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International scientific collaboration between Australia and China: A mixed-methodology for investigating the social processes and its implications for national innovation systems

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ABSTRACT

This article is based on a study of international scientific collaboration between Australia and China. The analytical approach adopted for this research takes the concept of scientific and technical human capital (STHC) as a starting point and seeks to explain the role and the extent to which collaboration networks can be utilized as a potential source for gaining access to flows of knowledge, that contribute to both building research careers and strengthening national innovation systems (NISs). The study is based on a combination of bibliometric analysis and interviews. The bibliometric analysis indicates that international scientific collaboration between the two countries has expanded rapidly, from just four co-authored papers in 1981 to 2,040 in 2010. The interviews suggest that a framework of exchange can be used as an approach to explain the underlying dynamics of collaboration. The findings suggest that augmenting the information base with qualitative data helps toward a more comprehensive understanding of science, technology and innovation (ST&I) dynamics. This has potential implications for the formulation of future policies with respect to STHC.

1. Introduction

This paper is concerned with networks for scientific collaboration between Australia and China. The focus is on the role and the extent to which international scientific collaboration can be a source for development of national innovation systems (NISs) for both countries. According to a report prepared by the British Royal Society, international scientific collaboration has expanded on a global scale [1]. There are various forces underpinning international collaboration; mobility is an important one of these [2–5]. Scientists are mobile and as they move through their careers, they establish linkages contributing to the formation and extension of networks [6]. Through these networks scientists share resources for research, and extend their international presence [1,7]. These professional and organizational characteristics of scientific mobility, in turn, have important implications for system development and the building of scientific and technical human capital (STHC) [8]. However, little is known about how scientists' networks are formed and maintained.

Scientific and technical human capital as an analytical concept helps to explain the dynamic network capabilities of scientists. It takes into account the complicated system of professional and social interactions in the context of international collaboration. Bozeman et al. described STHC as:

> … the socially-embedded nature of knowledge creation; transformation and use; and the dynamic, capacity-generating interchange between human and social capital.
>
> [[8, p.719]]

The concept helps to explain the science, technology and innovation (ST&I) capacity for Australia and China beyond the human resource approach. This means where scientists have been and what they did at a particular point in time

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should be considered in the investigation of international collaboration. The approach takes into account the sharing and learning that occurs through both formal and informal channels and in social or profession contexts (see [3,9–12]).

Many countries have adopted a NIS approach for national development (see [13–15]). The NIS approach investigates the learning capacity of institutions for national development. Lundvall et al. defined a NIS as:

> … an open, evolving and complex system that encompasses relationships within and between organizations, institutions and socio-economic structures which determine the rate and direction of innovation and competence-building emanating from processes of science-based and experience-based learning.
>
> [[16, p.6]]

However, understanding the dynamics of a NIS is a complex process. It involves a wide range of social and professional factors, formal and informal networks; and sharing and learning activities [17–19]. The NIS presumes and measures the presence of a national research system (among other components). Both Australia [20] and China [21] have emphasized the need to utilize global avenues as a source for NIS development [14,22]. This is because a sufficient STHC base needs to be in place in order for the system to develop [23,24].

The NIS depends on productive relationships between institutions as well as between countries (see [25]). Although the NIS approach does recognize social capital as an important component for national development [16], it appears insufficient in investigating the social process of relationship building between individual scientists. Interactions between scientists are important because individuals are at the front end of innovation. The present study argues that a social exchange process, built on personal relationships and trust, is central to international science collaboration. The creation and application of knowledge within and across NIS 'borders' is underpinned by an organic process through which scientists share and exchange resources to fulfill various expectations.

Scientists are not alone in the process of collaboration. They also respond to the expectations of the state, funding agencies and their organizational employers. For example, policy initiatives of governments to promote mobility are an example of how states can influence the behavior of scientists while responding to global pressure of the need to develop the NIS. The Australian and the Chinese national governments have both made significant policy efforts to stimulate the international movement of researchers [20,26,27]. A significant turning point for building international connections between China and countries in the North came with the implementation of the nation's 'Reform and Opening-up' regime in 1978 [26,28], and a series of national science reforms that followed [21,29]. The inflow and outflow mobility of students and scholars over the past three decades has helped the nation to build international connections as shown by Xiang [27]; Australia is one of China's international partners in science [30], with connections established at the individual level (see for example: [12,31]) and the institutional level (see for example: [32,33]).

The networks constructed through scientists' mobility are recognized as having a positive impact on STHC for Australia and China [14,20,24,34]. Developments in information technology have clearly contributed to increase flows of information [1,35]. Australia and China are part of this global trend. For example, the number of joint scientific publications produced between Australia and mainland China has expanded from just 4 in 1981 to 2,040 in 2010 [36]. The increase in joint research, as measured by the proxy of co-authored publications, reflects increased international collaboration.

However, relying only on bibliometric analysis to measure international collaboration misses some important information about how co-authorship evolves and what is actually shared [37]. Scientists do not live in a social vacuum [38] and the reasons behind two or more scientists publishing a paper together need to be considered beyond that of a scientific and technical in nature [39]. Bozeman et al. argued that '… in modern science being scientifically brilliant is only necessary, not sufficient' [8, p.724]. In the context of publications, that 'sufficiency' is not just about whether the work is of any academic value worth publishing but also how to locate the path for getting it published. The present study sets out a research methodology that demonstrates how bibliometrics and interview data can provide a useful mixed methodological and analytical approach for the study of international collaboration in science.

The methodology includes two parts: the first is bibliometric analysis of co-authored papers indexed in the Science Citation Index Expanded (SCIE) and of scientific publications collected from Scopus. This is used as an indicator to describe the location of dispersed/diaspora knowledge networks constructed and maintained between scientists working in Australia and China.[1] This is followed by a second phase: a qualitative analysis of selected interviews conducted with collaborating scientists in Australia and China. The latter focuses on the Beijing and Tianjin municipalities. In this part of the study, scientists identified from the bibliometric analysis were asked questions about their motivations, aspirations, and career trajectories with respect to international collaboration. The interviews help reveal the underlying dynamics of collaboration indicated by the bibliometric analysis.

2. International scientific collaboration, STHC and the NIS

Australia and China both recognize the importance of gaining access to the flow of knowledge for development of NIS. This is reflected in policy initiatives such as Australia's most recent review of the NIS [20] and China's National Medium- and Long-term S&T Development Plan (2006–2020) [42]. With an overarching aim of improving the country's innovation performance, this Chinese policy reaffirms the need to utilize international connections for the development of China's NIS [42,43]. Likewise, the Cutler Review argued that Australia needs to utilize international networks to develop NIS, while also stressing the need to expand connections with China for both social and economic gains [20]. The need to strengthen

[1] According to Stein and Stren, knowledge networks (KNs) are '… spatially diffuse structures, often aggregations of individuals and organizations, linked together by shared interest in and concern about a puzzling problem' [40, p.7]. Dispersed KNs contain the connections and nodes established and maintained between scientists for the production and diffusion of knowledge (see [41]).

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