Case Study

TIP

McGill cipp CENTRE FOR INTELLECTUAL PROPERTY POLICY

Designing Metrics to Assess Impacts and Social Benefits of Publicly Funded Research in Health and Agricultural Biotechnology

The Problem with Metrics

Policy makers in health and science face the challenge of encouraging innovation while at the same time ensuring widespread access to the products of innovation. Setting appropriate policy depends on having the proper tools to measure the social benefits arising from research in health and agricultural biotechnology. Unfortunately, such benefits are very difficult to measure because the systems that give rise to innovation are enormously complex. They comprise numerous and diverse actors participating in a range of activities related to basic science and the discovery and development of commercial products, processes and therapies. In addition, some basic data sources, especially those related to licensing and funding applications are almost impossible to access.

Research has shown that encouraging networks, which bring researchers in multiple fields together, promotes basic and applied research as well as activities that translate research into products and therapies. Further layers of networks may be created by involving a diverse range of stakeholders from research institutions, special interest groups and non-governmental organizations, as well as those from government and industry. Innovative models such as Private Public Partnerships for product development can likewise be counted as networks. Not surprisingly, analyzing the outputs from networks and the impact of policies (such as policies directed at commercialization) on networks is very difficult. To date, most science policy is driven by economic measures or by statistics that are easy to collect (such as counts of research publications, patents or spin-off companies).

What Tools Do We Have and What Tools Do We Need?

The first step is to align metrics with policies or with the missions of publicly funded research institutions. In doing so, care must be taken first to determine the desired policy outcomes and, only then, to select appropriate metrics. Poor choices can lead to inefficient outcomes. For example, counting patents is a poor measure of innovation or success for a university technology transfer office because of the potentially adverse affects on downstream research. Aligning metrics with mission requires using both established tools in novel ways and developing new tools. In light of the importance of networks in enhancing innovative research as well as technological development and diffusion, it is useful to measure factors such as: the creation and spread of knowledge and technology, movement of trained individuals, and patterns of collaboration between researchers and other network members. Once network descriptors are in place, we can then measure the impacts of policies related to commercialization, licensing, or global access.

Available Tools

Network analysis tools originate in a field of Information Science known as Scientometrics. The analyses are based on the wealth of data available on the internet or from other digital records. They differ from traditional methods in that scientometric analyses can visually depict networks of actors (e.g., those who publish, patent, or seek funding together) while taking into account other relevant factors such as geography, institutional affiliation, and personal or group attributes.

Other methods illustrate the structure of a field of research, how the field changes over time, and the influence or activities of specific groups of researchers in a global research environment. Visualization of uptake and diffusion of new technologies is accomplished by tracking key publications over time and geography. Collectively, these tools allow a more nuanced understanding of the benefits flowing from innovation networks.

Evaluating and Developing New Tools

In its research, the International Expert Group on Biotechnology, Innovation and Intellectual Property examined the Stem Cell Network (SCN), with the aim of evaluating existing network analysis tools and developing new tools. The research was based on publication, abstract, and patent outputs for SCN research as well as some basic, publicly available curriculum vitae data for network researchers and students. The full dataset included hundreds of patents, tens of thousands of citing documents, and hundreds of thousands of cited documents. "From this, information was extracted on the complex network of individual authors, research institutions, and geographical regions linked through authorship, collaboration, citation, membership, similarity, and other types of relationships". There were hundreds of thousands of authors, and millions of links connecting them. The first challenge was therefore to develop automated tools to "clean" the data so that actors were correctly identified. The next step was to visualize and analyze the networks in different ways, depending on the information being sought. For example, to understand how central or important an actor is within the network, it is necessary to track formal knowledge flows in the form of co-citation or bibliographic coupling networks, as well as seminal research publications, technologies, or patents. To track tacit knowledge flows, it is necessary to trace the educational and employment history of individual actors, as well as key words, phrases, and concepts used by authors in different types of documents.

Evaluating Policies

Once the networks were visualized and network statistics calculated, we developed and tested regression models to explore the impact of policy on knowledge flows and scientific collaboration networks. The models presented numerous variables and policy questions that could be explored. In this particular case study, we chose to assess whether policies directed at commercialization are compatible with policies directed at enhancing networking and the functioning of virtual networks, such as the Stem Cell Network. The proxy for measuring the former was patenting activity while various network statistics were used to measure the latter. Other variables used in the statistical models were geographic location, institutional affiliation, institutional patenting ownership policy, and field of research as determined by author co-citation analysis.

The analysis determined that some collaboration patterns were best explained by institutional affiliation rather than geography; research quality (average number of citations) rather than quantity (number of publications); research area; and, not surprisingly, seniority. Most importantly, however, commercialization activity as measured by the number of patents negatively impacted the total number of collaborators and at least one other network measure. This suggests that policies aimed at commercialization and networking may not be wholly compatible.

Findings

1. Metrics must be designed to align with institutional missions or policy goals.

2. Promising new tools are available to analyse the vast quantities of data currently available on the internet, but these need to be improved to deal with large network datasets. The tools provide a more nuanced view of complex innovation networks and allow an assessment of policy. Theoretically, most of these tools are language neutral and could be used internationally.

3. The main obstacles to establishing appropriate metrics are critical gaps in publicly available data, incompatibility between databases and analysis tools, and the skewing of data sources toward the developed world.

Recommendations

1. Publicly funded research institutions should develop measures of success that respond to the mandate and purpose of the institution rather than to simple measures such as licensing revenue or number of patents and spin-off companies created.

2. Given the importance of innovation networks, metrics and analyses should be developed for assessing their success in light of their stated mission. More funding is required to develop tools to automate the expensive process of data collection, cleaning, and analysis.

3. Governments should facilitate the development of science and technology databases that permit robust searching (especially for patents), that link information between jurisdictions, and are more user-friendly.

4. Publicly accessible databases should be promoted over commercial databases, e.g., Elsevier's Scopus citation database and Thomson ISI's Web of Science.

5. Methodologies should be developed for overcoming language barriers to fully assess global innovation in biotechnology and other fields.

6. Licensing information from publicly funded research should be compiled and made available to innovation systems researchers.

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