

> CHAPTER 6

STI-SDG alignment across countries

How research priorities relate to
countries' SDG challenges

AUTHORS

Hugo Confraria
Tommaso Ciarli
Ed Noyons
Ismael Ràfols

OVERVIEW

- We developed new methods to analyse the alignment between countries' research priorities and their SDG-related challenges.
- We found that countries with higher challenges relating to SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 3 (Good health) and SDG 6 (Clean water and sanitation) are prioritizing research in these areas.
- For all other SDGs, we found a misalignment or inconclusive relationship between research priorities and SDG challenges.
- For example, the countries with the most unsustainable consumption/production patterns, and which contribute most to biodiversity loss, are usually higher-income countries that do not specialize in research related to SDG12 (Responsible consumption and production), SDG13 (Climate action) or SDG15 (Life on land).

Footnotes for this chapter are on page 78. A full list of references can be found on page 140.



➔ Introduction

This chapter analyses the extent to which countries’ research priorities align with their most significant SDG challenges and whether misalignments are worse in certain SDGs than in others.

Although the type of research that contributes to meeting an SDG target depends on the context and on the complex interactions between science and society, here we make the general assumption that a misalignment between a country’s research priorities and its SDG challenges may reduce the effectiveness of investments in research to address those goals.

This assumption builds on the work of Pavitt,¹ who argued that the main practical benefit of scientific research is not the production of easily transmissible information, ideas and discoveries, but rather the construction of a problem-solving capacity. This capacity involves the transmission

of often tacit knowledge through training and face-to-face interactions. Therefore, the benefits of research tend to be geographically localized, meaning each country needs its own pool of researchers who belong to international professional networks and exchange new scientific knowledge.² Moreover, SDG-related research undertaken by local researchers can help to inform local policy decisions through an understanding of context and different pathways to solve challenges.

The findings presented in this chapter can help guide and rebalance research priorities towards generating research capabilities that can address countries’ major challenges.

Alignment patterns for individual countries

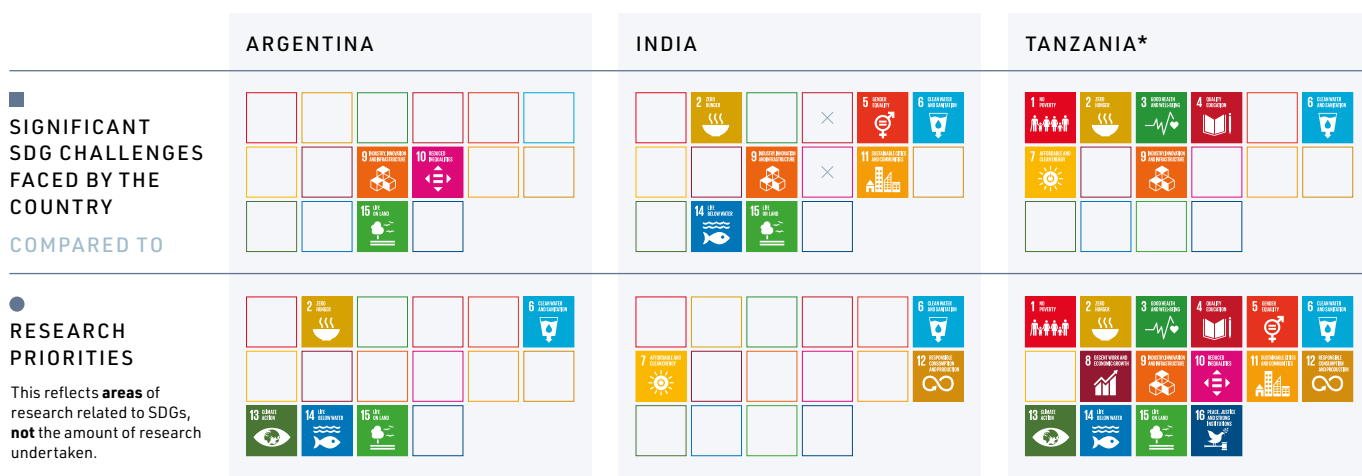
We calculated the relations between research priorities and SDG challenges for all countries where data was available. The cases of Argentina, India and Tanzania described below (and in Figure 6.1) illustrate some of the varying issues we found.

Argentina

In Argentina (an upper-middle income country), we found a low alignment between research priorities and SDG challenges. The country faces significant challenges in relation to SDG 9, SDG 10 and SDG 15 yet its research priorities relate to SDG 2, SDG 6, SDG 13, SDG 14 and SDG 15.

The high level of research specialization in SDG 2 is surprising since hunger is not a major problem in Argentina. This focus might be related to Argentina’s strong trade in cereal, soya and meat production, and the consequent importance of agricultural productivity for the economy.

Figure 6.1 / SDG challenges and research priorities in Argentina, India and Tanzania: a visual comparison



⊗ = No data

*Although Tanzania produces a very low share of world research (less than 0.03%), research in the country appears strongly related to almost all SDGs.

Figure 6.2 / SDG challenges and research priorities in Argentina, India and Tanzania: a graphical comparison

Left hand column:

SDG SCORE (CHALLENGES) 2008-2017

A score of 1 indicates a major challenge (country furthest away from the frontier in this SDG), and a score of -1 indicates a country at the frontier in this SDG. See 'Our methods and approach', p75 for an explanation.

*Some scores were not calculated as some countries do not have data available for certain SDG indicators (for example, India for SDG 4 and SDG 10).

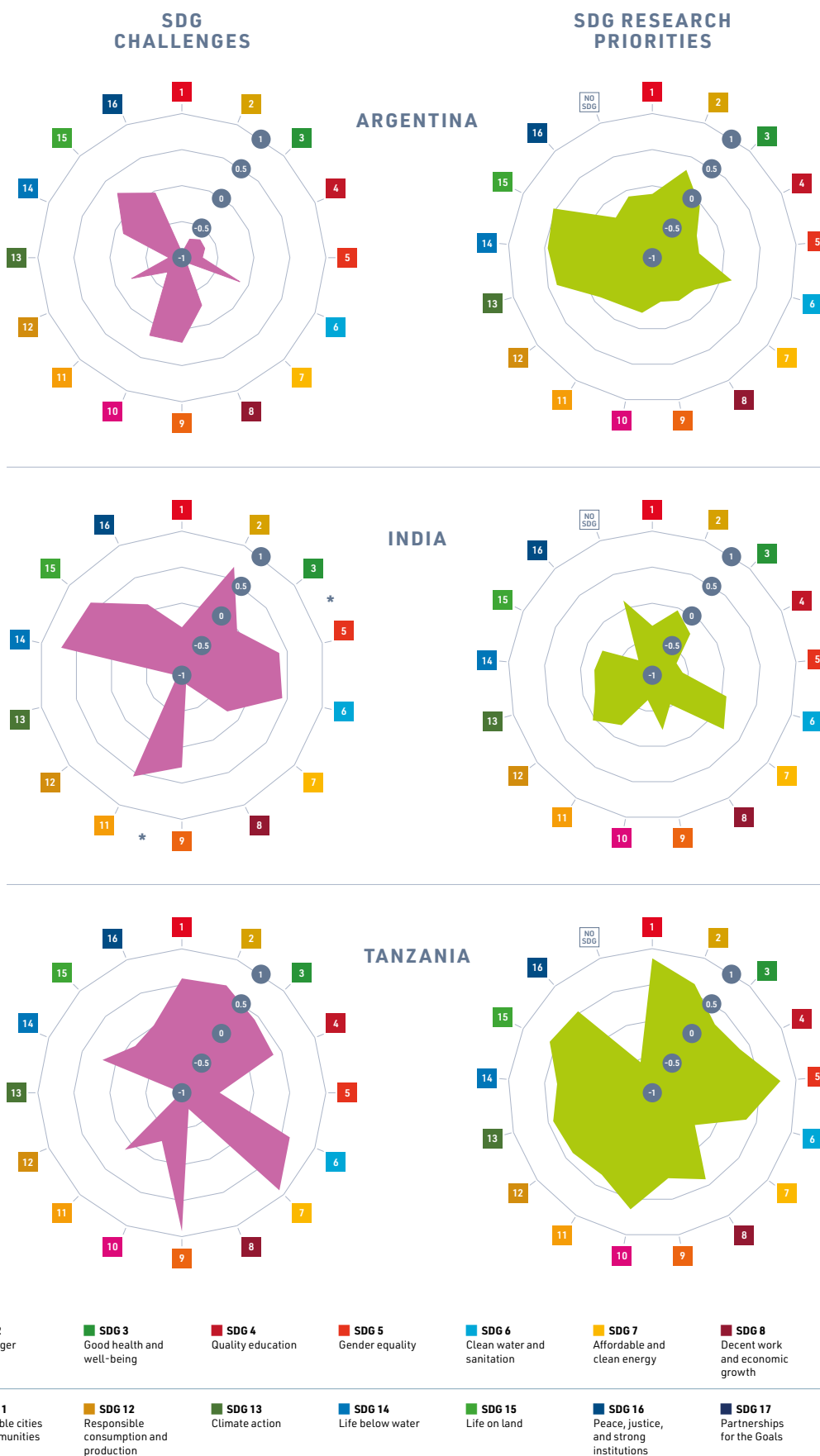
Right hand column:

SDG RESEARCH SPECIALIZATION 2015-2019

Research specialization above 0 indicates that a country is relatively specialized in research related to that SDG. A score below 0 indicates less specialization than the world average.

> KEY: Score range

- 1 MAJOR challenge
HIGH research specialization
- 0 AVERAGE challenge
AVERAGE research specialization
- 1 MINOR challenge
LOW research specialization



- | | | | | | | | | |
|---|--------------------------------------|---|---|---------------------------------|--|---|--|---|
| SDG 1
No poverty | SDG 2
Zero hunger | SDG 3
Good health and well-being | SDG 4
Quality education | SDG 5
Gender equality | SDG 6
Clean water and sanitation | SDG 7
Affordable and clean energy | SDG 8
Decent work and economic growth | |
| SDG 9
Industry, innovation and infrastructure | SDG 10
Reducing inequality | SDG 11
Sustainable cities and communities | SDG 12
Responsible consumption and production | SDG 13
Climate action | SDG 14
Life below water | SDG 15
Life on land | SDG 16
Peace, justice, and strong institutions | SDG 17
Partnerships for the Goals |

This pattern of intensive agriculture might, in some cases, lead to unsustainable practices of land use and damage to terrestrial ecosystems. This leads to a trade-off with SDG 15 (Life on Land), which is a particular challenge in this country. Therefore, it is interesting to note the high research specialization in SDG 15, which focuses on issues such as the effects of land use on local biodiversity⁷ and the importance of soil science in challenges such as food security, water scarcity, climate change, biodiversity loss and health threats.⁸

The lack of research prioritization in SDG 9 and SDG 10 is worrying given the significant challenge that Argentina faces in relation to these SDGs relative to other countries.⁹

India

In India (an upper-middle income country), alignment is also quite low. The country faces significant challenges in relation to SDG 2, SDG 5, SDG 6, SDG 9, SDG 11, SDG 14 and SDG 15 yet its research priorities relate to SDG 6, SDG 7 and SDG 12.

The specialization in research relating to SDG 6 (Clean water and sanitation) appears to be well aligned with the size of the challenge, given that India still had over 300 million people defecating in the open in 2017.¹⁰ However, the other major challenges – relating to SDG 2, SDG 9, SDG 11, SDG 14 and SDG 15 – receive relatively little research attention.

Tanzania

Tanzania (lower-middle income) faces several challenges that are usually more problematic in low-income countries. These include issues relating to SDG 1, SDG 2, SDG 3, SDG 4, SDG 6, SDG 7 and SDG 9. In terms of research priorities, although Tanzania produces a very low share of world research (less than 0.03%), research in the country appears strongly related to almost all SDGs. The exception is SDG 7, in which Tanzania is one of the countries furthest away from the SDG frontier.

This analysis can be performed in more detail for each country to better understand research capabilities in relation to SDG challenges.¹¹ This may help to guide the priorities of national research councils and international research funds.

We also conducted case studies in Argentina and India (see Chapters 8 and 9). Kenya (our third case study country) does not have enough indicators to compute all SDG scores.

Alignment patterns by SDG

Below, we analyse how the alignment between research priorities and major challenges differs for individual SDGs. The alignment patterns for SDGs 2, 4, 6 and 13 are described below and illustrated in Figure 6.3.¹²

We found patterns of alignment for SDG 2 and SDG 6, meaning that countries with significant challenges in these SDG areas are conducting more research related to those SDGs than the average country.

Our methods and approach

SDG-related research

We used the method explained in Chapter 4 to identify research that is related to each SDG. This process involved examining research areas with a high share of publications that contain text related to specific SDGs.

Research priorities

We calculated the research priorities of each country, between 2015 and 2019, by using a comparative specialization index that allows us to measure whether a country's research is more or less specialized in a certain SDG than the world average.^{4,5} We used a scale from -1 and 1, where 1 = high specialization, 0 = world average, and -1 = low specialization.

SDG challenges

To analyse each country's SDG-related challenges, we built a unique data set with 80 different indicators covering 16 SDGs (1-16). We calculated the relative distance of each country to the 'frontier' for each indicator, where the frontier represents the performance level of the top 5% countries.

Based on this information, we ran a principal component analysis for each SDG to obtain a single score for the countries and SDGs for which data is available. Countries with a high SDG challenge score are those furthest away from the frontier in that specific SDG, meaning they face a greater challenge in achieving that goal. Countries with a low score are at the frontier in that particular SDG.

For more details about how we created these indicators, please see our working paper: <https://www.merit.unu.edu/publications/working-papers/abstract/?id=9407>

On the other hand, our analysis shows a misalignment pattern for both SDG 4 and SDG 13, meaning that countries with the biggest challenges relating to these two SDGs are conducting less research on those challenges than the average country.

These patterns are based on correlations between research specialization and the SDG score, and do not take into account underlying confounding factors that may influence a country's specialization in particular research topics. To address this, we use multiple regression analysis to control for factors such as path dependence (past research specialization) and country research productivity.¹³

When controlling for these factors, we found a robust positive association between the size of an SDG challenge and the development of research priorities in only one SDG: SDG 6 (Clean water and sanitation).

Figure 6.3 / Alignment between SDG challenges and SDG research

The charts show the relationship between SDG challenges (2008-2017) and SDG research priorities (2015-2019) for SDGs 2, 4, 6 and 13.

Countries are shown in different colours based on their income group.

The y-axis represents the research specialization of a country in a certain SDG (> 0 indicates that a country is relatively specialized in research related to that SDG, < 0 indicates less specialization in this area than the world average).

The x-axis represents SDG challenge scores. A score of 1 indicates a major challenge (country furthest away from the frontier in this SDG), and a score of -1 indicates a country at the frontier in this SDG (see 'Our methods and approach', p75). Each dot indicates a country.

Figures based on Web of Science data (CWTS version) and on the SDG Index data.

> KEY

● High income

● Upper-Middle income

● Lower-Middle income

● Low income

--- Linear regression

--- 95% confidence interval



This means that countries furthest from the frontier in SDG 6 are specialized or becoming specialized in research related to SDG 6. The five countries in which research on SDG 6 represents the largest share of the SDG-related research portfolio are Bolivia, Benin, Ethiopia, Nepal and Zimbabwe. These countries are all low-income or lower-middle income countries which have experienced recent problems related to water governance (for example, the Cochabamba Water war in Bolivia, the 2015–16 El Niño-induced drought in Ethiopia, and lack of access to sanitation and water services in Nepal).

The good match between research priorities and SDG challenges in this case might be related to the occurrence of particular shocks, which have incentivized national and international research funders to solve these issues. However, further research is needed to understand the causes for other alignments and misalignments.

We also found positive pairwise correlations between countries’ research priorities and challenges in relation to SDG 1 and SDG 3.⁶ These findings indicate that countries with serious challenges in relation to these SDGs are prioritizing related research, which should enable the development of relevant research capabilities. However, these correlations disappeared when we controlled for previous specialization.⁶ This implies that the positive correlation between research specialization and SDG challenge for SDGs 1 and 3 is mainly due to historical and long-term research priorities, rather than a response to SDG challenges. These results were expected, since it is well known that lower-income countries have historically specialized in health and agricultural sciences,¹⁴ mainly due to the research funding priorities of aid agencies, philanthropists and other international funders.¹⁵

Figure 6.4 / Alignments between SDG challenges and SDG research by income group

The graph shows the relation between SDG challenges (2008-2017) and SDG research share (2015-2019) by income group.

The y-axis shows the average country score of SDG challenges by income group. A score of 1 indicates a major challenge (country furthest away from the frontier in this SDG), and a score of -1 indicates a country at the frontier. The x-axis shows the share of SDG-related research that relates to each SDG by income group. Each colour represents an income group.

> KEY

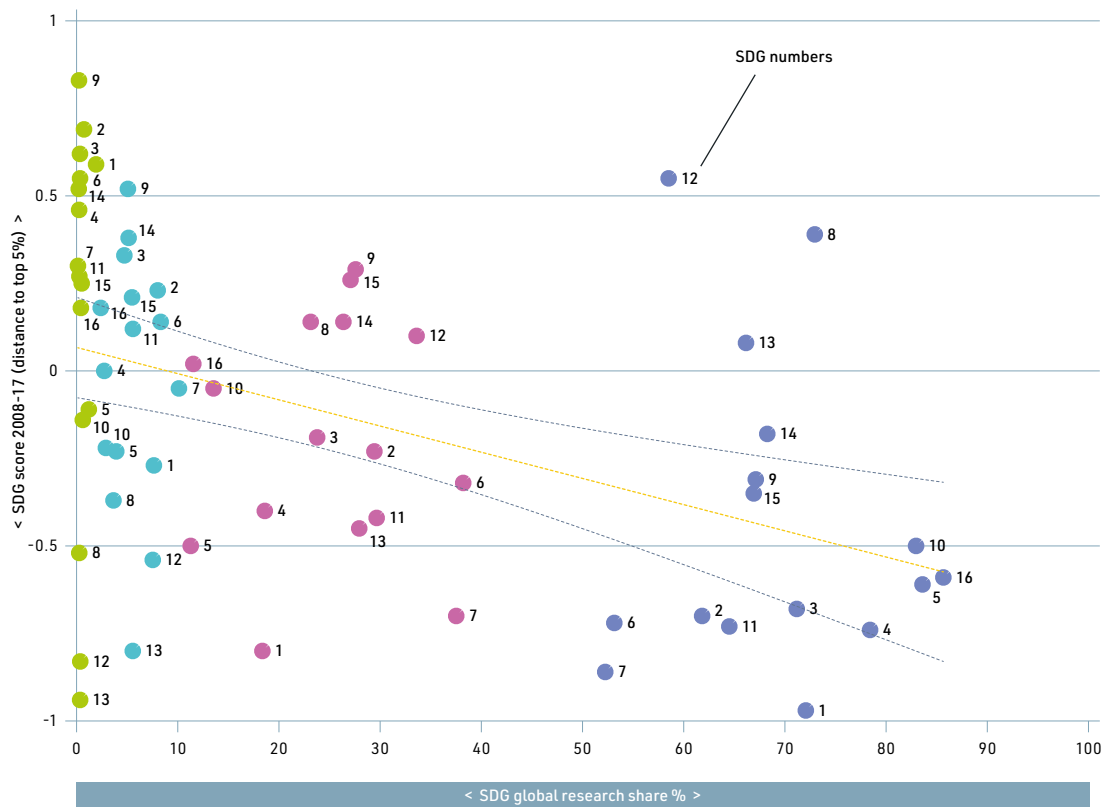
- High income
- Upper-Middle income
- Lower-Middle income
- Low income

--- Linear regression

--- 95% confidence interval

1-16 SDG number

Source: Own calculation based on Centre for Science and Technology Studies (CWTS) Web of Science version, UN, SDG Index and World Bank data.



> KEY: Sustainable Development Goals

■ SDG 1 No poverty

■ SDG 2 Zero hunger

■ SDG 3 Good health and well-being

■ SDG 4 Quality education

■ SDG 5 Gender equality

■ SDG 6 Clean water and sanitation

■ SDG 7 Affordable and clean energy

■ SDG 8 Decent work and economic growth

■ SDG 9 Industry, innovation and infrastructure

■ SDG 10 Reducing inequality

■ SDG 11 Sustainable cities and communities

■ SDG 12 Responsible consumption and production

■ SDG 13 Climate action

■ SDG 14 Life below water

■ SDG 15 Life on land

■ SDG 16 Peace, justice, and strong institutions

■ SDG 17 Partnerships for the Goals

For all other SDGs, we found no alignment or a negative alignment. For SDG 12 and SDG 13, the countries with the greatest challenges are high-income countries that have unsustainable consumption and production patterns and contribute the most to climate change. However, these countries do not specialize in research in these areas. The countries that are the most specialized in research related to SDG12 and SDG13 are lower-income countries. This is clearly a severe misalignment since the biggest polluters and CO₂ emitters should be prioritizing research to solve environmental issues.

We also found a negative association for SDG 4 and SDG 15. The countries that prioritize research relating to SDG 4 are also those closest to the frontier for SDG 4. This misalignment might generate further inequalities between different countries' education capabilities, as higher-income countries expand their understanding of best practices while others continue with less efficient methods.¹⁶ In the case of SDG 15, the countries that contribute most to the destruction of biodiversity are not prioritizing SDG 15-related research.

Alignment patterns by income group

Beyond the relative misalignments between national research priorities and challenges, a further source of misalignment exists at the global level due to the vast inequalities in research capabilities and funding across countries (see Figure 6.4).

Low-income countries

While most SDG challenges are worse in lower-income countries, only a small proportion of SDG-related research takes place there. The 29 low-income countries contain 8.2% of the world's population yet contribute to less than 0.3% of SDG-related publications. This negligible involvement of researchers from lower-income countries limits the impact of research in these countries. Research carried out by locals usually brings advantages in terms of ownership of results, trust, sharing of expertise between researchers and policymakers, and increased contextualization of findings. Without this, policymakers and research users must rely on research produced elsewhere, which is likely to be less relevant to their contexts.

The SDG-related research produced by low-income countries relates mostly to SDG 1, SDG 2, SDG 3, SDG 5, SDG 13 and SDG 15. Together, these SDGs account for more than 50% of all the research carried out in this income group.

Middle-income countries

While the 104 upper-middle and lower-middle income countries produce 37% of all global research, they are responsible for only 32% of SDG-related research. This group is more specialized than the world average in research relating to SDG 6 and SDG 7, and less specialized in SDG 5, SDG 10 and SDG 16. China, India, Brazil and Russia, which contain 75% of the world's population and produce 27% of global research, are included in this group and substantially shape these results.

High-income countries

The 72 high-income countries produce the majority (68%) of all SDG-related research, despite being home to only 16% of the global population. They are relatively specialized in SDG 16, SDG 10, SDG 5 and SDG 4. Their major SDG challenges relate to SDG 8,¹⁸ SDG 12 and SDG 13.

Limitations and pointers for future research

This study has some limitations, related to the uncertainty and ambiguity of our estimates of research priorities¹⁹ and challenges.²⁰ Our results are thus designed more as a tool to explore potential misalignments between research priorities and SDG-related challenges than as an accurate measure.

Further research is needed on the marginal impact of increasing SDG-related research on the achievement of a particular SDG. This impact may not be the same for all SDGs. For example, more local research in health (SDG 3) may improve a country's health outcomes, but more local research on poverty (SDG 1) may not produce similar progress in poverty reduction. Future studies should look carefully at this issue, as well as considering spillovers between SDGs and the positive and negative interactions between them. These factors may guide research prioritization and enable the building of research capabilities to address the SDGs. ●

Notes

- Pavitt, 1998.
- Salter and Martin, 2001.
- Balassa, 1965.
- Ciarli and Ràfols, 2019; Confraria and Wang, 2020.
- To avoid outliers, we did not include countries with less than 500 publications. This affects mostly low-income countries.
- We present results for the period 2008-2017, the period for which we could obtain the most data.
- Newbold et al., 2015.
- Keesstra et al., 2016.
- Arza and López, 2021; Cimoli and Katz, 2003.
- World Health Organization and UNICEF, 2017.
- Graphs for all countries for which data is available are in the Supplementary Figures, Section 2.
- Results for all other SDGs are in Appendix 4.
- See Table A.4.1 in Appendix 4 for a summary of results and further details.
- Confraria and Godinho, 2015; UNESCO, 2015.
- Kozma et al., 2018.
- Nelson, 2011.
- Kraemer-Mbula et al., 2020.
- Interestingly, in relation to SDG 8 (Decent work and economic growth) dividing countries by income groups might not provide the most useful insights. For SDG 8, some indicators include the annual growth rate of GDP per capita/employed person, rather than the level of per capita income. Since lower income countries' economies grew more during 2008-2017, they score more highly than higher income countries on this indicator.
- Armitage et al., 2020.
- Miola and Schiltz, 2019.