The Policy Effectiveness of Complexity Science:

Measuring Divergent Impact Across Sustainable Development Goals

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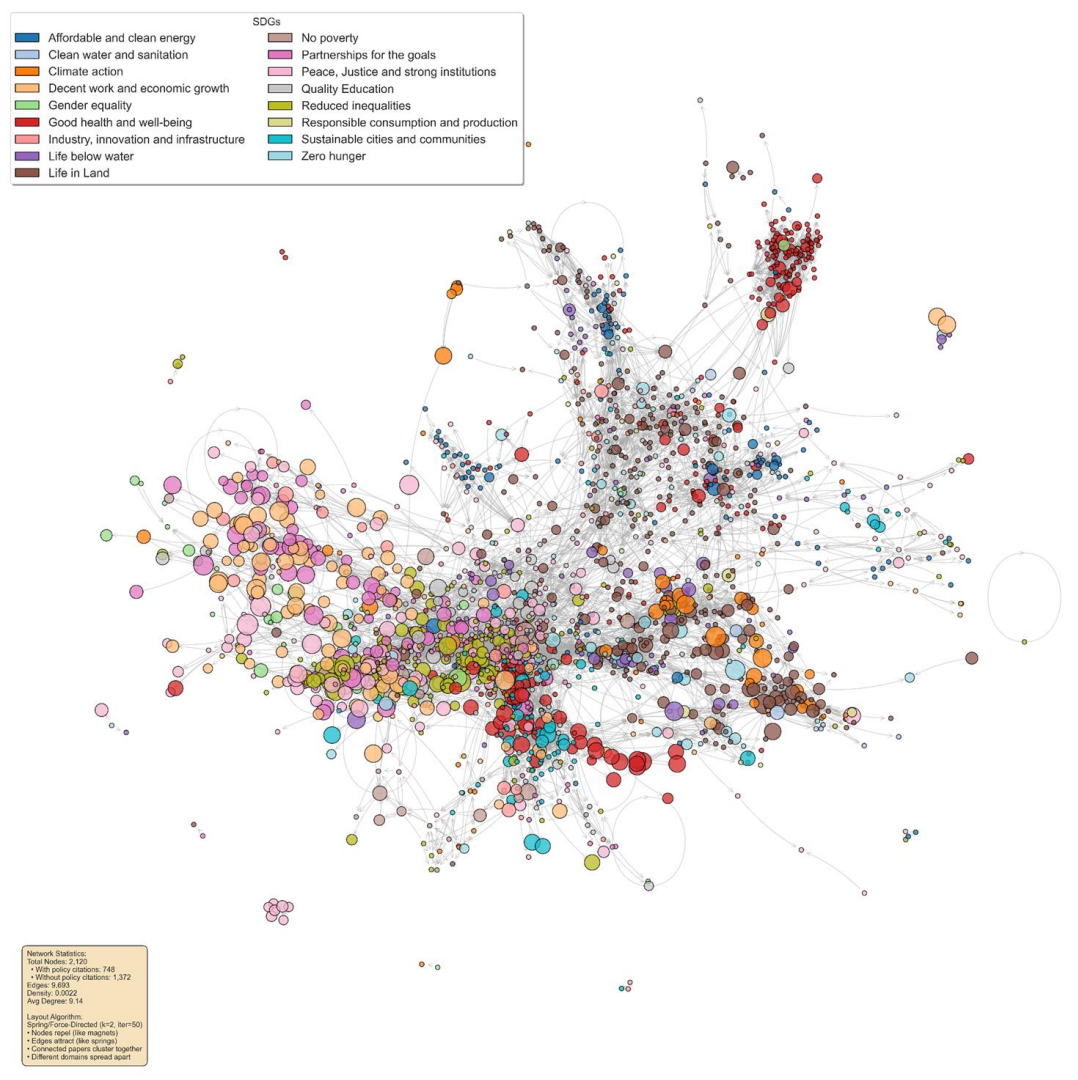
Complexity Global School - 2025



Research Question

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- How are complexity science methods being employed and applied in public policy, and how are complexity concepts being understood in this field?

- Sub-questions:
  - What specific complexity methods (system dynamics, agent-based modeling, network analysis, participatory systems mapping) are being integrated into policy?
  - In what forms is complexity being interpreted in policy? Is it implemented pragmatically through policy strategies or left only as proposals and drafts?

Hypothesis:

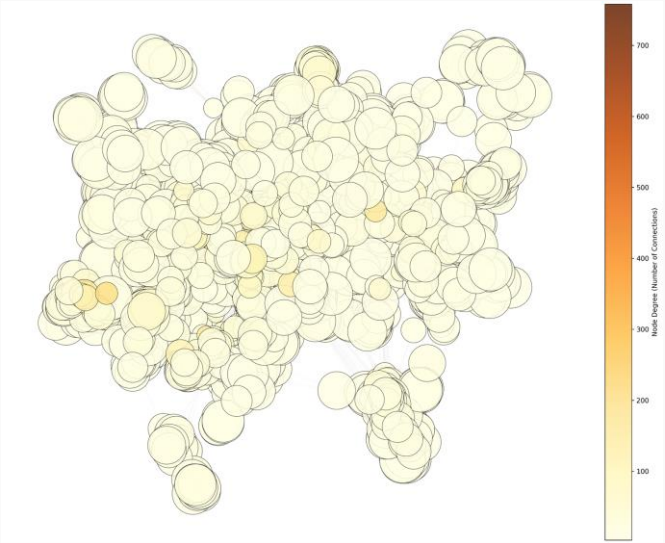
- We therefore hypothesize that complexity science tools can be systematically integrated into policy processes, bridging the gap between theoretical foundations and practical applications. However, at the same time, we expect that some of the most influential scholarly works in complexity science do not reach policymakers, while the methods that are most useful or practical for policy tend to diffuse independently of deeper theoretical foundations.

Methodology

Building the Complexity Science Corpus

- Publications from three leading institutions in the field

- We built a bibliographic coupling network
- Kept only its M strongest connections and k-core decomposition



Nodes: 5,252 Edges: 80,045 Av. Degree: 30 Max Degree: 626

Density: 0.0058 Most connected: ”Emergence of Scaling in Random Networks”

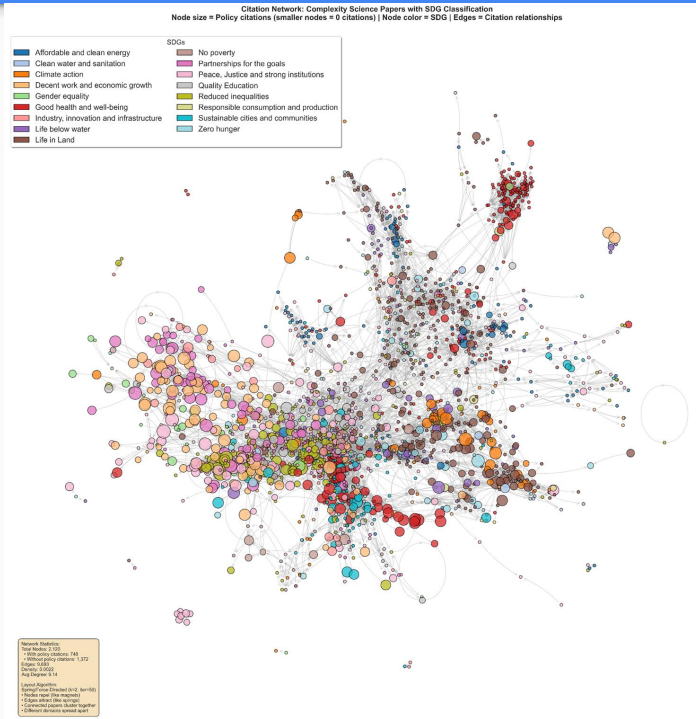
Measuring Policy Impact

Metrics

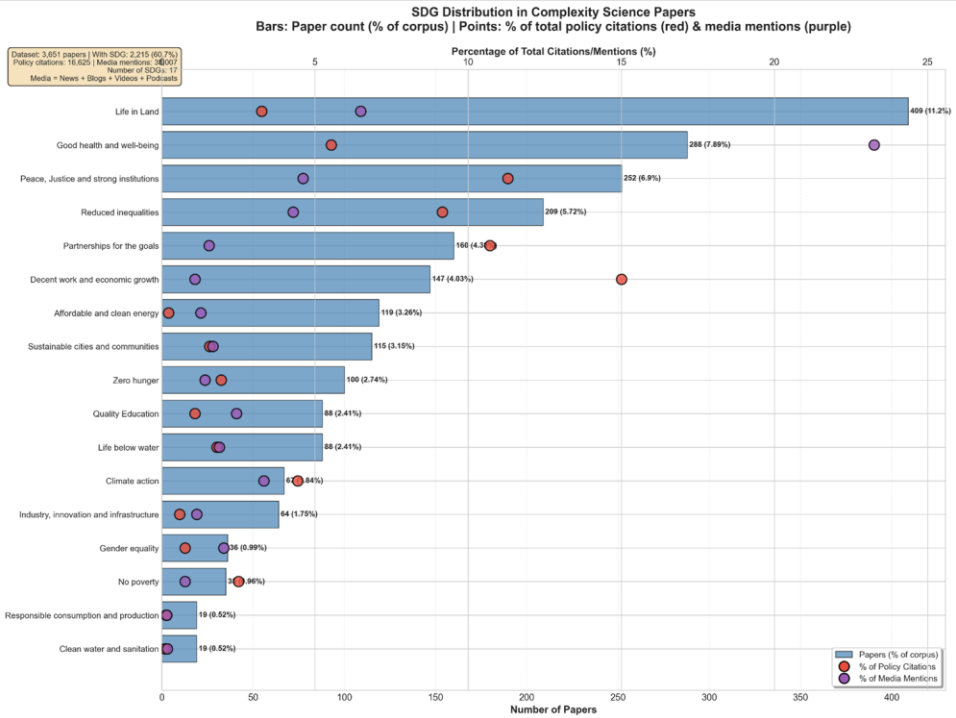
OpenAlex → Altmetric

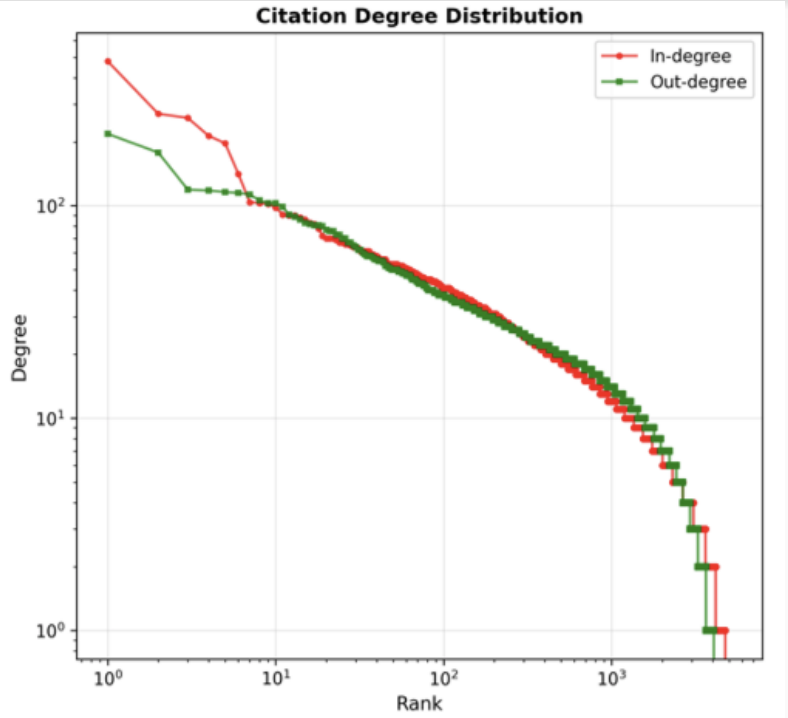
- Academic citation counts
- Affiliations
- Referenced work
- SGD classification

- Policy mentions
- Overall scholar impact
- Media coverage
- Social media
- 3,652 matched records (69.53%)



Results


SDG Distribution in Complexity Science Papers
Bars: Paper count (% of corpus) | Points: % of total policy citations (red) & media mentions (purple)
Dataset: 3,651 papers | With SDG: 2,215 (60.7%)
Policy citations: 16,625 | Media mentions: 38007
Number of SDGs: 17
Media = News + Blogs + Videos + Podcasts
Percentage of Total Citations/Mentions (%)
Life in Land
Good health and well-being
Peace, Justice and strong institutions
Reduced inequalities
Partnerships for the goals
Decent work and economic growth
Affordable and clean energy
Sustainable cities and communities
Zero hunger
Quality Education
Life below water
Climate action
Industry, innovation and infrastructure
Gender equality
No poverty
Responsible consumption and production
Clean water and sanitation
409 (11.2%)
288 (7.89%)
252 (6.9%)
209 (5.72%)
160 (4.3
147 (4.03%)
119 (3.26%)
115 (3.15%)
100 (2.74%)
88 (2.41%)
88 (2.41%)
64 (1.75%)
36 (0.99%)
19 (0.52%)
19 (0.52%)
Papers (% of corpus)
% of Policy Citations
% of Media Mentions
Number of Papers


Citation Degree Distribution
In-degree
Out-degree
Degree
Rank

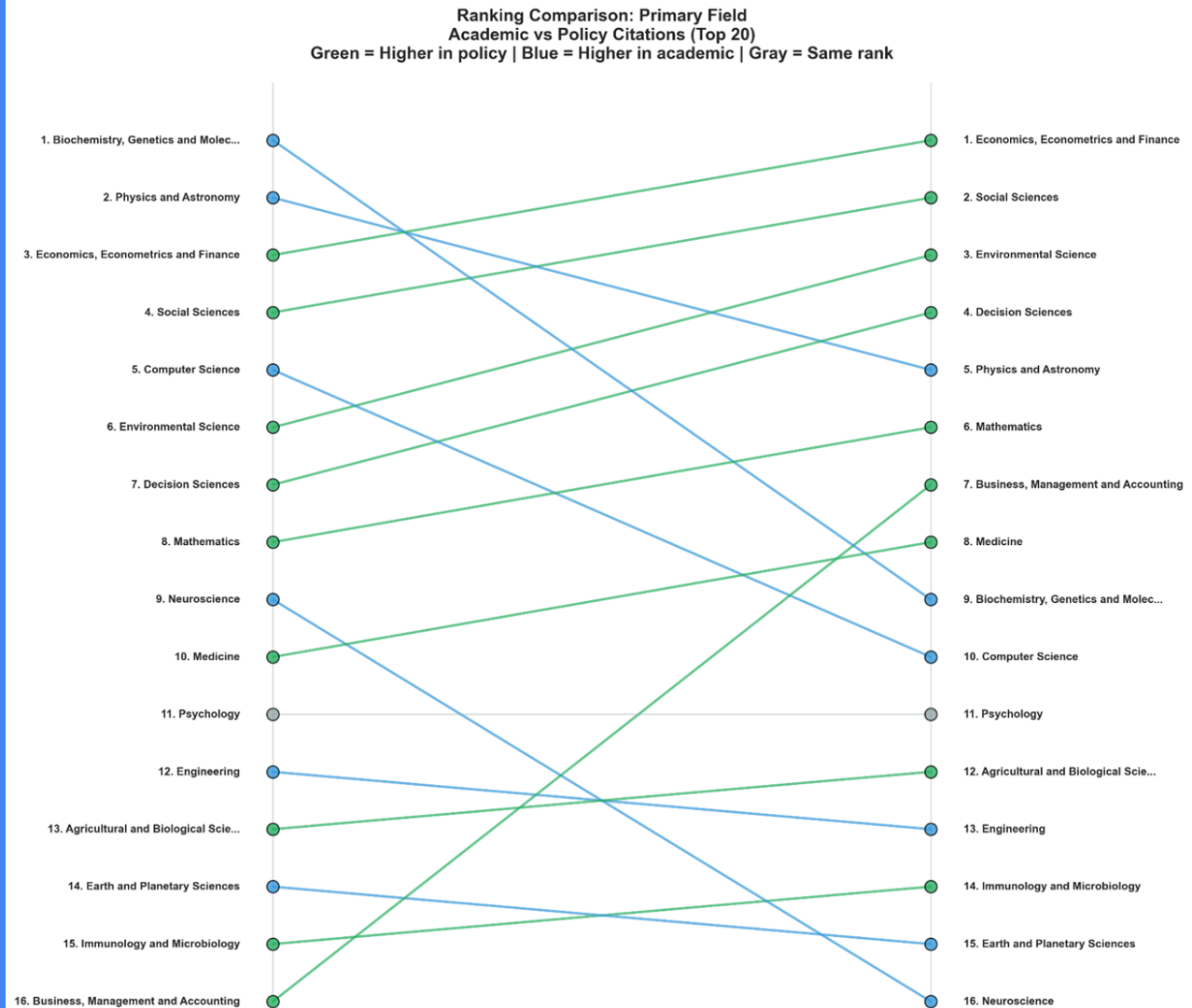
Results

Academic and policy impact follow divergent pathways.

The data confirms the well-documented power law in citations

Only one-third of our complexity science corpus has ever been cited in policy documents

32.8%

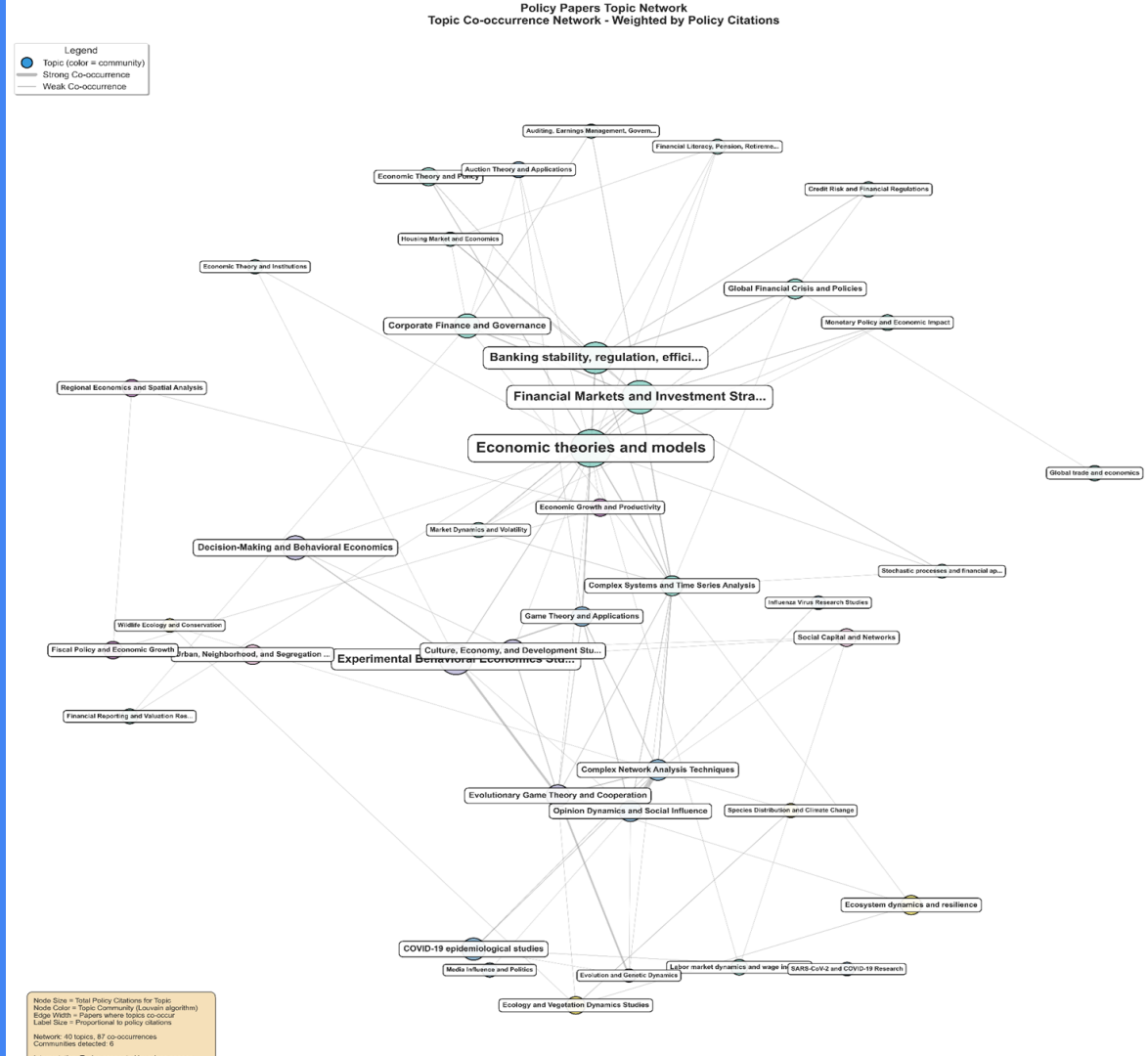


Results

Academic and policy impact follow divergent pathways.

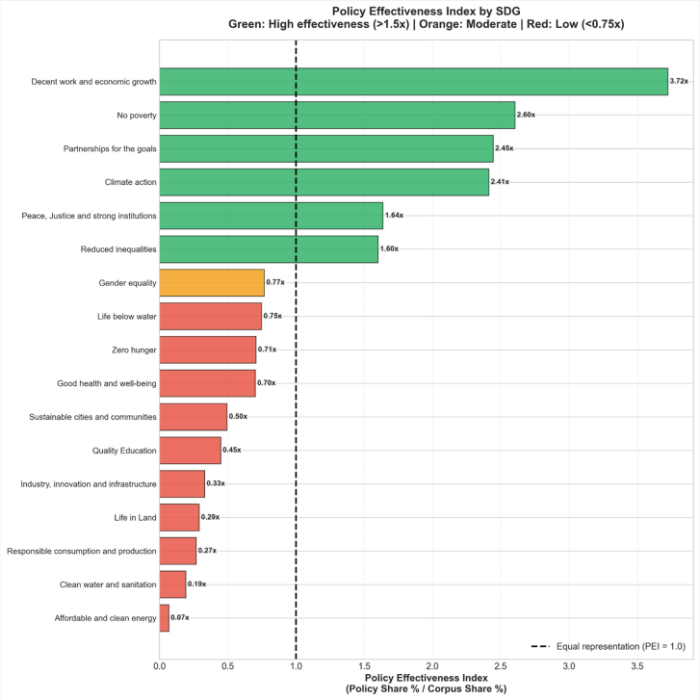
At field level, Academic communities cluster around genetics, biochemistry and physics

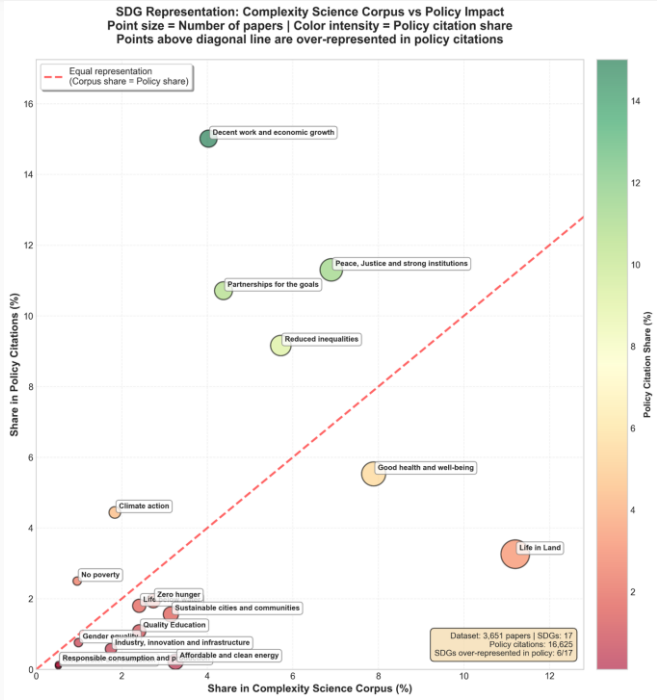
Policy communities gravitate toward economics, social sciences, and environmental sciences topics



Results: The Policy Effectiveness Index

$$PEI = \frac{\text{Policy citations share}}{\text{Academic citations share}}$$



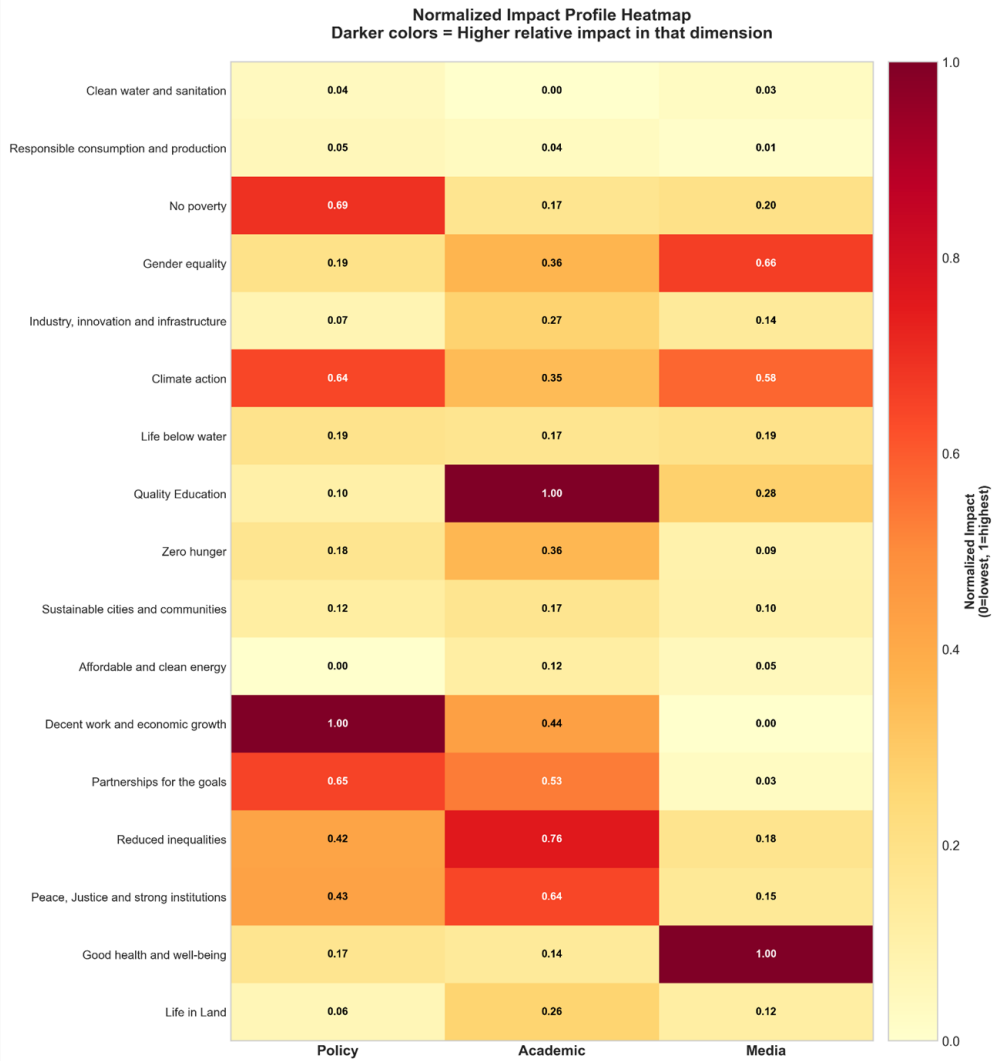


Results

Policy impact peaks with socioeconomic SDGs: Decent Work, No Poverty

Academic impact peaks with Quality Education and Reduced Inequalities

Media impact peaks with Good Health and Gender Equality mainly driven by virology papers published in 2020 amid the Covid-19 pandemic.



Discussion

1. What makes a paper policy-influential?

- High policy-cited papers translate complex ideas into simple, intuitive mechanisms.
- Examples:
  - Heuristics (Tversky & Kahneman): Clear vocabulary for decision-making under uncertainty.
  - Weak ties (Granovetter): Portable insight into information flows and labor markets.
  - Product Space (Hidalgo et al.): Visual, structural explanation of development traps.

2. Academic impact ≠ policy impact

- Many highly cited academic papers do not reach policy audiences.
- Some of the most practically useful insights in policy come from papers with moderate academic citations.

3. SDG-specific patterns

- **High policy penetration:** SDG 8 (Economic Growth), SDG 16 (Governance), SDG 13 (Climate).
- These domains benefit from concepts like feedback loops, networks, and bounded rationality.
- **Low policy penetration**: SDG 3 (Health), SDG 15 (Life on Land). Technical, specialized research is harder to translate into portable policy mechanisms.

4. Policy-relevant complexity = conceptual clarity

- Policymakers favor concepts that are:
  - Intuitive
  - Cross-sectoral
  - Actionable

Conclusion

1. Complexity science and policy interact asymmetrically

- Academic influence and policy influence operate along different dimensions.

2. Policy-impactful papers share three features

- Clear, portable mechanisms
- Cross-domain applicability
- Ability to structure reasoning under uncertainty

3. Technical sophistication alone does not guarantee policy relevance

- Highly specialized research often fails to translate into actionable policy insights.

4. Complexity science becomes impactful when it clarifies—not complicates—policy problems

- Policymakers adopt complexity approaches that help navigate interdependence, feedback loops, and bounded rationality.

5. Major challenges remain

- Geographic and institutional concentration of complexity science in the Global North.
- Gaps between technical findings and implementable policy frameworks.
- Lack of clear guidance for policymakers on when and how to use specific complexity methods.

6. Overall contribution

- This study maps how complexity science travels into policy.
- It provides actionable insights for researchers seeking policy impact and for policymakers navigating complex systems.

Next steps

Deeper Network Analysis

- Rigorous analysis of network properties
- Examine propagation dynamics and structural characteristics
- Distinguish high-impact from low-impact papers

Policy Application Deep Dive

- Beyond citations: How are papers actually *used*?
- Implementation vs. ideas that never materialized
- Trace real influence vs. performative citation
- Analyze by SDG category

Data & Methods

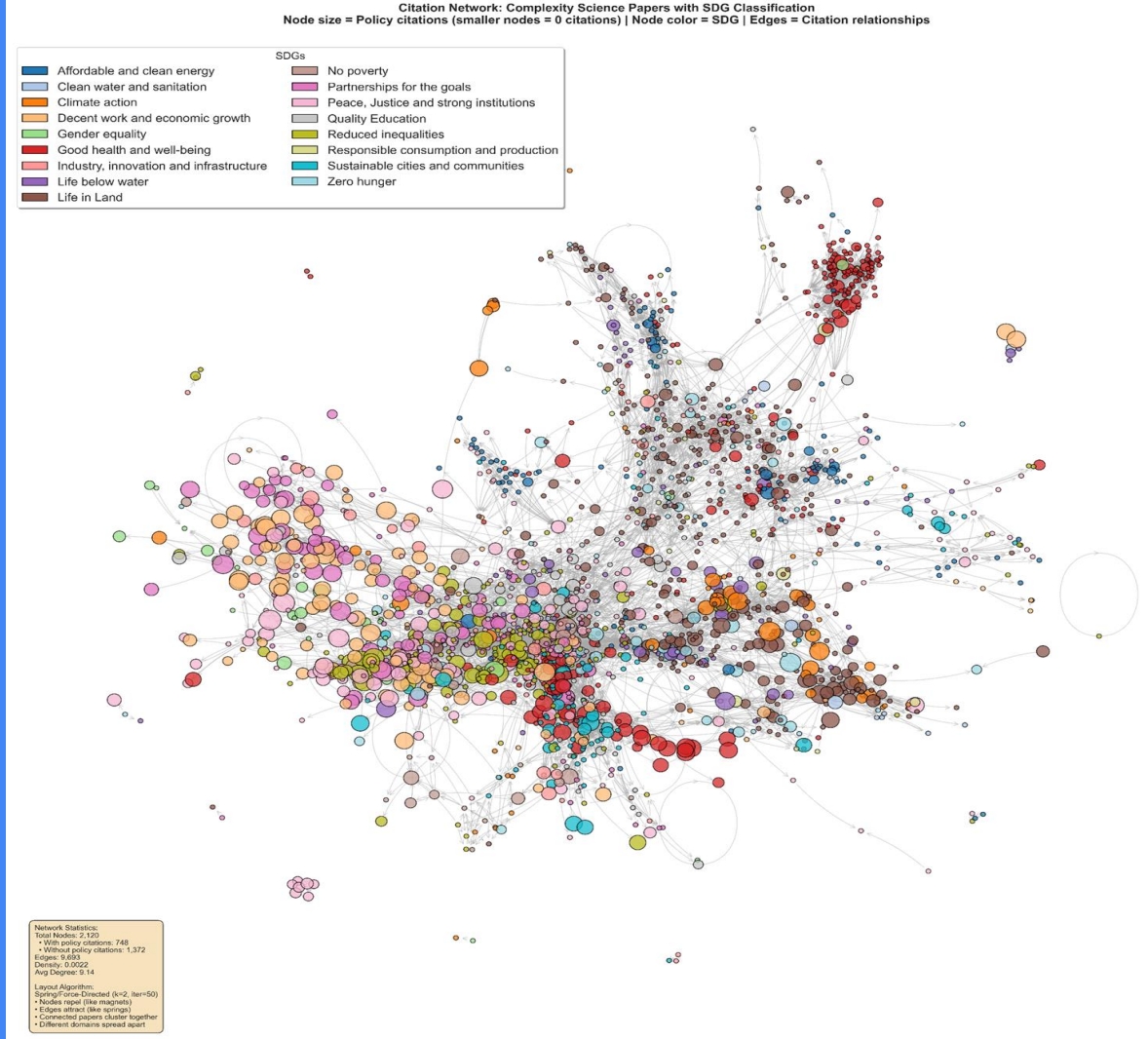
- Existing data infrastructure supports deeper investigation
- Trace citation patterns → application contexts
- Develop mechanisms of successful knowledge translation

Publication Goals

- Develop into publishable article
- Provide actionable guidance for:
  - Complexity scientists seeking policy impact
  - Policymakers navigating complexity under bounded rationality
- Move beyond bibliometrics → understand translation mechanisms

Visit: https://complexity-and-policy.lovable.app/

Thank You


Citation Network: Complexity Science Papers with SDG Classification
Node size = Policy citations (smaller nodes = 0 citations) | Node color = SDG | Edges = Citation relationships
SDGs
Affordable and clean energy
Clean water and sanitation
Climate action
Decent work and economic growth
Gender equality
Good health and well-being
Industry, innovation and infrastructure
Life below water
Life in Land
No poverty
Partnerships for the goals
Peace, Justice and strong institutions
Quality Education
Reduced inequalities
Responsible consumption and production
Sustainable cities and communities
Zero hunger
Network Statistics:
Total Nodes: 2,120
• With policy citations: 748
• Without policy citations: 1,372
Edges: 9,693
Density: 0.0022
Avg Degree: 9.14
Layout Algorithm:
Spring/Force-Directed (k=2, iter=50)
• Nodes repel (like magnets)
• Edges attract (like springs)
• Connected papers cluster together
• Different domains spread apart