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Article

A comparison of the innovation ecosystems in China and Finland using the triple helix model

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Abstract

This research compares and contrasts the innovation ecosystems in China and Finland using the triple helix model of innovation. The Chinese innovation ecosystem prioritizes the industry, as the major recipient of R&D funds, in the knowledge space for generation of new knowledge and innovations, and its consensus space is organized with a top-down approach under the leadership of the national government. The Finnish innovation ecosystem, on the other hand, has a more balanced structure in its consensus space merging top-down and bottom-up approaches with the involvement of multiple stakeholders. It empowers regional innovation ecosystems, and the university has a more prominent role for new knowledge generation in the knowledge space than in China. Our analysis brings suggestions to both China and Finland to further develop their innovation ecosystems.

Keywords: Innovation ecosystem, triple helix model, China, Finland.

1. Introduction

Innovations play a key role in enhancing the competitiveness of firms, and in today's knowledge-based societies, these innovations come to life through the interactions of a network of innovation actors in geographic proximity. The innovation ecosystem refers here to the activities and inter-linkages of innovation actors such as firms, universities, research institutes, financial institutions, and government regulatory bodies (Ranga and Etzkowitz 2013). Literatures on national innovation systems (Lundvall 1992), regional innovation systems (Maskell and Malmberg 1997), clusters (Porter 1998), the triple helix model of innovation (Etzkowitz and Leydesdorff 2000) as well as the quadruple and quintuple helix models of innovation (Carayannis and Rakhmatullin 2014) study these interactions with the purpose of understanding why certain countries or regions are more innovative than others.

Understanding differences in innovation performance of countries requires comparative studies of national innovation ecosystems, which are relatively rare (Fukuda and Watanabe 2008; Solesvik 2017). This research aims to contribute to the existing literature on innovation ecosystems through a comparative study of the innovation ecosystems in China and Finland using the triple helix model of innovation (Etzkowitz and Leydesdorff 2000). The triple helix model is selected as the theoretical framework deliberately rather than the quadruple helix or the quintuple helix models in order to restrict the focus of the study. Comparing the media-based and culture-based public, the fourth sphere of the quadruple and quintuple helix models, and understanding its impact on national innovativeness would be by itself the subject of a separate research because the Chinese and Finnish societies differ in culture, which is a multi-dimensional concept, and the roles of the media are diverse.

There are earlier studies which use the triple helix model to investigate the innovation ecosystem of China (Liu and Huang 2018; Cheng et al. 2019) and Finland (Brännback et al. 2008; Jauhiainen and Suorsa, 2008; Solesvik 2017; Meyer et al., 2018). This study, however, is the first one to compare and contrast the innovation ecosystems of these two countries. These two countries are selected because Finland is a highly innovative country, the 6th in the world according to the 2019 global innovation index ranking, and China, the world's manufacturing factory which ranked the 14th most innovative country in 2019, has been comprehensively upgrading its industry and aspires to become a global innovation hub with its Made in China 2025 strategy (Cornell University et al. 2019). The two countries, however, differ more in the ranking of their entrepreneurship ecosystems. Whereas Finland ranked 12th, China ranked 43rd in the world as measured by the global entrepreneurship index in 2018 (Ács et al. 2018). This comparative study could help China to identify areas to further improve the innovation and entrepreneurship ecosystems based on good practices in Finland. It could also benefit Finland in two ways. First, there could be some learning from the practices in China to improve the Finnish innovation ecosystem which has been stagnant for the last 10 years following the fall of Nokia. Second, as China is a large market with high ambitions, there could be opportunities for stakeholders in the small market of Finland for possible cooperation with Chinese stakeholders in developing joint innovation projects.

This research pursues a qualitative benchmarking approach. Using the triple helix model as the theoretical framework, we study the spheres of government, university and industry as well as their intersections in terms of the relationships and functions of the key innovation actors (Ranga and Etzkowitz 2013). The benchmark study aims to find out who the key innovation actors are, and how their relationships and functions are organized in the two countries.

The rest of the paper is organized as follows. The next section reviews the literature and outlines the theoretical framework. Then the third section presents the methodology, and the fourth section shares the results. Finally, the paper ends with a discussion on the findings, limitations of the research, and avenues for future research.

2. Literature review

2.1 Innovation ecosystems and clusters

Jackson (2011) defines the innovation ecosystem as a dynamic set of complex relationships between actors and entities that aims to enable technology development and innovation. In this definition, the actors are human resources and material resources (e.g., funds and facilities), and the entities include universities, business firms, venture capitalists, research institutes, regional development agencies, business support organizations, funding agencies, and state institutions. In contrast to the business ecosystem, which relates to value capture, the innovation ecosystem relates to value creation (de Vasconcelos Gomes et al. 2018). By combining the two distinct economies of research and commerce, the innovation ecosystem covers all actors and supporting systems (e.g., culture, education, policy, funding and leadership) around the activities of research, product development and commercialization (Estrin 2009; Oh et al. 2016). The diverse research on innovation ecosystems is carried out at macro level (e.g., national innovation ecosystem), middle level (e.g., industry or regional innovation ecosystem), and micro level (e.g., enterprise innovation ecosystem) (Zhao and Zeng 2014), and the main themes of study are open innovation and product platform, strategic management of the innovation ecosystem, evolutionary economics, organization of innovation ecosystems, and ecosystem and innovation constructs (de Vasconcelos Gomes et al. 2018). Despite its popularity, the concept has been subject to criticisms for lacking clarity and rigor as well as its over-emphasis on market forces (Oh et al. 2016).

Clusters are geographic concentrations of interconnected firms and institutions in a particular field, linked by commonalities and complementarities in providing a related group of products or services (Porter 1998). Members of a cluster are very similar to those of an innovation ecosystem. They include firms in an industry and their value chain partners like suppliers and distributors, firms from related industries, banks, venture capitalists, universities, research institutes, regional development agencies, trade associations, and cluster organizations.

Firms benefit from clustering in three ways (Porter 1998; Sölvell et al. 2008). First, they achieve higher levels of efficiency by having access to more specialized assets and suppliers within close proximity. Second, they achieve higher levels of innovation through close interactions with suppliers, collaborators from related industries, and research institutes. Innovations are more likely to occur through knowledge-sharing when close interactions in formal and informal social networks create relationships based on trust. Third, as a result of new ideas and innovations, the rate of new business formation is also higher in clusters. In summary, patenting rates, new business formation, start-up employment and survival, employment growth, and growth of wages are higher in strong clusters (Delgado et al. 2010; Delgado et al. 2012). As a result, many countries around the world have been adopting cluster initiatives and cluster-based economic development policies in order to drive growth and employment. For example, the European Cluster Policy Group was established on October 22, 2008 by a decision of the European Commission to strengthen the quality of cluster programs in Europe. Clustering, however, is not equally beneficial to all firms in improving their innovativeness (Rocha 2004). Studies show that innovation performance improves only when innovative firms co-locate with other innovative firms (Beaudry and Breschi 2003; Folta et al. 2006). Hence, clustering seems to benefit more when firms with high knowledge stocks interact with each other (McCann and Folta 2011).

2.2 The triple helix model of innovation

In the knowledge-based economy, the triadic interactions between the government, industry, and the university are influential in driving innovative regions (Etzkowitz and Leydesdorff 2000). In contrast to the earlier double helix of industry and government, the university takes on an entrepreneurial role in the triple helix model of innovation in addition to its traditional roles of teaching and research, becoming the so-called 'entrepreneurial university' (Etzkowitz et al. 2008). While there are good examples of the entrepreneurial university, e.g., the Massachusetts Institute of Technology and Stanford University, many universities in developing and less developed countries do not have the capabilities that are needed for a well-functioning triple helix model (Liu and Huang 2018). The interactions of the three spheres vary in different contexts. They can be top-down under the leadership of the government (i.e. the 'statist' configuration), or the three spheres can be completely independent from each other (i.e. the 'laissez-faire' configuration) (Etzkowitz and Leydesdorff 2000). In these configurations the government makes policies and legislation, provides infrastructure, and supplies research funding; the industry carries out business activities; and the university educates talent and generates new knowledge (Etzkowitz 2018). The third type of configuration is the 'balanced' configuration where the three spheres intersect with each other in a dynamic way (Etzkowitz and Leydesdorff 2000). This is the optimal configuration because independent hybrid organizations in these intersections create a favorable environment for innovation (Ranga and Etzkowitz 2013; Champenois and Etzkowitz 2018). Examples of hybrid organizations are technology transfer offices at universities, state research institutes, industrial liaison offices, science parks, business incubators, start-up accelerators, public and private venture capital firms, and angel networks (Ranga and Etzkowitz 2013). In the 'balanced' configuration the government, industry and the university do not only perform their own roles but also sometimes substitute for a weak or underperforming sphere (Etzkowitz 2018; Etzkowitz and Zhou 2018). The roles of a sphere can also change during different stages of the innovation and the accompanying new business formation process (Steiber and Alänge 2013). For example, while the key role of the university is research in the early innovation stage, it turns into entrepreneurial role at early stages of new business formation and then into teaching after new business formation (Pique et al. 2018). In addition, the level of interactions among the spheres also vary over time: they are the highest during the innovation and new business formation stages, and they diminish afterwards (ibid.).

Technology transfer and acquisition, collaboration and conflict moderation, collaborative leadership, substitution, and networking are the key relationships in the triple helix model of innovation, realized through the articulation of the knowledge, innovation and consensus spaces (Ranga and Etzkowitz 2013). The knowledge space creates knowledge resources for innovations at universities and research institutes, and the innovation space develops an ecosystem that supports technology transfer, entrepreneurship and new business development (ibid.). Finally, the consensus space coordinates the interaction between the knowledge and innovation spaces by bringing together triple helix actors into a collaborative process of exchanging ideas and resources and negotiating shared purposes (ibid.).

There are different views regarding the media-based and culture-based public. Rather than seeing it as a fourth sphere, Etzkowitz (2018) argues that it is a platform on which the triple helix model is built. Etzkowitz and Zhou

(2018) see it as the third sphere of the triple helix, replacing industry, when it comes to issues related to sustainability. It is added as a fourth sphere in the quadruple helix model of innovation (Carayannis and Campbell 2009; Carayannis and Rakhmatullin 2014). Carayannis et al. (2012) suggest in addition the natural environment as a fifth sphere in their quintuple helix model of innovation. From the purposes of this comparative study, the triple helix model of innovation is the most suitable for two reasons. First, we see the natural environment as a resource and not as an actor that can actively contribute to innovations. Second, including the media-based and culture-based public in this comparative study will dilute the focus and create challenges in conducting the empirical study. The challenges will arise because culture is a multi-dimensional concept, and media has diverse channels. Taking these considerations into account, we utilize the triple helix model of innovation as the theoretical framework for the empirical study. In doing that we also note that it has been criticized for its high level of abstraction, exclusion of the entrepreneur as a key innovation actor, ignorance of challenges related to the ownership of intellectual property rights, industrial collaboration and transferring research results to the market, and failed attempts to hybridize academic work and business in the company that spins off from the innovation (Tuunainen 2002; Brännback et al. 2008).

3. Methodology

3.1 Research approach and context

This is a qualitative comparative study conducted with the aim of exploring insights on the differences between China's and Finland's innovation ecosystems using the triple helix model of innovation as the theoretical framework. Qualitative approach suits well to the exploratory nature and the objectives of the research. In the empirical study, the theoretical framework acts as the guide in comparing the two innovation ecosystems by the roles and relationships of the government, university and industry. China and Finland are selected as the countries for this research because they differ in their innovation and entrepreneurial capabilities as measured by the global innovation index and the global entrepreneurship index. Since China set an ambitious target to become an innovation hub by 2025 with its Made in China 2025 strategy, understanding the key mechanisms of Finland's innovation and entrepreneurship ecosystem can guide policy makers of China to build policies and institutions for improving their performance. Policy makers of Finland, the innovation ecosystem of which is stagnating for the last 10 years since the fall of Nokia, can also learn from the good practices in China. Furthermore, there can also be cooperation possibilities between different stakeholders in the two countries in for example joint innovation projects. Such cooperation is likely as Finland is a small market with limited resources but good knowledge, and China is a large market with high ambitions and resources.

Officially known as the People's Republic of China, China is the world's largest country by population (1,439 million people) and third largest by its geographic area (9.6 million square kilometres) following Russia and Canada. China is located in East Asia, between North Korea and the East China Sea in the east, the South China Sea, Vietnam, Laos, Myanmar, Bhutan, Nepal and India in the south, Pakistan, Afghanistan, Tajikistan and Kyrgyzstan in the west, and Kazakhstan, Mongolia and Russia in the north. Beijing is the capital. Ranking the world's second by nominal gross domestic product (GDP) after the United States of America and the first by the purchasing power parity (PPP) adjusted GDP, China has been the world's fastest growing economy during the last 30 years. Known as the manufacturing factory of the world, China has been continuously improving its innovation capabilities under the Made in China 2025 strategy. As of 2019, China was the world's 14th most innovative and 28th most competitive country with a PPP adjusted GDP per capita of 16,187 USD.

Finland is located in Northern Europe, between Russia in the east, the Baltic Sea and the Gulf of Finland in the south, Gulf of Bothnia and Sweden in the west, and Norway in the north. Helsinki is the capital, and it has a population of 5.5 million. Forests cover nearly 70% of its land, and as a result, the country is a global leader in forest-based industries such as pulp and paper. A member of the European Union (EU) since 1995, Finland achieved to become the world's most competitive economy in 2000 thanks to investments in education and R&D (Sölvell and Porter 2011). This was evidenced by the emergence of the world's leading mobile phone manufacturer, Nokia from Finland during the 1990s. Finland's competitiveness, however, has been degrading during the last decade following the fall of Nokia and budget cuts from education and R&D (El Husseini and Akpinar 2019). As of 2019, Finland was the world's 6th most innovative and 11th most competitive country with a PPP adjusted GDP per capita of 41,899 USD.

3.2 Data collection and analysis

Data is collected from extensive reliable secondary sources on China and Finland in English, Chinese and Finnish languages. Data collection and analysis go hand in hand. Following Cresswell (2014) data is analysed in a systematic manner by the method of qualitative content analysis using the following codes from the theoretical framework: G – government, U – university, and I – industry. These codes represent the spheres of the triple helix model. Data is reduced by the aid of these codes and then organized using the filter and sort functions of Excel for further analysis. We use mind maps for comparing the roles and relationships of each sphere in China and Finland in their knowledge, innovation and consensus spaces. No special qualitative data analysis software is utilized due to the fact that the amount of data is at a manageable level.

4. Results

4.1 China

The triple helix in China is government-pulled, i.e. the government pulls its two "wings" (university and industry) to achieve innovations (Etzkowitz and Zhou 2018). In this model, all universities, research institutes and most large-scale companies are affiliated to the central or provincial government, the political authority directs the innovation ecosystem, and the decision-making powers of the university and industry are limited as innovation actors since they have to follow the government completely (ibid.). The roles and relationships of the three spheres are elaborated in detail below.

Government. The Chinese government has been the main driver and most powerful sphere of the innovation ecosystem in China since 2006 through its innovation-oriented strategy and corresponding policies. For example, "building an innovation country" was the topic of the 17th National Congress in 2007, then the 12th Five-Year Plan proposed to speed up the construction of a national innovation system in 2011, the goal of "adhering to the path of independent innovation with Chinese characteristics" was underlined and at the 18th National Congress in 2012. Later the Chinese government developed the strategy of "Popular entrepreneurship, mass innovation" in 2014 and introduced the Made in China 2025 strategy in 2015 in order to upgrade the competitiveness of its manufacturing industry through innovation. The 13th Five-Year Plan released in 2016 stressed that innovation must be placed at the core of national development, conveying the Chinese government's commitment to an innovation-driven economy. As a result, more than 2,000 guidance and incentive policy documents have been published at national and regional level, covering finance, taxation, talent, government procurement, intellectual property and technical standards, and innovation platforms (Yuwei 2016). The evaluation of these policies, however, is a key challenge for the Chinese government.

The second key role of the Chinese government is the funding of R&D projects. The government's total investment in R&D increased from 1.4 trillion yuan (2.0% of GDP) in 2015 to 1.76 trillion yuan (2.1% of GDP) in 2017, ranked the second in the world after the United States (Xinhuanet 2018). While 77.6% of all investments went to industry, public research institutions received 13.8%, and universities got 7.2%. The industry was further supported through tax deductions and exemptions for large high-tech companies and the innovation special fund, which was used to support the R&D activities of small and medium-sized companies via loan discount, gratuitous subsidy and capital investment. (Ministry of Science and Technology of the People's Republic of China 2019a). Despite these incentives, there is still room for improvement in the efficiency of resource allocation and development of an innovation culture that allows for failure.

The third role of the Chinese government relates to the development of innovation infrastructure. The government has been investing heavily in the development of ultra-high voltage electricity transmission circuits, which is crucial for engineering and technological innovation development (World Economic Forum 2016). In addition, 16 National Independent Innovation Demonstration Zones were constructed by local governments as the pioneers of innovation and high-tech industry development, and municipal, provincial and national science and technology business incubators have been established in many Chinese cities (ibid.).

Finally, the fourth main role of the Chinese government is the reinforcement of the protection of intellectual property rights (IPR), a key issue concerning innovation development in China. Related laws and regulations have been released such as a new trademark law, amendments to the copyright law, the patent law and the unfair competition law, and IPR courts were set up in 2014 in Beijing, Shanghai and Guangzhou (ibid.). Despite these developments, inadequate IPR legislation and weak law enforcement remain to be a major challenge in China.

University. The higher education institutions in China are classified as state-run national universities and provincial universities. National universities are usually multi-disciplinary and research-oriented. Provincial universities, on the other hand, aim primarily at teaching and training, but they also conduct applied research, serving regional economic development. The annual number of graduates from universities grew from 2.1 million in 2003 to 7.7 million in 2016, contributing to the development of human resources for Chinese industry (China Education Online 2016). The number of science and engineering doctors also increased from roughly 10,000 in 2003 to 30,000 in 2014, ranking the second in the world behind the United States (Yuwei 2016). Despite these developments, there is room for developing the higher education system in China to be more application-oriented in close cooperation with the industry, as there is a gap between the demands of the workplace and the cultivated competences of the graduates.

Thanks to government policies and financial support, R&D investments, the number of full-time equivalent researchers, and the number of innovation outputs of Chinese universities maintained steady growth over the years from 2005 to 2017 (Ministry of Science and Technology of the People's Republic of China 2019b). Universities contribute to more than 80% of Chinese scholarly articles and account for 20-25% of all invention patent grants in China. The number of invention patent grants grew from nearly 20,000 in 2010 to more than 76,000 in 2017 (ibid.). Universities in China are encouraged to utilize their internal administrative structures and financial resources to start new businesses called University-Run Enterprises (UREs) since the 1950s (Etzkowitz and Zhou 2018).

Public research institutes in China are also key actors of the innovation ecosystem, located in the intersection of government and university. Their R&D investments and the number of full-time equivalent researchers have also increased significantly from 2005 to 2017, reaching 24.4 billion yuan and 406,000 full-time equivalent researchers in 2017 (Ministry of Science and Technology of the People's Republic of China 2019c). Although public research institutes have more resources than universities in terms of R&D investments and full-time equivalent researchers, their innovation output doesn't reach the corresponding level. Although they signed more technology sales agreements than universities with the industry, the number of their invention patent grants was approximately 30-40% of that of universities during 2011-2017, and the share of their publications in domestic scientific journals, around 11%, was much less than that of universities, about 66%, during 2013-2016.

While the strategic lines of research in universities and public research institutes are guided by the directions provided by the government, cooperation between universities, research institutes and industry is perceived as highly relevant in the transformation of new technology into productivity. Industry-university-research institute strategic alliances, collaborative innovation platforms, co-constructed R&D institutions, and jointly established research centers are key initiatives that are initiated and governed by regional governments in China to promote cooperation. These initiatives engage in developing innovations to tackle key scientific and technical problems. However, there is still room for developing stronger ties with the industry for successful technology development and transfer. There are limitations for example in the long-term growth of UREs because, unlike real spin-offs, their assets are owned by universities, they are operated by university faculty and students rather than professional management, and they rely on their mother universities for their R&D (Etzkowitz and Zhou 2018).

Industry. China has gained the reputation of being the manufacturing factory of the world traditionally due to low wages in the country. This situation, however, started to change as wages and the costs of energy and land in China are rising, the population is ageing, and multinational companies are moving their operations to other low-cost countries. As China's pace of economic growth started to slow down after 2012, the Chinese government responded to the downturn by emphasizing innovation-driven development, e.g., the Made in China 2025 strategy in 2015, and undertaking the Belt and Road initiative, a mega international infrastructure project to revitalize the old Silk Road from land and sea in order to strengthen the export possibilities of Chinese manufacturing industry. There were also pressures for innovations from the domestic market where the average disposable income of Chinese residents was growing at about 9% per year (World Economic Forum 2016).

Corporate R&D spending in China has experienced double-digit growth, driven mainly by large industrial companies, rising from 1.2 billion USD in 2005 to 39.4 billion USD in 2015. For example, Huawei has been reserving nearly 15% of its revenues for R&D, ranking it the 5th among all companies in the world. In parallel to this development also the number of corporate R&D personnel has increased to 3.1 million in 2017, accounting for around 77% of the total R&D personnel in China (Ministry of Science and Technology of the People's Republic of China 2019a). Corporate R&D has become an attractive profession for talented engineers through benefits such as stock options and dividends. As a result, the number of patent applications by Chinese companies rose significantly over the years in double digits. In Patent Cooperation Treaty's international patent application ranking Chinese companies ZTE and Huawei were the first and second respectively in the world in 2016 (Ministry of Science and Technology of the People's Republic of China 2019d). The top three innovative industries in China are the professional equipment manufacturing industry, the chemical raw materials and chemicals manufacturing industry, and the computer, communications and other electronic equipment manufacturing industry.

Cooperation with universities and research institutes is key for technological innovations, and this is encouraged by the Chinese government. On average 79% of large companies, 68% of medium-sized companies, and 63% of small companies have been cooperating in their innovation activities in 2017 (Ministry of Science and Technology of the People's Republic of China 2019e). A major challenge, however, remains to increase the participation of small and medium-sized enterprises in innovation activities. Lack of the availability of research funds and talented innovative engineers continue to limit the innovation capabilities of Chinese companies. Some of the Chinese multinationals have responded to this challenge by acquiring strategic assets in foreign markets, e.g., the acquisition of Volvo by Geely or the acquisition of IBM's computer division by Lenovo.

4.2 Finland

As of 2010 Finland was a leading innovation nation with R&D expenditures accounting for 3.7% of GDP. The fall of Nokia from 2008 until 2014 was a big blow on the Finnish innovation ecosystem, as the company accounted for 37% of all R&D expenditures in 2008 and 43% of all patents in 2006 (Ali-Yrkkö 2010). Coupled with budget cuts by the government from R&D expenditures (2.8% of GDP in 2016), the innovation performance of Finland fell significantly behind its peers in Europe from 2010 to 2016 (OECD 2017). As a result, there were calls for a creative destruction and reorganization of the innovation ecosystem in order to improve Finland's competitiveness (Maliranta 2014a, 2014b). The Finnish innovation ecosystem was reorganized in 2009 and 2010 with the launch of six Finnish Strategic Centers for Science, Technology and Innovation (SHOKs) in the areas of bioeconomy (FIBIC oy), construction (RYM Oy), energy and environment (CLEEN Oy), metal products and machine construction (FIMECC Oy), health and well-being (SalWe Oy), and information and communication industry (DIGILE Oy). Following the principles of smart specialization and regional development in the EU, the innovative cities program replaced the SHOKs for the period from 2014 to 2020, aiming to accelerate new innovation-based businesses under the leadership of the cities and (in the areas) of Joensuu (bioeconomy), Jyväskylä (cybersecurity), Oulu (future health), Tampere (smart city and renewal of industries) and Vaasa (sustainable energy solutions). Compared with that of China, the Finnish innovation ecosystem presents a more balanced and collaborative structure involving multiple stakeholders such as the Ministry of Employment and Economy, Business Finland, the Academy of Finland, the Confederation of Finnish Industries, Sitra (the Finnish Innovation Fund) and Finvera (the export credit agency of Finland) (Meyer et al. 2018). The roles and relationships of the three spheres are elaborated in detail below.

Government. The Finnish government has a direct impact on the innovation ecosystem through making necessary legislation and funding R&D activities. It also has indirect impact through independent public organizations in setting the direction at national level. For example, Sitra, an independent public organization under the Finnish Parliament, published Finland's national road map for moving to the circular economy in 2016 after discussions with all stakeholders, and the Finnish government incorporated it as a key theme of the government program. As a second example, the Strategic Research Council of the Academy of Finland, a hybrid organization under the Ministry of Education, Science and Culture, proposes research themes that will have high societal impact, and the Finnish government decides which themes to fund. A third example is the Technical Research Centre of Finland (VTT). Established in 1942 by the Finnish government as an independent research center under the Ministry of Trade and Industry, VTT aims to contribute to the competitiveness of Finnish companies through applied research. Spin-offs from VTT are the main source of new business development from knowledge-based innovations in Finland. A fourth example is Business Finland, which aims to support the growth and internationalization of innovative Finnish small and medium-sized enterprises (SMEs) through consultancy services as well as funding opportunities such as the provision of innovation vouchers (Business Finland 2020a). The government of Finland will be supporting Finnish SMEs through a program by Business Finland to recover from the economic damages of the Covid-19 pandemic (Business Finland 2020b). Recently a network of hybrid organizations for innovation, business growth and internationalization was established under the name of Team Finland (Team Finland 2020).

In the innovative cities program, policy makers of municipalities and regional stakeholders were empowered to develop innovation hubs leading to knowledge-based ecosystems and lead markets. Funded evenly by the Finnish government, selected cities and European structural funds, the program aimed also to increase cross-regional cooperation. For example, the future health program was led by the city of Oulu, but the Helsinki capital region, Kuopio, Tampere and Turku were also partners in the program. Similarly, the smart city and renewal of industries program was led by the city of Tampere, but the Helsinki capital region, Lahti, Oulu and Turku were also partners in the program. Cities in Finland establish their own innovation strategies which target to improve the international appeal of research and expertise, reinforce knowledge-based clusters, create common development platforms, reform public services, and support innovation activities (Solesvik 2017).

Key challenges facing the government that may impede the achievement of the goals of the program are recent budget cuts from R&D and having a large public sector but at the same time not adequate public sector support to small and medium-sized enterprises (OECD 2017). As such, the correspondingly low level of entrepreneurial activity in Finland can be attributed to the perception of Finnish entrepreneurs that the national innovation ecosystem is a centralized government-run system, and the regional innovation ecosystem is just a downsized version of the national one (Brännback et al. 2008). The Finnish government is also criticized by researchers for its high level of bureaucracy (ibid.).

University. A key strategy in Finland after the Second World War was to increase the number of cities with higher education institutions (Jauhiainen and Suorsa 2008). The higher education system in Finland includes 13 universities and 23 universities of applied sciences, all of which are public and administered by the Ministry of Education and Culture. Whereas universities focus more on basic research and offer degrees at bachelor, master and doctoral level, universities of applied sciences, established in the 1990s in order to bridge the gap with the industry, conduct more applied research in cooperation with the industry, aiming regional development, and they offer degrees only in bachelor and master levels. Following the budget cuts from education and R&D, there were some strategic mergers between higher education institutions, such as the merger between Tampere University and Tampere University of Applied Sciences.

The ties between the industry and the university are strong. Cooperation takes place in a number of ways. First, higher education institutions educate the talent for the industry. In doing that especially small and medium-sized enterprises are ideal collaboration partners as they lack resources. Students are required to engage in real-life projects with companies, and they also do internships and write their theses for companies. Second, it is a pre-requisite to have a consortium of higher education institutions and companies in most R&D funding applications. Finally, continuous learning is highly appreciated in Finland, and companies encourage their employees to develop their competences through further studies.

A survey by Brännback et al. (2008) suggests that most Finnish researchers do not perceive entrepreneurship as a feasible or desirable progression of their career, and they prefer to stay away from the commercialization of their innovations. Entrepreneurship is recognized as a key driver of growth by higher education institutions such that they integrate it into curriculums of degree programs and offer support services, e.g., business incubation, and incentives, e.g., seed funds, to students and faculty who plan to establish their own start-ups. These efforts, however, remain far away from becoming a truly entrepreneurial university (Etzkowitz et al. 2008). Another challenge of the Finnish higher education system is its low level of international R&D collaboration (OECD 2017).

Industry. As Finland is a small country, it is highly dependent on its exports. Pulp and paper, information and communication technology, ship building, machinery, bioeconomy, sustainable energy, education, health care, construction, and mobile gaming are among Finland's key industries. Learning the hard lesson from its heavy reliance on a single company, Finland has been trying to diversify its economy with the SHOKs and innovative cities programs during the last decade. The innovation capabilities of the Finnish industry deteriorated due to government cuts from the R&D budget (El Husseini and Akpinar 2019). EU's sanctions to Russia, a key trading partner of Finland, after the annexation of Crimea by Russia in 2014, possible trade wars between the United States and the EU, the departure of the United Kingdom from the EU (Brexit), and the spreading Covid-19 virus pose external threats for the Finnish industry. The industry also has structural challenges such as the lack of integration of especially small and medium-sized enterprises to global value chains, and inadequate framework conditions for entrepreneurship resulting in low start-up rates and low contribution of young firms to employment (OECD 2017). In order to promote growth entrepreneurship, Finland hosts Slush, the world's leading start-up event that brings together more than 20,000 entrepreneurs and investors annually.

5. Discussion

This research compared and contrasted the Chinese and the Finnish innovation ecosystems. In doing that it analyzed the roles of the government, university, and industry while identifying the key challenges of the two innovation ecosystems. The theoretical contribution of the research lies in its being the first study to compare and contrast the two innovation ecosystems, taking the findings from earlier studies on the Chinese innovation ecosystem (Liu and Huang 2018; Cheng et al. 2019) and the Finnish innovation ecosystem (Brännback et al. 2008; Jauhiainen and Suorsa 2008; Solesvik 2017; Meyer et al. 2018) to a next level. Organizing the findings under concepts from the established triple helix framework such as government, university and industry as well as knowledge space, innovation space and consensus space (Etzkowitz and Leydesdorff 2000; Ranga and Etzkowitz 2013) provided a consistent comparison and meaningful practical implications.

Table 1. Selected innovation indicators of China and Finland in 2018. Adapted from OECD (2020a) and OECD (2020b)

Innovation indicator	China	Finland
Share of innovative firms to all firms (%)	39.8	64.8
Number of triadic patents per 1 000 000 population	2.9	47.1
Share of R&D spending to GDP (%)	2.2	2.8
Industry share of R&D spending (%)	77.4	65.7
University share of R&D spending (%)	7.4	25.2
Government share of R&D spending (%)	15.2	8.3
Non-profit sector share of R&D spending (%)	0.0	0.8
Number of researchers per 1 000 employed	2.4	14.5
Number of R&D personnel per 1 000 employed	5.6	19.2

Results from Table 1 suggest that Finland performed better than China in 2018 according to innovation outputs measured by both the share of innovative firms to all firms and the number of triadic patents per million population. This is not a surprise as Finland also invested more for innovation input factors measured by the share of R&D spending to GDP, the number of researchers per thousand employed, and the number of R&D personnel per thousand employed.

Table 2. Comparison of the innovation ecosystems in China and Finland

	Knowledge space	**Innovation space**	**Consensus space**
China	• Government funding for R&D to industry, universities and public research institutes • Publications and invention patent grants • Legislation on IPR	• Tax deductions, innovation special fund • Legislation on IPR • University-Run-Enterprises (UREs) • Innovation Demonstration Zones, business incubators, infrastructure	• University and industry follow the government • Made in China 2025 strategy • Belt and Road initiative • 5-year plans, national congresses
Finland	• R&D by universities, universities of applied sciences and VTT • Government funding via Academy of Finland • Strategic research lines • University-industry collaboration	• University-industry collaboration, science parks • Slush, seed funds, venture capital • Entrepreneurship education, business incubators • Spin-offs from VTT	• Balanced, collaborative structure with multiple stakeholders • Public hybrid organizations (e.g., Sitra, Business Finland) • Empowerment of regions and cross-regional collaboration (SHOKs and innovative cities programs)

Table 2 compares and contrasts the innovation ecosystem of China with that of Finland in terms of the roles of the government, university and the industry in the knowledge, innovation and consensus spaces respectively. Our analysis suggests that the government is the most influential actor in the innovation ecosystem in both countries, as it sets the strategic direction and it is the main source of funding for R&D. There are, however, three major differences in the government's operations in Finland vs. China. The first one is that the Finnish government integrates multiple stakeholders through independent hybrid organizations in making key decisions in the consensus space. Although the government has the final word, the opinions of experts representing the university and industry are taken well into consideration. In China, the university and the industry follow the government. Hence, whereas the Chinese innovation ecosystem has a top-down approach, the Finnish innovation ecosystem is more balanced combining top-down and bottom-up approaches (see the consensus space in Table 2). The second difference is that regional governments, i.e. municipalities, are empowered in Finland through the innovative cities program to pursue regional innovation strategies based on the principle of smart specialization. In China, the national government is the engine of the innovation ecosystem with its Made in China 2025 strategy and Belt and Road initiative (see the consensus space in Table 2). Finally, the third difference is about the allocation of government funding for R&D in the knowledge space. While most of the R&D investments of the Finnish government go to universities, universities of applied sciences and VTT, the research institute, the majority of the R&D investments of the Chinese government go to the industry (see the knowledge space in Table 2). The Chinese government is also more actively involved in the innovation space by providing tax deductions, special funds for the commercialization of innovations, and development of innovation infrastructure. A key difference in the two innovation ecosystems is that, as a result of the different allocation of the government R&D investments in the two countries, whereas the university is the key actor in creating new knowledge and innovations in Finland, it is the industry in China.

China has been improving its innovation ecosystem continuously under the government's Made in China 2025 program. As a result, its ranking in the global innovation index increased from 29th place in 2011 to 14th place in 2019. However, key challenges exist especially in developing the role and contributions of the university in the knowledge space. Chinese universities need to improve in terms of both their quality of education and R&D performance for raising competent graduates to the industry and delivering knowledge-based innovations to the industry. We recommend policy makers to allocate a higher share of R&D investments to the university, as it is the case in Finland, in order to make university research an attractive profession. Chinese universities can also increase cooperation with Finnish universities in R&D and teaching, as Finland is well-known for good pedagogical practices in its education system. While industry R&D delivers applied innovations that add incremental value, there is need for more basic research by the university to bring to life high value-adding disruptive innovations in China. We also recommend strengthening collaboration between the university and the industry, and in doing that good practices from Finland can be benchmarked. Finally, we suggest making new arrangements to transfer technology from the university to the industry instead of the current inefficient UREs. These suggestions shall contribute to the Chinese innovation ecosystem in reaching its 2025 goals.

Decreasing R&D budgets since 2010 have been negatively impacting on the performance of the Finnish innovation ecosystem. Key challenges exist especially in the innovation space in developing successful new businesses from knowledge-based innovations. More concrete actions are needed to promote growth-based entrepreneurship and the internationalization of small and medium-sized enterprises. China, which is a large market with abundant resources and ambitions to develop its innovation ecosystem, can be an ideal destination for all stakeholders in the Finnish innovation ecosystem to seek cooperation. Finnish government can also follow the Chinese example and increase its share of R&D funding for the industry. While collaboration between the university and the industry as well as life-long learning are strengths of Finland, there is a lot to be done before the concept of the entrepreneurial university can be successfully implemented. We recommend that Finnish policy makers in the field of higher education study the examples of the Massachusetts Institute of Technology and Stanford University to foster academic entrepreneurship. In doing that they can also show leadership to their peers in China.

Two specific measures improved the validity and reliability of the findings. First, the consistent use of an established theoretical framework in the two countries increased internal validity, and second, the use of multiple reliable secondary data sources enabled data triangulation and increased reliability. A limitation of the study can be considered the use of only secondary data. It is true that interviews would provide richer insights, but this limitation was compensated to a certain extent by the availability of rich secondary data and by the fact that the two authors represent the two countries and have in-depth knowledge of their innovation ecosystems. That shall suffice for the purposes of this exploratory study. For future in-depth research we recommend interviews with key informants from all spheres in both countries. We deliberately selected the triple helix model rather than the quadruple helix or quintuple helix models in order to focus the scope of the research. As such, we recommend future research to investigate the roles of the media-based and culture-based public as well as the natural environment in the innovation ecosystems of the two countries. Finally, we also recommend future research to conduct more comparative studies on national innovation ecosystems using the triple helix model. These rare studies will increase our understanding of good practices in the world (Fukuda and Watanabe 2008; Solesvik 2017).

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