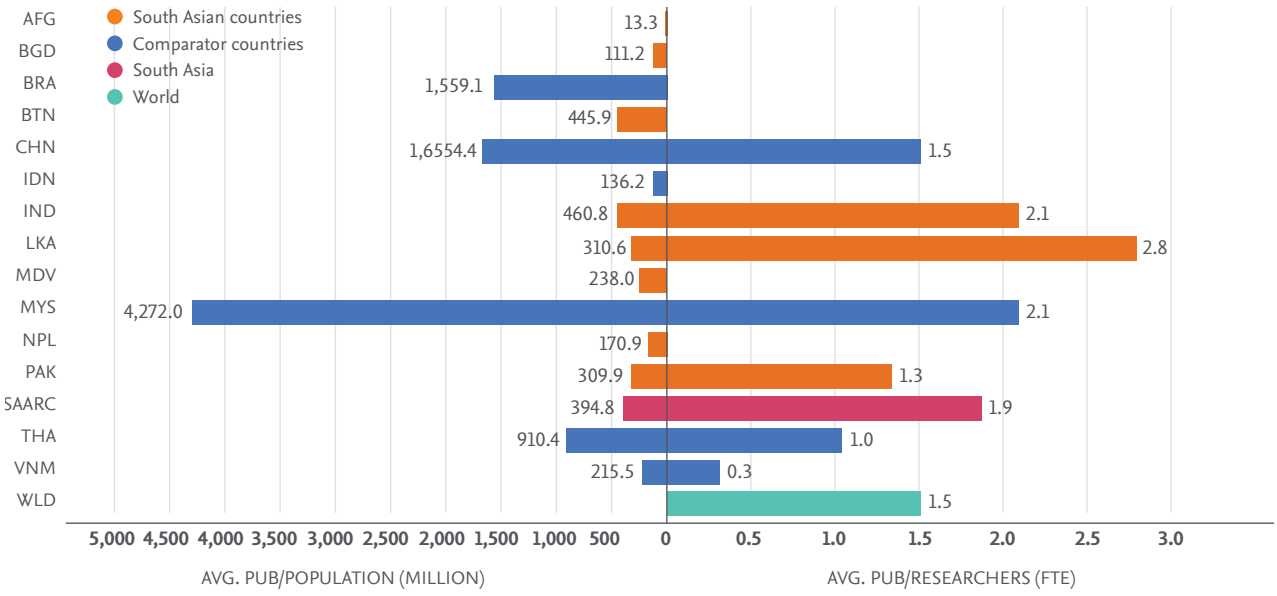


Figure 4

Number of scholarly publications by population size (lhs) and number of FTE researchers (rhs), South Asian countries and global comparator countries, 2012-2016. Sources: UNESCO and Scopus®

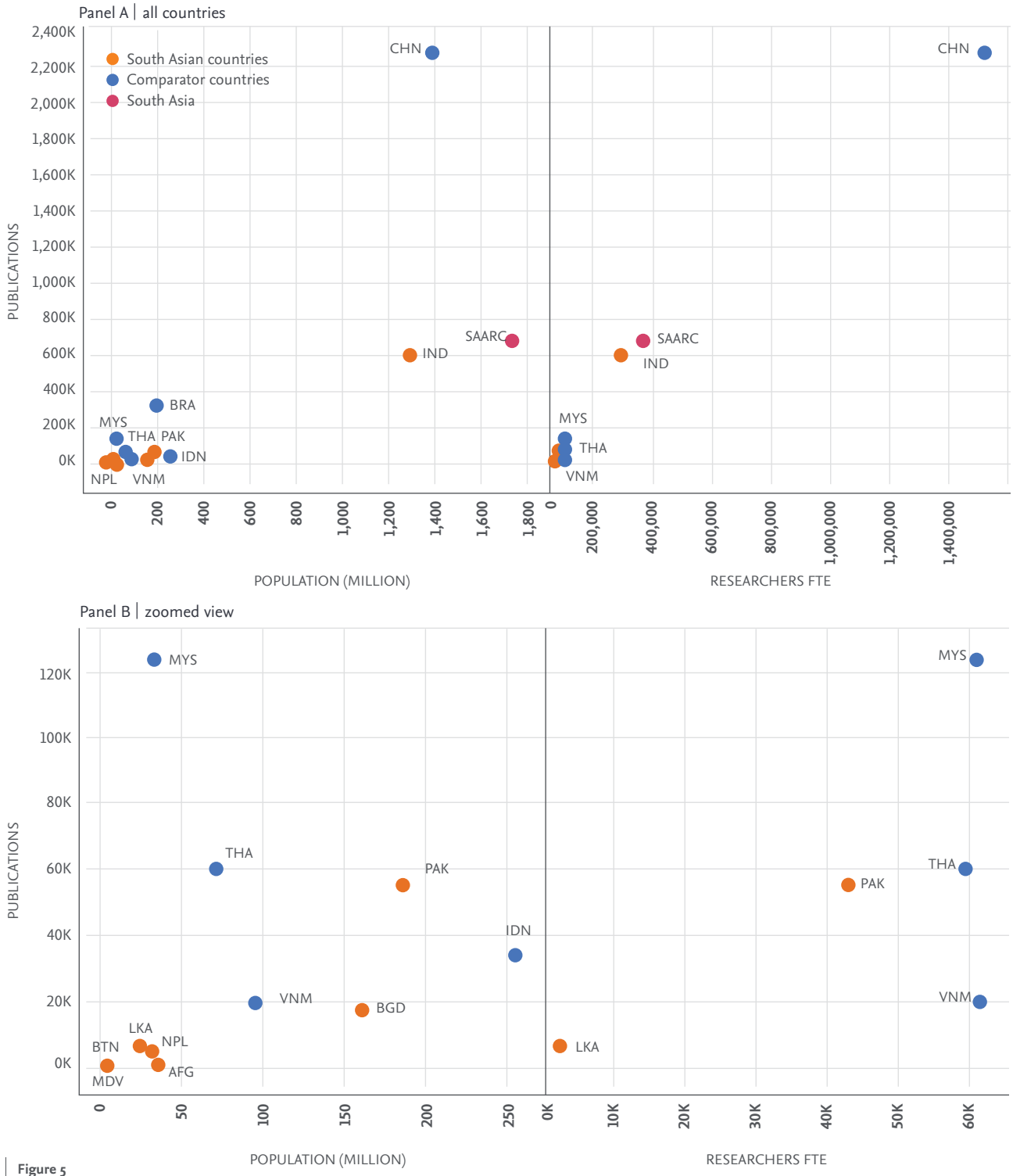


Figure 5

Number of scholarly publications versus population size (lhs) and number of FTE researchers (rhs), South Asian countries and global comparator countries, 2012-2016. Sources: UNESCO and Scopus®

1.2 South Asia's scholarly impact in comparative perspective

The contribution of a country's researchers cannot be measured solely in terms of their scholarly output, but also by the extent to which their output advances global knowledge in or beyond their respective fields. The impact of scholarly publications can be measured by the Field-Weighted Citation Impact indicator (FWCI), which compares the actual number of citations received by a paper with the expected number of citations for papers of the same document type, publication year, and subject area. The FWCI is a normalized index of citation activity with a global baseline of 1.00.

Consistent with the findings of previous studies,[19] analysis indicates that while researchers in India produce numerous scholarly papers, research in several smaller countries tends to have a greater citation impact *(Figure 6)*. South Asia's overall citation impact is below the world average, but the citation impact of Bangladesh, Sri Lanka, Nepal, Afghanistan, Bhutan, and the Maldives all exceed the world average. Multiple large-scale collaborative projects boost the citation impact of these countries, especially hyper-collaborated physics papers and internationally relevant medical research including clinical guidelines, World Health Organization studies, and publications produced as part of the Global Burden of Disease program. The latter has a highly beneficial effect on the citation impact of countries with lower levels of scholarly output. Afghanistan is a particular example of this, where Global Burden of Disease studies accounted for 8,809 citations out of the 11,866 citations received during the period (74%), despite comprising less than 3 percent of the country's scholarly output. Afghanistan's experience emphasizes the key role of international collaboration as a driver of citation impact among countries with smaller, less prolific research bases.

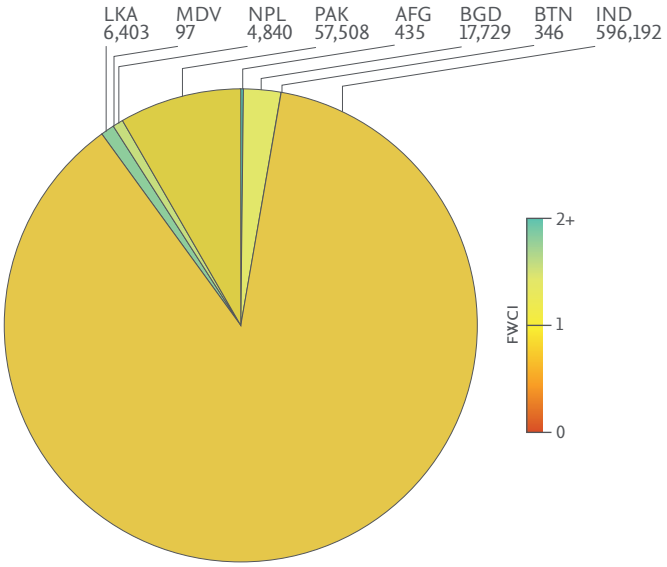


Figure 6
Number and share of scholarly publications (data label and angle of slice) and FWCI (color), per South Asian country, 2012-2016 Source: Scopus®

19. Gul, S., Mahajan, I., Shah, T. A., Tramboo, S. R., & Nahida-Tun-Nisa. (2015). Research endeavour of SAARC nations: A reflection from InCites. Paper presented at the 2015 4th International Symposium on Emerging Trends and Technologies in Libraries and Information Services, ETTLIS 2015 - Proceedings, 229-233. doi:10.1109/ETTLIS.2015.7048203

To address critical shared development challenges, regional governments must improve the quality of education at all levels, develop criteria to identify priority research areas, and establish mechanisms to enhance the quality and quantity of scholarship in those priority areas. Increasing the citation impact of scholarly publications can enhance their contribution to national and international research, and output volumes should not be increased at the expense of publication quality. To simultaneously improve both the quantity and quality of research output, governments must mobilize financial resources to support postgraduate students and postdoctoral research fellows. Specific funds and financial incentives should also be established to promote domestic, intraregional, and extra-regional research collaborations. Investing in collaborative knowledge production can generate positive economic and labor market outcomes for individual countries, while also yielding critical insights into common regional challenges.[20]

Defining and measuring scholarly output

This report measures scholarly output in terms of the total number of peer-reviewed scholarly publications compiled in the Scopus® database (including research papers, systematic reviews, and conference proceedings). Scholarly output for each country is defined as the number of papers with at least one author from that country. Papers produced through international collaboration are recorded once for each country and deduplicated at aggregated levels. For example, a paper co-authored by a researcher in India and a researcher in Sri Lanka would be measured as one paper for India and one paper for Sri Lanka, as well as one paper for South Asia as a whole.

20. For an overview of regional efforts to improve the quality of scholarly research and enhance the impact of international collaborations, please see the Annex.

1.3 Focus areas of South Asian research

A Relative Activity Index (RAI) can identify areas of scholarly specialization at national and regional level. The RAI is calculated as the share of scholarly output represented by a given field at country or regional level, relative to the share of scholarly output represented by that same field worldwide. It reveals how intensively researchers at country or regional level focus on a given field, relative to researchers worldwide. For example, the agricultural sciences account for 7.9 percent of South Asia's scholarly output, versus 6.8 percent worldwide. South Asia's RAI for the agricultural sciences is therefore 1.16 (or 7.9 divided by 6.8).

Reflecting the region's priority development challenges, significant research in South Asia focuses on disciplines related to food production, infrastructure, and economic productivity. South Asia's aggregate RAI scores for engineering and technology, the natural sciences, the agricultural sciences, and the medical sciences are all slightly above the global average, while its scores for the social sciences and especially the humanities are well below the global average *(Figure 7)*.

The SAARC specifies agriculture, rural development, environmental management, natural-disaster risk mitigation, and biotechnology as priorities for regional collaboration, which is reflected in South Asia's scholarly specialization. At a national level, South Asia's focus on engineering and technology is driven by India, while the natural sciences are an area of specialization for India, Bhutan, and the Maldives. The agricultural sciences are an important focus for all South Asian countries except India, while Nepal prioritizes the medical sciences to a much greater degree than any other South Asian country. South Asia's citation impact is closest to the global average in engineering and technology, and it represents 80 percent of the global average in the natural sciences. However, South Asia's citation impact in the agricultural sciences is relatively low, despite the agricultural sciences being an important focus for almost all regional countries.

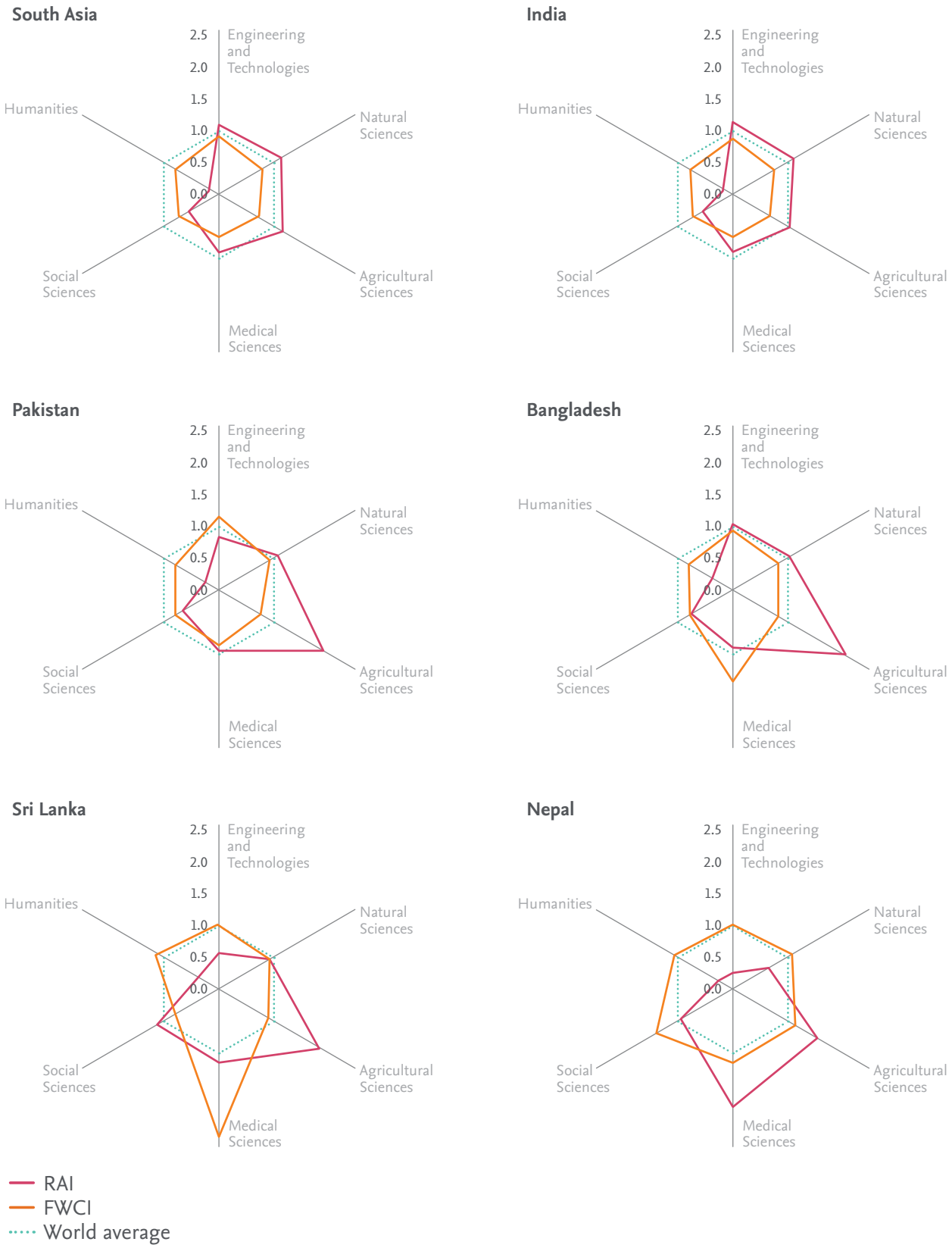


Figure 7

RAI and rebased FWCI for the world, South Asia, and South Asian countries that published over 1,000 publications between 2012 and 2016. Source: Scopus®

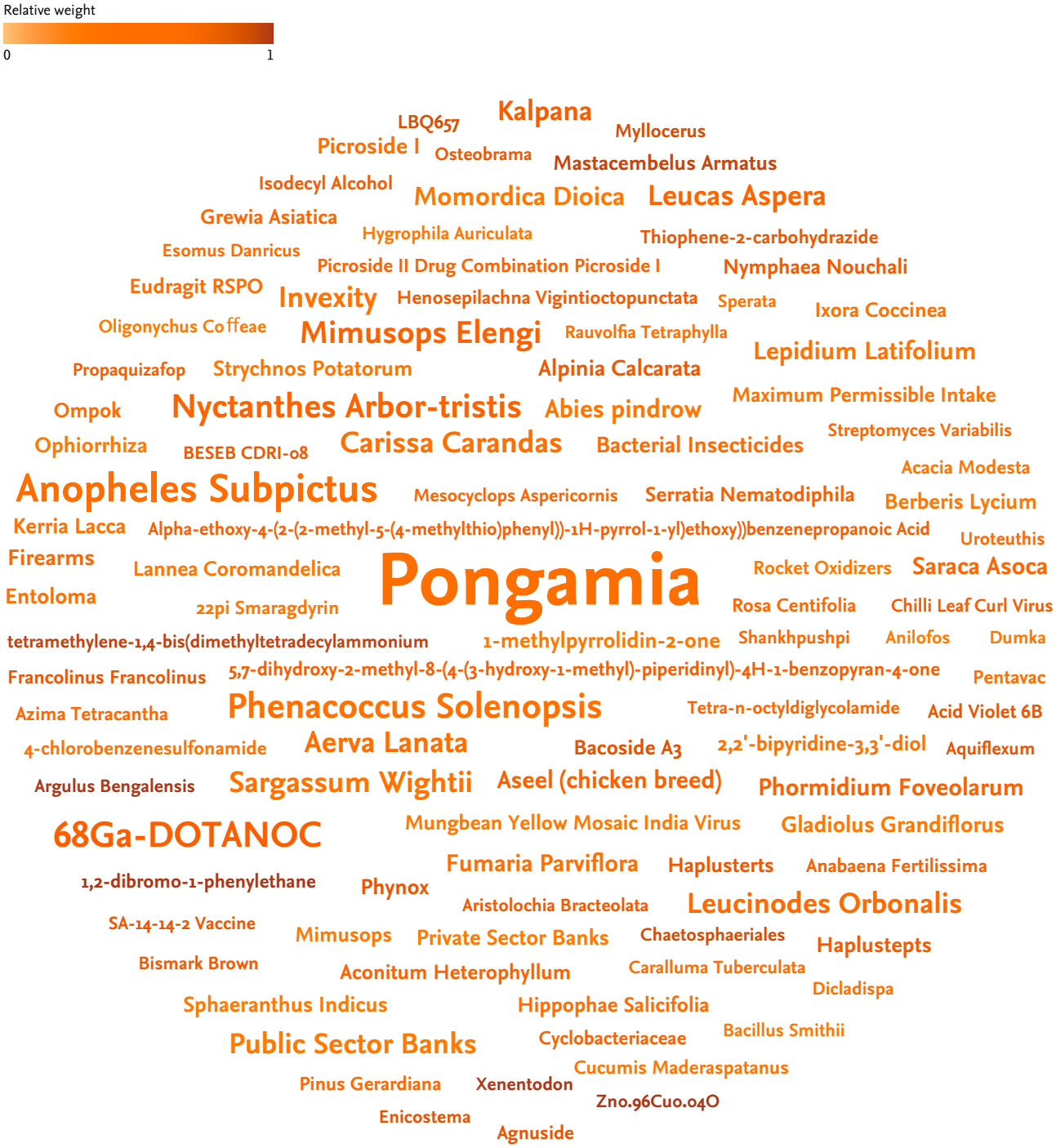


Figure 8

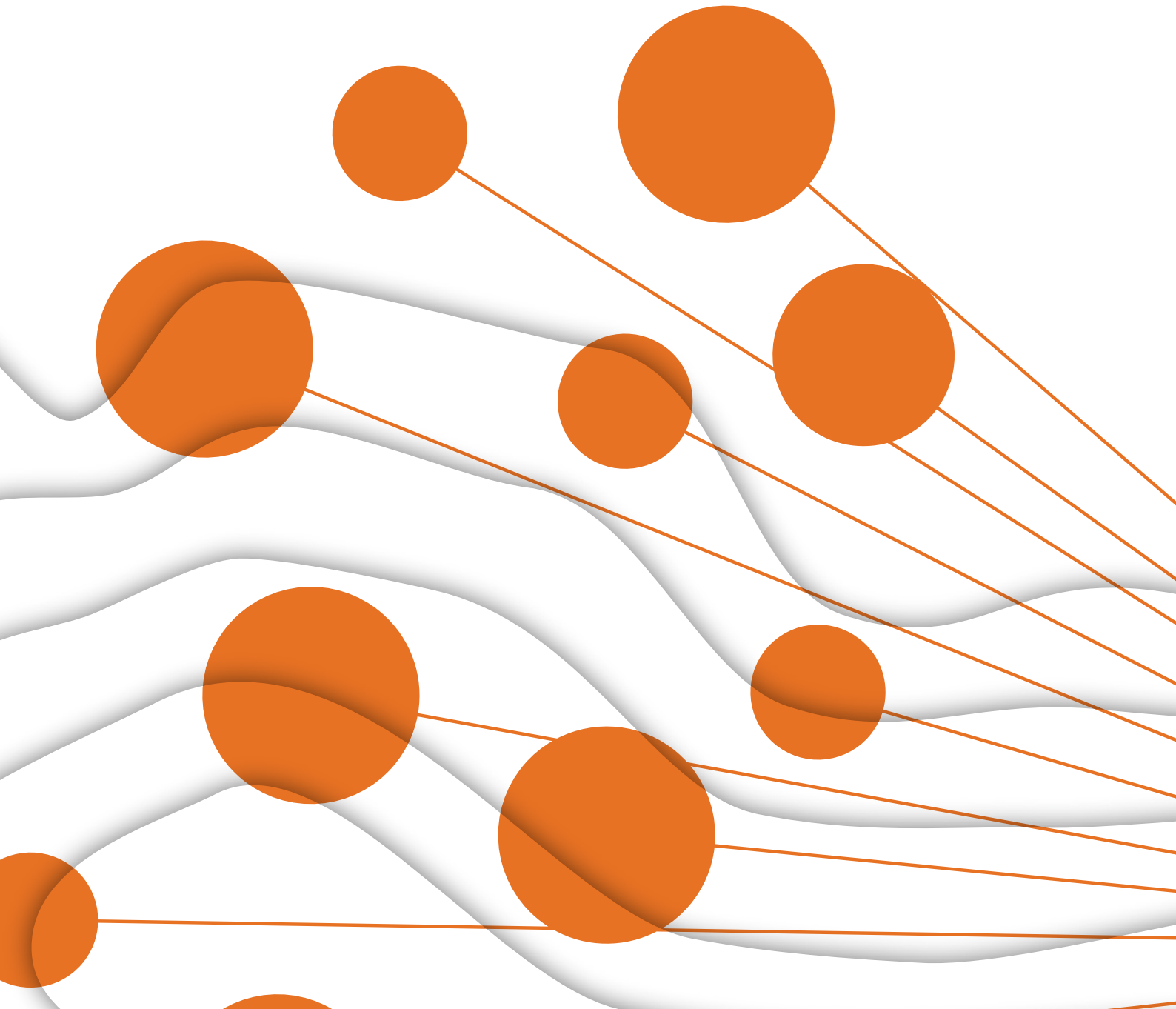
Top 100 terms used in scholarly publications by number of publications (size) and relative weight (color), South Asia, 2012-2016. Sources: Scopus® and Elsevier Fingerprint Engine™

A list of the 100 most prominent terms used in South Asia's scholarly publications highlights the region's specialization in the agricultural sciences *(Figure 8)*. Many of the most frequently used terms are plant and crop names, such as Pongamia, a genus of trees with promising biofuel applications. Plants and pests comprise more than half of the top 20 terms by number of papers. Medical or health-related terms are also prominent. Among the top 20, the Anopheles Subpictus mosquito species ranks second in terms of number of papers, reflecting the burden of mosquito-borne disease in the region. The third is 68Ga-DOTANOC, a carcinoid detector used primarily to diagnose gastroenteropancreatic neuroendocrine tumors (GEP-NETs).[21]

Assessing scholarly specialization

Identifying the most prominent terms in a body of published research can yield important insights into areas of national and regional specialization. The Elsevier Fingerprint Engine™ uses natural language processing techniques to mine the text of scientific documents. Key terms are identified in thesauri spanning all major scholarly disciplines. The Elsevier Fingerprint Engine™ then creates an index of terms weighted according to their "semantic fingerprint." This index consists of all the key concepts derived from a given text, weighted to reflect their relative importance.

21. *J Nucl Med*. 2013 Mar;54(3):364-72. doi: 10.2967/jnumed.112.111724. Epub 2013 Jan 7 https://www.ncbi.nlm.nih.gov/pubmed/23297077



Chapter 2

Challenges and benefits of research collaboration

2.1 International collaboration in South Asia

Collaboration is vital to scientific innovation, as it facilitates the exchange of ideas and expands the range of perspectives on a given subject.[22] International collaboration can yield highly significant benefits among countries with lower levels of GDP and GERD, by enabling them to leverage and complement the resources of countries with more developed research bases. However, less than 20 percent of South Asia's scholarly publications are produced through international collaboration. India drives this trend, as its researchers undertake relatively low levels of international collaboration by regional standards *(Figure 9)*. South Asia's overall collaboration rate is consistent with the global average, and slightly higher than that of China.

Among South Asian countries, economic size appears to be inversely correlated with international collaboration, as countries with the smallest economies are the most reliant on international academic networks. While only 16 percent of India's scholarly output is produced through international collaboration, this figure rises to 75 percent in Afghanistan, Bhutan, and the Maldives. Since scholarly papers produced through international collaboration tend to have a relatively high citation impact, internationally-collaborative publications have a significant influence on the FWCI of these countries. International collaborations in South Asia generally reflect areas of national specialization, but they tend to be more prominent in the agricultural sciences and less frequent in the social sciences and the humanities.

22. de Beaver, 2013. The Many Faces of *Collaboration and Teamwork in Scientific Research*: Updated Reflections on Scientific Collaboration, COLLNET Journal of Scientometrics and Information Management, 7:1, 45-54, DOI: 10.1080/09737766.2013.802629

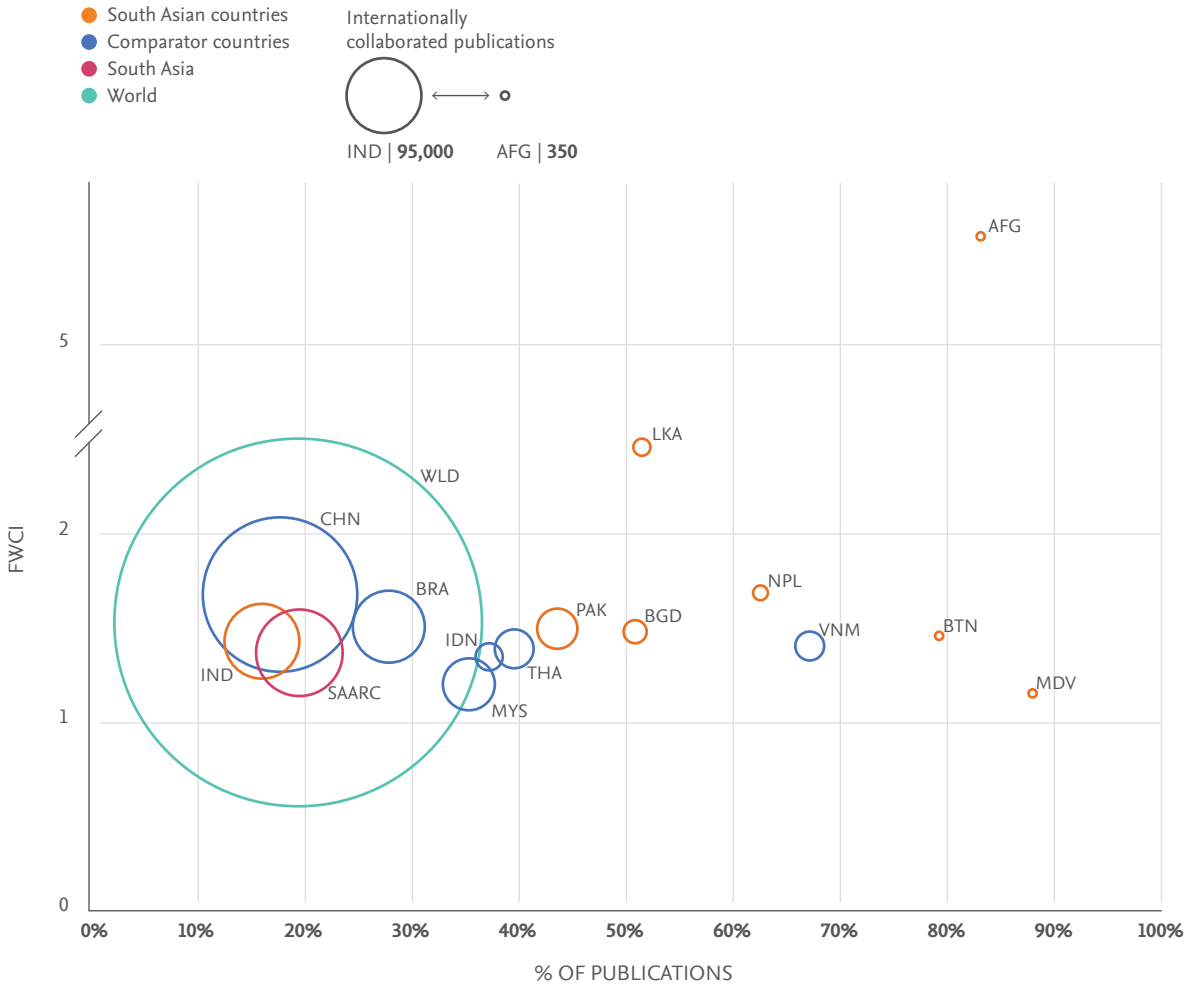


Figure 9
International collaboration by number of publications (size of circles), share of total scholarly publications (x-axis), and FWCI (y-axis), World, South Asian countries, and comparator countries, 2012-2016. Source: Scopus®

2.2 South Asia in the international collaboration network

Historically, South Asian countries have pursued extra-regional rather than intraregional scholarly collaborations. Extra-regional collaborations offer important benefits, especially in fields such as the natural sciences that rely on highly sophisticated scientific facilities and equipment. However, intraregional collaborations can help South Asian countries address common regional challenges in areas such as agriculture, medicine, and infrastructure. Intraregional collaboration across South Asia is also crucial to achieving the SAARC Charter objectives "to promote and strengthen collective self-reliance among the countries of South Asia; to contribute to mutual trust, understanding and appreciation of one another's problems; to promote active collaboration and mutual assistance in the economic, social, cultural, technical and scientific fields; to strengthen cooperation with other developing countries; to strengthen cooperation among themselves in international forums on matters of common interests; and to cooperate with international and regional organizations with similar aims and purposes."[23]

The SAARC countries would benefit from increased intraregional cooperation, yet South Asia remains the least economically integrated region in the world.[24] Recent research has identified opportunities for South Asian countries to work together to increase intraregional trade, travel, and commerce,[25] and increased scholarly collaboration could initiate other aspects of intraregional cooperation.

South Asian countries are currently scattered across the global collaboration network. Rather than operating within a common collaborative framework, each South Asian country manages its own system for international collaboration. The most prolific international collaborators, India and Pakistan, are closer to the center of the global collaboration network, while less prolific collaborators such as Afghanistan, Bangladesh, the Maldives, Nepal, and Sri Lanka are on the outer edge as shown in *Figure 10*.

Analyzing international collaboration

To study international collaboration, we rely on the affiliation country specified by authors of scholarly papers. A paper with at least two different countries in the author affiliation byline is deemed to result from international collaboration. In this analysis, whole rather than fractional counting is applied, which means that a paper written by authors with affiliations in several countries is counted once in each country's total, but deduplicated at aggregated levels (for example, across South Asia).

23. SAARC Secretariat website, http://www.saarc-sec.org/

24. World Bank, 2015. Benefits and Opportunities of Regional Cooperation in South Asia, http://www.worldbank.org/en/news/video/2015/11/06/regional-integration-the-answer-to-south-asias-development

25. De and Rahman, 2017. Regional Integration in South Asia. https://files.acrobat.com/a/preview/97b32311-8b7c-478d-8783-9193dd7cc859

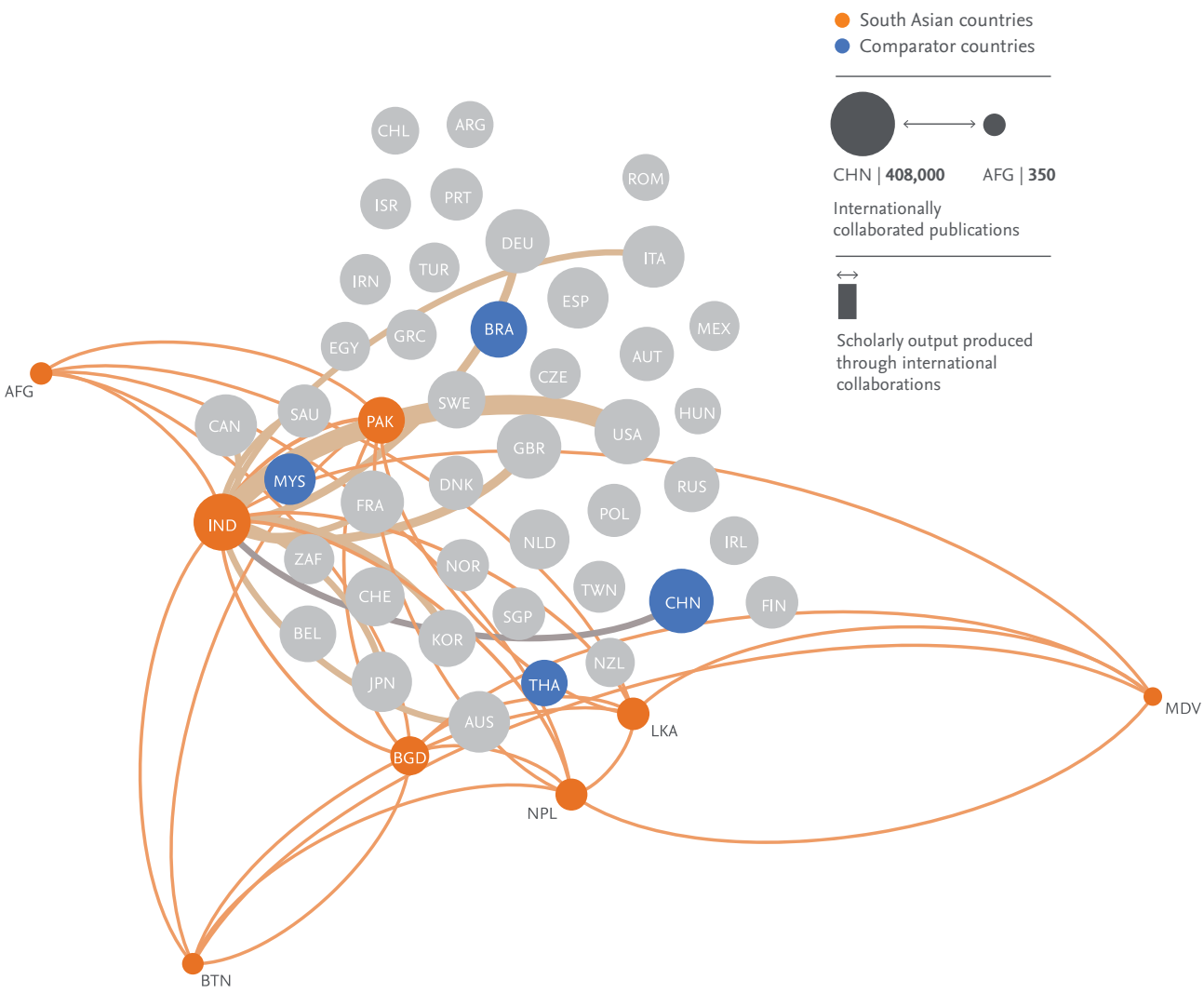


Figure 10

Global international collaboration network showing South Asian countries in orange and comparator countries in blue, 2012-2016; source: Scopus®
Note: the size of the nodes denotes the number of publications resulting from international collaboration for each country, while the thickness of the lines denotes the number of publications resulting from international collaboration between countries. For clarity, the following filters have been implemented: for nodes, South Asian country, or country with over 20,000 internationally-collaborated publications. For edges, collaboration between South Asian countries, or collaboration with South Asian country with over 5,000 internationally-collaborated publications.

	AFG	BGD	BTN	IND	LKA	MDV	NPL	PAK
AFG		18		56	15		12	62
BGD			13	601	66	1	133	336
BTN				52	7	2	18	6
IND					531	16	708	1,532
LKA						5	51	285
MDV							5	
NPL								104
PAK								

Table 1

International scholarly collaboration among South Asian countries, 2012-2016. Source: Scopus®
Note: Each cell shows the number of collaborative publications produced by each country pair.

India and Pakistan publish the largest number of collaborative papers in South Asia, and most frequently collaborate with each other. India also collaborates frequently with Nepal, Sri Lanka, and Bangladesh. Collaborations between Pakistan and Bangladesh are less common, as are collaborations between Pakistan and Sri Lanka, Bangladesh and Nepal, and Nepal and Pakistan. Other bilateral pairings are marginal, and Afghanistan, Bhutan, and the Maldives rarely engage in international collaboration with other South Asian countries.

India's prominence as an intraregional collaborator reduces when the number of collaborative papers is adjusted to account for the size of each country's scholarly output and the frequency of its international collaborations *(Figure 11, lower panel)*. Collaborations between India and Pakistan also become less prominent when these factors are controlled for, while collaborations between Pakistan and Bangladesh, Pakistan and Sri Lanka, Bangladesh and Nepal, and Nepal and Sri Lanka, become increasingly prevalent. While the collaborative link between Bhutan and the Maldives is strengthened, this is largely attributed to their low levels of scholarly output.

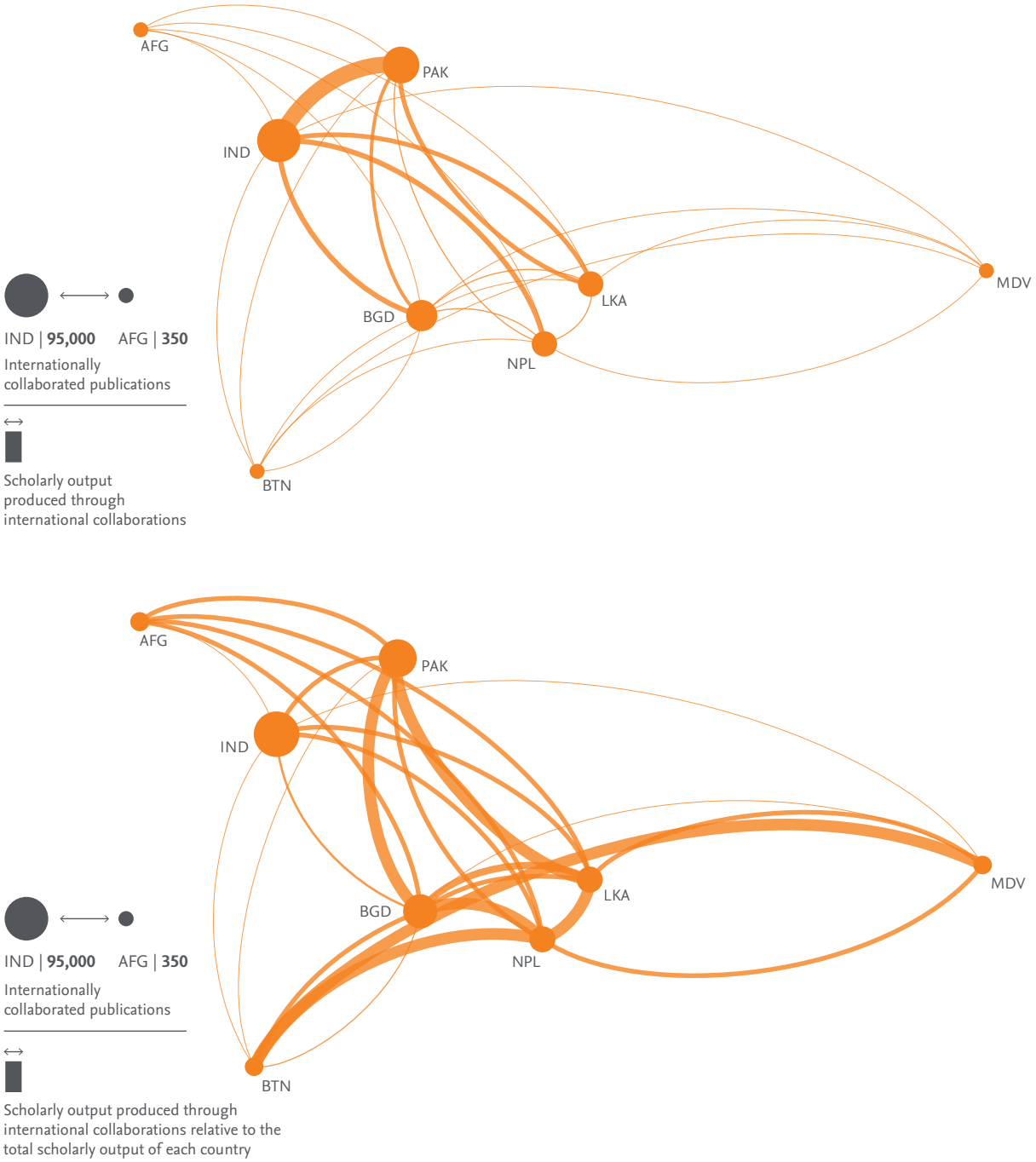


Figure 11

Scholarly output produced through international collaborations in absolute terms (upper panel) and relative to the total scholarly output of each country pair (lower panel), South Asian countries, 2012-2016; source: Scopus®

2.3 Characteristics of collaboration types

While intraregional collaboration represents a marginal share of all international collaborations in South Asia, the relative importance of intraregional collaboration varies significantly by country *(Figure 12)*. Intraregional collaboration accounts for just 0.15 percent of all collaborative papers in South Asia; however, this rises to 5-10 percent among countries with relatively modest levels of scholarly output, including Nepal, Afghanistan, Bhutan, and the Maldives. Extra-regional collaborations have a higher average citation impact than intraregional collaborations, due in part to large-scale, high-impact projects such as hyper-collaborated physics papers and internationally relevant medical research. This includes clinical guidelines, World Health Organization studies, and publications produced as part of the Global Burden of Disease program.

It is observed that overall patterns of collaboration tend to be consistent in individual subject areas, with higher levels of intraregional collaboration in the agricultural sciences and lower levels of intraregional collaboration in the social sciences and the humanities. Importantly, the difference in citation impact between intra and extra-regional collaboration is smaller for the agricultural sciences, the natural sciences, and the social sciences than it is for other subject areas, highlighting the strong regional relevance of these fields to South Asia's development challenges *(Figure 12)*.

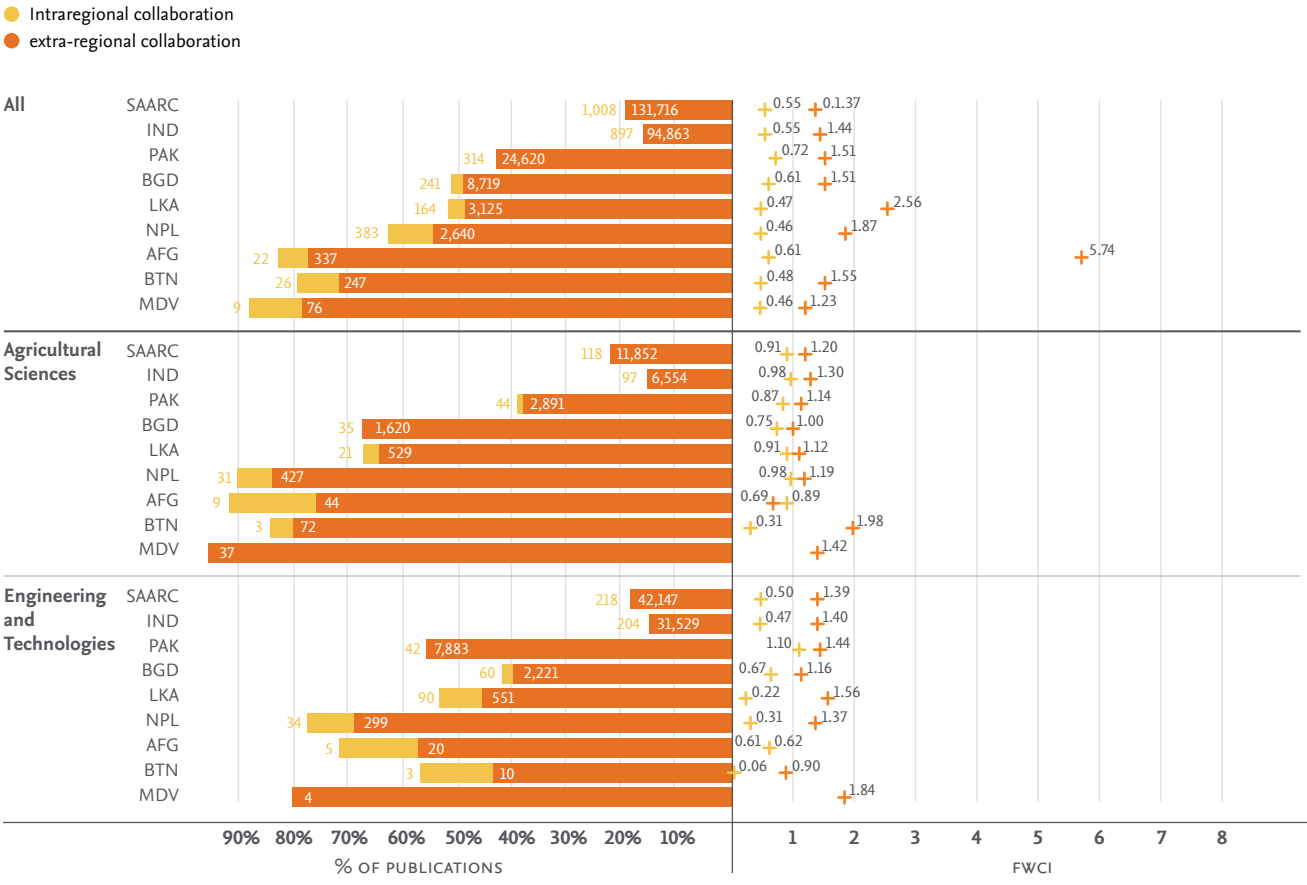
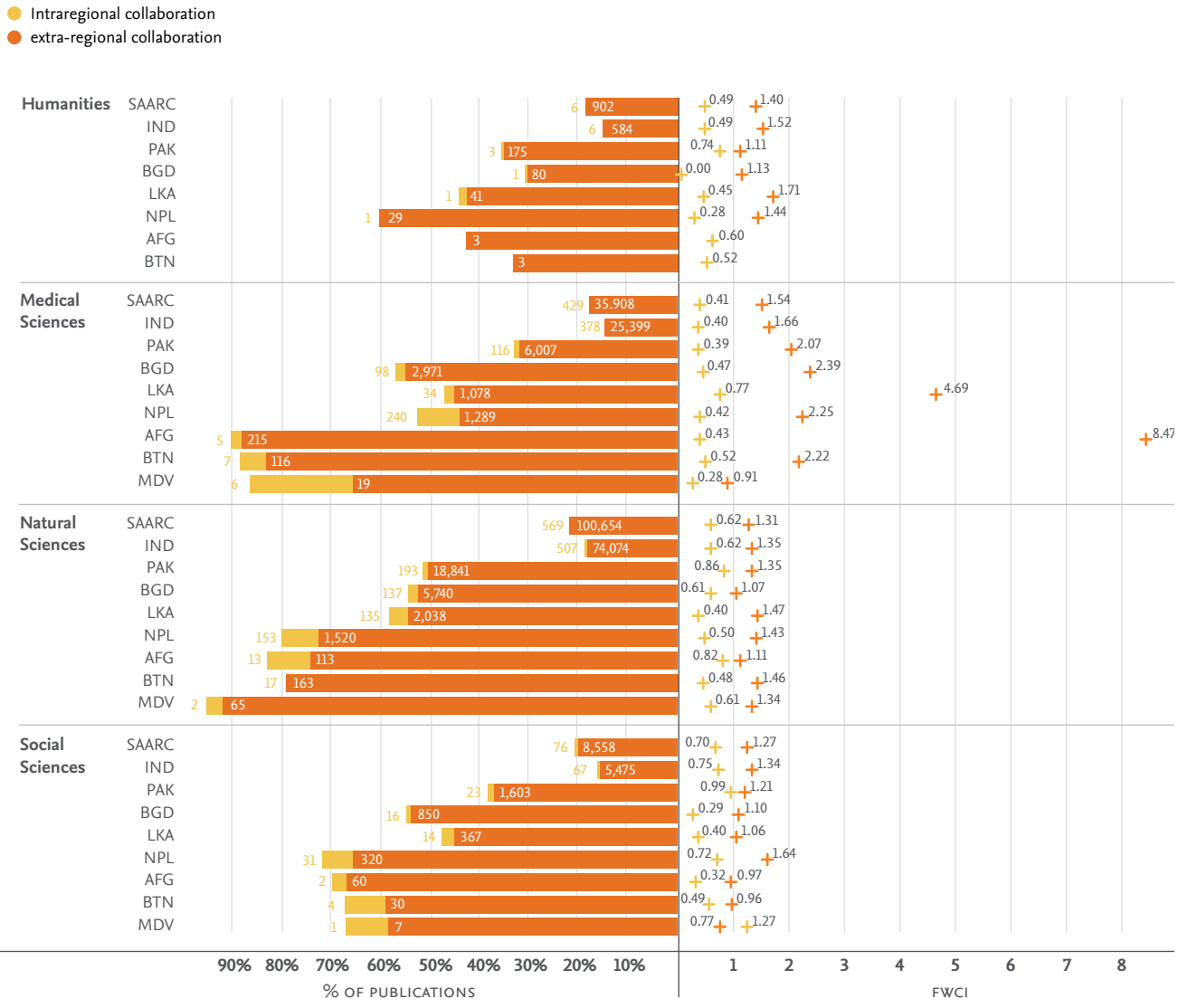


Figure 12

Intraregional collaboration (light orange) and extra-regional collaboration (dark orange) by percentage and number of scholarly publications (lhs) and FWCI (rhs) among South Asian countries, overall and by discipline, 2012-2016. Source: Scopus®


Intraregional collaboration
extra-regional collaboration
Humanities
SAARC
IND
PAK
BGD
LKA
NPL
AFG
BTN
Medical Sciences
MDV
Natural Sciences
Social Sciences
90% 80% 70% 60% 50% 40% 30% 20% 10%
% OF PUBLICATIONS
1 2 3 4 5 6 7 8
FWCI

Countries and geographic designations are the most frequently used terms in extra-regional collaborations *(Figure 13)*. The five most common terms are Pakistan, Bangladesh, Nepal, South Asia, and Sri Lanka, and 7 of the top 10 terms are geographic. The LIGO physics observatory features as the sixth most frequently used term, with "global burden of disease" in tenth place. Several of the 100 most frequently used terms also relate to hyper-collaborated physics research or globally-relevant medical studies, reflecting the influence of large-scale global projects on extra-regional collaboration in South Asia. The region's focus on the agricultural sciences is less prominent, but still visible through the names of fungi and plants. The importance of regional medical research is also evident in the term "mosquito-borne diseases", as well as the names of specific mosquito species. Several species of animals also appear on the list, possibly reflecting research related to ecological conservation.

Many of South Asia's intraregional research collaborations appear to address local issues or regional challenges. Location names feature prominently among the most frequently used terms in intraregional collaborations, and three of the top five terms are geographic *(Figure 14)*. The regional focus on the agricultural sciences is evident in the frequency of terms related to crops and yields, which include 4 of the top 10 terms, as well as other words related to agriculture and food production, such as "farmers" and "edible." Many of the most common terms relate to geological features and land characteristics, with water emerging as a major theme. The top 100 terms also feature key aspects of sustainable development, such as climate change, health, and resource management.

Comparing the most prominent terms used in intra and extra-regional collaborations suggests that intraregional

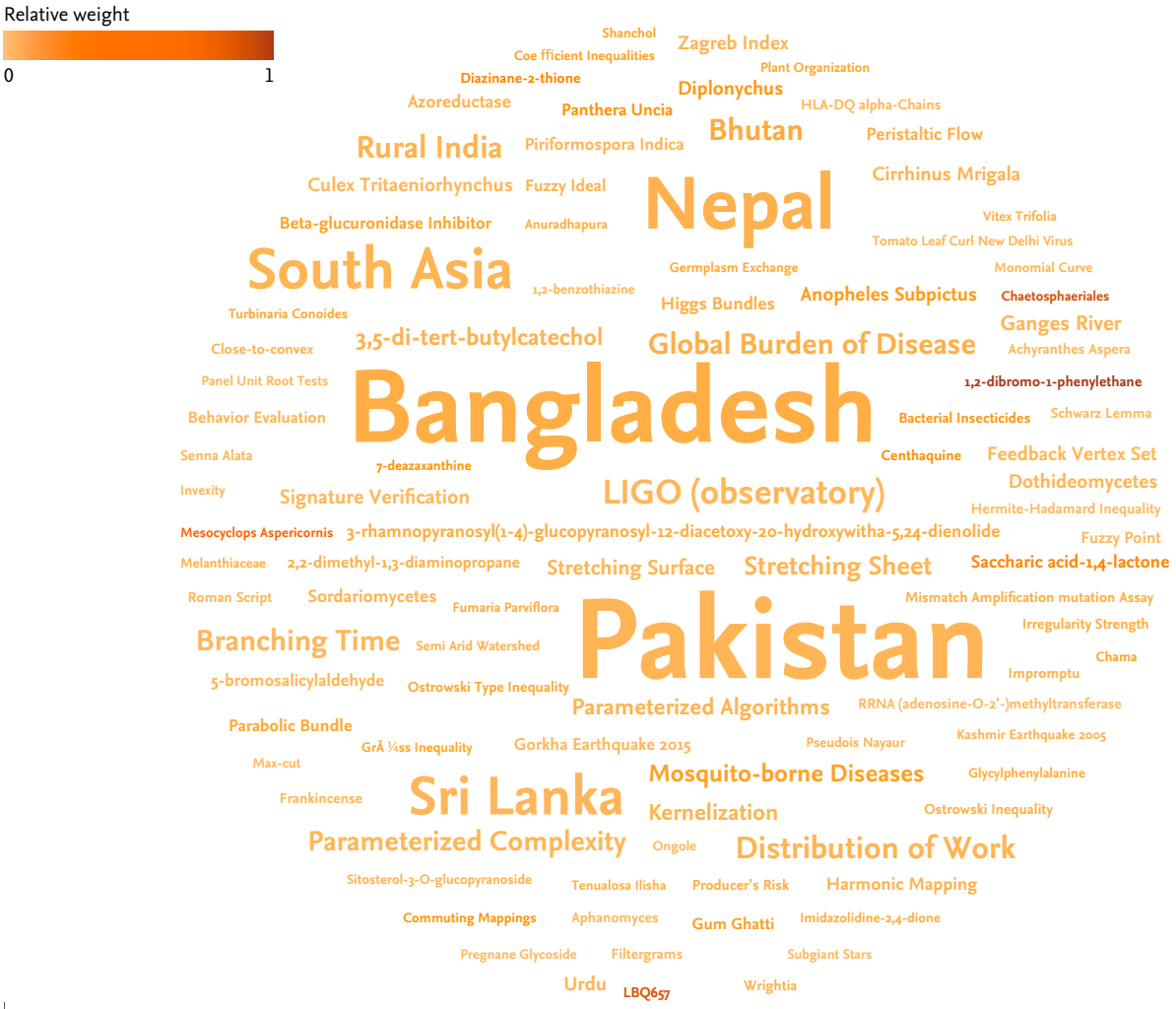


Figure 13

Top 100 terms used in extra-regionally collaborated research publications by number of scholarly publications (size) and relative weight (color), South Asian countries, 2012-2016. Sources: Scopus® and Elsevier Fingerprint Engine™

collaborations can have a practical focus, as their most frequently used terms tend to be more pragmatic and those used in extra-regional collaborations more theoretical. Further analysis could examine whether the type of collaboration influences whether South Asian research is applied or basic. Detailed analysis of extra-regional collaboration on topics such as agriculture could examine links between South Asia and regions with similar research specializations and development priorities, such as Sub-Saharan Africa.

Overall, the data indicates considerable scope for greater intraregional research collaboration among South Asian countries. Investing dedicated funds to incentivize collaborative research in countries with relatively modest research bases such as Afghanistan, Bhutan, and the Maldives, could yield significant gains in a short period of time. The value of intraregional collaboration in South Asia could be further enhanced by focusing on shared priority areas, such as improving land and water management, boosting agricultural production, and combating endemic diseases.

Two key challenges inhibit research collaboration in South Asia. The first is a lack of funding, as few resources are dedicated to supporting scholarly collaboration, especially intraregional collaboration. Increasing national investment in research and development could encourage greater collaboration at the domestic, intraregional, and extra-regional levels, whilst also expanding collaborative efforts to encompass a more diverse range of researchers and institutions. The second challenge is proposal development, as regional researchers often lack the specialized skills necessary to produce high-quality research proposals. National governments, regional higher education, and research associations are positioned to address these challenges, and could implement programs and funding schemes specifically designed to stimulate intraregional collaboration. Opportunities such as scholarships and fellowships could increase academic exchange and attract grants for projects that address region-wide challenges. Over the longer term, measures that reduce income inequality and expand education access will be vital to the quantity, quality, and international impact of collaborative research in South Asia.

Figure 14

Top 100 terms used in intraregionally collaborated research publications by number of scholarly publications (size) and relative weight (color), South Asian countries, 2012-2016. Source: Scopus® and Elsevier Fingerprint Engine™

Chapter 3

Knowledge transfer between the public and private sectors

3.1 Knowledge transfer between sectors

Knowledge transfer between sectors[26] can improve the quality of scientific research, strengthen its citation impact, and increase the value of its applications. Collaboration can encourage knowledge transfer not only between countries, but also between the public and private sectors. Knowledge transfer between academic institutions and private firms can enhance the economic contribution of universities and public research agencies, as well as promote better labor market outcomes.[27] Analyzing collaborative publications between academia and the private sector can highlight intersectoral knowledge transfer and open further opportunities for scientific cooperation in South Asia.

Collaborations between academia and the private sector account for roughly 1.3 percent of South Asia's scientific output *(Figure 15)*, about half the global rate. Among South Asian countries, only Afghanistan exceeds the global rate for academic-corporate collaborations. In South Asia and among comparator countries, academic-corporate collaborations tend to have a relatively high FWCI, which is boosted by large-scale collaborations such as the Global Burden of Disease studies. Academic-corporate collaborations most frequently occur in the natural sciences, as well as in engineering and technology.

Analyzing knowledge transfer

Collaboration is not the only way for knowledge to pass between sectors. The transition from theoretical research to practical application also represents a critical form of knowledge transfer from academia to industry. Citations of scholarly papers in patents can serve as a proxy for this form of knowledge transfer.

26. Scopus® designates a sector for each institution, such as academic, medical, or governmental.

27. Parker, 1992. "Industry - university collaboration in developed and developing countries (English)." Education and Employment Division Background Paper Series no. PHREE 92/64. Washington, D.C.: the World Bank. http://documents.worldbank.org/curated/en/675261468740666204/Industry-university-collaboration-in-developed-and-developing-countries

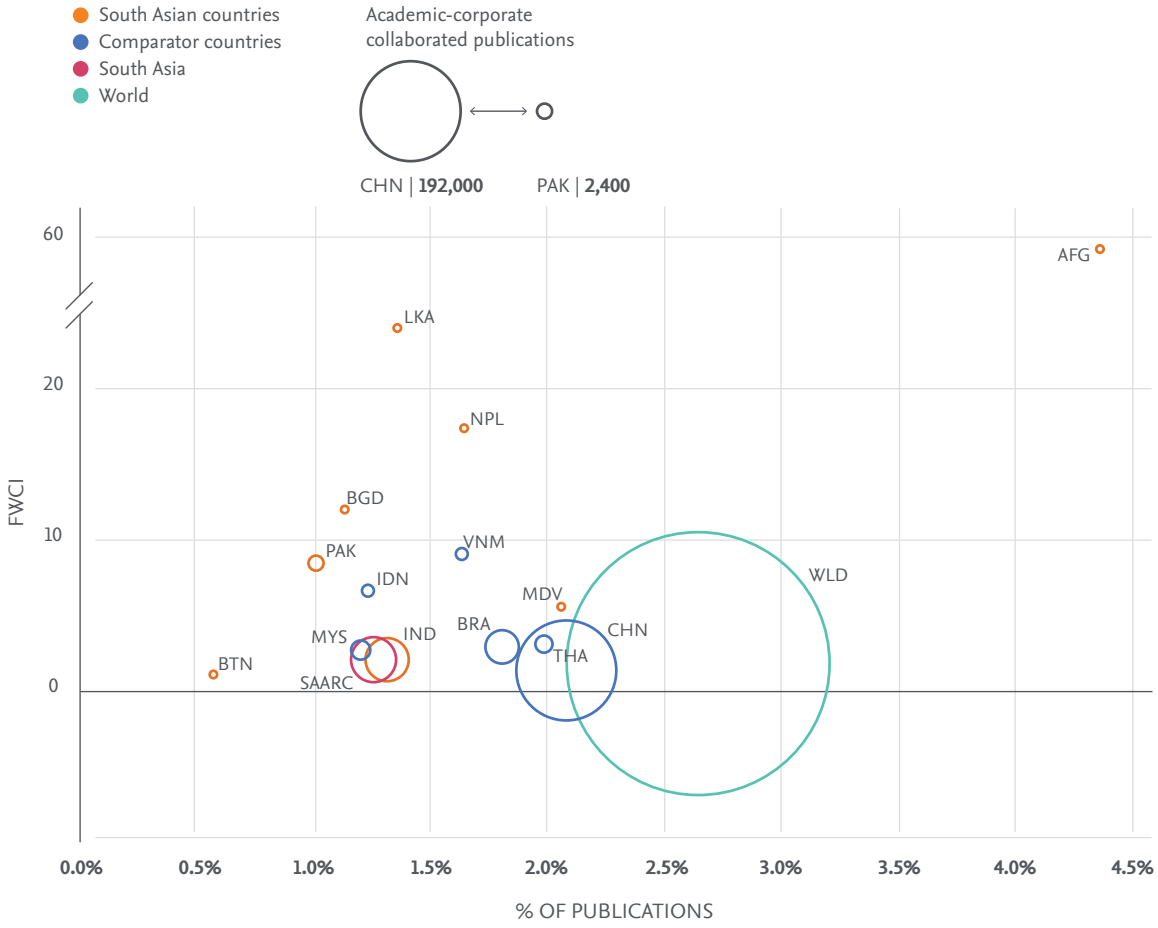


Figure 15

Academic-corporate collaborations by share of total publications (x-axis), number of publications (size of circles), and FWCI (y-axis), South Asia and comparator countries, 2012-2016. Source: Scopus®

With the exception of Afghanistan, most South Asian countries and their extra-regional comparators tend to have fewer patent citations than the world average in relation to their scholarly output *(Figure 16)*. While this may be partly attributed to coverage of the World Intellectual Property Organization database, it could also identify an opportunity to enhance cross-sector knowledge transfer through greater academic-corporate collaboration. The largest shares of patent citations are in the agricultural sciences, the medical sciences, and the natural sciences. Further analysis could reveal how cross-sector knowledge transfer affects intraregional collaboration, raising opportunities to increase collaboration between South Asian countries.

Collaboration between academia and the private sector has significant potential to promote social change and increase intraregional cooperation. Currently, South Asian corporations rely very little on the knowledge produced by local academics, and regional governments could take steps to stimulate academic-corporate collaboration. Establishing Technology Transfer Offices (TTOs) at universities could provide an interface between academic institutions and private firms. Measures could also be taken to encourage academic institutions to produce more commercially-relevant research, such as allocating funds for academic-corporate collaborations, building the capacity of patent offices, and providing training in intellectual property literacy.

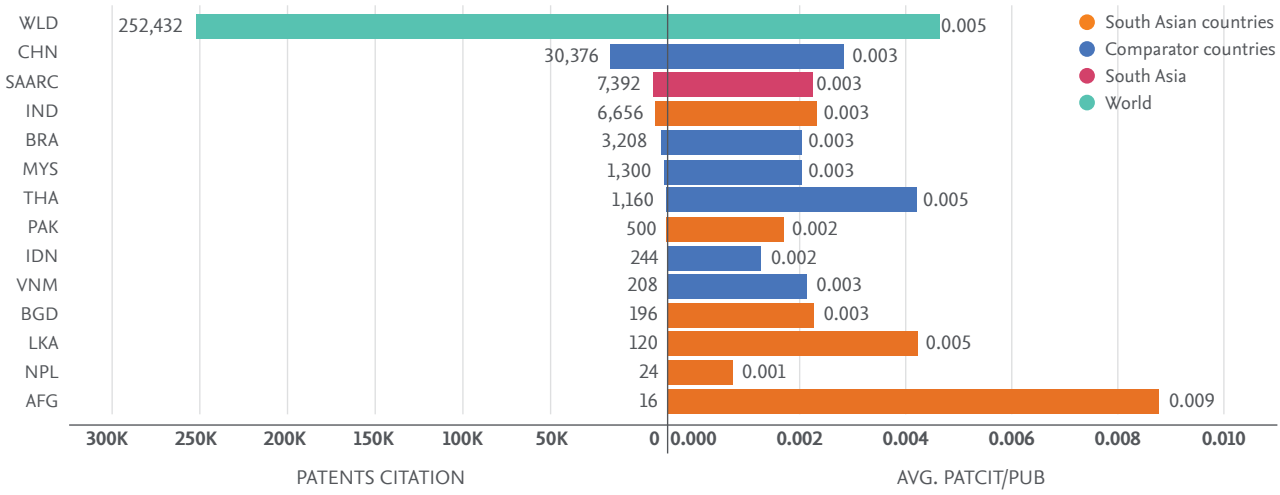


Figure 16

Patent citations numbers (lhs) and patent citations per scholarly publication (rhs), for the world, for South Asia, per South Asian country, per comparator country; 2012-2016. Sources: Scopus® and WIPO

Dedicated funding to support academic-corporate collaboration could strengthen ties between the private sector, national scientific organizations, and tertiary education institutions. This would leverage private resources to support research and patent submissions by academics, while increasing the productivity of industries. Establishing TTOs on university campuses could enhance the relevance of academic research in relation to private sector competitiveness and productivity. TTOs can serve as innovation spaces and business incubators that allow students, faculty, and firms to collaboratively develop marketable technologies. TTOs can also expand the capacity of universities to train students in intellectual property policies, licensing agreements, and the national and international laws governing intellectual property rights. The latter is critical, as many South Asian countries lack strong legal frameworks for defining and protecting intellectual property rights. Legal assistance provided via TTOs should be supported by legislative reforms, designed to ensure that researchers profit directly from the value their innovations create.

Competitive funding mechanisms to strengthen research capacity: Sri Lanka's higher education for the 21st century project [28]

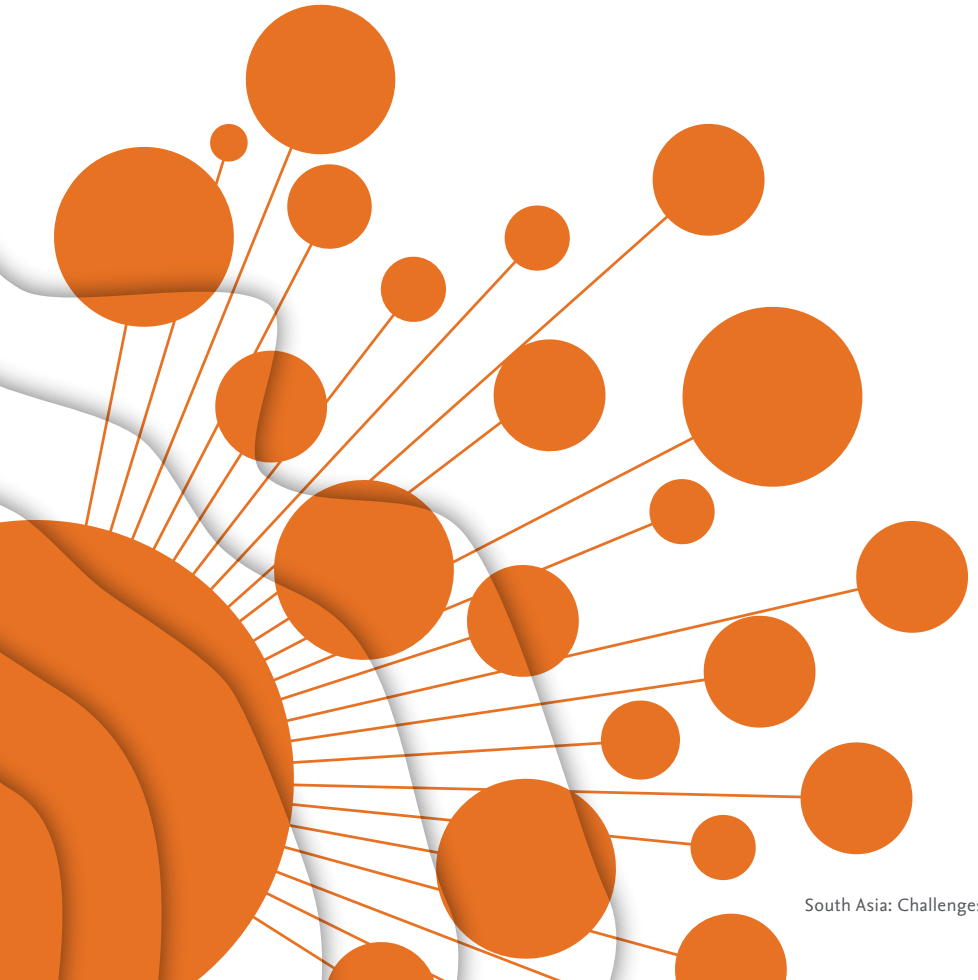
Funded by the Ministry of Higher Education and the World Bank, Sri Lanka's Higher Education for the 21st Century project incentivizes academic-corporate partnerships through its Quality and Innovation Grants, which focus on research dissemination and commercialization. These grants have been the catalyst for internal performance-based reforms, promoting improved institutional management. The project also revealed considerable demand for academic-corporate collaboration and encouraged advocacy for stronger intellectual property rights.

28 More information on Sri Lanka's higher education for the 21st century project can be found at http://projects.worldbank.org/P113402/higher-education-twenty-first-century-project?lang=en

Conclusions and recommendations

Greater academic and scientific collaboration between South Asian countries could increase the region's scholarly output and enhance its global citation impact. As South Asian countries face a range of similar challenges, collaborative research could address shared problems and reduce the region's dependency on extra-regional collaboration. Increased collaboration between South Asian countries, as well as stronger links between academia and industry, could also enhance the commercial relevance of the region's scholarly output, magnify its contribution to economic growth, and improve conditions in regional labor markets. Increasing GERD regionally could advance these goals, but greater funding should be accompanied by targeted policies designed to increase intraregional, extra-regional, and academic-corporate collaboration.

South Asian countries must effectively leverage their research sectors to address critical development priorities, and to contribute to economic productivity and competitiveness. To achieve this, it is concluded that South Asia must address the following:



1. Increase the quantity and improve the quality of tertiary education, with a focus on science, technology, engineering, and mathematics;

2. Develop criteria to determine priority research areas at national and regional level;

3. Establish financial and administrative mechanisms to enhance the quality and quantity of research produced in priority areas, at national and regional level;

4. Encourage academic institutions to produce research that meets the needs of domestic and regional corporations, increasing the citation impact and number of patents submitted by academics while enhancing national and regional economic productivity and competitiveness;

5. Build the capacity of researchers to develop high-quality proposals, both for domestic and international projects;

6. Dedicate specific funding streams to support domestic, intraregional and extra-regional collaboration, including financial assistance, scholarships and fellowships for postgraduate students and postdoctoral research fellows;

7. Promote research partnerships between academic institutions and the private sector;

8. Establish TTOs and business incubators on university campuses to leverage the resources of the business community to support local research and development, while bolstering the competitiveness and productivity of the private sector;

9. Earmark funds for academic-corporate collaborations, build the capacity of patent offices, and provide training in intellectual property literacy to encourage academic institutions to produce more market-relevant research; and

10. Encourage greater participation in international research programs funded by multilateral institutions, to alleviate fiscal constraints on the tertiary education sector while expanding national and regional networks of scholarly collaboration.

Annex

The drive for excellence: enhancing the quality of research in South Asia

South Asia recognizes that innovation and knowledge are critical in sustaining productivity growth, building competitiveness, and facilitating structural economic transformation. In response to this, countries across the region have launched initiatives designed to enhance the quality of scholarly research and highlight the impact of international collaborations.

As part of a strategic move to internalize higher education, educational institutions in South Asia are striving to transform their international engagement beyond the development of links between researchers and their counterparts in other countries. Faculty exchange programs are being created or expanded, the establishment of foreign university campuses is permitted, and global perspectives are being incorporated into academic programs.

In a recent survey, about 70 percent of participating South Asian educational institutions reported that they support the professional development of their faculty, by building capacity to integrate international and intercultural dimensions into courses. The participating institutions cited the professional development of their faculty as the most important dimension of their internationalization efforts.[29]

29 World Bank, 2018. *Ready to Learn, Ready to Thrive: Before School, In School, and Beyond School in South Asia.* Washington, DC: The World Bank, p.267

Cross-border internationalization in South Asia

India

Indian academic institutions and policymakers have extensively discussed how to regulate foreign universities establishing campuses in India, and concerns have been raised regarding the impact of these campuses on quality and standards of higher education. An Indian government initiative called "Institutions of Eminence" and launched in 2018 will provide selected academic institutions with greater scope to establish international partnerships, employ foreign faculty, and admit students from abroad.

Sri Lanka

The Sri Lankan government has authorized foreign universities to establish satellite campuses in Sri Lanka, and the development of these campuses has the potential to greatly expand domestic linkages between international academic networks. Thus far, one private domestic university has partnered with a foreign university to offer undergraduate programs in select fields. The government's goal is to attract 10 foreign universities to Sri Lanka by 2020 and increase total international student enrollment to at least 50,000.[30]

30 Ibid., p.266

Competitive funding mechanisms for research collaboration

Bangladesh

Financing mechanisms can also support research and innovation at national level. Launched in 2009, Bangladesh's Innovation Fund supports 439 projects across 28 public and nine private universities. Committed to transparency, the fund involves the academic institutions at all stages of the funding allocation process. In order to allocate funds fairly, universities of similar sizes and capacities are grouped accordingly and compete against each other. Project design, development, and implementation all take place at a university level, which has created a strong sense of ownership and responsibility for success by researchers and institutions. This has also helped shift the focus of research from quantity to quality. The fund also seeks to mainstream international good practice, such as peer review, to ensure appropriate monitoring and oversight. Bangladesh's Innovation Fund demonstrates how well-designed funding mechanisms can sustainably strengthen research capacity.[31]

In addition to expanding opportunities for global engagement, South Asian countries have created competitive funding mechanisms to strengthen links between academic researchers and the private sector.

India

The Indian government has implemented several funding mechanisms to support research on a variety of fields including IMPRINT (for technology), IMPRESS (for social sciences), STARS (for fundamental sciences), STRIDE (for humanities and languages) and SPARC (for joint research with global best universities). Also, the GIAN funding program has helped in getting more than 1,800 academicians from foreign universities to India; and under the GIAN Plus scheme it is intended to provide an option to the Indian academicians to take short-term courses and develop research collaboration in foreign universities. Also, some regional institutions have fully integrated collaborative research into their core mission. For example, the Indian Institute of Technology, Bombay (IIT Bombay) is among the region's leading research universities. Whereas faculty members at most engineering colleges tend to focus on teaching and evaluation, at IIT Bombay they frequently undertake research and consultancy projects sponsored by Indian government agencies, foreign and domestic private firms, and international organizations. A dedicated office, the Industrial Research and Consultancy Centre, coordinates sponsored research and consultancy projects and acts as a liaison between the faculty, the university, and the project sponsors. On average, IIT Bombay's faculty implements a total of 400–500 sponsored projects per year. This focus on collaborative research has greatly strengthened links between IIT Bombay and the private sector, setting it apart from many other Indian higher education institutions. Sponsored research and consultancy projects generate considerable revenue, and the university has established clear norms for sharing revenue from the commercialization of intellectual property, aligning faculty incentives with those of the university and its partners in the public and private sectors.[32]

31 World Bank, 2018. Ready to Learn, *Ready to Thrive: Before School, In School, and Beyond School in South Asia.* Washington, DC: The World Bank, p.289-290.

32 Jayaram, N., 2011 "Toward World-Class Status? The IIT System and IIT Bombay." In Altbach and Salmi (eds.) *The Road to Excellence: The Making of World-Class Research Universities.* Washington, DC: The World Bank, pp.184-5

While the proceeds from research applications can be substantial, regular financing mechanisms are essential to maintain a highly skilled pool of research scholars. To attract promising researchers, IIT Bombay offers graduate and postgraduate research fellowships and summer internships. Research fellows and interns contribute directly to research projects and may be considered for admission to postgraduate or doctoral programs. IIT Bombay faculty members and students also receive considerable financial assistance to enable them to participate in international conferences. IIT Bombay has encouraged a culture of scholarly competition by establishing multiple awards for outstanding faculty achievements in research and development.[33]

Pakistan

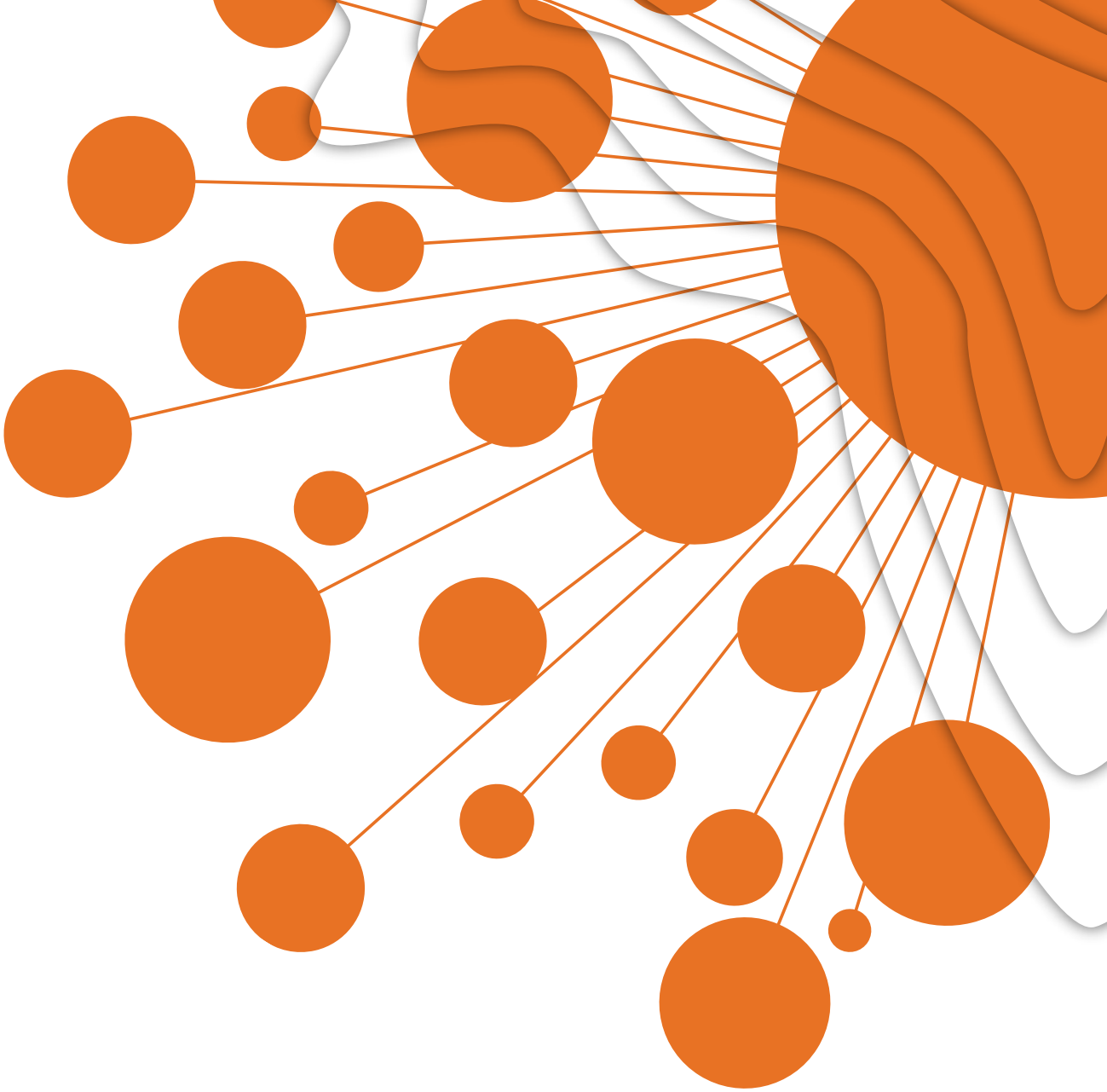
Under the umbrella of the Higher Education Commission (HEC) and the Ministry of Science and Technology (MOST), a variety of funding opportunities for research and innovation allow higher education institutions to have access to additional financial resources. Some of the funding schemes have been developed in collaboration with partner countries, such as the US-Pakistan Centers for Advanced Studies in Energy (USPCASE). This collaboration was established as a partnership between Arizona State University and the National University of Science and Technology (NUST) in Islamabad, and the University of Engineering and Technology (UET) in Peshawar, with the goal of focusing on applied research relevant to Pakistan's energy needs. This partnership provides a link between government, industry, and academia as well as fosters the development of policies in sustainability. In addition, competitive funding schemes are in place at HEC to support activities such as university-industry collaboration, patent development, problem-based applied interdisciplinary research, start-ups, and upgrading of laboratories and libraries.

Sri Lanka

Sri Lanka's Higher Education for the 21st Century project introduced two competitive Quality and Innovation Grants: one focused on research dissemination and the other on the commercialization of research output. Supported by these grants, at least nine university faculties have produced research output with significant commercial value. Recipients reported that the grant mechanisms had fostered a culture of applied research, encouraged private-sector partnerships, spurred internal reforms to improve academic performance, and enhanced institutional management.[34]

33 Ibid.

34 World Bank, 2018. *Ready to Learn, Ready to Thrive: Before School, In School, and Beyond School in South Asia.* Washington, DC: The World Bank, p.291



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