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Scientific collaboration in indigenous knowledge in context: Insights from publication and co-publication network analysis

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ABSTRACT

Scientific collaboration has been cited as a major stimulant in innovation and a major component for the development of indigenous technologies particularly in countries invested in rapid technological catch-up in East Asia and Southeast Asia. In this study, we assess the comparative advantage of the selected economies and employ a network perspective to drill down to the case study of indigenous knowledge, using the traditional medicine sector – a focus indigenous industry of several Asian economies – to understand how the State, Industry and Universities link to drive innovation in this growing field. From our selected economies in East Asia, we identified three network models that describe the outcomes of the innovation strategies in place, a network-based extension of previous studies. We examine publication output and co-publication network structures to investigate the comparative advantage and composition of the research networks in the various economies. Our results suggest that the university-centric model remains the most popular, with Hong Kong appearing to attain the most functional innovation system with a competitive selection environment and high comparative advantage in this field. We propose this methodology as a means to explore the scientific infrastructure of a specific sector, thereby acting as a precursor to forecasting potential technological spill-over and growth in specific sectors.

1. Introduction

The rapid growth and development of East and South East Asia in the past 25 years has drawn much attention to the technological catching-up capabilities of national innovation systems in fast developing countries such as Taiwan, Singapore and South Korea, within established global value chains (Whang and Hobday, 2011; Wong and Goh, 2015). Nonetheless, the 1990s also saw a new emphasis on incorporating the development and deepening of indigenous technologies in the national innovation agenda — in order to leverage on existing knowledge within the population to explore new export activities and satisfy local demand.

The development and success of indigenous technologies would provide a new dimension to the Newly Industrialized Economies (NIEs) such as Taiwan, South Korea, Hong Kong and Singapore as well as rapidly developing countries such as Malaysia and China. Rather than relying on catching-up strategies, in established technological sectors, pioneering new sectors based on indigenous knowledge would grant 'first mover' advantages and tip the scales from the West to the East. This is particularly true for countries such as Malaysia and Singapore, who have adopted a model that leverages heavily on foreign direct investment (FDI) and the presence of manufacturing activities of multi-national companies (MNCs) to drive exports, secondary industries, and knowledge transfer (Wong and Goh, 2015).

The purpose of this paper is to investigate how research entities organize themselves in order to create a network routine for scientific output as a multiplier effect for subsequent technological spill-over. We do so by visualizing dynamic growth patterns in scientific output and scientific capability (as a proxy for "creative accumulation") and cross-analyze this with university-industry-government-linkages represented by co-publication networks.

Network analysis has been used to visualize and analyze knowledge networks in specific sectors such as nanotechnology, bio-pharmaceuticals, and biotechnology (Calero et al., 2007; Eslami et al., 2013; Miyazaki and Islam, 2007), as well as at a national level (Park and Yoon, 2014). However, there remain many uncharted sectors that warrant study, particularly in the bio-based disciplines where scientific research and publishing is a core activity in product development and registration. Even more so, there is a lack of studies on the modernization or legitimization of traditional knowledge through science which

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is a phenomenon we have observed in East Asia and Southeast Asia in particular in recent years. We see value in applying a bibliometric approach to studying this angle of research in more detail.

1.1. The case of traditional medicine

For the purposes of this study, we explore the case of traditional medicine as an example of indigenous knowledge in several economies in Asia: China, Hong Kong, Japan, Malaysia, Singapore, South Korea and Taiwan. We define traditional medicine as sole or mixtures of natural products consumed or administered based on traditional medicine systems indigenous to the local population. In the case of multicultural countries such as Malaysia and Singapore, this encompasses the traditional medical systems of several ethnicities.

The World Health Organization released the "WHO Traditional Medicine Strategy 2014–2023" in 2013 to map out the necessary steps for countries to implement a comprehensive traditional medicine strategy (World Health Organization, 2013). Not only does it have potential for the development of consumer goods (such as drinks, tonics and supplements) but also has the potential for the development of blockbuster drugs and pain mitigation (artemisinin, camptothecin, arsenic trioxide, acupuncture) (Hafsi and Hu, 2016; Qiu, 2007; Shen et al., 1997; Tu, 2011; Wall et al., 1966; Xutian et al., 2009).

The modernization of the traditional medicine industry is a key element of the healthcare and bio-economic agendas of the respective economies studied. We observe a wave of State intervention in the 1990s in these economies to improve the regulation and promotion of traditional medicine (Chen, 2012; Xu et al., 2013). A by-product of this stress inflicted on the industry is the consistent production of scientific papers which act as credible evidence to meet the exacting international standards placed on health products.

1.2. Research questions

In this study, we wish to analyze the growth of scientific activity and scientific capability in traditional medicine research, and investigate the comparative advantage of selected economies. In this case, we define scientific activity as the production of scientific articles in peer reviewed journals whereas scientific capability is represented by the ratio of the production of scientific articles to the population of the economy in question.

We are also attempting to determine a rough typology of how organizations organize themselves through co-publication routines in order to gain insight into research network structures. As scientists from different institutions collaborate, we are able to track the overall research network of the economy based on the affiliations of the various individuals.

In this study, we analyze the co-publication networks of the economies mentioned to ascertain the key universities and research institutes in the field of traditional medicine cross-analyzed against the national innovation strategies in order to draw potential innovation policy implications relevant to this growing industry. By comparing the networks we derive and the innovation strategies that are employed by specific economies we hope to derive useful policy lessons.

Pursuant to these research objectives, we wish to propose the following methodologies as a means for policy makers and innovation scholars in identifying competencies, gaps and opportunities in the emerging area of traditional medicine.

2. Literature review

Academia, industry and government exist in an evolving network of communication from which interactive learning and knowledge spillover occurs leading to innovations which drive the advancement of technology industries (Caraça et al., 2009; Leydesdorff and Etzkowitz, 1998). The case of traditional medicine, presents an interesting case study as we see varying strategies from the selected economies with regard to the development of research networks.

Traditionally, the role of pioneering product technology falls on industrial firms, profit-centric entities that bring technology applications to market with the State acting as facilitator, referee, and supporter whether in terms of funding, networking and collaborating (research and development) (Wong, 1999; Wong and Goh, 2015). However, in highly-regulated sectors with an infantile or relatively low-to-medium tech industry – such as traditional medicine – firm performance in knowledge building can be lacklustre, due to the high cost for research and development and the low likelihood of return on investment. Because of the absence or lack of highly innovative firms – due to high market and scientific uncertainty – we argue that the role of academia and public research institutes is increased to compensate for the lack of participation from industrial firms in research and development.

For the purposes of this study, we focus on identifying capability, potential path dependency and interaction based on the network maps derived from our network analysis of the selected economies as well as relative comparative advantage (Woolthuis et al., 2005).

2.1. Capability development

We are also concerned with capabilities, where systems may be locked in to existing technologies due to the lack of learning capability or manpower, thus not being able to progress into more advanced technologies (Malerba, 2002; Smith, 1999). This is particularly true for the case of indigenous technologies and traditional knowledge where economies are forced to rely on local capabilities in order to bring products to market, as opposed to imported technologies or knowledge that has been developed elsewhere.

Caraça et al. (2009) proposed a multi-channel interactive learning model which portrays the innovation landscape as intertwining loops of relationships between firms, research institutions and market forces. One strategy to streamline this is through academic collaboration with local and foreign universities/institutes, thus stimulating knowledge flow; sharing of resources and building of personal networks; all of which have contributed to the health of the innovation system. This can be visualized using co-publication network analysis.

The development and building capability of local entrepreneurs is crucial to the sustainable development of indigenous production capacity, which will in turn lead to the enhanced continuous cycles of science and technology evidenced by statistics taken from scientometric data (publications and patents) (Amsden, 1989; Wong and Goh, 2015). Thus, local universities and PRIs play a crucial role in developing knowledge workers and entrepreneurs that will spearhead this industry through their research activity and pool of active researchers on staff.

For this study, we measure capability development through bibliometric output and comparative advantage of specific economies in traditional medicine. We believe that a comparative advantage analysis would reveal the accumulation of competency over time which would serve as a useful proxy for capability development.

2.2. Path dependency and interaction

We define path dependency and interaction in the context of this study as that among the research community in traditional medicine. In order for us to study this, we focus on co-publication between actors in traditional medicine measured through network analysis. This methodology has been used by Miyazaki and Islam (2007) to measure knowledge networks as well as class specializations for different countries in nanotechnology.

Network analysis has been utilized in the past for the purposes of measuring the diffusion of technology and theorizing university-industry relations in high tech sectors such as biotechnology as well as in assessing scientific excellence at a macro level (Bornmann et al., 2015; Leydesdorff, 2004; Rogers, 2010; Valente, 2010). It has also been used

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