The roles of universities in Chinese regional innovation systems—an re-examination of the Triple Helix model

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Abstract

This paper is aimed to understand the role of universities in regional innovation systems in China. It particularly examines how the Chinese practices concerning the universities' engagement with the society for promoting regional innovation systems are different from the western experiences which has been often understood within the Triple Helix framework (Etzkowitz & Leydesdorff, 1995, 1997). By focusing on China's leading metropolis, Shanghai, and taking Tongji Creative Cluster as a case study, the paper finds that although Triple Helix model was introduced in China as a guiding principle, the practices are actually following another model. It is interpreted as a state-led model, with constant interaction between the university and the industry and with the government controlling and coordinating their internal and external relations. The paper also recognises the possibility of generalising the experiences of Shanghai to other regions of China while pointing out its unique characteristics which are unlikely to be applicable elsewhere.

Keywords: university, regional innovation system, Triple Helix, China, Shanghai

Introduction

Innovation systems consist of complex functions and interactions among various organisational actors, including government, enterprises, universities and research institutes, as well as institutions in the forms of governmental policies and social norms (Edquist, 1997; Kumaresan & Miyazaki, 1999; Lundvall, 1992; Nelson, 1993; OECD, 1999). Accordingly, Etzkowitz and Leydesdorff (1995, 1997) has developed the Triple Helix model for understanding dynamic interactions between university, industry and government, which foster entrepreneurship, innovation and economic growth. Among the actors, universities' contribution to industrial innovation is critical (Etzkowitz, 2003; Godin & Gingras, 2000; Mowery & Sampat, 2004).

In the fields of innovation system, research policy, and higher education research, the Triple Helix model has been commonly used as a normative framework for understanding interactions between key actors in innovation systems. It has also become a common strategy of many governments in developing national and regional innovation systems.

In spite of the popularity of the Triple Helix, it has also encountered controversies and criticisms. One criticism is that the Triple Helix model has paid little attention to national contexts (Balzat & Hanusch, 2004; Shinn, 2002, p. 610) and other social settings (Cooke, 2005, p. 1130). Therefore,

the Triple Helix framework can hardly provide appropriate rationales on which systematically structured criteria and indicators can be developed for researching, measuring and comparing different empirical cases (Mowery & Sampat, 2004) especially when the cases are in different national and culture contexts (Eun, Lee, & Wu, 2006).

It should be noted that the formation of the Triple Helix model is a result of inductive theorising but mainly in the contexts of western countries. Although there have been increasing amount of studies applying the Triple Helix concept in developing and transforming countries, as demonstrated by the conference papers in the Triple Helix conferences and a big volume of journal articles, some scholars (For example, Eun et al., 2006; Williams & Woodson, 2012) argue that many of these studies have not sufficiently realised that some fundamental assumptions underlying the Triple Helix model are less likely to be found ground in developing countries.

In line with this thinking, we will analyse the context of Chinese innovation systems and examine the particular characteristics of universities' engagement in regional economic development taking Shanghai as an example. Based on the case, we will discuss the possible modification of Triple Helix model in the Chinese context.

We select Shanghai as a case for analysis because Shanghai is more advanced in developing knowledge based society than many other Chinese regions. It is in the transition from investment-driven to innovation-driven economic growth (Zhang, 2009) while many other regions in China are transforming from factor-driven to investment-driven. Many regional development strategies are put forward first by Shanghai and then spread to the whole country. For example, Shanghai is the first in China to propose the goal of developing a learning city as early as in 1999. The regional innovation system in Shanghai is therefore more advanced and close to the western situation as described by the Triple Helix model.

The roles of universities in innovation systems from the perspective of Triple Helix

Universities have substantial impact on regional economic development. The impact can be distinguished between short-run and long run effects (Armstrong & Taylor, 2000, pp. 18-19). The short-run multiplier effects are mainly through universities' employing local workers, using large area of land and demanding for local services. Universities' long-run effects on regional economic development can be observed in the following ways.

- University will enhance the quality of local labour through training graduates.
- The existence of a university in the region acts as an incentive for local firms to expand their activities in order to take advantage of its highly skilled graduates.
- A university's highly skilled staff may provide expert advice to local development agencies as well as to local firms.
- The presence of a university in an area enhances the cultural as well as the economic attractiveness of an area for mobile firms and highly skilled workers.

Since the late 1990s, such long-run effects have gained a central place in regional studies, research policy and higher education research, and are often understood in the framework of Triple Helix. The rise of the Triple Helix model is along with the rise of the knowledge-based economy and innovation system, in which economic growth is based on continuous innovation and advancement in science and technology. One fundamental statement in the Triple Helix thesis is that the Triple Helix relations between academia-industry-government relations are indispensable conditions for fostering innovation (Etzkowitz & Leydesdorff, 2000; Leydesdorff & Etzkowitz, 1998). Particularly, university has transformed from a secondary to primary institution for economic growth in the modern society (Etzkowitz, 2008, p. 41).

As suggested by Etzkowitz (2008, p. 8), "a Triple Helix regime typically begins as university, industry, and government enter into a reciprocal relationship with each other in which each attempts to enhance the performance of the other". The rationale behind the cooperation is an emerging belief that knowledge and technology becomes a key in economic growth. The fast development and increasing complexity of technology can largely alter the environment of many types of organisations. It has been realised that the ability of a single organisational sector alone is no longer respond to the changes and uncertainties, unless they cooperate with each other. For example, universities and other knowledge producing organisations make up the core spiral of knowledge generation. University produce and transfers more knowledge to the industry, while gaining additional funding sources from industry and government to strengthen the performance of research.

The new inter-organisational relationships lead to the internal transformation within each group of the organisations, and hence leads to the main characteristics of the Triple Helix, namely "taking the role of the other"(Etzkowitz, 2008, p. 9). It means that in addition to performing its traditional tasks (as primary activities) each takes the role of the other (as secondary activities). Firms continue

to produce goods and services, but also do research and provide training at high levels (e.g. through corporate university). Government is responsible for resolve market failures by adjusting public policies and setting up market rules, but also makes available venture capital to start new enterprises, particularly for high risk business. Universities keep their traditional roles of teaching and research, but also devoted to capitalisation of knowledge, patents, start-up companies. Related to this, some cognate concepts are developed, such as, "academic capitalism" (Slaughter & Leslie, 1997), "entrepreneurial university" (Clark, 1998; Etzkowitz, 2003), "model 2 of knowledge production" (Gibbons, 1998) and "the third mission of university" (Molas-Gallart, Salter, Patel, Scott, & Duran, 2002).

The internal transformation also result in challenges and demands within and cross sectors. As a solution, they need more close cooperation and interactions with each other. Thus, another main feature of the Triple Helix model is the trilateral interactions between university, industry and government. In the Triple Helix system, one spiral has significant influence on the other. Meanwhile, through the interactions, organisations in each spiral are able to find new ideas from others to solve problems and meet new needs. This process is characterised by increasing interdependency between the three sectors. For instance, university's knowledge production cannot be carried out completely by itself, but needs industry as not only a source of research problems but also strong partner in knowledge production. Meanwhile, university's technology transfer is dependent on the conditions or environments created by the government. The interactions also result in the creations of hybrid organisations, such as incubators, joint research centres, science parts, etc. (Etzkowitz, 2008).

The Triple Helix model develops from two opposing standpoints, namely statist and laissez-fair model (Etzkowitz, 2002, 2008). In the statist model, government controls both academia and industry, and is expected to take the lead in developing projects and providing the resources form new initiatives. The examples can be seen in former Soviet Union, France and many Latin American countries. In the laissez-faire model, industry, academia, and government separate and are independent from each other. These actors interact only modestly across strong boundaries. This model is typically exemplified by the US.

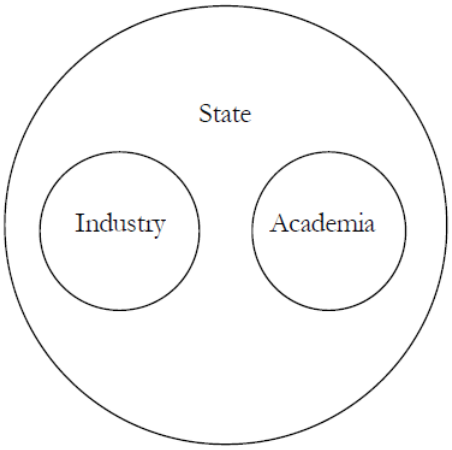

Figure 1. Statist Model

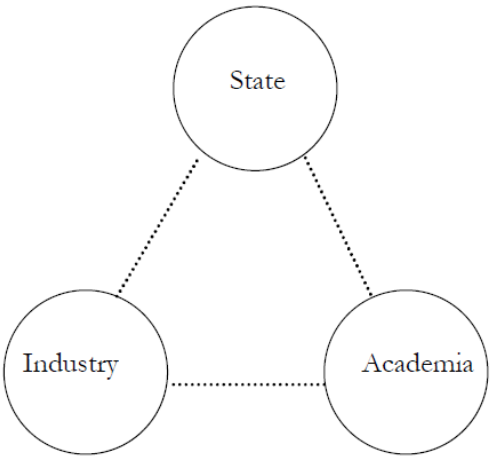

Figure 2. Laissez-faire Model

A global tendency is a move towards an overlapping model in which the three institutional spheres overlap and collaborate with each other. The model represents a change "from one of strong boundaries between separate institutional spheres and organisations to a more flexible overlapping system, with each taking the role of the other" (Etzkowitz, 2002, p. 2). The core idea in an ideal Triple Helix model is that academia should be closely linked with the industrial world. In general, the education and research activities in universities should be more integrated into the development of knowledge economy. Particularly, universities should form direct links with industry to maximise capitalisation of knowledge. Basically universities have three options to commercialise knowledge:

- Patenting and licensing technology innovation

- Direct cooperation with enterprises through contact based R&D cooperation
- Set up spin-off enterprises or university run enterprises.

To support the role of university, government is supposed to offer incentives and encourage academic institutions to go beyond performing the traditional functions of education and research.

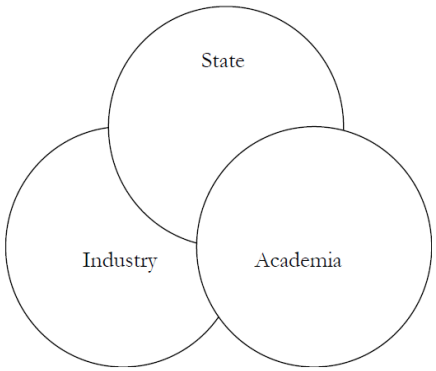

Figure 3 Overlapping model

The context of developing innovation systems in China

While China has maintained very rapid economic growth over the past three decades, the low-wage and labour intensive manufacturing as a main drive to economic growth has been challenged by emerging competitors in South East Asia as well as by China's domestic environmental degradation. To ensure sustainable development in the future, China has recently shifted its economic priority from labour-intensive production to capital-intensive and technology intensive production (OECD, 2007) with two major objectives: 1) to keep China's development not only sustained but also economically, socially and economically sustainable, and 2) to seek new economic growth point through technology progress and innovation. As such, since the turn of the new century, China has been boosting investment in science and technology, and taking steps towards building a high-performing innovation system and knowledge economy. A national policy has set the goal of construct China as an innovative country by 2020 (State Council, 2006).

The above economic changes have mainly addressed two kinds of demands for higher education, concerning the human resource development and the engagement of higher education in economic development.

First, for developing a knowledge economy, China needs to further improve the quality of human resources. As the former President Hu Jintao proposed in the 17th National Congress of the Communist Party of China in 2007 that China will switch from a country with large population into a great country with strong human resources. The Report on Chinese Talented People (Chinese Ministry of Personnel, 2005) pointed out that China had a gap of 20 million talented people during the period of 2006-2010. This requires universities to improve the quality of education, and adjust their programme structure as well as education orientation to meet the demands in economic construction. There are also demands for different types of highly educated talents for various needs for economic development.

Second, the economic transformation towards an innovation system has pushed universities into a central place of the arena. In addition to teaching and research, universities are expected to be more engaged with society, particularly the industrial sector. This is called the third mission of university and the core of the mission is capitalisation of knowledge (Etzkowitz, 2008, p. 27): universities are expected to link themselves to users of knowledge more tightly and even become economic actors in their own right. This also reflects the demands for higher education in China. Particularly, Chinese universities are required by the economic sector to improve the quality in both teaching and research and to increase their relevance to the industrial needs. In addition, universities are expected to be innovative and effective in transferring their knowledge to the industry and directly support national and regional economic development (H. Wang & Zhou, 2008).

Against this background, the Triple Helix model has been introduced to China for understanding the innovation systems and the role of university in the innovation systems (Zhou & Peng, 2008). However, it should be noted that the formation of the Triple Helix model is a result of inductive theorising but mainly in the contexts of western countries. Although there have been increasing amount of studies applying the Triple Helix concept in developing countries and emerging economic, as demonstrated by the conference papers in the Triple Helix conferences and a big volume of journal articles, some scholars (For example, Eun et al., 2006; Williams & Woodson, 2012) contend that many of these studies have not sufficiently realised that some fundamental assumptions underlying the Triple Helix model are less likely to found ground in less developed countries.

For instance, one basic argument is that the rationale, of Triple Helix relations of university, industry and government are based on the nature of knowledge in certain industries, such as biotechnology, in developed countries, but they are irrelevant to the situations in less developing

and emerging economies. Moreover, in most developed countries the economic competitiveness is mainly derived from continuous creation of new and better product, while the economic growth in other contexts is mainly dependent on technology learning from the advanced countries and production of standardised products (Eun et al., 2006; Kroll & Liefner, 2008).

Particularly, the different contexts of innovation systems in China and developed countries can be summarised as shown in the Figure 1.

	Developed countries	China
Basis of competitiveness	Competing through creation of new and better products	Competing through low–tech product process and low price
Availability of skilled labour	Abundant highly skilled labour	Lack of skilled labour
Position of manufacture industry in economy	Outsourcing manufactures	Manufacturing cheap product for export as a key pillar of economy
Use of technology and skills	Employing skilled workers and investing in new technology for high return	Focusing on simple manufacturing tasks using little technology and a lot of manpower
Demand for new knowledge	High demand for new knowledge	Low overall demand for new knowledge
Beliefs on university-industry relationship	The concept that universities are important source of new and potential product-related technology is becoming institutionalised	The concept of university-industry relations are not interested by companies

Source: Adapted from Kroll and Liefner (2008)

The roles of universities in regional innovation systems in China

It has been argued that province-level regions as the basic unit for developing innovation systems in China (Chen & Guan, 2011). These regions, directly under the control of the central government, have high degree of administrative and economic autonomy. In China, the four municipalities, namely Beijing, Shanghai, Tianjin and Chongqing have the same administrative statues as province.

The higher education institutions are administrated at either the central government level or the provincial/municipal level. The institutions at the first level are called national universities, which are normally research oriented and for elite education and serve national priorities. The rest institutions administrated at the provincial/municipal level are regional universities. Regional higher education institutions are mainly for mass higher education and serve regional interests.

In spite of clear distinction between administrative lines, national universities often engage in local development in the areas in which they are located through joint jurisdiction. Joint jurisdiction refers to that central government department and local authorities run higher education institutions in cooperation, though one party normally takes more responsibilities than the other depending on a bilateral agreement. The first example of such arrangement dated back to 1992 when the Ministry of Education and Guangdong Provincial Government agreed to co-administrate Zhongshan University and Huanan University of Science and Technology. Another example is the "Tongji" model. In 1995, Tongji University was co-administrated by both the State Education Commission (renamed as Ministry of Education in 1998) and the Shanghai Municipal government. Subsequently, the university merged with the Shanghai Institute of City Construction and Shanghai Institute of Construction Material Industry in 1996 and continued to merge with the Shanghai Railway University in 2000.

The higher education institutions in a province/municipality, regardless of national or regional ones, normally recruit more local students than the students from other regions. In China, students need to take national higher education entrance examination (or *gaokao* in Chinese) in order to get a study place in higher education. Each province/municipality sets its own admission cut-off scores mainly based on the capacity of higher education institutions in the region. Thus it leads to the situation that in the regions with more higher education institutions, students are easy to access to higher education due to lower cut-off scores. For instance, in 2005 the higher education gross enrolment

ratio is 57% in Shanghai, the highest rate in the nation, while the lowest one is only 10% in Guizhou province (Planning Department of Chinse Ministry of Education, 2007).

Majority of Chinese higher education institutions are mainly absorbing the mass demands for higher education, while paying little attention to diversified needs in the labour market. The problem in Chinese higher education is that all higher education institutions are striving for improving that vertical status and in turn they tend to adjust their missions alike, i.e. becoming more research oriented. Regardless of their wishes, only a small number of Chinese universities can be selected in the "Project 211" and "Project 985", and they are mainly research universities. Among over 2,000 Chinese higher education institutions, research universities are a distinct minority.

In general, it has been criticised that the cooperation between universities and enterprises remains weak in China (Eun et al., 2006; Kroll & Liefner, 2008; Lai & Shyu, 2005; J. C. Wang, 1999) and particularly enterprises cannot effectively absorb the universities' research achievement (H. Wang & Zhou, 2009). The limited links between the two sectors can be understood from three perspectives, namely institutional environment's perspective, universities' perspective and enterprises' perspective.

From the first perspective, there are incomplete legal system and practice in protecting intellectual property in China, as well as deficiencies of contract law (Kroll & Liefner, 2008). For most universities, they have relatively weak propensity to directly engage in economic activities. Faculty members are critical of devoting too much time and energy to engage in commercial activities. The third mission has not been considered a main task in the university. For enterprises, they normally have little demands for services from the universities, and most of them undertake only short-term cooperation with universities to solve some practical technology problems in production (H. Wang & Zhou, 2009, p. 103). A recent survey reveals that most companies conduct R&D by themselves, while the cooperation with universities in R&D only account for 15.4% among a number of selected cases (X. Wang, 2011). Finally, it has been observed that there are lack of trust and motivation between university and industry for developing effective and reciprocal cooperation relationship (Kroll & Liefner, 2008; X. Wang, 2011).

Nevertheless, the importance of science and technology to economic development has been recognised by Chinese government and there is a strong policy motive to commercialise knowledge through strengthening university-industry relations since the 1990s. Currently, university and industry interactions mainly take places in three ways: 1) university-run enterprises, 2) science and technology parks of universities, and 3) university towns.

University-run enterprise is one, but dominating, kind of governance form through which science and technology flows from university to industry. In western countries, establishing spin-off formation is interplay of academic entrepreneurs, parent organisations, and venture investors in western countries. University-run enterprises in China try to perform all three roles at once, integrating several stages of the research, development and commercialisation process into one organisational entity (Kroll & Liefner, 2008).

University-based science parks in China have been inspired partly by the legends of Stanford Science Park, Cambridge Science Park, and many others. By 2010, there were 86 university-based science parks of national level throughout China. Besides, there is also a large group of university-based science parks launched by local governments or independently organised by universities themselves. Some science parks that were independent of the universities at the initial stage of their development would also like to collaborate with universities when they develop into certain scale. Science parks provide a sound environment for innovation ranging from managing real estate to fundraising, from talent hunting to assuring legal arrangement. The performance of university-run enterprises in science parks is much better than those off-parks. For example, in 2004, out of 4563 university-owned enterprises in China, 24.57% were located in science parks. Although their number is in the minority, their income, profit and tax paid accounted for a much larger proportion, respectively 60.10%, 64.95% and 49.26% of the total capital generated by all the university-run enterprises (Table 1).

Table 1. Performance of University-Owned Enterprises in Science Parks in China, 2004

	Number	Income (billion yuan)	Profit (billion yuan)	Tax paid (billion yuan)	Income to University (billion yuan)
University-Owned Enterprises in Science Parks	1121	58.26	3.24	2.39	0.49
Total University-Owned Enterprises	4563	96.93	4.99	4.87	1.75
Ratio of the Former to the Latter	24.57%	60.10%	64.95%	49.26%	25.56%

Source: Xue (2006).

Another strategic initiative to meet various challenges facing universities is the set-up of university towns led by local governments in China. The development of university town is based on the

principle of '1+1>2', which means that an extra value could be added and productivity gain could be achieved by gathering multiple universities together, hopefully to trigger the development of innovative industries. Yet the isolation of university towns in the deserted suburb has downgraded their social attributes and constrained their interaction with the industry. University towns are founded before significant regional development takes place. There is less interaction between the university and the industry. Given university town is a relatively recent phenomenon in China, it can be considered that suburbanisation of regional development happens first in the fields of higher education, which is ahead of the large scale movement of population, industry, commerce and office. So the interplay between the university and the industry in terms of university towns in China is likely to and should be further intensified in the future.

University Engagement and Regional Development: the Case of Tongji Creative Cluster in Shanghai

Regional Innovation System in Shanghai

The above discussion on the context in which Chinese universities engage in economy reflects a general picture in China. As China is a huge and diversified country, the situation can be different from one region to another. A crucial factor that influences university engagement is the development conditions of the region. As China's leading metropolis, Shanghai is in an advanced urban stage compared with other Chinese regions. It is in the transition from investment-driven to innovation-driven economic growth (Zhang, 2009). There are more evident and urgent needs for higher education and innovation in Shanghai's regional development. Universities in Shanghai are facing more severe challenges to promote the development of regional innovation system.

Since 1994, Shanghai Municipal Government has signed agreement with Ministry of Education, Ministry of Health, Ministry of Finance, and the former Textile Association for the joint jurisdiction of eight national universities. From 1998 to 2000, the leadership of another 11 national universities were transferred to Shanghai municipality. Therefore, Shanghai Municipal Government could place these top research universities into regional development plans and provide funding for them; in return, the universities would gear to the regional needs in their education and research.

To encourage the engagement of universities in regional innovation system, a legal framework was established in Shanghai in line with the national directive. In 2004, Provisions of Shanghai Municipality on Promoting the Transformation of New and High-tech Achievements was put

forward. The 2004 Provisions encourages university personnel to engage in the transformation of new and high-tech achievements as a concurrent occupation and makes it easier for them to move back and forth between research and business. It also makes generous allowance for rewarding discovers of innovative and productive knowledge: researchers making the achievements may be rewarded no less than 20% of the after-tax income or stock from technology transfer.

Similar laws and favourable policies about tax relief and intellectual property protection have also been enacted. In addition, a network of service centres for policy consultation and difficulty coordination have been established (Fan, 2003). Shanghai Municipal Government has also controlled strictly over population inflows through urban household registration system, providing larger quotas for the higher educated and special talents while setting up long and complicate process for the poor-educated and low-skilled (Li & Wu, 2006).

Correspondingly, along with the regional needs of innovation, there is a rapid university expansion in Shanghai. From 2000 to 2010, the number of higher education institutions in Shanghai increased from 37 to 66, and the number of students has more than doubled (SMSB, 2011). At the same time, the linkages between the university and the industry have been intensified. The industrial sector has become the second largest source of R&D funds for universities, with the percentage getting close to 34% in 2009, only inferior to the government with 59.3% of funding (SMEC & SMSB, 2010). Through its engagement efforts such as cultivating human resources and building commercial linkages, it's possible for the universities to trigger regional development. In this aspect, Tongji Creative Cluster represents a typical development model in Shanghai.

University Spill-Over Effect: Tongji Creative Cluster

Tongji Creative Cluster was originated from the spontaneous agglomeration of creative industries around Tongji University. It was developed by harnessing the superiority of the university's leading disciplines in commercializing academic research and managing industrial linkages. As early as in the 1980s, some teachers and researchers began to set up companies publicly inside the university. In the mid-1990s, there came a large-scale increase of enrolment. Facilities in the university, such as classrooms, dormitories, and offices, were in serious shortage. Ancillary services such as rendering, model making and printing, as well as the teachers' design companies were gradually spilled out of the campus. Most of them were relocated along Chifeng Road, a secondary urban street bisecting the university into central campus and south campus. By 2003, there had been about 400 enterprises concentrated along the 860 meter long Chifeng Road (Yu & Chen, 2005). The

scenery of Chifeng Road was being transformed and it became famous for the agglomeration of creative industries.

At that time, Yangpu District, where Tongji University locates, was suffering urban decaying as a traditional industrial base. Traditional industries such as textile and manufacturing which were characterised by extensive growth couldn't adapt themselves well to the market mechanism. The contribution of industrial added-value to the urban added-value in Yangpu District decreased from 34.24% in 1992 to 18.57% in 1998, and it became a negative force for economic growth (Li & Chen, 2005). Therefore, it was necessary for Yangpu District to transform the modes of economic development. The prospering of Tongji Creative Cluster at that time provided such an opportunity and soon attracted the attention of the local governments.

In 2003, Yangpu District Government invested over eight million yuan to improve the environment around Chifeng Road and officially named it Tongji Modern Architecture Design Street. When the enterprises along Chifeng Road expanded into the neighbouring area, Yangpu District Government invested another five million yuan to renovate the infrastructures and provided a lot of space by exchanging land use right and reusing the idle buildings. There was a trend of developing university towns in China at the turn of the century and therefore the idea of Yangpu University Town was put forward by Yangpu District Government. It was aimed to facilitate collaborative growth through the joint effort of multiple universities and to develop the cluster into a high-tech industrial base predominated by large enterprises.

But it was soon discovered that the high-tech orientation of the cluster was in contradiction with Zhangjiang High-Tech Park, a national level science park that was established in 1992. Reflecting on the advantages of Tongji University and the characteristics of the enterprises, the cluster was readjusted to incubate small and medium start-ups based on creative industries, which could be integrated with Zhangjiang when they were developed into a larger scale. A series of favourable policies and services were provided by Yangpu District Government. These include financial service of preferential loans and venture investment for medium and small businesses, entrepreneurship service of pioneering funding and guidance for startup companies, procedural service to assist program evaluation and funding application, training service for policy interpretation and vocational training, human resource service for personnel recruitment and recommendation, intermediary service to provide professional consultancy about property rights, law, finance and so on.

In 2007, Wan Gang, president of Tongji Univeristy at that time, proposed to develop the cluster around Tongji University into a knowledge economic area. The proposal received immediate approval from Yangpu District Government and they worked out together two important documents – Preliminary Agreement on Strengthening Further Cooperation in Promoting Independent Innovation, Planning Framework for Tongji Knowledge Economic Area. The knowledge economic area was planned to include the core area, the expansive area and a number of distant nodes (Figure 4). It was formally launched by Yangpu District Government and Tongji University in May 2007 and was integrated into the management system of Zhangjiang High-Tech Park in 2008. In January 2009, the cluster was included into the National Torch Plan by the Ministry of Science and Technology. It is the first and the only state-level characteristic industrial cluster based on modern services in China: all the other clusters in the National Torch Plan are based on high-tech industry. In September 2009, the cluster was named as Tongji Creative Cluster by Shanghai Economic and Information Technology Commission. And it ranked the first batch of Creative Cluster Exemplar in Shanghai in May 2010.

Tongji Creative Cluster has proved to be an effective catalyst for local development. It helped to optimise the land use structure in Yangpu District and transform a large scale of industrial land into creative space. The output value of Tongji Cluster kept increasing at a rate of over 20% year by year (Yuan & Zhao, 2011). Knowledge-based services have become an important economic momentum in Yangpu District. Positive social relations and partnerships were established. Successful experiences, such as 3-zone interaction (university-industry-community), have already been institutionalised and spread to the whole city.

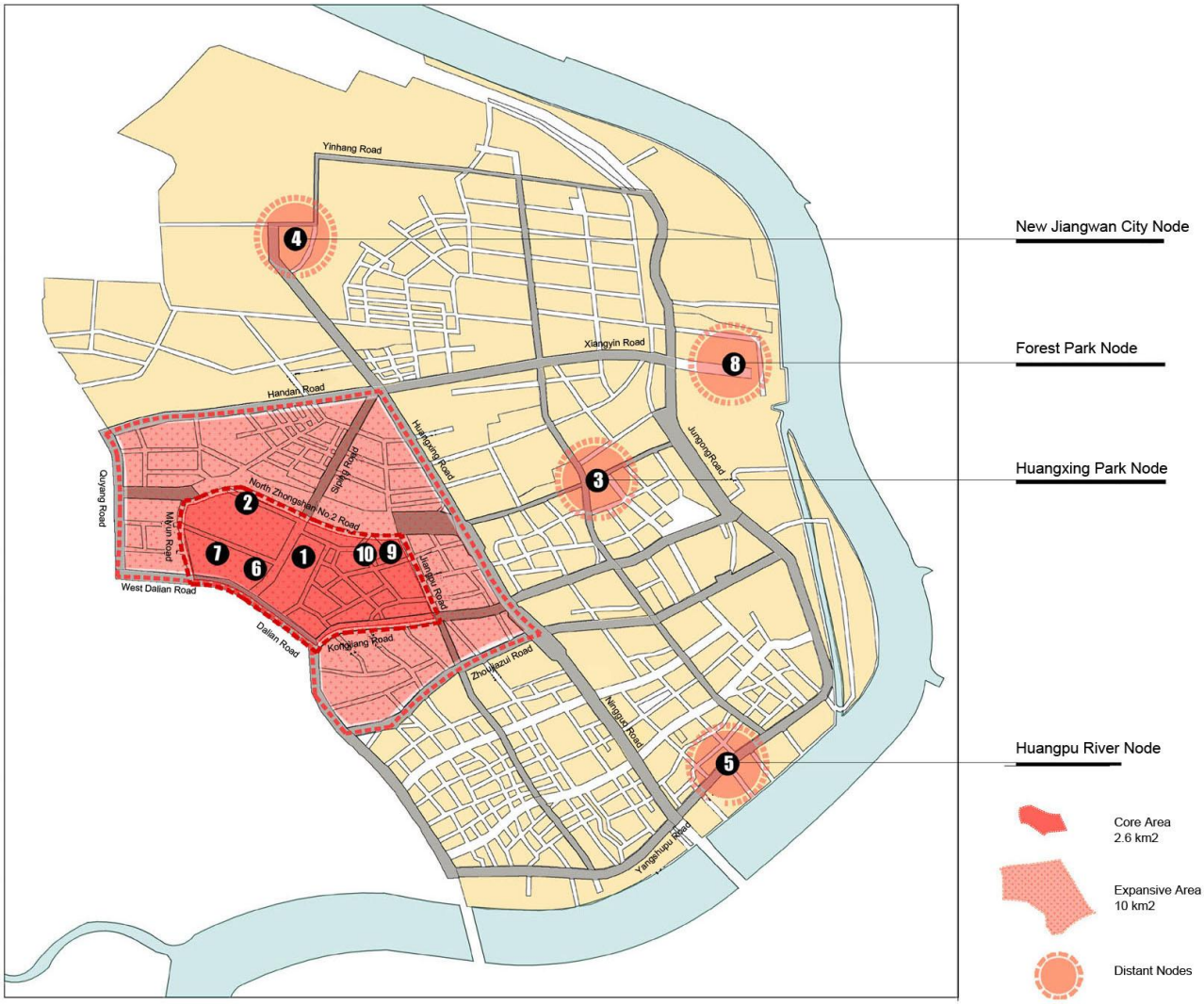

Figure 4. Spatial Layout of Tongji Knowledge Economic Area

Source: Yangpu District Government, 2011.

Discussions

Different from the top-down strategy of science parks launched by the government, Tongji Creative Cluster came into being spontaneously and grew up from the bottom. And there have been various driving forces in its development process. At the initial stage, it was driven by the spontaneous spill-over of university spin-off companies. When the cluster began to grow, the neighbouring community played an important role to meet the increasing spatial needs of housings and offices. With the urban strategy of relying on science and education for economic restructuring, the cluster got special attention from multi-level governments with financial and institutional support.

Even though there are various driving forces, the government has always become the leader in the end no matter in a top-down or bottom-up way. This leads to reflections on the diversity in the modes of innovation, which remains to be discovered. Perhaps, in the Chinese context, it's better to be defined as a state-led model (Figure 5) rather than a Statist Model in the past or Triple Helix in the ideal. When the power of the government is much stronger than the university and the industry, or when the university and industry are basically part of the state, there can be constant interaction between the university and the industry, but it tends to be under the control of the government. In fact, the strategic manipulation of the government is largely considered as a key factor and an important characteristic to achieve the great success in Chinese regional innovation systems.

Moreover, interrelations among the university, industry and government are not stable, but keep changing over time, which is actually also recognised in the Triple Helix model. The Triple Helix model, the state-led model, as well as other innovation models, can all be considered to be the representation of the constant interaction among the three institutional spheres in different development stages and under different conditions. Along with the changing power of the three (internal mechanism) and the changing context (external mechanism), one innovation model can be gradually transformed into another. Sometimes, the transformation from one model to another is manipulated deliberately to achieve the flexibility in regional development. This can also explain the dynamic transformation of Tongji Creative Cluster from a spontaneous industrial agglomeration to a national level creative cluster.

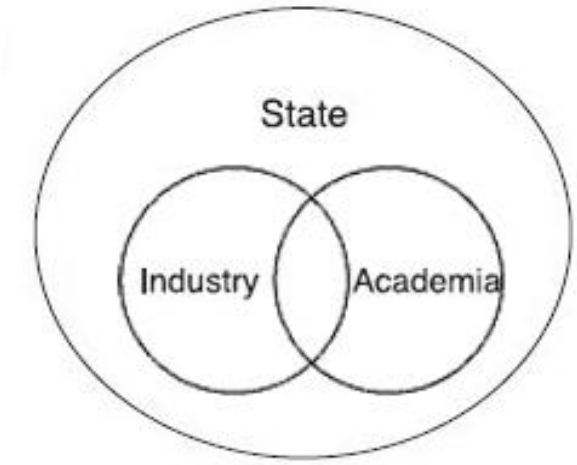

Figure 5. State-Led Model

Source: Liu (2013)

Conclusions

The role of universities in the knowledge society is elevated to an equivalent status as government and industry, in contrast to previous institutional configurations in which government and industry have always been major institutions and university occupied a secondary status. This concept is represented in the notion of Triple Helix as a guiding principle in dealing with university-government-industry relations. The core idea in the Triple Helix model is that the three institutional spheres should overlap and collaborate with each other, with each taking the role of another. However, the ideal model of Triple Helix does not apply to all the regions given their divergence in terms of development stages, university characteristics and so on. Even though there is a pursuit of Triple Helix in theory, it is difficult to fulfil in practice.

At present, China is shifting its economic priority from labour-intensive production to capital-intensive and technology intensive production. The university-government-industry relations are in the transition from a Statist Model to the Triple Helix. The universities are not only encouraged to upgrade the quality of human resources, but also to engage in economic development through knowledge commercialisation. However, the cooperation between universities and enterprises still remains weak due to the incomplete legal system, short-term view, lack of trust and motivation and so on. To strengthen the university-industry relation, multi-level governments have jointly put forward a series of measures, which include university-run enterprises, university-based science parks, and university towns. In this process, the government plays a leading role to promote the engagement of universities in regional innovation system.

In Shanghai, the most developed region in China, there have been some successful experiences with regard to university engagement. To build a competitive regional innovation system, Shanghai Municipal Government not only endeavours to upgrade labour quality by cultivating top research universities, expanding university enrolment, and attracting special talents, but also encourages university-industry linkages by issuing favourable laws and policies, setting up service centres, and providing generous allowances. These provide a superior and indispensable environment for university engagement in economic development. Taking Tongji Creative Cluster as an example, it was originated from the spontaneous spill-over of university resources and received little support from the government at the initial stage of its development. When its economic and social value began to show up, the government intervened quickly and provided both financial and institutional

support. With the guidance of the government, Tongji Creative Cluster has adjusted the development orientation and optimised the management system, which all proved to be key factors for its success.

The success of Tongji Creative Cluster show that the collaboration between university and industry is important to promote regional development, more important is whether it can be integrated into the regional innovation system. Regional innovation system incorporates complex functions and diverse interaction among various organisational factors. It would be difficult, if not possible, to achieve the proposed goal without the central control and coordination of the government. Although in other countries and regions, the power of the government may not be as strong as in China, it is still possible and necessary to strengthen the leading role of government in certain stages of development. The institutional efforts of multi-level Chinese governments, such as university-based science parks, legal framework, and service centres, can also work as successful references.

At the same time, the development of Tongji Creative Cluster follows a step-by-step evolutionary process and proceeds by trial and error, with frequent mid-course corrections and reversals of policy. In this way, its development goal was able to be readjusted in time to avoid competition with Zhangjiang Hi-tech Park which has got strong national and local support in the same field. In this sense, the incremental development experience in Tongji Creative Cluster provides a good example for other cases.

The characteristics of Tongji Creative Cluster also imply that some experiences may not be applicable in other regions. For example, Tongji Creative Cluster was developed by harnessing the superiority of the top university's leading disciplines in commercializing academic research and managing industrial linkages. In other regions where there are no such competitive universities, it might be difficult to depend on a sole university to promote regional innovation system. Instead, a possible way might be to build a positive network of academia instead of relying on a single university.

In addition, most universities in China are public ones and subject to government control, though controlled by different levels of government. Therefore it's easier for the Chinese government to intervene in the development strategy of universities. In other contexts where most competitive universities are private and autonomous, it might be difficult to exert any deep influence over the university by external actors.

There is also a work unit tradition in Chinese universities to run enterprises directly by themselves, which is quite different from some other countries where the universities are not allowed to engage

in profit-oriented activities. Chinese universities can transform the research outputs into market products directly through university-owned enterprises rather than going through a long and complicate negotiating process with other enterprises.

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