Mapping Research Systems in Relation to the Sustainable Development Goals

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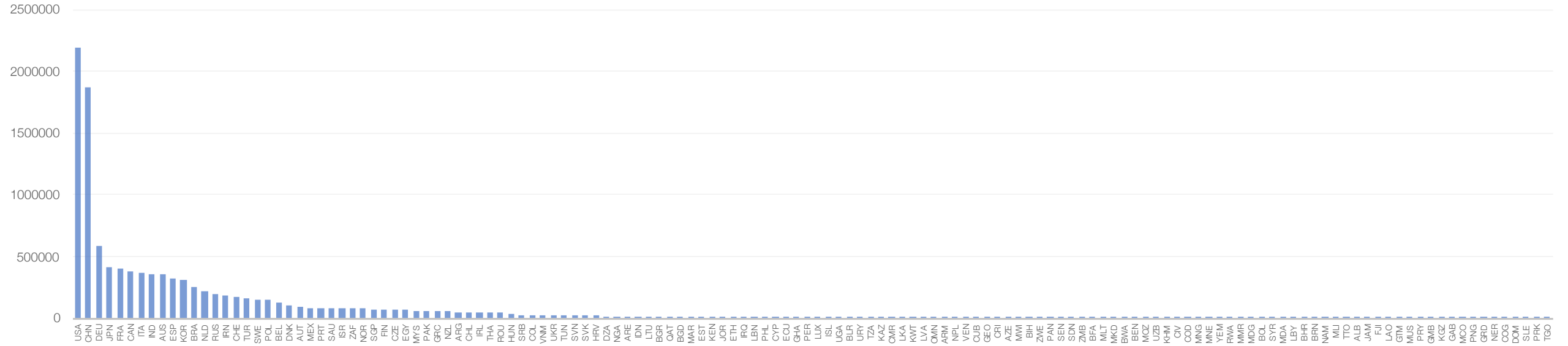
Motivation

- There is an increasing demand for science and research funding to be better aligned with socio-economic needs.
- In this context, research priorities should be directed to solving our major collective challenges (e.g. SDGs), that usually are more problematic in lower income contexts.
- **However, most of the research published in the World (WoS, 2015-2019) is done in higher income contexts…**



Research question

- **To what extent is the distribution of research priorities related to SDG achievements across countries?**

Answer to this question should provide guidance on:

- How investment in the research system may need to be rebalanced to contribute to advancing SDG targets?
- How different research funders should contribute to countries' priorities?

Central assumption: a misalignment between investment in research areas and socio-economic challenges may reduce the impact of the investments in research to address those challenges (Ciarli & Ràfols, 2018; Sarewitz & Pielke Jr., 2007).

Approach

1. Measuring scientific production associated to SDGs.
2. Measuring countries performance in relation to SDGs achievements.
3. Understanding the relations between these two dimensions.

1. STRINGS Approach (Science): Four Steps

1. **Search** reports (policy documents, grey literature), scientific publications and other web content that describes specific SDGs (e.g. descriptions, progress and major problems)
   - Must contain text referring specifically to at least one SDG
   - Balance across SDGs
   - Sources:
     - SDGs targets and indicators
     - SDGs and UN website (Progress & Info)
     - Wikipedia
     - SDG Forums
     - Scientific publications retrieved from Scopus with an adequate query
     - SDG related reports and policy documents retrieved from Dimensions, ODI and Interacademies, Google, SDG pathfinder, Google Scholar, Project members
     - Backwards and forward citations in selected publications

1. STRINGS Approach (Science): Four Steps

2. Select relevant text from the documents [Examples]

- Alternative **descriptions** of an SDG (with respect to official definition): author framing of the SDG (e.g. definition of Material Footprint)
- **Problems** related to the SDG: author's framing of most relevant issues (e.g. "Poor water quality directly impacts people who rely on these sources as their main supply by further limiting their access […]" (United Nations, 2019b))
- **Measures and Indicators**: author view in assessing the problem/solution
- **Assessment** of the current state of the SDG: view of what is most severe (e.g. "The proportion of renewable energy […] grew by an estimated 5 per cent in 2015" (Scharlemann et al, 2016))
- **Relevance** of the SDG: view on relevant aspects (e.g. "Birth registration is fundamental to helping people access their individual rights […]" (United Nations, 2019a))

1. STRINGS Approach (Science): Four Steps

3. Partition of text in blocks of entries that can be machine-analysed

- The assumption is that a new paragraph or section reflects a different idea

4. Selection of terms

- We combined two methodologies and careful manual check.
- The two methods were Textrank (Mihalcea and Tarau, 2004) and Vosviewer keywords extraction.
  - Select terms that are **relevant** because they occur across different text partitions, but not always (e.g. “SDG”, “Sustainability”), and are well connected to other terms
  - Keep most terms with more than one word or most frequent
  - Eliminate duplicates
- Manual check (all terms were manually checked by at least three project members)
  - Clearly related to the SDG across contexts (to vague or non-related removed)
  - Associated to an SDG, but may need specification
    - "habitat degradation" with "ocean" OR "sea" OR "marine”
    - "fishing resource" with "conservation" OR "sustainable"
  - Manually check all disagreements, and add associated terms where needed

STRINGS Approach (Science): 5th step (ongoing)

5. <u>Expand publications</u> using research areas (clusters of publications in WoS) [Example]

- Publications that frequently cite/are cited by the publications that contain SDG terms, may also be contributing to the same SDG, even if they do not use SDG terms

- Precision & Recall: Comparison with Different Methods (STRINGS vs SIRIS) [Example]
  - **Recall**
    - Check all SIRIS terms not in our list, retrieving publications in clusters in top 10% of the share distribution (publications per cluster)
    - Include all SIRIS terms that retrieve publications in clusters with SDG relevant labels, but not too general (e.g. “poverty”)
  - **Precision**
    - Check relevance of all terms retrieving publications in clusters not retrieved by SIRIS

➢ Results presented here are based on **queries** after our 1st P&R iteration

➢ We used research specialization of each country in relation to the world average as a proxy for **revealed research priorities in a certain SDG** (Ciarli and Rafols, 2018)

2. How to evaluate what countries perform better in what SDGs?

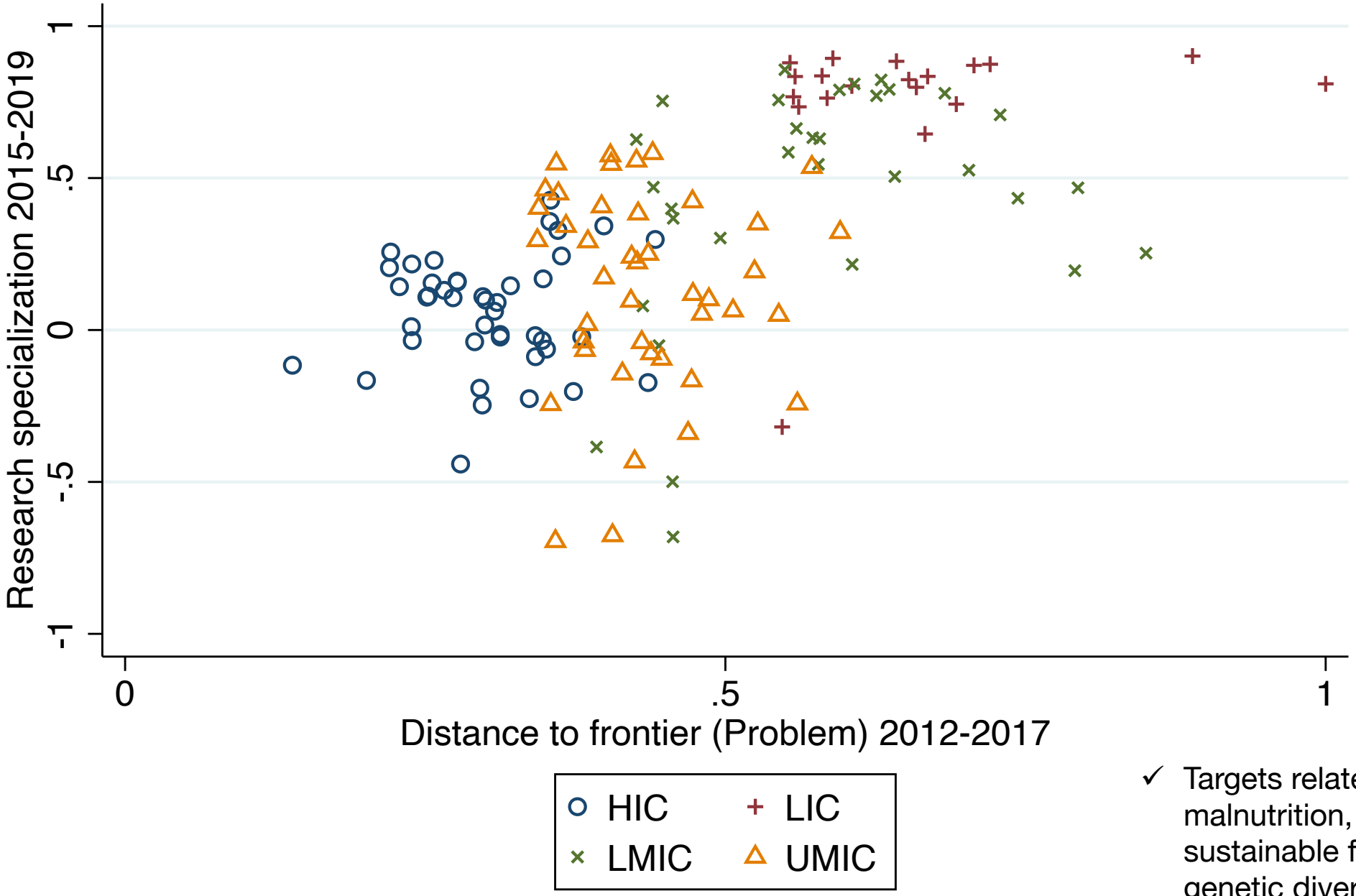
- Following Confraria & Ciarli (2020), we collected all the **UN SDG indicators** for all periods available and we checked which indicators have better data availability for all countries/SDGs -> 2012-2017
  - For the selected indicators (see appendix) we did a linear transformation -> 1 (Best) and 0 (Worst)

$$N_{ct} = \frac{Worst_t - x_{ct}}{Worst_t - Best_t}$$

  - For each variable, we calculated the relative **distance of each indicator/country to the frontier** of that indicator (top5% - percentile 95), and we changed all values below zero to zero. After this transformation, higher values represent worst results with respect to the SDG targets (higher challenges relative to countries at the frontier).
  - We calculated z-scores for each relative distance to the frontier (top5%).
  - We computed a principle component analysis (PCA) (Jackson, 1991) for each SDG with more than one indicator available, and we forced the PCA to give us only one component per SDG.
  - We predicted the scores of all SDGs for all countries and we normalized the results between 0 and 1 (1 = Worst country; 0 = Best country).

Preliminary findings

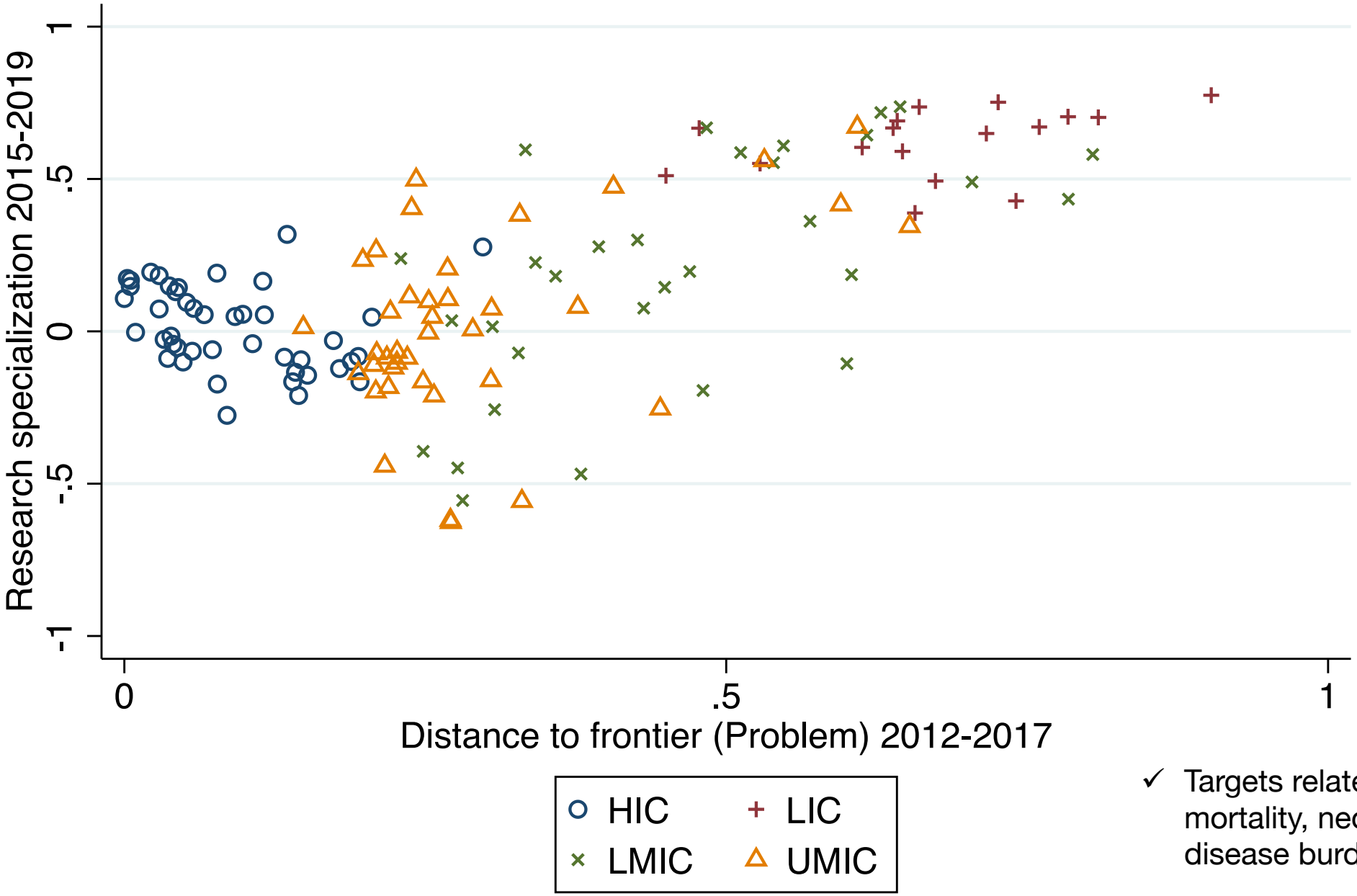
SDG2 - Zero Hunger



- Positive (non-linear) correlation
- Lower income countries perform worst and are on average more specialized in SDG research
- Expected given LIC/LMICs relative specialization in Agricultural Sciences (UNESCO, 2015)

✓ Targets related to levels of hunger, malnutrition, agricultural productivity, sustainable food production systems, genetic diversity of seeds, etc.

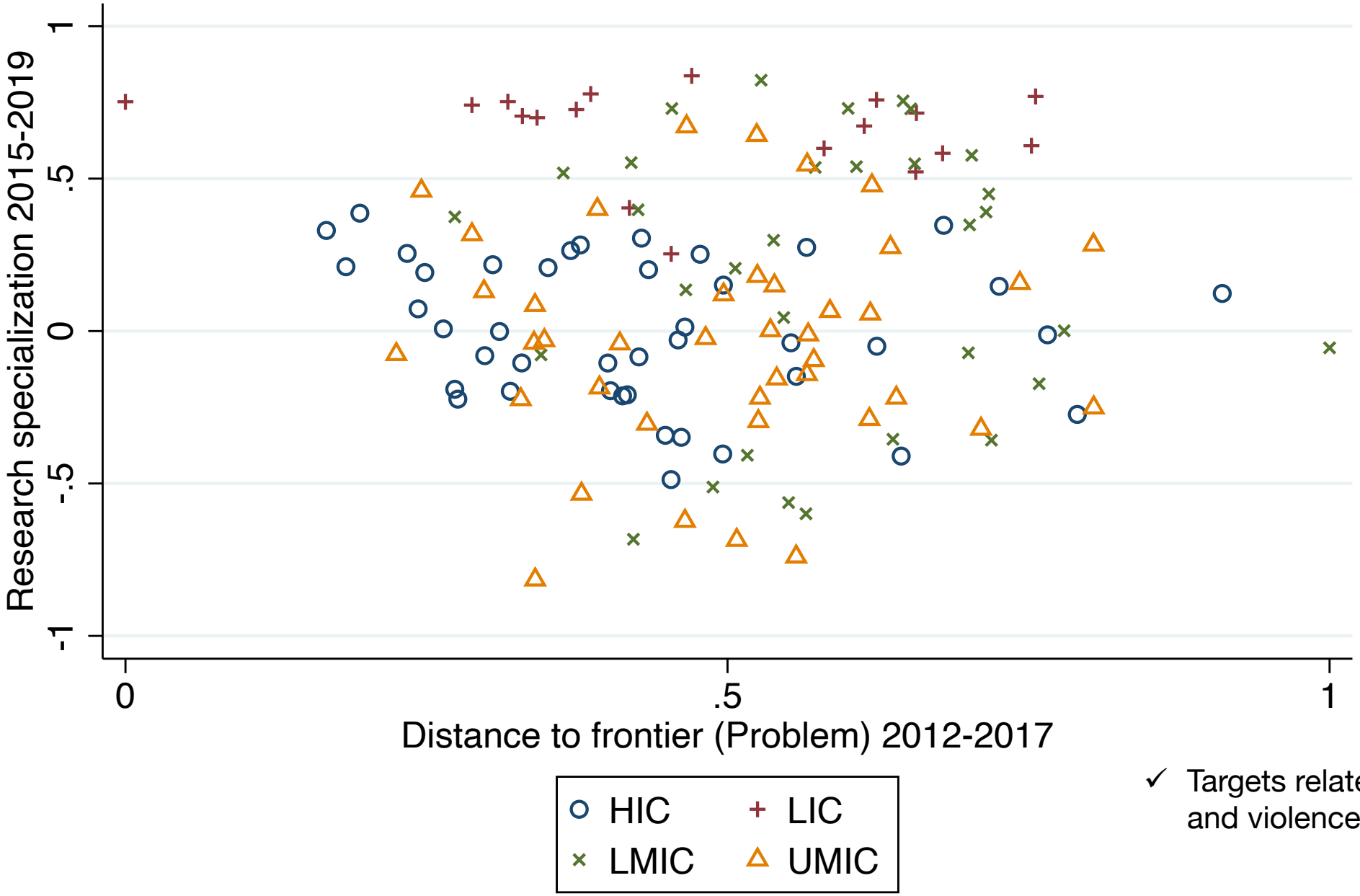
SDG3 - Good Health and Well-Being



- Positive correlation
- Lower income countries perform worst but are on average more specialized in SDG research
- Expected given LIC/LMICs relative specialization in Health Sciences (UNESCO, 2015)

✓ Targets related to levels of maternal mortality, neonatal mortality, health access, disease burden, end of epidemics etc.

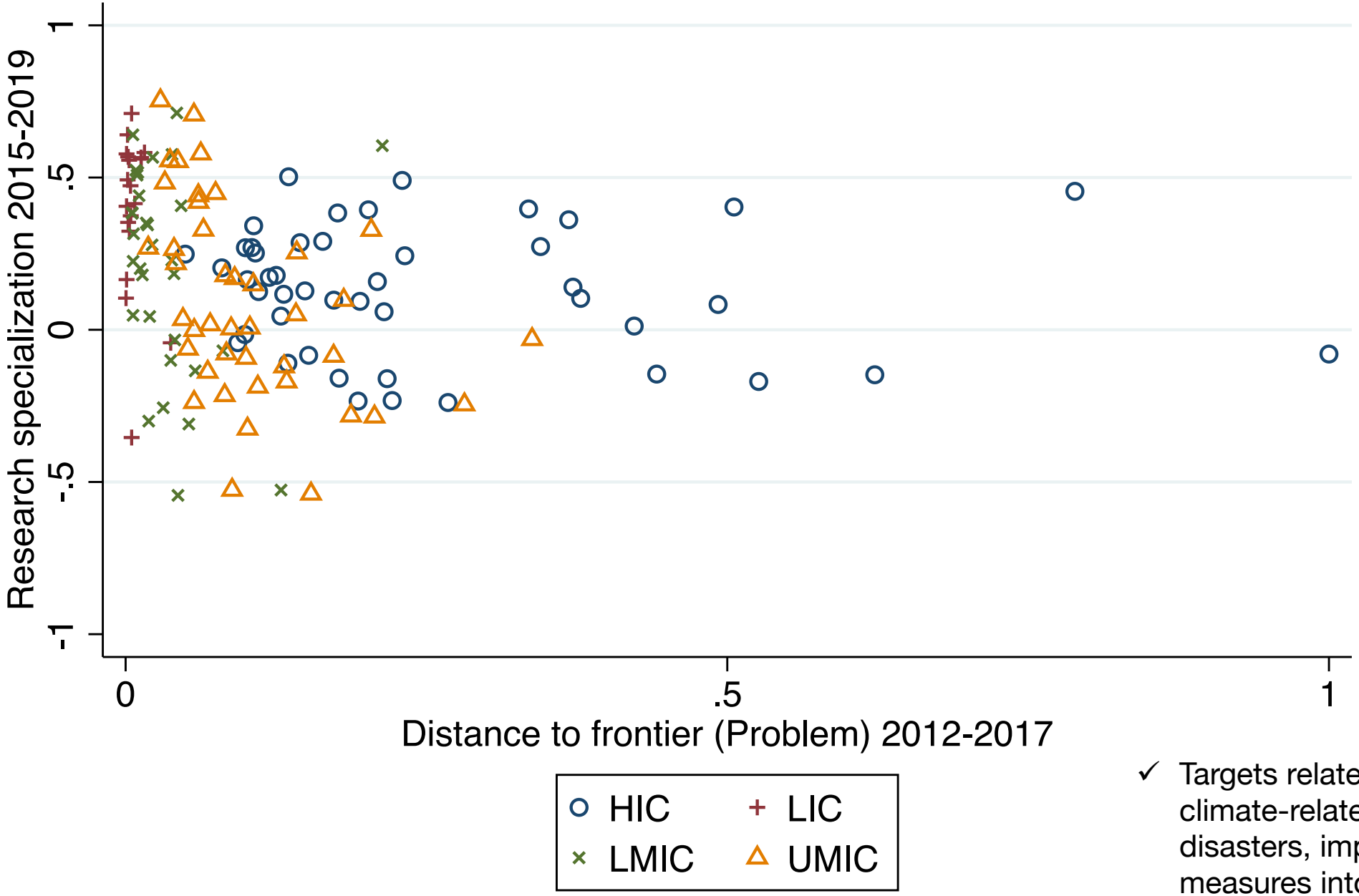
SDG5 - Gender Equality



- No clear relation
- Interesting to notice that LIC/LMICs are more specialized in this SDG than higher income countries
- International research funding dynamics?

✓ Targets related to levels of discrimination and violence against women, etc.

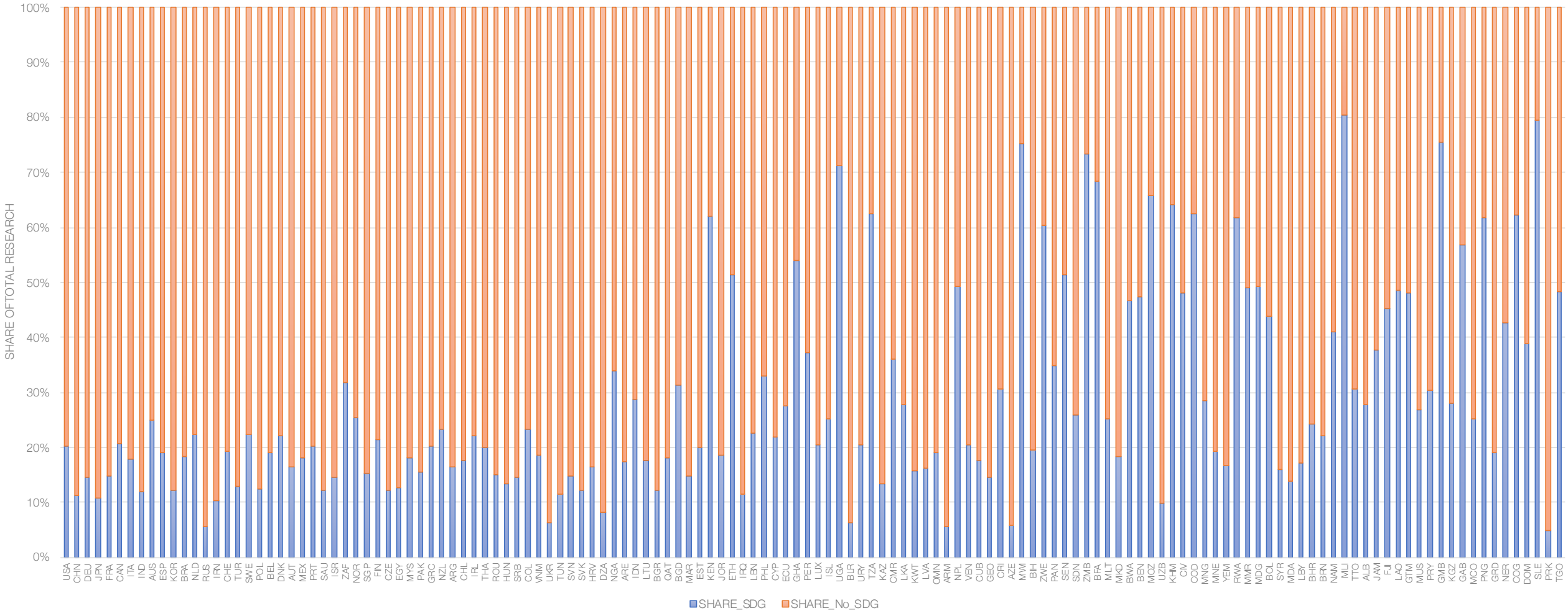
SDG13 - Climate Action



- No clear relation
- Interesting to notice that higher income countries perform worst (e.g. CO2 emissions due to oil production)
- Most LICs are specialized (>0) in research related to this SDG

✓ Targets related to levels of resilience to climate-related hazards and natural disasters, implementation of climate change measures into national policies, etc.

Share of “all” SDG research by country. 2015-2019

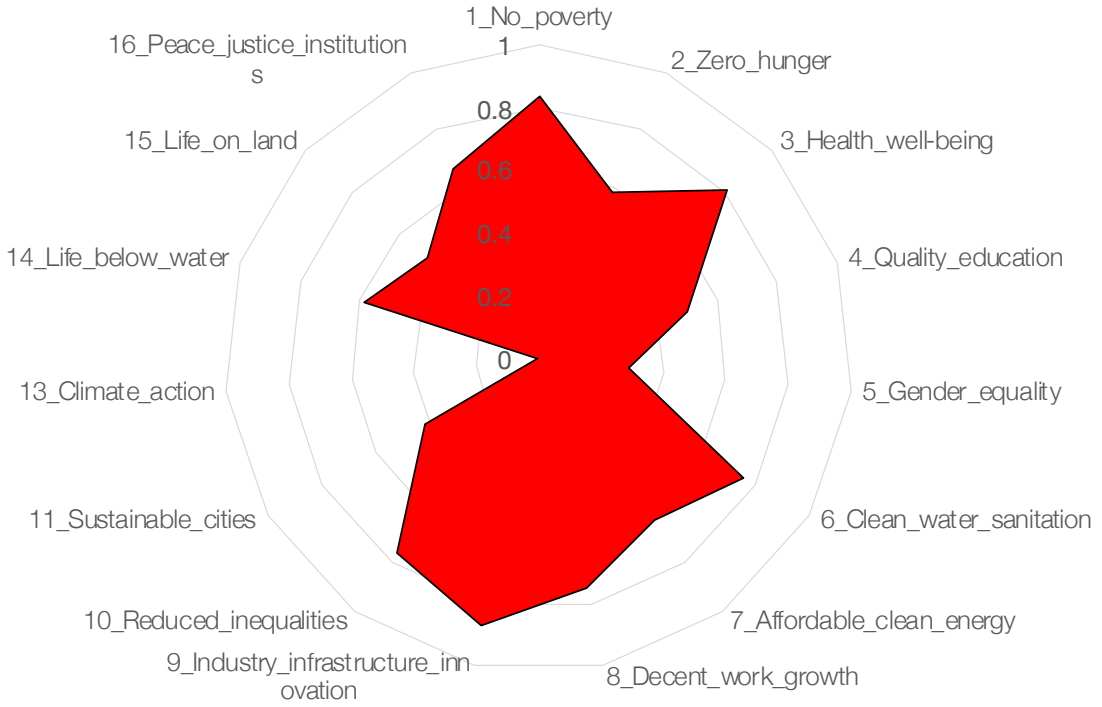


- According to our initial approach, the World average SDG research is 16.3%
- The share of SDG research from countries that produce less publications is much higher, on average

Mozambique

SDGs Research specialization - 2015-2019

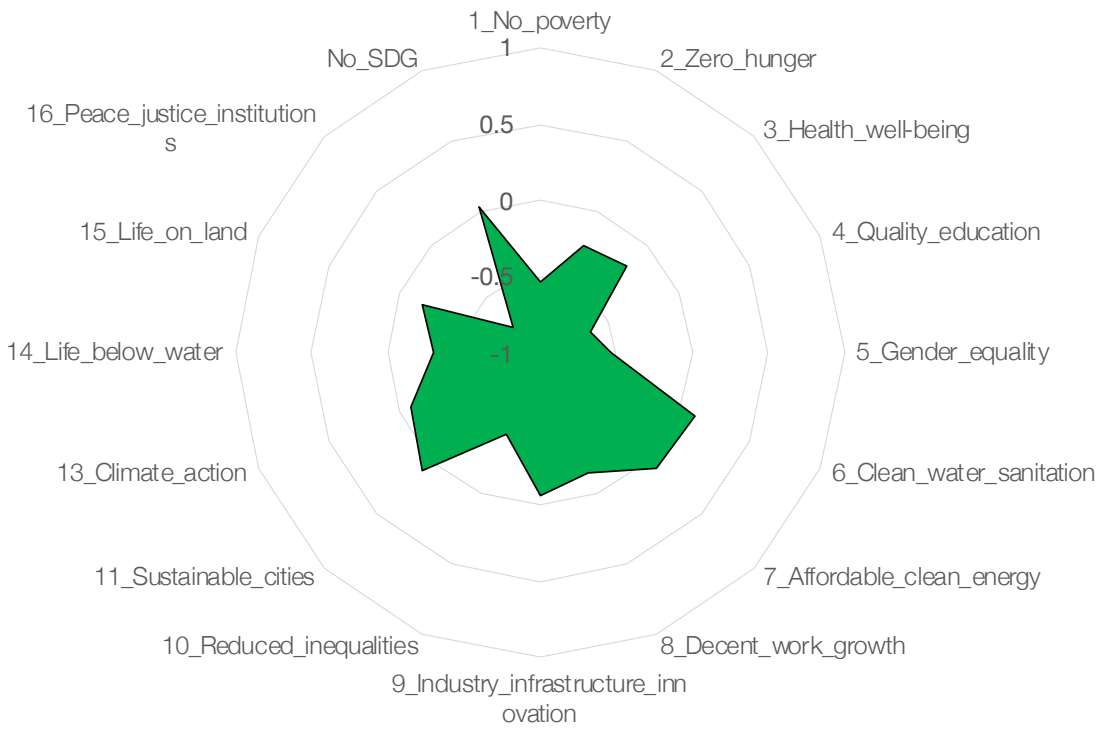
More Problematic SDGs - 2012-2017



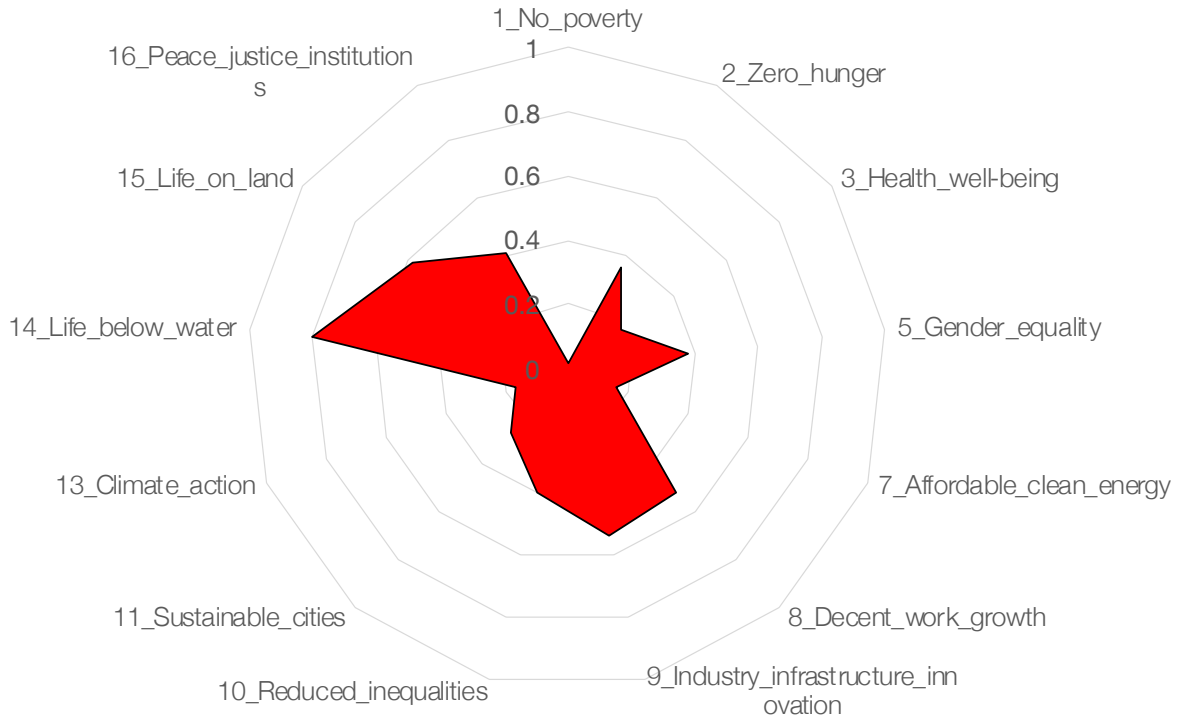
- Although low research output, publications with MOZ authors seem to be on issues related to SDG topics
- Non-Major SDG problems -> SDG13 (Climate action) & 15 (Gender Equality)

China

SDGs Research specialization - 2015-2019



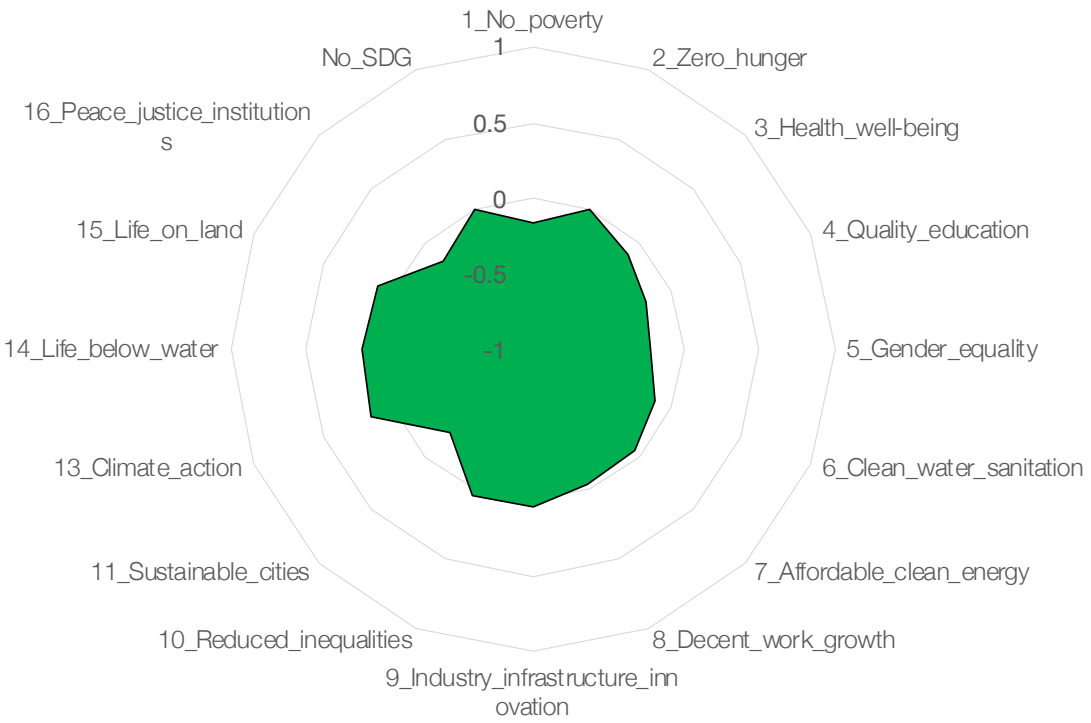
More Problematic SDGs - 2012-2017



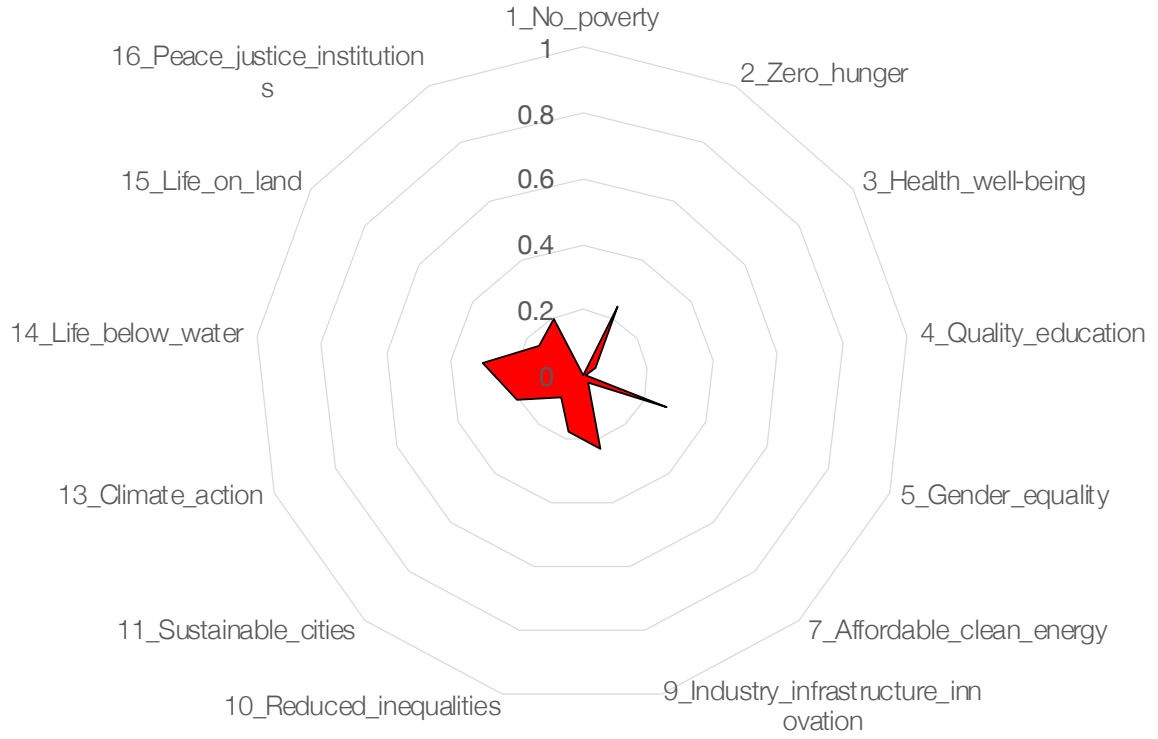
- No clear specialization in SDG research (11.3% of total against 16.3%)
- Major relative SDG problems -> SDG14 (Life below water) & 15 (Life on Land)

Germany

SDGs Research specialization - 2015-2019



More Problematic SDGs - 2012-2017



- Research specialization homogeneous in relation the World average
- No major SDG problems

Limitations

- Comparisons with other approaches show significant disagreements (e.g. Armitage et al. 2020).
- Table 1. STRINGS v1 vs **Dimensions** approach on a set of 2018 WoS Pubs

SDG	STRINGS	STRINGS_%	Dimensions	Dimensions_%	Intersection	Union	Intersection/Union
1 No Poverty	871	0.1%	889	0.1%	311	1449	21.5%
2 Zero Hunger	1648	0.1%	3378	0.2%	769	4257	18.1%
3 Good Health and Well Being	28647	1.8%	36222	2.3%	5681	59188	9.6%
4 Quality Education	1760	0.1%	6939	0.4%	1760	6939	25.4%
5 Gender Equality	5236	0.3%	531	0.0%	241	5526	4.4%
6 Clean Water and Sanitation	8598	0.6%	2758	0.2%	1076	10280	10.5%
7 Affordable and Clean Energy	7785	0.5%	48788	3.1%	5658	50915	11.1%
8 Decent Work and Economic Growth	4101	0.3%	4212	0.3%	637	7676	8.3%
9 Industry, Innovation and Infrastructure	17258	1.1%	346	0.0%	124	17480	0.7%
10 Reduced Inequalities	5052	0.3%	4078	0.3%	1638	7492	21.9%
11 Sustainable Cities and Communities	12533	0.8%	6579	0.4%	3438	15674	21.9%
12 Responsible Consumption and Production	8781	0.6%	2399	0.2%	1023	10157	10.1%
13 Climate Action	16231	1.0%	20176	1.3%	8147	28260	28.8%
14 Life Below Water	7812	0.5%	2738	0.2%	1374	9176	15.0%
15 Life on Land	15659	1.0%	2944	0.2%	2307	16296	14.2%
16 Peace, Justice and Strong Institutions	4921	0.3%	9402	0.6%	2152	12171	17.7%
17 Partnerships for the Goals			183	0.0%			
Total	1556293		1556293				

Limitations

- Comparisons with other approaches show significant disagreements (e.g. Armitage et al. 2020).
- Table 1. STRINGS v1 vs **NESTA** approach on a set of 2018 WoS Pubs

SDGs	STRINGS	STRINGS_%	Nesta_pred	Nesta_50%	Intersection	Union	Intersection/Union
1 No Poverty	910	0.1%	17295	1.1%	*356*	17849	2.0%
2 Zero Hunger	1704	0.1%	23975	1.5%	*756*	24923	3.0%
3 Good Health and Well Being	29636	1.8%	520449	31.9%	*25810*	524275	4.9%
4 Quality Education	1843	0.1%	117637	7.2%	*1626*	117854	1.4%
5 Gender Equality	5441	0.3%	157575	9.7%	*4643*	158373	2.9%
6 Clean Water and Sanitation	8900	0.5%	13476	0.8%	*2266*	20110	11.3%
7 Affordable and Clean Energy	7905	0.5%	78924	4.8%	*5703*	81126	7.0%
8 Decent Work and Economic Growth	4328	0.3%	10525	0.6%	*1345*	13508	10.0%
9 Industry, Innovation and Infrastructure	17958	1.1%	40436	2.5%	*2581*	55813	4.6%
10 Reduced Inequalities	5333	0.3%	93145	5.7%	*2726*	95752	2.8%
11 Sustainable Cities and Communities	13054	0.8%	4647	0.3%	*2599*	15102	17.2%
12 Responsible Consumption and Production	9045	0.6%	220140	13.5%	*1971*	227214	0.9%
13 Climate Action	16634	1.0%	102388	6.3%	*8405*	110617	7.6%
14 Life Below Water	8032	0.5%	27213	1.7%	*4639*	30606	15.2%
15 Life on Land	16290	1.0%	79879	4.9%	*9651*	86518	11.2%
16 Peace, Justice and Strong Institutions	5327	0.3%	47548	2.9%	*3222*	49653	6.5%
Total	1630350		1630350				

Discussion

- Shift in priorities? Research for SDGs, instead of research for economic growth.
  - The relation between S -> productivity/growth is complex and non-linear
  - Relation between S -> SDGs achievements is even more complex given the trade-offs*, synergies* and the variety of outputs

- How can we try to understand if a country/community is generating research that is relevant to their socio-economic needs?
  - **Lack of data and robust methods** (especially in LMICs).

- Different approaches to SDG research mapping seem to lead to substantially different results. What should analysts do?

Thank you!

The Sustainable Development Goals Report 2019

United Nations

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Sustained and inclusive economic growth can drive progress, create decent jobs for all and improve living standards. Globally, real GDP per capita and labour productivity have increased, and unemployment has dropped back to pre-financial-crisis levels. However, sluggish growth overall has prompted a rethinking of economic and social policies to achieve the transformational objectives of Goal 8 so as to meet economic growth targets in least developed countries; increase employment opportunities, especially for young people; reduce inequalities across regions, age groups and genders; decrease informal employment; and promote safe and secure working environments for all workers.

The Framing of Sustainable Consumption and Production in SDG 12

Des Gasper, Amod Shah and Sunil Tankha

International Institute of Social Studies (The Hague), Erasmus University Rotterdam

Underlying SDG 12 is a faith in human ability to manage the adverse environmental impacts of unending economic growth, including in already rich countries, through technological innovation and cooperation (see, e.g., Targets 12.1 and 12.a), efficient resource use (Target 12.2) and cleaner production processes (Targets 12.3, 12.4, 12.5 and 12.c). Many of the targets incorporate ideas from the 1990s discussions around product design (12.5), lifecycle approaches (12.3, 12.4 and 12.5) and sustainable corporations (12.6 and 12.7).

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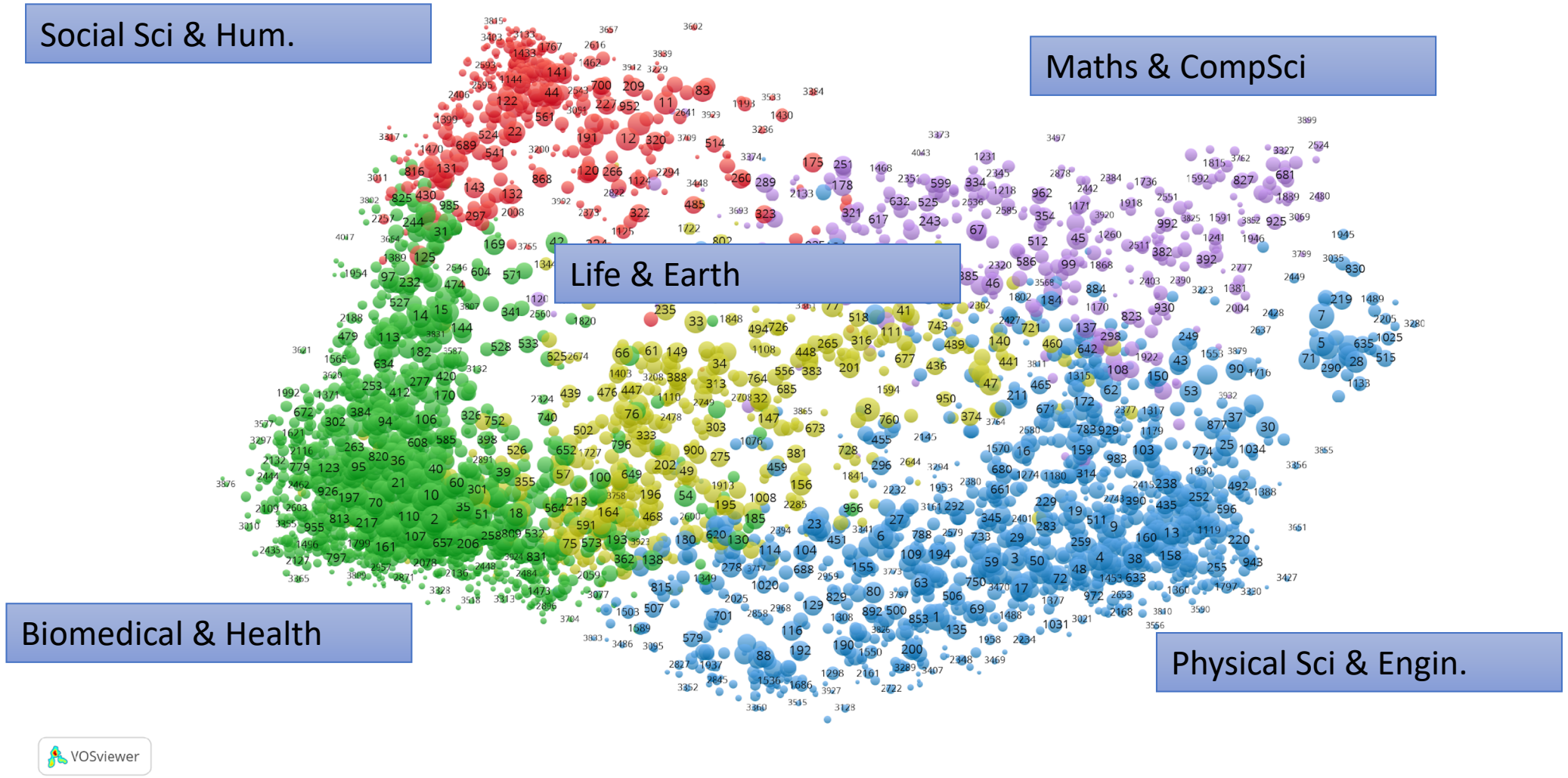
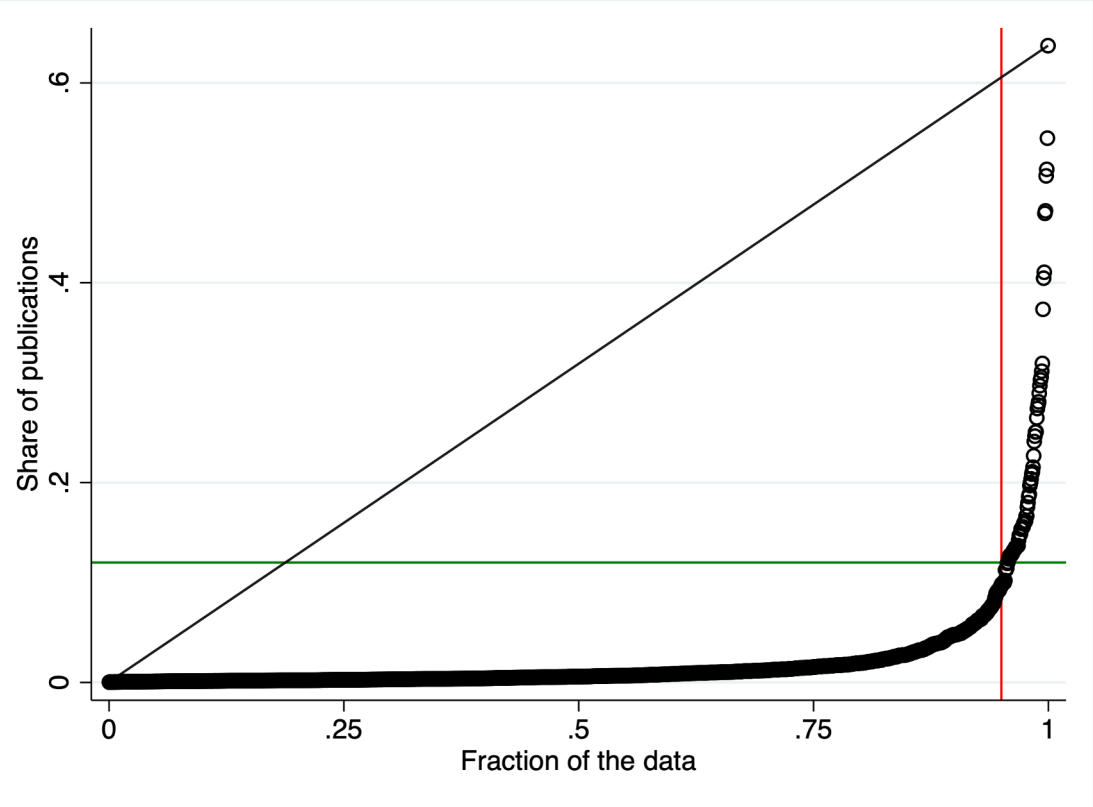
Communities within the WoS science landscape

(publication based classification, 4000 clusters, areas)

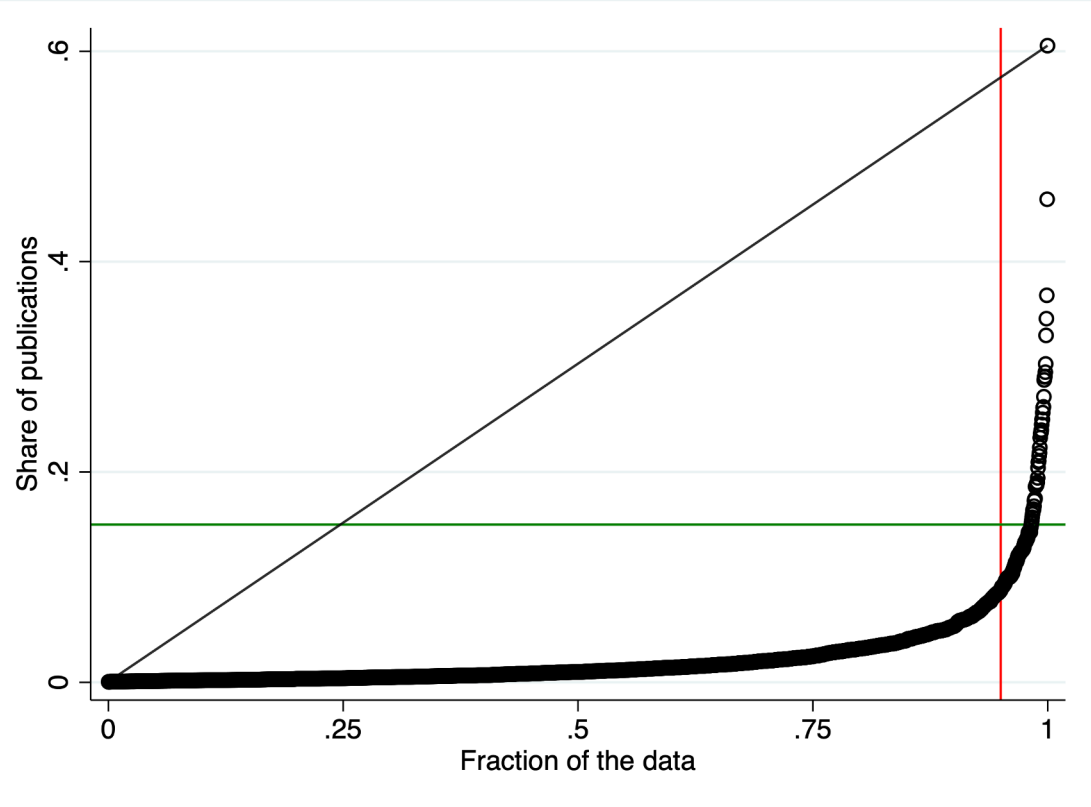


Minimum and Maximum Thresholds

SDG 7 (Affordable and clean energy)



SDG 9 (Industry Innovation and Infrastructures)



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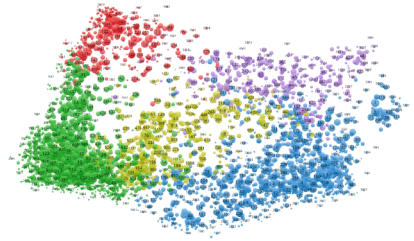
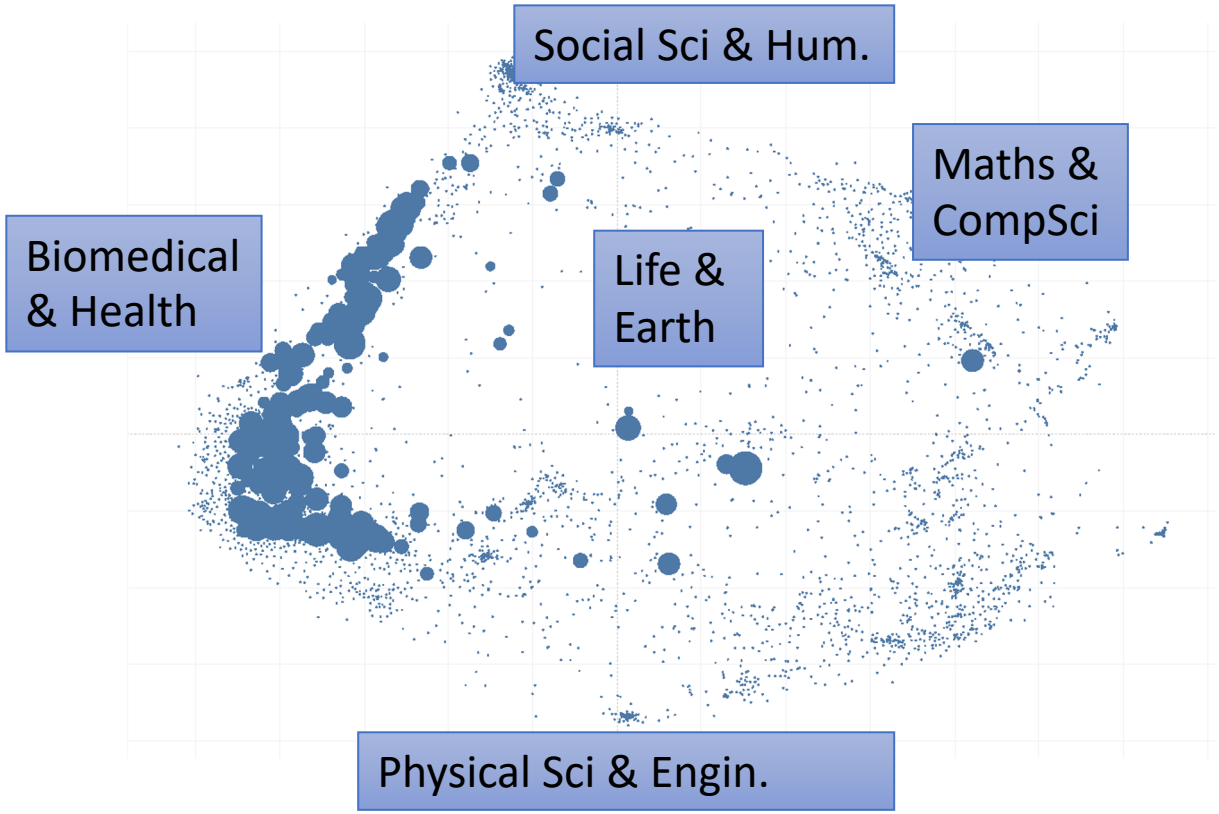
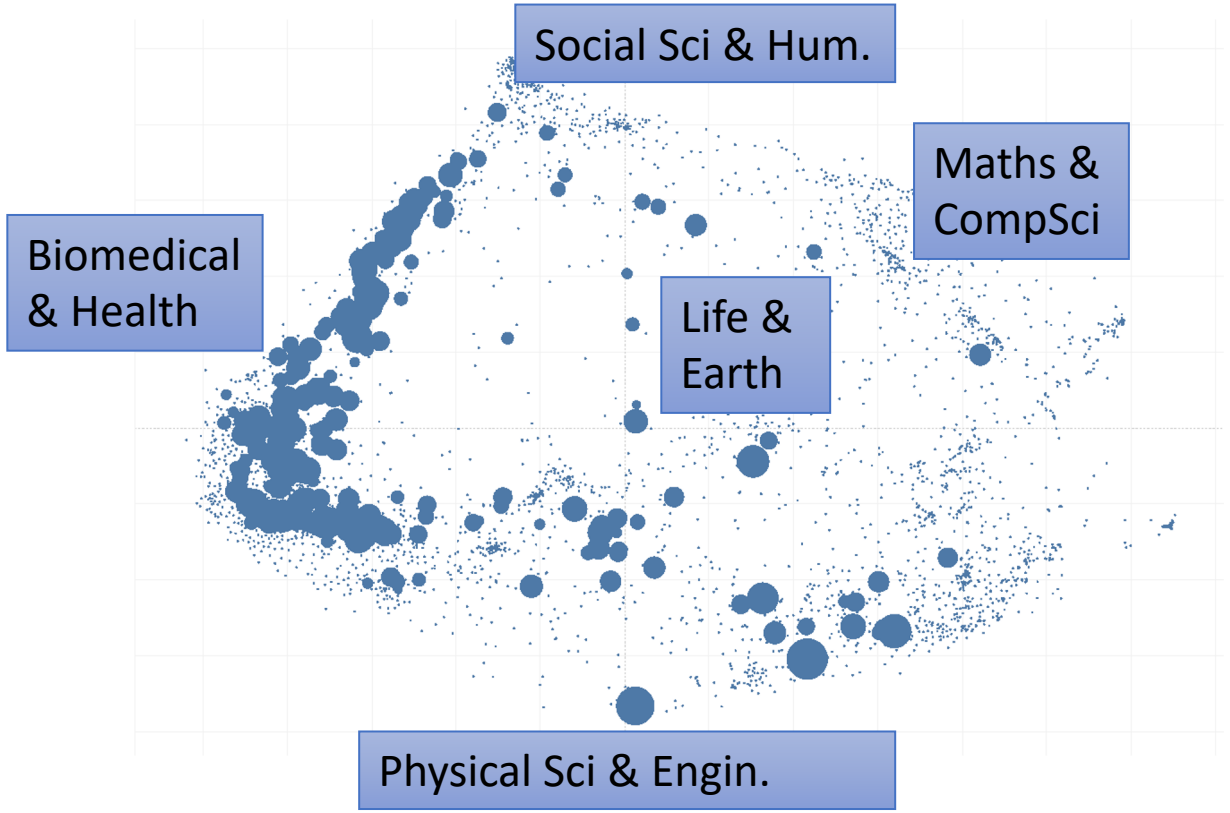
Comparing community-based selection (SDG 3: good health and wellbeing)



- STRINGS



- SIRIS



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SDG	Description	Reversed
1_No_poverty	Poverty headcount ratio at $1.90/day (%)	
2_Zero_hunger	Cereal yield (t/ha)	Yes
	Prevalence of stunting, under-5s (%)	
	Prevalence of wasting, under-5s (%)	
3_Health_well-being	Adolescent fertility (births per 1,000)	
	HIV prevalence (per 1,000)	
	Life Expectancy at birth (years)	Yes
	Maternal mortality (per 100,000 live births)	
	Death rate from NCDs (per 100,000)	
	Neonatal mortality (per 1000 live births)	
	Subjective wellbeing (0-10)	Yes
	Incidence of tuberculosis (per 100,000)	
	Traffic deaths (per 100,000)	
	Under 5 mortality (per 1000 live births)	
	UHC Tracer Index (0-100)	Yes
	Infants who receive 2 WHO vaccines (%)	
4_Quality_education	Net primary school enrolment rate (%)	Yes
	Mean years of schooling (years)	Yes
5_Gender_equality	Unmet demand for contraceptives (%)	
	Female labor force participation (% male)	Yes
	Women in national parliaments (%)	Yes
6_Clean_water_sanitation	Population using at least basic sanitation services (%)	Yes
	Population using at least basic drinking water services (%)	Yes
7_Affordable_clean_energy	Access to clean fuels (%)	Yes
	CO2 from fuels & electricity (MtCO2/TWh)	
	Access to electricity (%)	Yes
8_Decent_work_growth	Access to bank account or mobile-money (% adult pop.)	Yes
	Unemployment rate (%)	
9_Industry_infrastructure_innovation	Quality of overall infrastructure (1-7)	Yes
	Internet use (%)	Yes
	Mobile broadband subscriptions (per 100)	Yes
10_Reduced_inequalities	GINI index	
11_Sustainable_cities	Improved water source, piped (%)	Yes
	Annual mean levels of fine particulate matter in cities (population weighted)	
	Satisfaction with public transport (%)	Yes
13_Climate_action	CO2 emissions from energy (tCO2/capita)	
14_Life_below_water	Ocean Health Index - Biodiversity (0-100)	Yes
	Ocean Health Index - Clean waters (0-100)	Yes
	Ocean Health Index - Fisheries (0-100)	Yes
	Fish caught by trawling (%)	
15_Life_on_land	Freshwater sites, mean protected area (%)	Yes
	Terrestrial sites, mean protected area (%)	Yes
	Red List Index of species survival (0-1)	Yes
16_Peace_justice_instituions	Corruption Perception Index (0-100)	Yes
	Government efficiency (1-7)	Yes
	Property rights (1-7)	Yes
	Feel safe walking at night (%)	Yes

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