Knowledge Production and Scholarly Communication in China

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Contents

Introduction

Since the last decades of the 20th century, knowledge has become an engine of social, economic and cultural development, and knowledge-intensive economic activities have become main indicators measuring the level of development and the readiness of a country for further economic and cultural growth. A term—*knowledge-based economy*—which is directly based on the production, distribution, and use of knowledge and information (OECD, 1996a) was introduced (Foray & Lundvall, 1996; Abramowitz & David, 1996) to incorporate knowledge and technology in related theories and models and to better understand the role of knowledge and technology in driving productivity and economic growth. Based on research output of the author in 2006–2010, a period in which China had experienced rapid growth of scholarly publications, this book outlines China's performance in scholarly communication in both science and social sciences in the turn of the 20th century.

Since the adoption of the reform and open policy in China in 1978, the Chinese economy has been growing steadily for decades. If Criscuolo and Martin's announcement (2004) that China was catching up rapidly with other dynamic Asian economies and the Triad (i.e., Europe, the USA, and Japan; OECD, 2004) was somehow offbeat, China's importance to world economy has become a common sense. In order to ensure its economic development sustainable, the Chinese government has implemented a series of plans and policies (Zeng & Wang, 2007), among which is the *National Medium- and Long-term Plan for Science and Technology Development 2006–2020* (NMLPSTD, Xinhua Net, 2006).

Launched in 2006, the NMLPSTD aims at building China an innovation-oriented country. It clearly shows the strategic ambition of Chinese top leaders to shift its economic growth pattern from the one which heavily relies on a low cost labor force, low value-added products, and resources and energy consumption to a new pattern in which knowledge plays a major role for economic growth. The plan sets two priorities: 1) promoting S&T development in selected key fields; and 2) enhancing innovation capacity. While outlining major strategic tasks for the innovation targets, Hu Jintao, former President of China, expected to embark on a new path of innovation with Chinese characteristics. The core of the NMLPSTD was to adhere to innovation, seek leapfrog development in critical fields, make breakthroughs in key technologies and common technologies to meet urgent requirements in realizing sustained, coordinated economic and social development, and make arrangements for frontier technologies and basic research with a long-term perspective.

Globalization has made a national or regional economy a component of the world economic system. China's contribution to leveraging world economy during the world financial crisis starting from 2007 well illustrates such interdependency (IMF, 2005). When advanced economic entities are still struggling in the quagmire of financial crisis, more expectations are bestowed on China. Both the world and China need to understand the changing situation so as to establish a benign relationship and promote world economy develop in a healthy way. Based on a series of quantitative studies in combination with qualitative analysis, this book may contribute partially to understanding China's role in world knowledge-based economy.

1 Some basic terms

What is knowledge and how to classify it? Wikipedia defines knowledge as "a familiarity with someone or something, which can include information, facts, descriptions, or skills acquired through experience or education"[1]. Lundvall and Johnson (1994) generalized four types of knowledge which are "know what", "know why", "know how", and "know who". Knowledge is conveyed in schools where students learn to "know what", in universities where they learn to "know

1 https://en.wikipedia.org/wiki/Knowledge

why", in the workplace where they learn to "know how", and, as they become part of networks, they learn to "know who" (Lundvall, 2000). Knowledge can also be categorized into two types: formal knowledge vs. informal knowledge. Formal knowledge is produced through systematic enquiry, and disseminated largely through publication in peer-reviewed journals (Whitley, 2000). Informal knowledge is acquired through personal experience, outside of the formal learning environments such as schools and training courses.

This book focuses on formal knowledge which will be simply called "knowledge" subsequently. Knowledge transmission, knowledge production, knowledge communication, and knowledge application are all knowledge activities (i.e., knowledge related activities). Government departments, educational and research institutions, industries, and publishing agencies are major players in a knowledge system. Government departments are responsible for creating an environment that ensures and encourages knowledge activities by drawing national strategies, policies and plans, and investing in R&D activities. Educational and research institutes play major roles in knowledge transmission, production, and application through education and R&D activities. Industries, especially high-tech industries, focus on transferring knowledge into products. And publishing agencies mainly involve in knowledge transmission. These players are self-organized and interact with each other.

Scientific research is an important activity of knowledge production. Through scholarly communication, knowledge outputs can be spread among peers and thus promote science develops further.

(1) *Knowledge production*

Knowledge production can be defined as activities of creating or harvesting new knowledge or codifying meaning by research and development (R&D), and generally covers the following stages:

1) Formation of research ideas. In addition to background knowledge in relevant fields, knowing the state-of-the-art is important.

2) Implementation of research. This is the core stage in knowledge production,

with the purpose of solving research questions or puzzles, seeking new discoveries, and generating novel thoughts.

3) Communication of research output. Output form of knowledge production can be a seminar, an article, a patent, a book, graduates and/or researchers (Gault, 2005).

In a book entitled *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, Gibbons and his colleagues (1994) proposed two distinct modes of knowledge production—Mode 1 and Mode 2. Mode 1 is defined as traditional research which is academic, investigator-initiated and discipline-based knowledge production. Starting to emerge from the mid-20th century, Mode 2 is context-driven, problem-focused and interdisciplinary. Mode 2 involves multidisciplinary team brought together for short periods of time to work on specific problems in the real world. Communication in Mode 2 is a three-tiered system: 1) communication between science and society; 2) communication among scientific practitioners; and 3) communication with the entities of the physical and social world. Mode 2 is developed out of Mode 1, and both modes exist in knowledge production.

The mode theory was challenged subsequently (Etzkowitz & Leydesdorff, 2000; Fuller, 2000; Shinn, 2002; Nowortny et al, 2001, 2003). Shinn (2002) thought that both the book and concept tinged with political commitment, whereas Etzkowitz and Leydesdorff (2000, p116) argued that:

"The so-called Mode 2 is not new; it is the original format of science before its academic institutionalization in the 19th century. Another question to be answered is why Mode 1 has arisen after Mode 2: the original organizational and institutional basis of science, consisting of networks and invisible colleges. Where have these ideas, of the scientist as the isolated individual and of science separated from the interests of society, come from? Mode 2 represents the material base of science, how it actually operates. Mode 1 is a construct, built upon that base in order to justify autonomy for science, especially in an earlier era when it was still a fragile institution and needed all the help it could get."

In a national innovation system, knowledge production involves three different types of institutions—universities, industry and government. They interact with each other and thus influence the development of knowledge. Etzkowitz and Leydesdorff employed the notion of Triple Helix to illustrate the variety of institutional arrangements and policy models of their dynamics. The authors defined three types of Triple Helix. Triple Helix Ⅰ encompasses academia and industry and the relations between them. The strong version of this model could be found in the former Soviet Union and in Eastern European countries. Triple Helix Ⅱ consists of separate institutional spheres with strong borders dividing them and highly circumscribed relations among the spheres. Triple Helix Ⅲ generates a knowledge infrastructure in terms of overlapping institutional spheres, with each taking the role of the other and with hybrid organizations emerging at the interfaces (Leydesdorff, 2000, 2003a, 2005; Leydesdorff & Meyer, 2006; Leydesdorff & Fritsch, 2006; Leydesdorff et al., 2006; Etzkowitz & Leydesdorff, 1995, 2000; Leydesdorff & Etzkowitz, 2001a, 2001b).

Gibbons' Mode 2 emphasizes more on generalizing the characteristics of knowledge production while the Triple–Helix model focuses on the network overlay of communications and expectations that reshape the institutional arrangements among universities, industries, and governmental agencies (Etzkowitz & Leydesdorff, 2000). Both modes emphasize the importance of communication in knowledge production.

(2) *Scholarly communication*

In Mode 2 theory, communication in knowledge production is a three-tiered system: communication between science and society, communication among scholars, and communication with the entities of the physical and social world. Scholarly communication is the process of academics, scholars and researchers sharing and publishing their research findings so that they are available to the wider academic community (such as university academics) and beyond. Borgman defined scholarly communication as "how scholars in any field…use and disseminate information through formal and informal channels" (Borgman, 1990: 13–14). Scholarly communication is the process by which scholarly information is produced, disseminated, preserved, and used. Traditionally, scholars within academia create information and then turn to publishers to produce and package information. Libraries purchase information from the publishers, organize it, and provide access to the publications. This allows for the widespread dissemination of scholarly information and persistent use of information by scholars.

Thus, scholarly communication involves scholars who produce and receive knowledge, media that transmit knowledge, and repositories (e.g., libraries and online databases) for storing and disseminating knowledge. Media for scholarly communication can be in printed form like printed journals, books, conference proceedings, theses, and books; or in electronic form such as e-journals, author's self-archived documents, and open access journals. Researchers discussing a specific research topic by informal conversations, e-mail or letters is also a kind of scholarly communication.

Compared to other forms of media in scholarly communication, peer reviewed journals play a significant role for the following reasons:

1) Journals publications are peer-reviewed, which ensures the quality to a large extent.

2) Compared to books, journal publications report more recent research results.

3) Journals are regularly published, which ensures the continuity of scholarly communication.

4) Well-established journal citation databases, such as the Web of Science of produced by Thomson Reuters and Elsevier's Engineering Information (EI Compendex) and the Scopus etc., make it more convenient to understand either overall or specific situation of a research topic or a field.

Knowledge production and scholarly communication are closely related and dependent on each other: scholarly communication exists in every stage of knowledge production, and knowledge production ensures the sustainability of scholarly communication.

(3) *Bibliometrics and research evaluation*

Since its emergence in the late 60s of the 20th century, bibliometrics has become increasingly important in science policy-making and research management.

By definition, bibliometrics is "the application of mathematical and statistical methods to books and other media of communication" (Pritchard, 1969). Bibliometrics focuses on formal forms of knowledge output especially journal publications communicated by scholars. The intersection between scholarly communication and bibiometrics was addressed by Borgman decades ago (Borgman, 1990; Borgman & Praisley, 1989; Borgman, 2000a, 2000b). An analogous term of bibliometrics is scientometrics (Nalimov & Mulchenko, 1969), although the coverage of bibliometrics is wider than scientometrics (Glänzel, 2008a). Journal publications, (co-) authors, references, and citations are basic objects of scientometric study. Modern bibliometrics is mostly based on the work of Derek J. de Solla Price and Eugene Garfield. The former adopted a new element in the historiography and sociology of science in the course of examining the major transformation of science as prefigured in his book: *From Little Science to Big Science* (Price, 1963). The latter invented the *Science Citation Index*, and founded the Institute for Scientific Information (ISI) with the Web of Science (WoS) and the Journal Citations Report (JCR) (Garfield, 1979) as typical products.

Books, monographs, theses, and papers in serials and periodicals are objects of scientometric study, among which scientific papers are most frequently used (Glänzel, 2008a). As an inter-disciplinary instrument, scientometrics originates from information sciences with original purpose of improving bibliographic databases and extending information service. With tens of years' development, scientometrics plays a growing role in science policy and research evaluation. Journal publications, (co-) authors, references, and citations are basic objects of scientometric study.

Data sources of Thomson Reuters, especially the Science Citation Index Expanded (SCIE), the Social Science Citation Index (SSCI), the Arts & Humanities Citation Index (AHCI), and the *Journal Citation Reports* (*JCR*) are commonly used in bibliometric studies. Elsevier, a Dutch publisher established Scopus similar to those of Thomson Reuters in 2004. Since the late 80s of the 20th century, two Chinese science citation databases and one social science citation database were established successively. The first database, the China Scientific and Technical

Papers and Citations Database (CSTPCD), was set up in 1987 by the Institute of Scientific and Technical Information of China. By 2006, around 5000 S&T journals and 3000 journals in the social sciences and humanities exist in China. The CSTPCD covered 1723 S&T journals in 2007. In 1989, the Documentation and Information Center of the Chinese Academy of Sciences (DICCAS) constructed a similar database—the Chinese Science Citation Database (CSCD). The CSCD covered 1083 journals in 2007 (CSCD, 2008). Two databases in the social sciences and humanities are seen in China. The first Chinese citation database in the social sciences—the Chinese Social Science Citation Index (CSSCI) was established in 2000 by Chinese Social Sciences Research Evaluation Center affiliated to Nanjing University. The CSSCI covers 680 journals in the period of 2007 (CSSCI, 2008). Another database entitled the Chinese Humanities and Social Science Citation Database (CHSSCD) is produced by the Centre for Documentation and Information attached to the Chinese Academy of Social Sciences. The first citation database of the CHSSCD appeared in 2000 (Zhou, 2002). The CHSSCD covered 662 journals in 2001. All the Chinese databases have similar structures as their international counterparts, but are based on Chinese domestic journals.

With the development of science, bibliometric studies become an increasingly important tool for decision makers and policy studies, which promotes scientometrics to evolve from a sub-discipline of information science to an inter-disciplinary specialty (Glänzel, 2008b). Library and information science is the foundation of bibliometrics/scientometrics. Mathematics is the critical tool for constructing bibliometric indicators and models. Sociology of science lays theoretical ground for scientometrics. Scientometrics can also be used for studying the sociology of science (Elkana et al., 1978; Leydesdorff, 1986, 1998; Wouters, 1999). Social network analysis like citation analysis and betweenness centrality among journals has become an important practice in scientometrics (e.g., Otte & Rousseau, 2002; Leydesdorff, 2007a; Leydesdorff et al., 2008a; Park & Leydesdorff, 2009; Zhou & Leydesdorff, 2007a, 2007b).

Bibliometrics can be divided into three sub-areas (Glänzel, 2008a):

1) Bibliometrics for bibliometricians. This is the domain of basic bibliometric research focusing on methodological exploration. 2) Bibliometrics for scientific disciplines. This domain can be considered as an extension of science information by metric means. There is a joint borderland with quantitative research in information retrieval. 3) Bibliometrics for science policy and research management. The third application focuses on national, regional, and institutional structures of science and their comparative presentation. With several decades of development, institutions engaged in scientometric research and education have been established in many countries, for instance, the Information Science and Scientometrics Research Unit at the Hungarian Academy of Sciences, the Center for Science and Technology Studies (STS Center) in the Netherlands, the Centre for Research & Development Monitoring (Expertisecentrum Onderzoek en Ontwikkelingsmonitoring, ECOOM) in Belgium, the National Institute of Science, Technology and Development Studies (NISTADS) in India, and so on.

Significant compilations of science indicators, such as the Science and Engineering Indicators of the National Science Board of the USA. and the European Reports on S&T Indicators, heavily rely on publication and citation statistics and other more sophisticated scientometric techniques. Furthermore, some governments have embraced scientometrics with great expectation for the purpose of research evaluation. British government announced a new framework for assessing and funding university research following the completion of the research assessment exercise in 2008 (Universities UK, 2007). Metrics, rather than peer-review, will be the focus of the new UK system and bibliometrics provides core indices for quality in this system. In the Flemish region of Belgium, science policy has evolved very much into the direction of scientometric-based evaluation and allocation rules. Two mechanisms, the BOF and the IOF, rely heavily on bibliometric analysis. The BOF (i.e., the Bijzonder Onderzoeksfonds) mechanism distributes R&D funding to universities for basic research. The IOF (i.e., Industrieel Onderzoeksfonds) mechanism provides funding to universities for industry-relevant research. In order to better serve the bibliometric-based evaluation mechanisms, a specific organization, the Steunpunt O&O Indicatoren (SOOI), was established in 2002 and was renamed as Centre for Research & Development Monitoring (Expertisecentrum Onderzoek en Ontwikkelingsmonitoring, ECOOM). ECOOM is an interuniversity consortium with participation of all Flemish universities (K.U. Leuven, UGent, VUB, UA and UHasselt). The K.U. Leuven is responsible for indicators on research output and innovation. Ghent University focuses on Human Resources in Research (doctorates, doctoral careers and researchers' mobility). The other three Flemish universities (the Free University of Brussels, the University of Antwerp and the University of Hasselt) are partners in the project.

Some other countries also adopt biblometric analysis partly in R&D allocation. For example, linking research funding with quantitative performance measures has been practiced in Australian universities for over a decade (Butler, 2004). In 2005, the Norwegian government introduced an output indicator for scholarly publications in the funding formula for basic funding of research in the Higher Education Sector (Siversen, 2008). In the European Commission Bibliometric indicators also figure prominently in the Seventh Research Framework Program (FP7).

2 Objectives of the book

Up to now, there is no agreed upon model of national innovation, which makes it hard to reach a consensus in terms of what makes one innovation system more innovative (Valdez, 2008). With bibliometric tools and methodology, one can build up more quantitatively robust models to map the development of science, technology and innovation (STI) (Elkana et al., 1978). Bibliometrics plays an important role in performance measurement (Martin & Irvine, 1983; Martin, 1996). In view of the world's interest in China grows with China's increasingly important role in global economy and science, the author and her co-authors have conducted a series of research on China's performance in knowledge production and scholarly communication based on bibliometric instruments. Most of the chapters in the book are originated from journal publications based on such research output.

3 Outline of the book

The book is composed of three parts. The first two parts focus on scholarly communication in science (Part Ⅰ) and social sciences (Part Ⅱ) respectively. Part I contains seven chapters dealing with two issues: journal publications (Chapters 1 ~ 3) and journals publishing the publications (Chapters 4 ~ 7).

Chapter 1 aims at clarifying China's world position in science reflected by productivity, citation of journal publications, as well as R&D investment. Performances of the USA, the UK, Germany, France, Japan, as well as South Korea have been analyzed for comparison. Publication activities of relevant countries in nanotechnology, a front-edge technology being included in national strategic plan of leading nations in the turn of the 20th century, have been explored. This chapter is based on a paper in *Research Policy* (Zhou & Leydesdorff, 2006).

Regional contributions to Chinese scientific publications are explored in Chapter 2. Highly-skewed regional contribution is found with Beijing, Shanghai, Hong Kong, and Jiangsu, the top four in terms of both publications and citations. Hong Kong seems to have reached its potential in publishing international papers. Nevertheless, correlation between R&D expenditure and publications of Chinese leading regions is relatively low, which implies higher investment does not definitely result in higher productivity of publications. This chapter is based on a paper in *Scientometrics* (Zhou et al., 2009).

International collaboration in science is studied in Chapter 3. In ten years (1997–2007), China's internationally co-authored publications increased remarkably but with decreasing contribution to China's total publications because of a lower growth rate. The most important partner countries of China are USA, Japan, Australia, and Singapore. Japan and Singapore are geographically close to China. Scientific proficiency and distance play critical roles in determining possibility of international collaboration, in addition to cultural and political issues. This chapter is based on a publication in *Scientometrics* (Zhou & Glänzel, 2010).

Chapters 4 ~ 7 explore communication structure of Chinese journals from