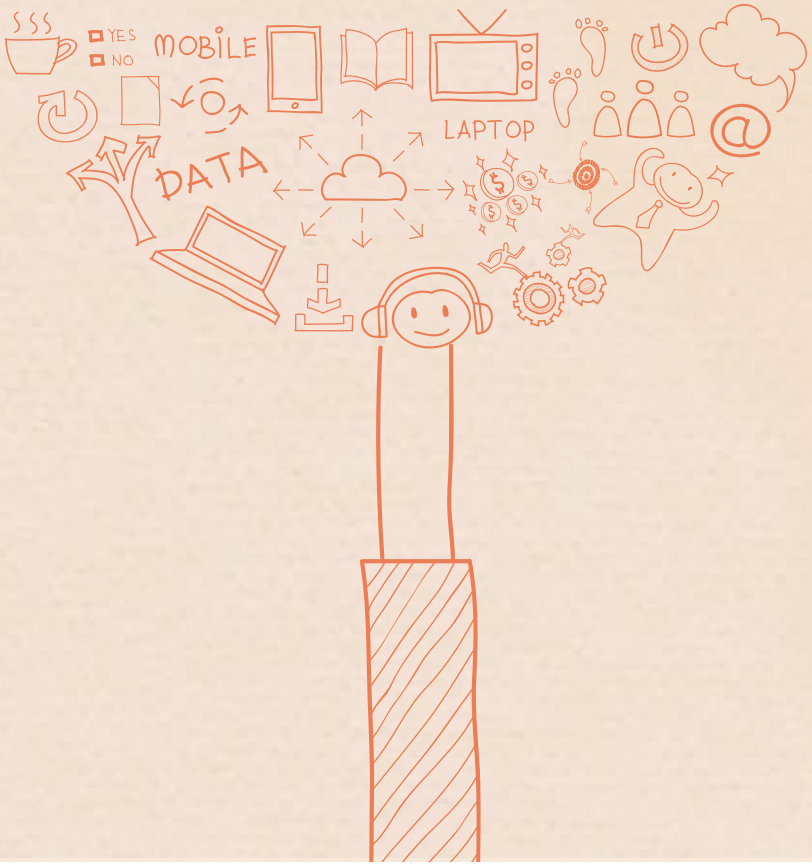
ASSESSING SCIENTIFIC RESEARCH & INNOVATION

The South Asian Case



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Abbreviations

DORA	Declaration on Research Assessment
GII	Global Innovation Index
OA	Open Access
OECD	Organisation for Economic Cooperation and Development
R&I	Research and Innovation
R&D	Research and Development
SAARC	South Asian Association for Regional Cooperation
STI	Science, Technology, and Innovation
WIPO	World Intellectual Property Organisation

Introduction

As one of the world's fastest-growing economies, India is often considered the country that leads scientific research and innovation ('R&I') in the South Asia region. However, it still faces significant challenges in areas like investment in scientific research, systems for allocating research funding, and quantity and quality of research output. Despite varying levels of economic development, the other countries in the region (Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan, and Sri Lanka) fare worse on most of these parameters. UNESCO's Science Report (2021) highlights the lack of industrial expenditure on scientific research and development ('R&D') in these seven countries. Nepal and Bangladesh have the highest research expenditure in the South Asian region (excluding India (0.7%)), at a staggeringly low 0.30% of their GDPs (ibid.). Comprising low to middle-income countries, South Asia represents a vast landscape of opportunity to utilise scientific research for economic and social progress.

Measuring R&I is critical to understanding and improving its functions. It interfaces with processes ranging from academic hiring to creating effective Science, Technology and Innovation ('STI') policies for entire countries and regions. Over the last two decades, several international efforts have been made to define and standardise metrics, methods, and norms used for measuring scientific R&I. These include the annual Global Innovation Index devised by WIPO (World Intellectual Property Organisation), the Leiden Manifesto, and the San Francisco-initiated DORA (Declaration on Research Assessment). However, instances of such regional collaborations over R&I assessment remain absent in South Asia. Our previous report on analysing research productivity metrics and practices notes how the aforementioned international frameworks tend to focus on economically advanced countries in the developed world (CCS 2022b). Building standards for R&I assessment at the South Asia level contributes to addressing this gap, and shifts focus onto the region-specific needs of smaller economies.

This report proposes two reasons as to why R&I is a compelling area for collaboration between South Asian countries, both in terms of opportunity and need. First, as noted at the outset, research and innovation outcomes in South Asia are less than desirable, compared to more economically advanced parts of the world. Even India, which invests approximately 0.7% of its GDP in scientific research, lags far behind the OECD average of 2.37% (OECD 2019). A common set of goals and parameters for assessing R&I would help countries advance more effectively in this area of shared priority. Second, cross-border collaboration through open sharing of scientific data and research has rapidly gained prominence in recent years, in part due to growing digitalisation. The imminent need for such collaboration is especially apparent as the world continues to grapple with the COVID-19 pandemic, and scientific research linked to healthcare seems more evidently relevant than perhaps ever before.

The objective of this report is to identify and pinpoint considerations that are relevant to the creation of South Asia-wide assessment parameters. It also seeks to offer recommendations on the shape these regional standards could take. The first chapter examines data and scholarship on R&I assessments in South Asia, highlighting areas in which it falls short of providing effective insights and outlining opportunities for regional collaboration within them. The second chapter evaluates how R&I can be utilised for economic growth, based on the overlapping economic

needs and priorities of South Asian countries. Both chapters conclude with a set of recommendations on tackling the concerns raised in it through South Asian collaboration over parameters for scientific R&I assessment.

This report is the last in our three-part study titled Assessing Scientific Research and Innovation. In our first report, *Study of frameworks and parameters for evaluating institutional research*, we analysed indices used to measure scientific innovation in Indian higher education institutions (CCS 2022a). The second report, *An analysis of research productivity metrics and usage guidelines*, examined global norms around measuring research productivity, highlighting limitations and providing recommendations to overcome them (CCS 2022b). Our final report carries forth relevant thematic areas from both these reports and situates them within the context of South Asia.

01 Scientific Research, Innovation, and Collaboration in the South Asian Context

Newly industrialised economies form the bedrock of South Asia's research output and thus, R&I assessments suffer from a lack of standardisation and infrastructure. This chapter evaluates South Asian countries' scientific contributions, and how they fare in comparison to one another based on assessments and data points that are readily available. Through this analysis, it identifies areas wherein the efficacy of existing assessment practices can be enhanced. Next, it examines opportunities for scientific collaboration between countries and establishes the context for how such collaboration over R&I assessment can be achieved. Finally, it proposes recommendations to address the gaps in existing assessment data and practices through such collaboration.

The State of Scientific R&I Assessment in South Asia

The application of bibliometric tools to data from popular scientific research databases is an oft-used measure of research productivity at the country level. Studies using the bibliometric approach focus on quantitative markers of research success. Scopus publication data in the field of Computer Science for the years 1996-2013 points to the underlying dissonance between the developed world and South Asia (Uddin and Singh 2014). The top nine countries in terms of research output are the United States of America, China, United Kingdom, Germany, France, Canada, Italy, and Spain, in order (ibid.). Interestingly, India, ranked 10th, is the only South Asian country ranked in the top ten, with Pakistan (ranked 46th) being the only other South Asian country in the top fifty (ibid.). Bangladesh, Sri Lanka, Nepal, Afghanistan, Bhutan, and the Maldives rank from sixty-third all the way to the one hundred and first rank (ibid.). Thomson Reuters' Web of Science publication data for 1973-2007 used the nationality of the author's address as the parameter to evaluate the yearly number of scientific publications in India, Bangladesh, Sri Lanka, and Pakistan (Mahbuba and Rousseau 2009). It points to India ranking the highest in terms of research output, Pakistan coming in second, Bangladesh at third, and Sri Lanka occupying the last place out of the four (ibid.). In relation to determining the quality and credibility of research through citations, Sri Lanka leads with the lowest number of non-cited research publications, with India at second, Bangladesh at third, and Pakistan at fourth (ibid.). PubMed publication data for South Asian Association for Regional Cooperation ('SAARC') points to a 242-fold increase in biomedical research output from 1985 to 2009 (Majumder et al 2012). Even then, the record for the region is a mere 1.1% of the total papers indexed (ibid.). Furthermore, India individually contributed 90.5% of the total publications generated by SAARC economies (ibid.). While these studies provide quantitative insight into the research contributions of South Asian countries, as well as a somewhat comparative picture of the scientific research landscape within the region, they are unable to shed light on what factors precipitate high-quality research outcomes.

WIPO's Global Innovation Index ('GII') ranks scientific innovation across detailed metrics for 132 economies (WIPO 2021). India, ranked 46th, is considered an over-performer in the category of upper-middle-income group economies—it ranks 1st in the world in terms of ICT (Information and Communication Technology) services exports, and 12th in terms of both domestic industry diversification and graduates in science and engineering (ibid.). Sri Lanka comes in next, ranked 95th, followed by Pakistan at 99th, Nepal at 111th, and Bangladesh at 116th (ibid.). Afghanistan, Bhutan, and the Maldives are not included in these rankings. The Global Innovation Index is made up of seven broad pillars— institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creative outputs (ibid.). Its methodology is covered in greater detail in the first report of our Assessing Scientific Innovation and Research series (CCS 2022a). Notably, Sri Lanka, Pakistan, Nepal, and Bangladesh all rank fairly low across most of the parameters, with the exception of Sri Lanka and Nepal being well-ranked in terms of business sophistication indicators (WIPO 2021). Despite its overall good performance on the Index, India fares poorly on parameters linked to infrastructure and creative outputs (ibid.). These insights provide a clearer view of the efficiency of scientific ecosystems in South Asia. However, there is still room to localise analyses around innovation further and focus on issues surrounding public underinvestment in R&D that are common to the countries in this region.

Opportunities for Regional Scientific Collaboration

South Asia is often considered one of the least integrated regions in the world. 'SAARC, created in 1985, was envisaged as a regional international organisation that would facilitate collaboration over economic and developmental goals. However, factors such as varying levels of development among countries, as well as political tensions between major players in the region like India and Pakistan, have historically impeded cooperation in these areas. In the absence of stronger regional coalitions, both political and economic, scientific collaboration in South Asia remains fairly underdeveloped at the moment. To put this into perspective, while the stated objectives of SAARC are compared to other regional international organisations, the European Union has announced a research budget of 1.8 trillion euros for the next decade, while SAARC has no mechanisms for funding research (Ahmed et al. 2021). Despite having a strong overall rate of international research collaborations that is consistent with the global average, South Asia has a fairly low scientific research output when it comes to intraregional collaborations (World Bank and Elsevier 2019). Only 0.15% of all collaborative papers in the region emerge from intraregional collaborations. At the same time, smaller economies—Afghanistan, Bhutan, and the Maldives— rely on international collaboration for as much as 75% of their scholarly output. Notably, the rate of intraregional research output is also significantly higher for these countries than the South Asia average, sitting between 5% and 10% (ibid.).

Variations within the region once again provide a plausible explanation for these figures. However, despite variations in resource capacity and academic as well as industrial specialisation, shared scientific priority areas for South Asian countries include improvements in land and water management, boosting agricultural production, and combatting endemic diseases (World Bank and Elsevier 2019). There has been a renewed focus on SAARC during efforts to combat the COVID-19 pandemic—such as the video conference held in March 2020 leading to the initiation of a COVID-19 Emergency Fund amounting to 21.8 million USD (Ahmed et al. 2021). There also appears to be a growing interest in science diplomacy in South Asia, with Pakistan and Nepal initiating the establishment of science diplomacy forums in recent years, while India has already established one earlier (ibid.). Further, the crucial role played by scientific progress in economic development, explored in detail later in our report, makes this a collaborative area that is strongly aligned with greater economic prosperity for countries in the region.

Growing international collaboration over Open Science practices is also an important factor to consider here. These practices are aimed at the free-flow sharing of information from every step of the scientific research process, including but not limited to research publications (also referred to as Open Access), software source codes, data, and even researcher notes (CCS 2022b). At present, there is a dominance of voices from economically advanced countries, primarily situated in Europe and the United States, in international standards around Open Access ('OA') and Open Science (ibid.). Regional standards provide a compelling way to challenge this dominance and represent the collective interests of smaller economies within this sphere. Following in the footsteps of Latin America, the creation of the Forum for Open Access in South Asia was initiated at an International Day for Universal Access to Information conference held in Sri Lanka in 2018 (Gautam 2018).

This section has sought to establish that South Asian collaboration over scientific progress is possible as well as viable. Common and context-specific standards for assessing the quantity,

quality, efficiency, and value of scientific R&I would help streamline such collaboration, as well as lay the groundwork for further collaborative interventions to improve scientific outcomes.

Recommendations

- **Developing context-specific assessment tools for South Asia to complement global ones**. A regional index similar to the GII, for instance, could yield detailed insights on shared scientific priorities related to resource management, agricultural productivity, and healthcare. It would also help establish comparative regional standards for R&I, and possibly even foster a spirit of healthy competition between countries in the region. This concern extends to scientific databases, which sometimes fall short when it comes to the inclusion of multilingual research output, and smaller journals and publications. Assessment tools that focus on effectively mapping such output from South Asian countries would yield richer data on quantity and quality of R&I as well as scientific trends within the region.
- **The creation of regional R&I assessment parameters related to capacity-building and infrastructure.** Resource constraints and a lack of adequate infrastructure for scientific R&I are concerns that appear to affect more or less every country in South Asia. Creating regional assessment standards that account for them would allow countries to strategically use their geographical proximity with one another to build shared capacity and infrastructure. This proximity enables easier flows of trade and labour across borders within the region, presenting the possibility of South Asian countries could offering each other material support in meeting goals in these two areas. Regional collaboration over assessment would be an effective tool in determining what shape these shared goals should take.
- **Assessment parameters that evaluate intraregional scientific collaborations.** As noted earlier, although smaller countries in South Asia are fairly reliant on international collaborations, there is a lack of research collaborations between South Asian countries. Building parameters for measuring countries' contributions to intraregional scientific R&I publications and projects would incentivise greater participation in scientific collaboration in the region.
- **Using regional OA standards as a basis for assessment parameters**. In our earlier report on scientific research productivity, we highlighted how OA productivity metrics suffer from a massive lack of standardisation in their current forms (CCS 2022b). This could be attributed at least in part to the variations across the globe in legal mechanisms linked to copyright and intellectual property. The creation of the Forum for Open Access in South Asia provides a viable path towards regional OA standards in the future. Assessing scientific R&I through such standards would contribute to solving this problem.

02 Evaluating the Role of Scientific R&I in Regional Economic Growth

This chapter explores the relationship between R&I processes and economic growth, situating this concern in the context of South Asian economies. First, it examines the economic needs of countries in this region, contextualising several priority areas within them. Second, it uses China as a case study to illustrate how a middle-income country has been able to use scientific innovation to accelerate its economic growth. Third, it puts forth suggestions on how R&I assessment norms can be amended to address these economic priorities in the region. In our second report titled Assessing Scientific Research and Innovation series, we highlight how international standards for assessments of research productivity are largely focused on the priorities of economically advanced countries and do not adequately address the unique economic needs of developing countries as a result (CCS 2022b). Regional collaboration over such standards provides a compelling path forward for scientific development and its role in economic development for South Asian countries.

Mapping the economic needs of South Asian countries

As of 2014, it was estimated that more than 67% of the intraregional trade potential of South Asia remained untapped each year (UNESCAP 2018). South Asia comprises low to middle-income economies. As a result, economic growth-related outcomes have the capacity to drastically improve the quality of people's lives. This section aims to highlight prominent economic growth and development needs of countries in the region, with a specific focus on post-pandemic economic recovery. Assessment standards that take these needs into account would orient scientific R&I towards measurable outcomes based on South Asian countries' economic interests, as opposed to measuring R&I success through abstract, universal developmental parameters.

The World Economic Forum's Global Competitiveness Report 2016-17 showed that South Asia was set to become the fastest-growing region in the world during this year, overtaking China's economic growth for the first time in 20 years (Battista 2016). Between 2007 and 2016, its countries improved substantially on competitiveness parameters including (A) higher education and training, (B) market size, (C) health and primary education, (D) technological readiness, (E) goods market efficiency, (F) innovation, (G) infrastructure, and (H) business sophistication (ibid.). Despite this improvement, lack of infrastructure and technological readiness in some countries, as well as the need to improve the functioning of labour and financial markets remain as major areas of concern (ibid.).

The onset of the COVID-19 pandemic in 2020—which had negative consequences for economies across the globe—brought South Asia to a near standstill, with a projected GDP contraction of 7.7% for the region (World Bank 2020). In a recent study, the World Bank (2021) outlined the state of post-COVID-19 economic recovery in South Asian countries, noting that subsequent waves of the pandemic did not disrupt their economies to the same extent that the initial ones did. Its findings indicate that the average annual economic growth in the South Asia region from 2020 to 2023 is expected to be 3.4%, as opposed to an annual growth rate of approximately 6% in the four years preceding the pandemic (ibid.). It suggests that the future of economic recovery in the region could be effectively navigated through services-led growth that relies heavily on technology and digital transformation (ibid.). An increasing share of South Asian countries' GDP comes from services today (ibid.). Digital transformation in the service sector, accelerated by the disruptive impact of COVID-19, has been accompanied by a growing share of South Asian countries' GDP coming from the services (ibid.). The World Bank study makes three claims to highlight the viability of such a recovery path. First, digital platforms have increased the tradability of services by circumventing the need for demand and supply to be geographically proximate with each other (ibid.). Second, there is scope to make significant productivity and efficiency gains through the automation of general business functions, such as improved management practices and branding (ibid.). Third, the opportunity to drive services-led growth through digital platforms leads to the creation of a large number of low-skilled jobs, unlike sectors such as business administration and ICT, which are far more skill-intensive (ibid.).

Using innovation and technology to mobilise economic progress has been a core agenda for South Asia since before the pandemic. However, the pandemic-initiated acceleration of digital transformation and the context of post-pandemic recovery has led to an even more prominent need for technological advancement.

Case study: scientific R&I and economic growth in China

To understand the role of research in driving economic growth, one does not need to look further than China's economic trajectory as a case study. This section uses insights from China to identify assessment parameters for scientific R&I that are relevant to South Asian economies' development needs.

The growth of the Chinese economy over the last few decades is positively correlated with two crucial factors— human capital formation, and scientific innovation (Wu et al 2017). At a macroeconomic level, Hulten and Has (2012) highlight that intangible capital, including software, R&D, designs and advertisement, accounted for one-sixth of China's economic productivity growth during 2000-2008. Fleisher et al (2015) demonstrate how investment in knowledge capital has enhanced productivity among both domestic and foreign-invested firms in the country. Since the late 1970s, China has implemented a series of Science and Technology (S&T) policies that have focused on boosting economic development by increasing and improving scientific R&I (WIPO 2015). In 2012, the country's government put forth an innovation-driven growth strategy as its primary developmental agenda, marked by the following features: (A) setting clear targets, (B) fostering more entrepreneurship, (C) driving innovation primarily through industry, and (D) building market-oriented mechanisms that facilitate collaborative technology transfers from the academic sector to the industrial (ibid.). The economic impact of China's R&I growth is highlighted by its rapidly growing GDP, as well as its success in developing a sizeable educated workforce (ibid.).

China's trajectory of economic development through scientific advancement offers two valuable insights for South Asian economies. First, it demonstrates that systematic S&T policies with a market orientation are key to enabling economic growth outcomes through R&I. Aligning scientific R&I with market mechanisms is a particularly compelling option for countries in South Asia, which as highlighted early on in this report, have an inadequate public investment in this area. Second, it highlights the positive relationship between investment in human capital and scientific innovation. As a region considered to be rife with issues of economic inequality and poverty, South Asia could benefit immensely from opportunities to build highly skilled scientific workforces. While identifying how assessment parameters for scientific R&I can account for economic growth imperatives among South Asian countries, it would help to keep these considerations in mind.

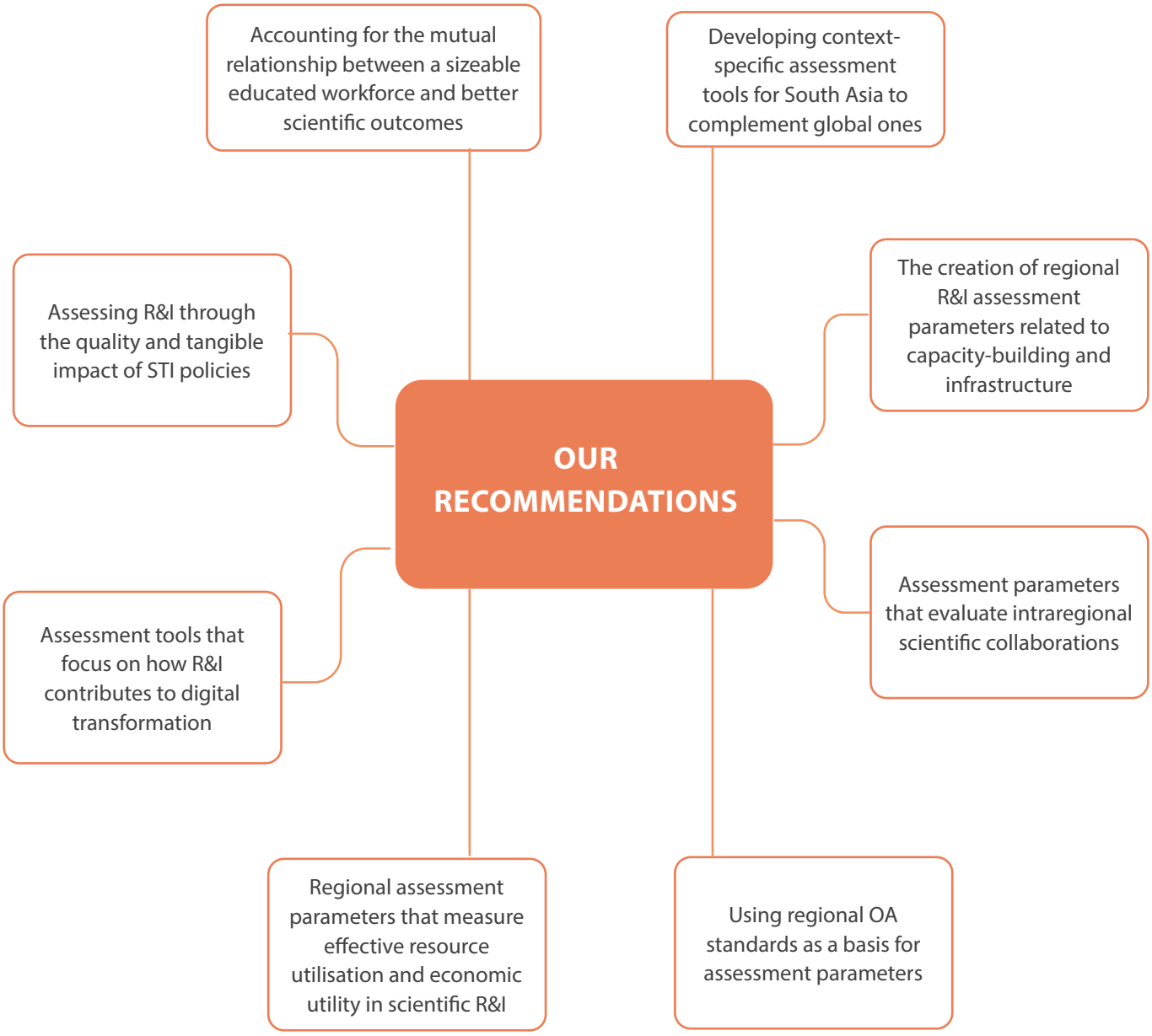
Recommendations

- **Regional assessment parameters that measure effective resource utilisation and economic utility in scientific R&I.** The need for resource optimisation, already a concern given the underinvestment in R&I by South Asian countries, has been made more relevant in the time of post-pandemic economic recovery. Parameters that measure scientific outcomes on the basis of their net economic value, as functions of the resources spent on them versus their economic utility, would effectively account for this concern. These could be devised in a number of ways. One compelling way of coming up with such parameters could be to examine knowledge transfers between the public and private sectors of countries, as well as between academia and industry. Knowledge transfers involve the transmission of insights from scientific research such that they can be put to economic use by businesses and industries.
- **Assessment tools that focus on how R&I contributes to digital transformation.** Digital transformation within the private sector involves a complete rewiring of business practices using technological innovation to enhance the speed, scale, and impact of processes. Therefore, technologies that enable digital transformation have the capacity to improve the economic efficiency of entire industries and sectors. A specific focus on scientific R&I that can be utilised for digital transformation takes into account South Asia's post-pandemic economic priorities. Additionally, it also accounts for the increasingly competitive need for countries to digitally transform their economies in a globalised world. Demarcating these technologies and prioritising them at the stage of scientific R&D holds significant economic potential for the region.
- **Assessing R&I through the quality and tangible impact of STI policies.** The Chinese case illustrates how the long-term streamlining of scientific processes through systematic STI policies can help integrate these processes with economic development. Regional collaboration to determine competitive standards for these policies would create a constructive frame of reference for what they could look like.
- **Accounting for the mutual relationship between a sizeable educated workforce and better scientific outcomes.** In terms of personnel, assessments of scientific R&I have traditionally focused on evaluating research within higher education institutions and public research bodies. Taking into consideration the strategic value of a market-first orientation for scientific progress in a region like South Asia, it is important to recognise the correlation between education and literacy levels among a country's larger workforce and the level of STI development it is able to achieve.

Conclusion

This report has sought to lay the groundwork for regional collaboration over assessment standards for scientific R&I in South Asia. Its primary focus has been to highlight prominent areas that these standards must take into consideration. R&I assessment is a burgeoning field at the moment. Several international assessment standards have come up over the last decade. In our report on research productivity metrics, we examined some of these frameworks in detail and found that they were inadequate in articulating the needs of countries outside the developed world (CCS 2022b). Through the analyses undertaken in this report, we have demonstrated how regional assessment standards can be used to represent the specific needs of South Asian countries, and the viability of the creation of such standards. We hope that this report will be a resource for different stakeholders using research assessment processes in South Asia—including but not limited to governmental agencies responsible for STI research policies, academics and professionals involved in research governance, and private actors looking to harness the potential of R&D for economic growth.

The first chapter presented insights on contemporary methods used for assessments at the South Asia level at present, and the state of scientific collaboration in the region. It highlighted the lack of actionable insights related to quality of R&I outcomes in quantitative approaches to assessment. Further, it reflected on convergences between South Asian countries that make increased scientific collaboration viable, and outlined opportunities for advancing such collaboration through Open Science practices. Its recommendations aim to point out how assessment data can be made more credible, contextual, and clear through the introduction of regional standards and practices. The second chapter undertook an in-depth examination of the relationship between scientific R&I and economic growth. In the process, it noted that the digital transformation of economies is key in the context of post-pandemic economic recovery in the region. It also took cues from a case study on China, evaluating how scientific outcomes can be translated into economic growth through investment in human capital and increasing the role of the market and the private sector in R&D. Its recommendations explore how these economic considerations can inform regional assessment parameters such that the needs of South Asian countries are put at the forefront.


OUR RECOMMENDATIONS
Accounting for the mutual relationship between a sizeable educated workforce and better scientific outcomes
Developing context-specific assessment tools for South Asia to complement global ones
Assessing R&I through the quality and tangible impact of STI policies
The creation of regional R&I assessment parameters related to capacity-building and infrastructure
Assessment tools that focus on how R&I contributes to digital transformation
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Regional assessment parameters that measure effective resource utilisation and economic utility in scientific R&I
Using regional OA standards as a basis for assessment parameters

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