Scientific publications

Scientific publications contribute to the diffusion of new codified knowledge, mostly to other researchers in the public sector research system but also to those working in firms and in government (policy and regulation). In addition, the process of working towards scientific publication – which demands novelty and quality – has considerable spillover effects on other activities and outcomes associated with public sector research, thereby contributing to innovation. While largely beneficial, too much emphasis on publication performance can lead to the generation of frivolous articles and sometimes to inappropriate behaviour. Therefore, the extent to which regular performance evaluations are incorporated into public sector funding regimes will be a factor in shaping contributions to scientific publication output. Availability of funding, proper R&D infrastructures, knowledge networks and quality scientific skills are also important factors influencing the number and quality of scientific publications.

What are scientific publications?

Scientific publications are a widespread form of scientific and technological communication used by [illegible] the wider economy and social life.

It has become a good practice to control the quality of scientific publications through the peer review [1] process, which usually involves two or more academic experts reviewing a given manuscript in a double-blind manner, where both reviewers and the author(s) cannot easily identify each other's names and hence can expect an objective evaluation and revision of an article to make it a genuine contribution to knowledge. Recently, concerns have been raised about the peer review process creating constraints on path-breaking research and interdisciplinarity, but it remains the best practice of major academic journals and an important scientific community norm. Nevertheless, the peer review process should involve the broader non-scientific community, in order to strengthen the practical significance and problem-solving focus of basic research.

Types of scientific publications

- books
- peer-reviewed journal articles
- non-refereed journal articles
- conference proceedings
- working papers
- reports
- research notes
- briefs, articles and comments in periodicals.

How do scientific publications contribute to innovation performance?

Scientific publications contribute to new codified knowledge, which is accessible to all those with the absorptive capacity to make use of it, i.e. mostly other researchers in the public sector research system but also those working in firms and in government (policy and regulation). Their contribution to innovation is through the publication of new knowledge that spurs or informs the generation of other kinds of new knowledge, which is ultimately used as a source of ideas by those developing new products, processes and services. Sometimes publications also contain more applied information, including evidence of new methods, processes and technologies that may be directly transferred to industry and commercialised, after certain additional efforts and adaptations. In this latter case, the contribution of scientific publications to innovation performance is more evident than in basic research.

In addition, the process of working towards scientific publication – which demands novelty and quality – has considerable spillover effects on other activities and outcomes associated with public sector research contributing to innovation. It is mainly these effects that justify countries funding their own public sector research, as opposed to relying solely on the contributions of other countries' researchers to scientific publications.

Meanwhile, despite their mainly public nature, public access to scientific publications is still rather restricted due to copyright restrictions imposed by publishing houses and individual journals. In recent years, this situation has attracted increasing attention from the scientific community, which proposes to encourage open access publications and knowledge repositories to allow a freer exchange of information and ideas between scientists and with a broader audience, who would otherwise be unable to participate in strongly advocated public engagement and deliberation mechanisms.

Main actors

Public sector research tends to be the largest contributor to publication output, though business R&D activities also contribute. This is because researchers' publication records are the main indicator used in career progression [2] decisions and for measuring the excellence of research performing organizations, especially in settings where basic research predominates.

The main actors involved in producing scientific publications include the following:

- Researchers [3] are knowledge producers and, therefore, the main contributors to scientific publications. Academic career [2] ... incentives for researchers to publish. However, if they are to do this consistently, they require resources and equipment.
- Research universities [4] and PRIs [5] provide resources, incentives and other elements of the work environment that shape the activities of researchers, but depend largely on public funding to do so.
- Research funding organizations [6] utilise scientific publications to identify research priorities ... that they conform to wider national development goals and use them as one of the main criteria for selecting which researchers to fund.
- Publishers are the key stakeholders ensuring the production of books, journals, brochures ... transferred to their respective journals, a rather controversial measure in recent years, since it may restrict access by the wider society to public knowledge.
- Scientific unions and associations [7] own or operate some of the most prestigious periodicals. In this role, they act as the guardians of scientific disciplines, contributing to the integrity of scientific publications.
- In addition to researchers themselves, research users, including firms [10], policy making organizations [8], regulatory organizations [9] ... third sector organizations ... capacity or at least innovation capacity to be able to search for and absorb the information contained within scientific publications.

Conditions ensuring the contribution of scientific publications to innovation performance

As scientific publications are predominantly based in the domain of fundamental research, their

contribution to innovation performance is also complicated by existing mechanisms of technology transfer and science-industry interaction. Four major mechanisms of interaction between the scientific community and other actors involved in innovation activity can be drawn from the literature: communication, participation, integration and experimentation.

Communication platforms, such as large-scale forums, exhibitions and expos, are essential in bringing together scientists with deeper knowledge of complex subject areas and entrepreneurs who are eager to commercialize existing applications. Such platforms will ensure that science and industry are "speaking the same language", and both parties will be able to better comprehend each other's ideas and needs, and continue their communication, through published outlets such as journals, newspapers and books. In turn, these developments are supposed to significantly improve the absorptive capacity of innovative firms, as well as resolve one of the problems of current publication mechanisms, where the role of non-scientific actors is rather minor and has little impact on problem-solving research.

Participation mechanisms imply that scientists publishing their research should be involved in the main decision-making bodies of private enterprises and government agencies, so that they can deliver the vision of the entire scientific community and share frontier research with a wider audience.

Integration of scientific results into innovation processes is the most difficult form of scientific contribution, since it implies participation of complex networks and multiple actors who must see the whole picture and identify challenges related to the entire national, regional or sectoral innovation system. However, the "absorptive capacity" of firms and the level of science-industry interaction gained through other channels should ensure the best possible outcome of such efforts to integrate and transfer scientific results into innovation activity.

Finally, experimentation is another form of scientific contribution to innovation performance through direct technological development and implementation, either independent or contractual, as a response to industrial needs.

Conditions ensuring generation of scientific publications

The most important factor allowing for better publication output is the availability of funding to cover the costs associated with performing novel and quality research. This will be shaped by the state of economic development [11] – with poorer countries typically spending less of their national income on research than their richer counterparts – and its specialisation [12] – with high-tech economies typically devoting more resources to R&D than those specialised in, for example, exploitation of natural resources. Economic specialisation also influences the capabilities of firms to utilise scientific publications, which often requires own-R&D activities to develop the necessary absorptive capacity. Such capabilities tend to be well developed in high-tech economies, less so in those specialised in exploiting natural resources.

However, funding availability alone is insufficient to guarantee contributions to publication output. Where funding is tied to publication performance, researchers are more likely to add to the overall scientific output. While largely beneficial, too much emphasis on publication performance can lead to the generation of frivolous articles and sometimes to inappropriate behaviour, e.g. plagiarism. Therefore, the extent to which regular performance evaluations are incorporated into public sector funding regimes [13] will be a factor in shaping contributions to scientific publication output. A related factor concerns academic career advancement [2], which, if based almost entirely on a researcher's publication record, will lead to more contributions to publications.

Proper R&D infrastructures, knowledge networks and quality scientific skills are also important factors influencing the number and quality of scientific publications. Without necessary facilities and competencies, researchers are unlikely to produce well-regarded papers and books, although certain theoretical disciplines (such as mathematics or theoretical physics) can flourish despite restricted access to modern equipment and have greatly relied on the availability of star scientists who have

exceptional talents and capabilities at the individual level (cf. Balzer, 1989).

Measurement

Bibliometrics [14] is one of the most popular techniques applied to the analysis of publication data. Thomson Reuters Web of Science and Scopus are probably the most widely used repositories of publication-related information, although they are not always accessible to researchers in some developed and developing countries due to their proprietary nature. The advantages of using these particular repositories consist in the fact that they deliver data in the field-tagged, i.e. structured, format that is much easier to analyze by available software tools and applications (see Figure 1).

Scholars implementing bibliometric analysis look for such major indicators as co-authorships, cross-disciplinary networks and citation records. The former may point to existing and potential knowledge networks that unite scientists, either domestically or internationally, who work for universities, research institutes, or industry. Cross-disciplinary networks may be one indicator of the maturity of national or regional science systems, showing the level of interdisciplinary links and knowledge spillovers in contemporary science that deal with increasingly complex phenomena and facts. Finally, citation analysis may indicate the level of integration of national science in international science and global epistemic communities, as well as possibly serving as an indicator of the quality of national science by showing how often the work of scientists is cited by their peers, both at home and abroad.

Despite various indicators showing its prevalence and quality, bibliometric analysis has a number of important limitations complicating the task of evaluating the impacts of scientific publications on innovation. For example, academic citations in patent applications can be taken as one proxy for measuring impacts, but it has all the limitations of patent statistics.

Another key weakness in bibliometric analysis concerns limited access to data in articles and books published in non-English languages. Although both Thomson Reuters and Scopus index a certain number of journals and books available in other languages, such as German, French, Russian, Arabic and Chinese, it has been often argued that these references provide only a small part of all academic literature and knowledge produced in those countries.

Nations have adopted different ways to deal with this problem. For example, China has chosen to promote scientific publications in English-language journals as a critical cornerstone of scientific careers. As a result of this policy, Chinese scientists have already outperformed their US counterparts in the number of publications in some fields, e.g. in nano science and technology. Meanwhile, Russia decided to create its own database that would include both English- and Russian-language publications by Russian authors (www.elibrary.ru). The database is not easily accessible but may prove to be a good way to deliver more objective results concerning the country’s science and technology progress.

In addition, some researchers point to the need to develop more people-centric methods of analyzing the scale and quality of science and technology progress, since publications often distort the picture by assigning most citations to senior researchers, while leaving out promising juniors simply because they have just joined the academic community and have not had a chance to accumulate enough citations.

Figure 1. PCT patents filed by PRIs, % of all PCT patent applications

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What policies relate to scientific publications?

Policy rationales

Supporting publication output primarily relates to the domain of science policy and plays an important role in the policy interplay serving the objectives of promoting national innovation capabilities. Being a main reflection of basic science development, scientific publications are critical in delivering deeper fundamental ideas about new products and services, as well as foreseeing their future development, and constructing technological roadmaps and strategies. By supporting domestic publication output, governments have more impact on the directions of scientific search and experimentation, and ensure that they serve the key objectives of national development and national security.

From the market failure perspective, government support of publication activity is explained by the failure of market agents, who are driven by the rational choice to maximize short-term gains, to invest in basic science, since it is an activity bearing excessively high risk and uncertainty. This contradiction requires public intervention to support fundamental research and deliver it to markets and societies in the form of public knowledge, using publications as one of the most important tools for knowledge sharing (cf. Arrow, 1962; Nelson, 1959). Publication activity also balances information asymmetries among private firms by disseminating knowledge to the widest possible range of stakeholders.

From the system failure perspective, it was mentioned that support for publicly funded research (and hence scientific publications) is important to bolster the absorptive capacity of domestic firms, research institutions, and universities so that they can keep up with cutting-edge research and technology developed in other technologically advanced countries. This rationale helps resolve the capability failures that occur when innovation actors lack the knowledge and competencies to carry out particular tasks by enabling them to source this information from scientific publications.

Policy objectives

Policy objectives regarding scientific publications include:

- increasing the number of scientific publications produced by researchers, industry and other actors
- guiding the directions of scientific search and experimentation so that they correspond with national priorities
- ensuring the presence of national science in major subject areas and cutting-edge research topics
- integrating national scientific communities into the world science system and promoting interactions with foreign researchers to raise awareness and support international scientific competitiveness
- fostering links with scientific diaspora abroad to ensure smoother knowledge flows and contributions by nationals who have migrated to other territories.

Policy instruments

Policies act indirectly on the scientific publication output by shaping public sector funding regimes – including the balance between discretionary organisational funding [15] and competitive R&D project grants [16] – and through regulations around academic careers. Therefore, important policy instruments include block funding of universities and PRIs, project-based grant finance, and incentives for researchers to produce scientific publications as part of their careers. Such incentives may take the form of financial rewards, as well as better career opportunities for productive researchers.

Support for R&D infrastructures [17] and centres of excellence [18] is also likely to increase contributions to publication output over time. Proper facilities allow for better experimental research, making empirical data available for further codification, and sharing in the form of publications, at conferences, and through working papers. Dependent on their scale, scientific output may reach 200-400 publications a year from such facilities as the synchrotron or the hadron collider (Klochikhin, 2012).

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Links
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[2] http://www.oecd.org/innovation/policyplatform/publicsectorresearch-shapingfactors-academiccareers.htm
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