How Science Informs International Policy: a Network Analysis

Keywords: Science and Policy, Network Analysis, IGOs, International Policy, Policy Citations

Extended Abstract

The past few years have seen a rising concern that while a chief function of scientific research is to inform political decision-making, current policy has little basis in scientific evidence[1]. At the same time, there is a rise in the idea that citation metrics alone are an insufficient gauge of academic value, but influence on policy has yet to be thoroughly considered[2].

The objective of this study then was to analyze the process by which academic findings make their way into policy, using citations provided in policy papers published by intergovernmental organizations (IGOs) (e.g. *The Innovation Imperative* (OECD, 2015)[3], *World Energy Outlook* (IEA, annual)[4], and *Health in 2015: from MDGs to SDGs* (WHO, 2015)[5]). The data used in the analysis is taken from two databases: Overton[6], a novel database containing policy papers and research papers, and Scopus, a highly accurate database for identifying authors.

To study the science-to-policy information process, we first turn to geographic influence factors. Of the 30 countries with the highest volume of academic output, their "scientific impact" and "political impact" are plotted in Fig 1. We find that there are three prominent groups of countries; the first group, consisting mostly of central and Northern European countries, have a large political impact relative to their scientific impact, while also maintaining a high scientific impact. The second group consists of the only Latin American and African countries in the 30, which have a high political impact relative to their low to mid-level scientific impact. The final group consists of Asian and Eastern European countries that have a low political impact relative to their scientific impact, despite their low to mid-level scientific impact. Overall, these results display a clear regional disparity where more research may provide further insight into the mechanism of science-policy influence.

Next, we examine the influence that individual authors may have. The number of IGO-cited authors follows a power law (Fig 2) above 20-30 citations, suggesting that a small number of highly cited authors have a large influence over international policy. Fig 3 shows a co-authorship network of the 500 most policy-cited authors. This resulted in five large components that included 400 of the total 500 (Fig 4). Most of the researchers in the largest components specialized in ecology and infectious diseases, both areas involving pressing issues of global interest. These findings denote that researchers with the most impact on policy collaborate in dense, field-specific rich clubs[7].

Furthermore, we generated a citation similarity network of IGOs to examine activity on the citing side (Fig 5). Large scale IGOs such as the World Bank, the OECD, and the United Nations have the highest centrality (Fig 6), with smaller IGOs near the periphery. That the network displayed this level of connectivity at an edge condition of Jaccard ≥ 0.25 suggests a high degree of similarity between the citing patterns of each IGO. Fig 7 shows that large scale IGOs such as the World Bank and the OECD have the highest volume of scientific citations in their policy papers. Moreover, these large institutions are also more likely to be the first to cite a paper, despite the percentage of first cites being ~30% at most. These results combined with

findings from the network suggest that there is a certain process by which IGOs cite science, whereby the largest IGOs with the most resources and specialists find and cite papers first, prompting smaller IGOs to follow in a similar citing pattern.

In this study, we found that there are regional differences in countries that have a high political impact relative to their scientific impact, and vice versa. This is consistent with research showing that countries perform better in certain areas of research over others[8]. We also found that there exists a rich club of collaborative researchers that have a large influence over international policy. We analyzed the author relationship and citation behavior of IGOs to uncover the reasons for the existence of the rich club. The rich club researchers worked in a select few areas (most notably Ecology and Environment and Infectious Diseases) that are of considerable global interest. IGOs inform each other on recent research, resulting in high similarity of citing activity. These mechanisms are new findings in the international policy domain that additional inquiries into IGOs' research and publication processes could elucidate.

To reach more detailed and concrete conclusions on the science-to-policy information process, it is recommended that further research address the contents of the clusters in the co-authorship network perhaps through topic modeling, conduct a time series analysis on policy publications and their citations, and explore policy-to-policy citation activity within the IGO sphere. Research could also expand into how policy in turn influences science, as seen after the declaration of the UN's SDGs[9] and with the onset of the COVID-19 pandemic[10].

References

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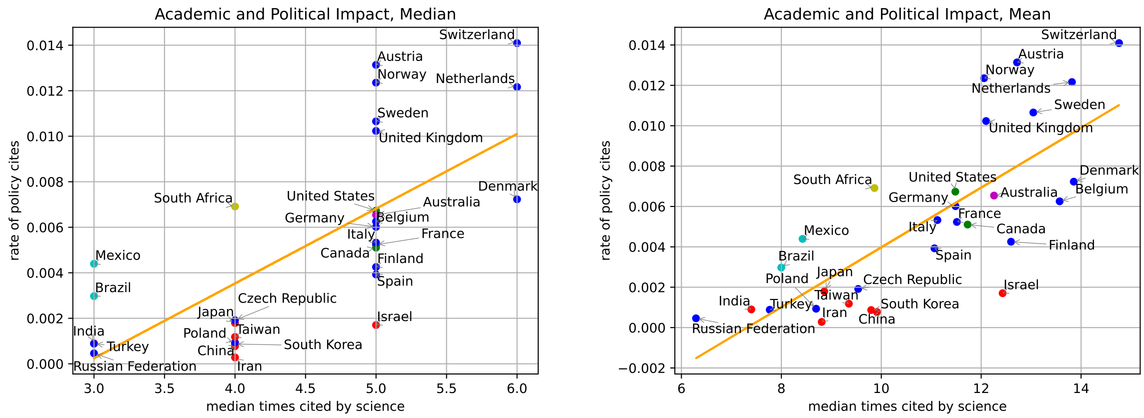

Figure 1: Scientific and Political Impact by Country: Top 30 countries by volume of academic output plotted by scientific and political impact (horizontal and vertical axes respectively). The scientific impact is the median (left)/mean (right) number of citations that each paper received from other scientific papers, and the policy impact is the mean number of policy citations received per paper. There are regional differences in political impact relative to scientific.

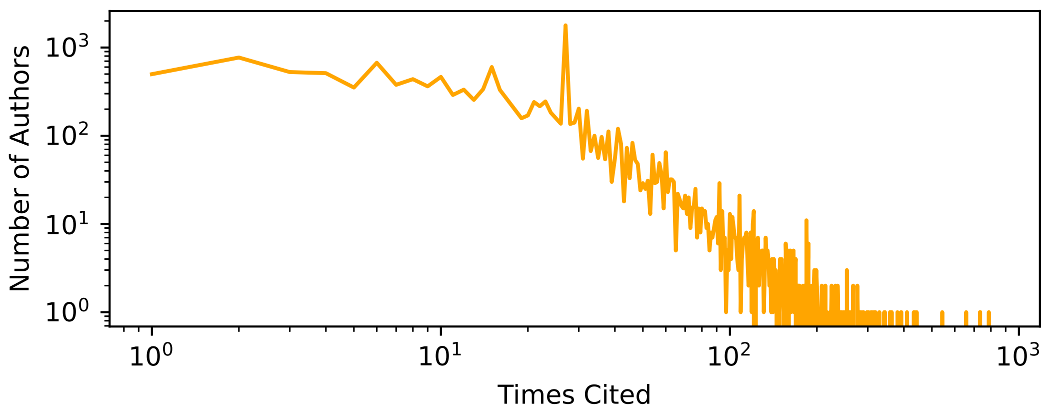

Figure 2: Distribution of Authors Cited by Policy: Number of authors cited in policy each number of times on a log-log plot. Distribution of authors over 20-30 cites follows a power law, suggesting a high concentration of highly cited authors.

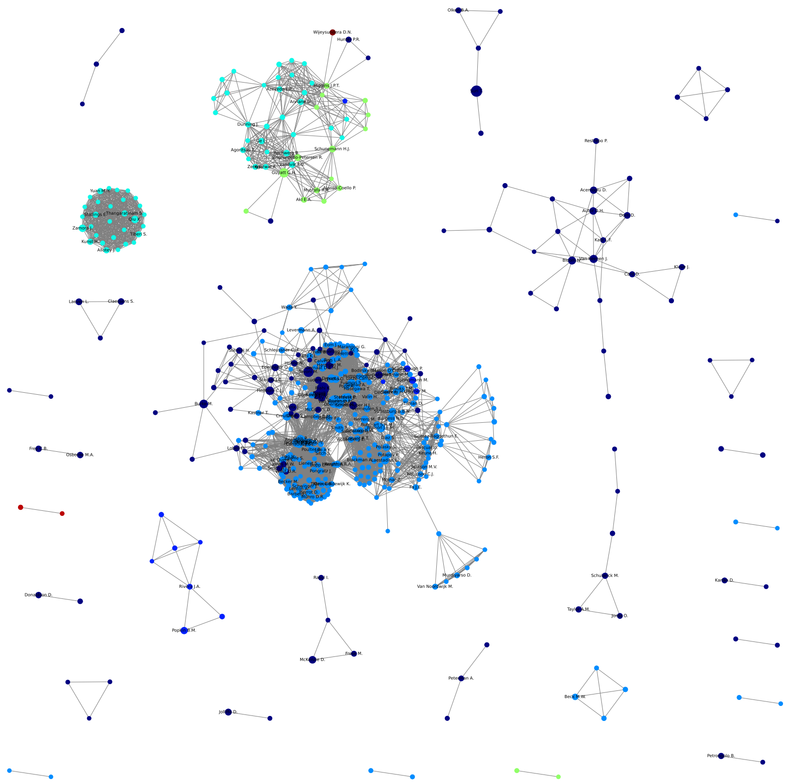

Figure 3: Co-Authorship Network of Top 500 Authors Cited by Policy: Co-authorship network of the 500 authors with the highest policy impact where the authors are the nodes and edges connect authors where there are any instances of co-authorship. 80% of these authors fit into the five largest components. Each author is colored by their main research topic. The topic of a paper is determined by citation network clustering, and the main topic of an author is the mode of the topic of his/her paper. Each component consisted mostly of researchers studying similar topics.

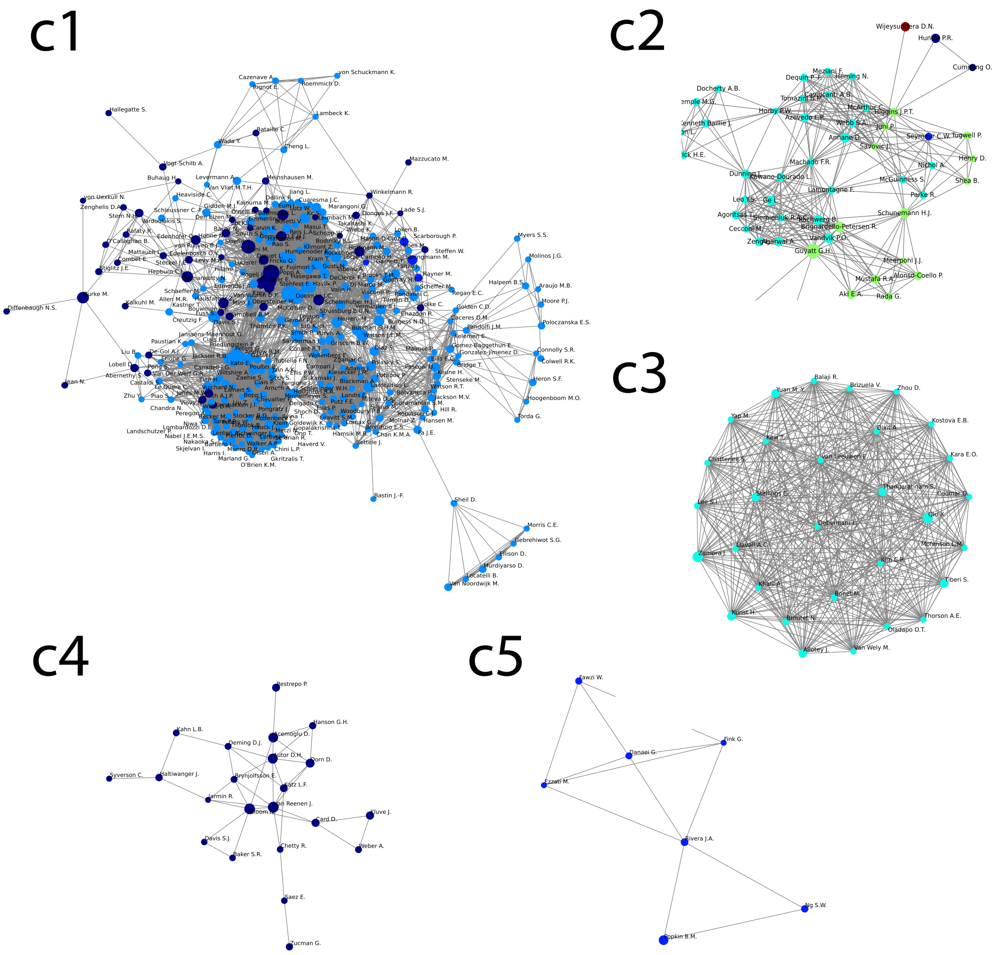

Figure 4: Five Largest Components in Co-Authorship Network: The researchers in the largest component C1 specialized in Ecology and Environment, while those of the next largest components, C2, and C3, specialized in Infectious Diseases. C4 and C5 were Economics and Chemistry, respectively. Each author is colored by their main research topic.

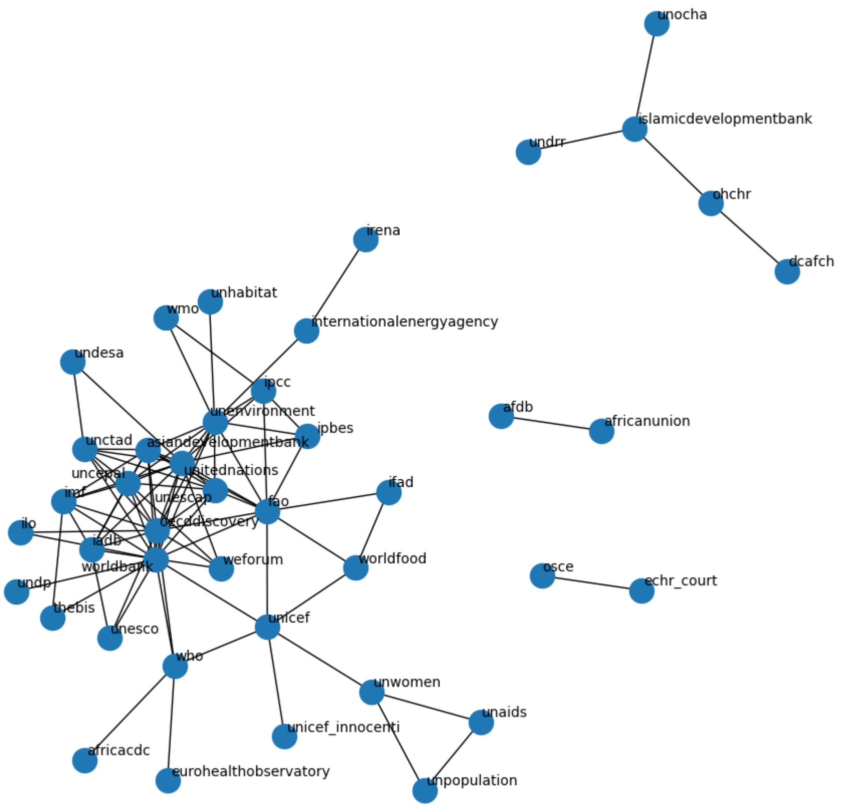

Figure 5: IGO Citation Similarity Network: For each pair of IGOs, edges are drawn where the Jaccard similarity of their set of citations was 0.25 or higher.

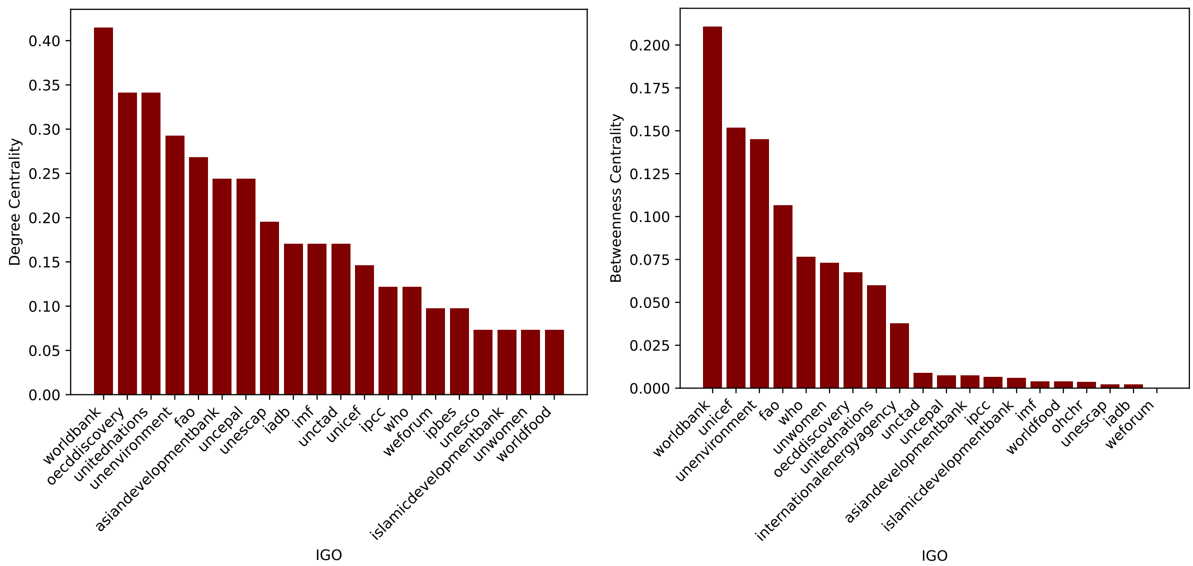

Figure 6: Centrality of IGOs in Citation Similarity Network (Top 20)

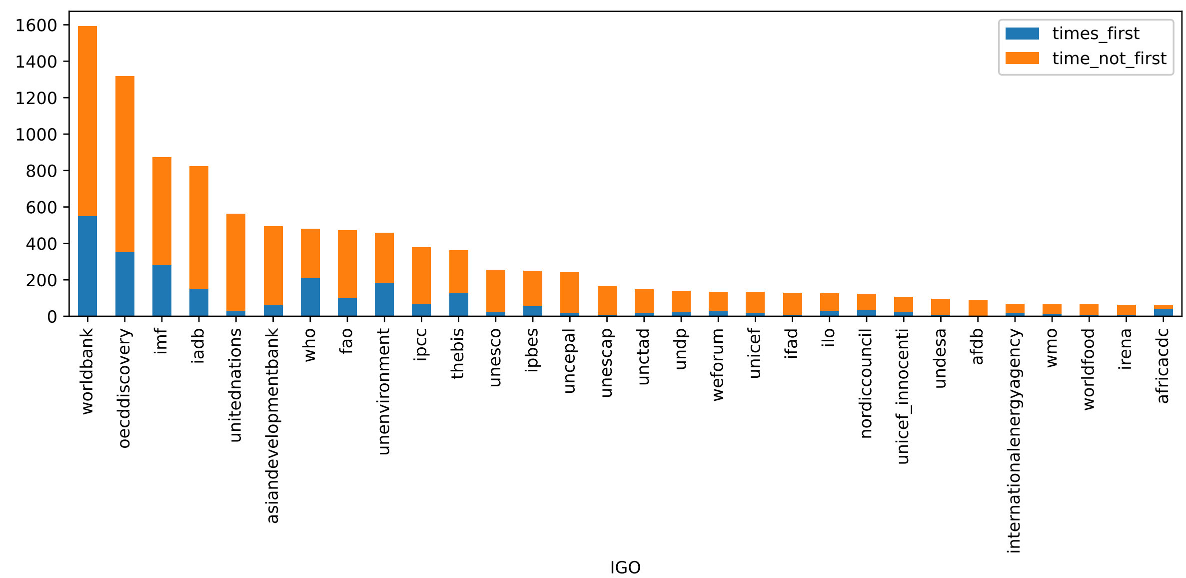

Figure 7: Number of First and Non-First Cites by IGO: Each IGO's instances of citing science, blue when it was the first among IGOs to cite it, orange when the same paper had already been cited in another policy document at the time of citing.