



# Intra- and inter-regional research collaboration across organizational boundaries: Evolving patterns in China

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## ABSTRACT

Both intra-regional and inter-regional research collaborations are significant determinants for regional innovation. However, systematic and empirical studies have seldom been reported integrating both of them. The present study advances a research agenda around a two-dimensional quadrant (TDQ) analytical framework to investigate regional research collaboration. It then applies such a framework to the Chinese case by examining collaborative invention patent applications between 1985 and 2008 with China's patent office. The results show that, first, the correlation between innovation capability and collaborative research was evolving, and the correlation between innovation capability and collaboration between enterprises (EE) is weaker than that between academic institutes and enterprises (AE); second, the intra-regional collaboration intensity was higher than the inter-regional one and AE collaboration dominated the regional collaboration; third, during the process of market-oriented reform, China's major innovative regions with different collaborative patterns were shifting from collaborative to independent research, from inter-regional collaboration to intra-regional collaboration, and from AE to EE collaboration, particularly in their inter-regional collaboration.

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## 1. Introduction

As a channel of open innovation, inter-organizational research collaboration boosts the flow of technology and knowledge between actors of an innovation system (Chesbrough et al., 2008; OECD, 1997). With recent advance in information and telecommunication technologies, especially Internet-based applications such as email, MSN, Skype, Facebook, and Twitter, “the tyranny of distance” seems to be no longer that influential (Castells, 1996; Cairncross, 1997). Nevertheless, geographic proximity and spatial physical distance still matter, because innovative actors in close vicinity tend to interact more frequently and intensively than those at a distance (Katz, 1994; Hoekman et al., 2010). Consequently, collaboration within a certain distance is significant, and may explain the difference

between regions in their performance in innovation (Döring and Schnellenbach, 2006).

Such difference is not only possibly determined by collaborative research within regional boundaries shaping regional knowledge bases but also possibly influenced by the knowledge spillover or sharing across regional boundaries through collaboration (Yang and Lin, 2012). Thus, intra-regional collaborative research and inter-regional collaborative research are both useful options for organizations to seek external knowledge, which consequently could also strategically narrow the regional difference in innovation. The existing literature has paid more attention to intra-regional or inter-regional collaboration and recognized the significance of distinguishing research collaboration within and across regional boundaries. However, systematic and empirical studies have seldom been carried out regarding the patterns of intra- and inter-regional research collaboration and their respective forms of inter-organizational research collaboration (more details in Section 2).

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Specifically, China, after a series of reform of its S&T system, has become a powerhouse in research and development (R&D). In 2012, China's research intensity (GERD/GDP) reached 1.98%, surpassing the 28 member states of the European Union, which together managed 1.96% (Sun and Cao, 2014). However, in contrast to Europe, which has received empirical examination of its regional collaboration, China, with its territory similar to Europe, has not been given attention in this respect. Indeed, the S&T reform, which started in 1985, boosted the enthusiasm of Chinese enterprises, universities and research institutes to be innovative, of which collaboration has been one of the main approaches.

In March 1985, when the market-oriented economic reform and opening-up had proceeded for several years, Deng Xiaoping made an important speech entitled *The Reform of the S&T System Is to Liberate the Productive Forces* during the National Science and Technology Work Conference. The Chinese Communist Party Central Committee and the State Council subsequently issued the *Decision on the Reforms of the S&T System* (Liu et al., 2011). From then on, China pushed forward to orient its S&T system toward serving the economy (Sun and Liu, 2010), which in turn would increasingly depend on the S&T development and better integrate S&T and the economy.

At this early stage of the S&T development and transition toward a market-oriented economy when the *Patent Law* was also recently enacted, there were not many patent applications, let alone collaborative ones. However, the collaboration between enterprises and academic institutions was encouraged since China's research resources were mainly concentrated at national research institutions such as the Chinese Academy of Science (CAS) and universities while enterprises were weak in terms of their innovative capability. Indeed, organizations were reluctant to collaborate out of the concerns of profit distribution, risk sharing, and ownership of intellectual property right (IPR). Meanwhile, Chinese organizations were still separated by the "tiao" (or ministerial) and "kuai" (or regional) relationship.

Deng Xiaoping's southern tour in 1992 has restarted China's reform and open-door initiative. The Chinese state has also issued policies to encourage collaboration. For example, in 1992, the State Education Commission (now the Ministry of Education), the State Economic and Trade Commission (repealed in 2003), and CAS launched the "Joint Development Programme of Industry–University–Research Institution (IUR)" (Sun, 1992). Then, the central government encouraged research collaboration via establishing joint units and cooperation platform, such as joint research and development centers, enterprise technology transfer centers, university science parks, joint committees of university–enterprise cooperation for research collaboration.

In May 1995, the government put forward the *Strategy of Revitalizing through Science and Education* and issued the *Decision on Accelerating Scientific and Technological Development* in the National Science and Technology Conference (Liu et al., 2011). The policy inspired enterprises to be more innovative and to pursue patent protection, and enhancing technological capability became more important for Chinese organizations, which started to concern more about their own economic interests instead of purely following administrative order. But collaboration was not a good choice for innovative organizations in economic transition. There was more collaboration between academic institutions and enterprises but less between enterprises because government and

administrative mechanism were in play while market mechanism was still in its infancy.

In August 1999, the Chinese government issued the *Decision on Strengthening Technological Innovation, Developing High Technology and Realizing Industrialization*, clarifying the task to speed up industrialization of S&T achievements. Strengthening the linkages between the economy and S&T has become most important and urgent for the reform of the S&T system. With the deepening of the economic reform after 1992 and in particular after 2000, an organization could decide whether and with whom to collaborate based on its own interests and the market rules, not necessarily considering the "tiao" and "kuai" administrative relationship.

The government has introduced a series of measures to promote collaboration between innovative actors and to incentivize inter-organizational collaboration, including corporatizing applied-oriented research institutes, setting up technology market and nurturing an environment for IPR protection. With marketization and enterprises enhancing innovation capability, collaboration between enterprises has also increased rapidly. At the same time, local governments have also introduced relevant policies to encourage collaboration to achieve rapid innovation-driven regional economic growth. For example, since 1999 Beijing municipal government has issued a series of policies with respect to high-tech development, technology market, S&T intermediaries, and the development of the Zhongguancun Science Park to drive collaboration between academia and enterprises. In 2007 the local government published a special document to encourage collaboration between industry, universities and R&D institutes via fiscal and tax incentives, S&T programs, and the creation of an environment conducive to innovation.

It is against the above background, in this paper, we advance an analytical framework for identifying regional choices of collaborative or independent innovation, intra- or inter-regional collaboration, and collaboration between enterprises (EE) or between academic institutions (universities and research institutes) and enterprises (AE). Then, we apply the framework to the longitudinal analysis of China's inter-organizational research collaboration in its 31 provinces and municipalities by using invention patenting activities as a measure. In particular, we examine a region's research collaboration patterns and evolving intra- and inter-regional research collaboration and EE and AE collaboration so as to help understand the characteristics of China's regional innovation system. Certainly, findings from the Chinese case may not be applicable to other countries; but the regional collaboration patterns identified in our study could be useful for policymakers elsewhere.

The remainder of the paper is structured as follows. Section 2 reviews relevant literature, Sections 3 and 4 introduce the framework and data used in this empirical study respectively, followed by a discussion of the research results of China's case in Sections 5 and 6. The last section presents conclusions and implications.

## 2. Intra- and inter-regional research collaboration: a literature review

### 2.1. Intra-regional research collaboration

Within a regional innovation system, geographic proximity obviously constitutes a clear advantage for establishing or

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