https://doi.org/10.1142/9789819807611_0001

Chapter 1

Collaborative Efforts for Boosting Innovation: The Complex Role of Innovation Intermediaries in China

Antonio Crupi[*,¶], Dominique Lepore[†,§], and Francesca Spigarelli[‡,‖]

[*]*Department of Economics, University of Messina, Italy*

[†]*Department of Economics, Statistics and Business, Universitas Mercatorum, Italy*

[‡]*Department of Law, University of Macerata, Italy*

[§]*dominique.lepore@unimercatorum.it*

[¶]*crupi.antonio@unime.it*

[‖]*francesca.spigarelli@unimc.it*

Abstract

In China's rapidly evolving innovation landscape, collaborative efforts among diverse stakeholders drive the development of groundbreaking solutions. This imperative is fostered by recent governmental policies that emphasize the need for cohesive collaboration among government, industries, and academia.

However, effective knowledge and resource exchange among these stakeholders poses significant challenges due to the differing objectives and interests.

To navigate these complexities, China must adapt its institutional environment to foster collaborative relationships among key innovation actors. In addressing these challenges, innovation intermediaries emerge as facilitators, bridging gaps between diverse actors and facilitating knowledge exchange and integration. The landscape of innovation intermediaries in China is diverse, ranging from government-initiated entities to private-sector agents, each with varying degrees of effectiveness and alignment with broader innovation goals.

Keywords: Collaboration, China, innovation intermediaries, triple helix, open innovation.

1. Introduction

In China, the innovation ecosystem is evolving rapidly. According to the Global Innovation Index (GII) of 2023, China is an innovation leader ranked at the 12th position among the 132 economies studied. This position is a remarkable improvement considering the country's 29th position back in 2015. Moreover, the GII shows that the country is positioned as the 1st among the upper-middle-income group economies. In terms of gross domestic expenditure on R&D, China is the second absolute spender after the United States. Moreover, China's R&D as percentage of Gross Domestic Product (GDP) has risen from 1.71% in 2010 to 2.45% in 2021. The business sector accounts for the largest expenditure on R&D increasing from 60% to 76.6% in 2020. The government is instead the second-largest R&D performer accounting for 15,7% of GERD in 2020. Additionally, China recorded 2.28 million researchers in 2020, which is the largest number in the world (OECD, 2023).

To continue boosting innovation, collaboration among different actors, including government, industries, and academia is imperative. In these regards, the Chinese government has issued a set of policies where relations among key stakeholders are becoming relevant, including the Chinese 14th Five-Year Plan (2021–2025) and the Long-Range Objectives to 2035 (Yao *et al*., 2021).

However, when considering collaborative approaches to innovation, ensuring an effective exchange of knowledge and resources among different stakeholders can be challenging due to different objectives and interests (Lepore, 2023). Furthermore, China has to adjust some elements of its institutional environment to facilitate the relations between key innovation actors and develop its own collaborative models (Cai, 2014).

Thereby, innovation intermediaries are necessary to foster and adjust collaborative approaches to innovation (Howells, 2006).

This chapter aims to introduce why innovation intermediaries are needed for boosting innovation as well as their multivariate nature within the Chinese innovation ecosystem.

After reviewing how collaboration can benefit innovation, a focus is dedicated to the rise of open innovation in China. Then, the role of innovation intermediaries in China is presented. Lastly, some conclusive remarks are outlined.

2. Collaborative Efforts for Boosting Innovation

Collaboration among many different stakeholders is necessary for supporting the development of innovative products and processes. Indeed, innovative solutions are often driven by exchanges of knowledge, skills, and resources among government, industry, and academia in the form of a Triple Helix model (Etzkowitz, 2008). The Triple Helix indicates not only the relationship between university, industry, and government but also the internal transformation within each of these spheres. In particular, the university has been transformed from a teaching institution into one which combines teaching with research and plays an active role in technology and knowledge transfer. The Triple Helix model has also evolved into a Quadruple Helix model. This model adds as the fourth helix the "public", more precisely defined as the "media-based and culture-based public" (Etzkowitz and Leydesdorff, 2000).

In the era of Industry 4.0, collaboration between academia, government, firms, and users is crucial. Industry 4.0 based on technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and blockchain, connects products, machines, and people with the environment and combines production, information technology, and the internet (Kagermann *et al*., 2013). In this complex scenario, the exchange of knowledge and resources can support firms adopt and develop innovative solutions. This is especially true for Small and Medium-Sized Enterprises (SMEs) facing financial and organizational constraints that obstacle their innovative performance (Lepore *et al*., 2023).

Collaboration among stakeholders becomes even more crucial as we transition from Industry 4.0 to Industry 5.0. This paradigm places more emphasis on human progress and well-being, overcoming the lack of attention of Industry 4.0 for the climate crisis, planetary emergency, and social tensions (Breque *et al*., 2021).

Concerning collaborative efforts for boosting innovation, the Chinese government has issued a set of relevant policies and regulations. These policies were introduced to facilitate the development of national scientific and technological innovation. Among these, the Chinese 14th Five-Year Plan (2021–2025) and the Long-Range Objectives to 2035 signal that China will optimize the resource allocation and knowledge sharing from scientific research institutes, universities, and enterprises, to enhance the efficiency of the innovation chain (Yao *et al*., 2021).

Focusing on academic collaborations in China, Zhou and Wang (2023) suggest that the government and universities should jointly launch R&D institutions to advance business incubation and regional industrial and economic development. The authors specify that within this type of partnership, universities, and scientific research institutions should be the source of technology and entrepreneurs while the government should act as financial support and technology buyer. Similarly, when focusing on academic collaborations, Kafouros *et al*. (2015) argue that institutions in China greatly impact their effectiveness.

In a more general perspective, Jensen and Schøtt (2014) note that even if networking and innovation are as extensive in China as abroad, and networking has a positive effect on innovation, the benefits in China are less than in the rest of the world. The authors suggest that this lesser efficiency is due to the guanxi tradition, referring to relationships that are long-term and supportive but that probably do not promote innovation.

The Triple Helix model has been used to investigate the relationships between the three helices in China. Li *et al*. (2020) by using this analytical framework found that interactions within the three helices have a positive impact on regional entrepreneurship by impacting the local entrepreneurial environment and advancing entrepreneurship activities. Furthermore, their study recognizes the significance of networking connections in facilitating the exchange of high-quality information, enhancing trust among collaborators, and fostering sustained collaboration and shared growth among academic institutions, the business sector, and government bodies. However, Cai (2014), acknowledging that the Triple Helix concept has been developed in advanced economies, suggests that China has to develop its own collaborative model. In particular, to optimise its innovation policies, China needs to adjust some elements of its institutional environment to facilitate the relations between key innovation actors (Cai, 2014).

The rise of open innovation in China further illustrates the shift toward more inclusive and externally engaged innovation practices, as the following paragraph addresses.

2.1 *The rise of open innovation*

The Open innovation paradigm is defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation" (Chesbrough, 2006, p. 1). This paradigm suggests that ideas can come from inside and outside the company and can go to market from inside or outside the company. Three core processes can be differentiated in open innovation. The outside-in process is based on integrating external knowledge sources, the inside-out process focuses on transferring ideas outside, for instance, by licensing intellectual property, and the coupled is grounded on co-creation with partners (Enkel *et al*., 2009).

China, alongside South Korea, emerged as a leading Asian country in open innovation research. China's prominent position can be attributed to its strong commitment to fostering an innovative economy on a global scale. This commitment is evident in the strategies adopted by Chinese companies to enhance their innovation capabilities, including technology licensing (Le *et al*., 2019). Indeed, Chinese firms have employed a variety of open innovation models since the reforms of the science and technology system in the mid-1980s. Policies introduced by the Chinese government for acquiring foreign technology, industry-university collaboration, and the "go global" strategy have encouraged Chinese firms to open innovation modes (Fu and Xiong, 2011).

Empirical studies indicate that Chinese companies operating in high-tech sectors widely adopt open innovation strategies to enhance their innovation capabilities. Specifically, these firms leverage technology licensing agreements to acquire new technologies, forge long-term partnerships with foreign counterparts to access cutting-edge innovations, collaborate with domestic universities and research institutes to extend their technological strength, and engage with local industries to further develop their technological expertise (Wang *et al*., 2012).

Other studies highlight the barriers to the adoption of open innovation by Chinese firms explaining that these might be largely related to the comparatively weak domestic research expertise and limited organisational

absorptive capabilities, with this most particularly evident for SMEs. At the same time, it is also confirmed that external knowledge sources from inter-firm networking are more important in creating the benefits of open innovation for Chinese SMEs than their larger peers (Huang *et al*., 2015).

3. Bridging the Gap: The Nature of Innovation Intermediaries in China

Collaboration itself is not straightforward. The variety of actors, spanning government, academia, industries, and recently also citizens share different objectives and interests. What makes it more complex is that they often speak different languages (Lepore, 2023). Moreover, as previously discussed, China has to facilitate relationships among innovation key actors, developing its own collaborative models (Cai, 2014).

This is why it becomes significant to consider the role of innovation intermediaries. Innovation intermediaries are structures that connect two or more parties in innovation processes (Howells, 2006). These entities by focusing on transferring and integrating external knowledge are also identified as boundary spanners, gatekeepers, and knowledge brokers (Haas, 2015). More specifically, innovation intermediaries can drive the sharing of technology-related knowledge, offer knowledge-based services, and provide policy advice. Through their multiple functions, intermediaries can support firms, especially SMEs, in introducing and developing innovative products or processes (Crupi *et al*., 2020).

China is aware of the importance of implementing policies for innovation intermediaries. The first policies of this kind refer to the 1980s when the reform of the science and technology (S&T) regime began (Wang and Wang, 2017). Among these policies, the Torch Programme was introduced in 1988 to support the commercialization of Chinese R&D. This Programme includes elements of decentralized institutional and policy experimentation such as an enterprise-dominated financing scheme and incubator activities (Heilmann *et al*., 2013).

The literature reveals a broad range of innovation intermediaries in China. In these regards, Xiaoyuan and Yanning (2011) distinguish three levels based on their involvement in the R&D activities of an enterprise. The core layer includes structures such as research centers offering advanced engineering and technological services including technology testing and design. The supporting layer is represented by organizations,

such as technology consulting firms, providing advisory services for various types of innovation challenges. Lastly, the corresponding layer features organizations like business incubators, science parks, high-tech development zones, and venture capital organizations which provide training, equipment, and financial support for innovation activities.

Dalziel and Yao (2010) analyzed six main types of innovation intermediaries in China, including government research institutes, property-based enablers such as science parks and business incubators, technology transfer offices, economic development organizations, industry associations, and business financing and support programs. The author noticed that most of these innovation intermediaries are initiated, financed, and operated by the government and may be poorly suited to support innovation that crosses industrial or disciplinary boundaries.

Indeed, there are studies such as that of Yao *et al*. (2022) focusing on Chinese industrial associations as institutional intermediaries providing both information and legitimacy. Such institutional linkages can, on the one hand, strengthen firm innovation by facilitating access to necessary government support and, on the other hand, impede it because they create regulatory institutional pressures (Yao *et al*., 2022). In a more general perspective, the Chinese government itself has been also recognized as a broker in facilitating technology transfer and lowering costs and risks (Wang, 2010). In opposition, some studies focused their attention on private technology service agents in China, especially within industrial clusters. Their role as technology gatekeepers and spanners, technical problem solvers, and innovation resource integrators can drive technological development and business growth (Guo and Guo, 2013).

Going more in-depth some remarkable functions can be found. This is the case of science parks which can connect domestic and international triple helices by linking academia, governments, and firms through partnerships and networking activities (Compagnucci *et al*., 2021). International connections are also identified as a key function of business incubators. In particular, Gao *et al*. (2021) show that these structures can act as international knowledge intermediaries and facilitate the international growth of startups originating from emerging markets and ultimately create international linkages between the networks of knowledge creation and knowledge application.

University satellite institutes are another type of innovation intermediary analyzed in China. These institutes can help overcome local barriers to university-industry interaction, interregional technology transfer, and

innovation. They can do so by brokering relevant knowledge to local industry and by gathering resources to create a critical mass for attracting external resources (Conlé *et al*., 2023).

When considering innovation intermediaries, scholars have also addressed specific sectors that deserve attention in the Chinese context. Referring to agricultural innovation, Li *et al*. (2022) recognize that little emphasis has been given to the role of innovation intermediaries in supporting the coevolution process of innovation at the community level in rural China. The authors offer a case study of the Science and Technology Backyard (STB) as a novel type of innovation support intervention designed to promote technical change at the community level. The authors note the evolution of this farming service from knowledge brokers to systemic innovation intermediaries has enabled the coevolution process of innovation inside villages. Instead, by focusing on the smart grid industry, OI intermediaries are developing in the web-based technology marketplace as in the cases analyzed by Chen *et al*. (2016). These intermediaries in particular help Chinese firms to address energy development and conservation issues providing great opportunities for collaborations.

Interestingly, individuals, especially as teams, can cover boundary-spanning activities. These individuals possess abilities suited to crossing organization boundaries as in the case of international joint ventures (Jiang *et al*., 2023). In these regards, Bai *et al*. (2021) show that top-level interpersonal ties have positive effects on both exploratory and exploitative innovation and operating-level interpersonal ties have a greater positive effect on exploitative innovation than on exploratory innovation.

Moreover, Kaiji *et al*. (2022) emphasize the critical role of team boundary-spanners in Chinese companies as innovation triggers. Managers who conduct boundary-spanning activities, including connecting with external resources, negotiating project scopes, and managing external interactions, are focal in enhancing team performance and driving innovation. These activities also improve organizational learning and job performance by facilitating knowledge flows and collaboration, especially in technology transfer contexts.

4. Conclusions

In the rapidly evolving innovation ecosystem of China, collaboration among different innovation actors plays a critical role. Collaborative

efforts are central to China's innovation strategy as outlined in recent policies and scholarly contributions. The rise of open innovation in China further illustrates the shift toward more inclusive and externally engaged innovation practices.

The chapter also addresses the challenges of collaborative innovation, including the adjustment of institutional environments and the development of China's own collaborative models. Innovation intermediaries emerge as critical facilitators, bridging gaps between diverse actors and fostering effective knowledge exchange and collaboration.

These intermediaries, ranging from research centers and consulting firms to incubators and science parks, play a multivariate role in supporting China's innovation ecosystem.

There is thus a need to focus on specific cases of innovation intermediaries to understand and compare their nature and role. This investigation is the aim of the following chapters, which explores the dynamics and strategic importance of these entities within China's innovation ecosystem.

References

Bai, X., Wang, Q., Sheng, S., and Li, J. J. (2021). Cross-level interpersonal ties and IJV innovation: Evidence from China. *Journal of Business Research*, 134, 618–630. https://doi.org/10.1016/j.jbusres.2021.05.047.

Breque, M., Nul, L. D., and Petridis, A. (2021). Industry 5.0: Towards a sustainable, human-centric and resilient European industry. *European Commission, Directorate-General for Research and Innovation*. https://doi.org/10.2777/308407.

Cai, Y. (2014). Implementing the Triple Helix model in a non-Western context: An institutional logics perspective. *Triple Helix*, 1(1), 1. https://doi.org/10.1186/s40604-014-0001-2.

Chen, H. H., Chen, S., and Lan, Y. (2016). Attaining a sustainable competitive advantage in the smart grid industry of China using suitable open innovation intermediaries. *Renewable and Sustainable Energy Reviews*, 62, 1083–1091. https://doi.org/10.1016/j.rser.2016.03.008.

Chesbrough, H. W. (2006). Open innovation: A new paradigm for understanding industrial innovation. In *Open Innovation: Researching a New Paradigm*, edited by H. Chesbrough, W. Vanhaverbeke, and J. West. Oxford: *Oxford University Press*.

Compagnucci, L., Lepore, D., and Spigarelli, F. (2021). Exploring the foreign exposure of Chinese science parks in a triple helix model. *Forum for Social Economics*, 50(3), 330–354. https://doi.org/10.1080/07360932.2020.1759440.

Conlé, M., Ten Brink, T., and Zhao, W. (2023). Innovation platforms as a tool for anchoring non-local knowledge: Smart specialisation strategies in Guangdong, China. *Industry and Innovation*, 30(6), 694–718. https://doi.org/10.1080/13662716.2022.2132919.

Crupi, A., Del Sarto, N., Di Minin, A., Gregori, G. L., Lepore, D., Marinelli, L., and Spigarelli, F. (2020). The digital transformation of SMEs — a new knowledge broker called the digital innovation hub. *Journal of Knowledge Management*, 24(6), 1263–1288. https://doi.org/10.1108/JKM-11-2019-0623.

Dalziel, M. and Yao, W. (2010). Innovation intermediaries in China. *SSRN Electronic Journal*, pp. 1–28. https://doi.org/10.2139/ssrn.2630739.

Enkel, E., Gassmann, O., and Chesbrough, H. (2009). Open R&D and open innovation: Exploring the phenomenon. *R&D Management*, 39(4), 311–316. https://doi.org/10.1111/j.1467-9310.2009.00570.x.

Etzkowitz, H. (2008). *The Triple Helix* (ed.). New York: Routledge. https://doi.org/10.4324/9780203929605.

Etzkowitz, H. and Leydesdorff, L. (2000). The dynamics of innovation: From national systems and "Mode 2" to a triple helix of university–industry–government relations. *Research Policy*, 29(2), 109–123. https://doi.org/10.1016/S0048-7333(99)00055-4.

Fu, X. and Xiong, H. (2011). Open innovation in China: Policies and practices. *Journal of Science and Technology Policy in China*, 2(3), 196–218.

Gao, Q., Cui, L., Lew, Y. K., Li, Z., and Khan, Z. (2021). Business incubators as international knowledge intermediaries: Exploring their role in the internationalization of start-ups from an emerging market. *Journal of International Management*, 27(4), 100861. https://doi.org/10.1016/j.intman.2021.100861.

Guo, J. and Guo, B. (2013). How do innovation intermediaries facilitate knowledge spillovers within industrial clusters? A knowledge-processing perspective. *Asian Journal of Technology Innovation*, 21(sup2), 31–49. https://doi.org/10.1080/19761597.2013.819245.

Haas, A. (2015). Crowding at the frontier: Boundary spanners, gatekeepers and knowledge brokers. *Journal of Knowledge Management*, 19(5), 1029–1047. https://doi.org/10.1108/JKM-01-2015-0036.

Heilmann, S., Shih, L., and Hofem, A. (2013). National planning and local technology zones: Experimental governance in China's torch programme. *The China Quarterly*, 216, 896–919. https://doi.org/10.1017/S0305741013001057.

Howells, J. (2006). Intermediation and the role of intermediaries in innovation. *Research Policy*, 35(5), 715–728. https://doi.org/10.1016/j.respol.2006.03.005.

Huang, F., Rice, J., and Martin, N. (2015). Does open innovation apply to China? Exploring the contingent role of external knowledge sources and internal absorptive capacity in Chinese large firms and SMEs. *Journal of Management & Organization*, 21(5), 594–613.

Jensen, K. W. and Schøtt, T. (2014). Firms' innovation embedded in their networks of collaboration: China compared to the world. *Journal of Chinese Economic and Business Studies*, 12(3), 273–292. https://doi.org/10.1080/14765284.2014.931427.

Jiang, F., Liu, L. X., and Li, J. (2023). From horizontal knowledge sharing to vertical knowledge transfer: The role of boundary-spanning commitment in international joint ventures. *Journal of International Business Studies*, 54(1), 182–202. https://doi.org/10.1057/s41267-022-00507-9.

Kafouros, M., Wang, C., Piperopoulos, P., and Zhang, M. (2015). Academic collaborations and firm innovation performance in China: The role of region-specific institutions. *Research Policy*, 44(3), 803–817. https://doi.org/10.1016/j.respol.2014.11.002.

Kagermann, H., Wahlster, W., and Helbig, J. (2013). *Recommendations for implementing the strategic initiative Industrie 4.0: Securing the future of German manufacturing industry*. Final report of the Industrie 4.0 Working Group. Frankfurt: Acatech.

Kaiji, X., Crupi, A., Di Minin, A., and Cesaroni, F. (2022). Team boundary-spanning activities and performance of technology transfer organizations: Evidence from China. *The Journal of Technology Transfer*, 47, 33–62. https://doi.org/10.1007/s10961-021-09843-8.

Le, H. T. T., Dao, Q. T. M., Pham, V. C., Tran, D. T., and Del Giudice, M. (2019). Global trend of open innovation research: A bibliometric analysis. *Cogent Business & Management*, 6(1). https://doi.org/10.1080/23311975.2019.1633808.

Lepore, D. (2023). Intermediaries in innovation systems: Match or mismatch? *Journal of the Knowledge Economy*. https://doi.org/10.1007/s13132-023-01566-5.

Lepore, D., Vecciolini, C., Micozzi, A., and Spigarelli, F. (2023). Developing technological capabilities for Industry 4.0 adoption: An analysis of the role of inbound open innovation in small and medium-sized enterprises. *Creativity and Innovation Management*, 32(2), 249–265. https://doi.org/10.1111/caim.12551.

Li, J., Leeuwis, C., Heerink, N., and Zhang, W. (2022). The science and technology backyard as a local level innovation intermediary in rural China. *Frontiers of Agricultural Science and Engineering*, 9(4), 558. https://doi.org/10.15302/J-FASE-2022465.

Li, M., He, L., and Zhao, Y. (2020). The triple helix system and regional entrepreneurship in China. *Entrepreneurship & Regional Development*, 32(7–8), 508–530. https://doi.org/10.1080/08985626.2019.1666168.

OECD. (2023). *OECD science, technology and innovation outlook 2023: Enabling transitions in times of disruption*. OECD. https://doi.org/10.1787/0b55736e-en.

Wang, B. (2010). Can CDM bring technology transfer to China? — An empirical study of technology transfer in China's CDM projects. *Energy Policy*, 38(5), 2572–2585. https://doi.org/10.1016/j.enpol.2009.12.052.

Wang, C. (Chengwei), and Wang, L. (2017). Unfolding policies for innovation intermediaries in China: A discourse network analysis. *Science and Public Policy*, 44(3), 354–368, scw068. https://doi.org/10.1093/scipol/scw068.

Wang, Y., Roijakkers, N., Vanhaverbeke, W., and Chen, J. (2012). How Chinese firms employ open innovation to strengthen their innovative performance. *International Journal of Technology Management*, 59(3/4), 235. https://doi.org/10.1504/IJTM.2012.047245.

Xiaoyuan, Z. and Yanning, Z. (2011). Development of Chinese science and technology intermediaries and their integration into the open innovation paradigm. *Technology Analysis & Strategic Management*, 23(1), 25–48. https://doi.org/10.1080/09537325.2011.537103.

Yao, N., Guo, Q., and Tsinopoulos, C. (2022). The bright and dark sides of institutional intermediaries: Industry associations and small-firm innovation. *Research Policy*, 51(1), 104370. https://doi.org/10.1016/j.respol.2021.104370.

Yao, X., Hu, Y., Gong, H., and Chen, D. (2021). Characteristics and evolution of China's industry–university–research collaboration to promote the sustainable development: Based on policy text analysis. *Sustainability*, 13(23), 13105. https://doi.org/10.3390/su132313105.

Zhou, J. and Wang, M. (2023). The role of government-industry-academia partnership in business incubation: Evidence from new R&D institutions in China. *Technology in Society*, 72, 102194. https://doi.org/10.1016/j.techsoc.2022.102194.