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Regional Innovative Capacity in China: From the Perspective of Embedded Autonomy

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Abstract

Innovation is widely considered as the core driver of nations' economic growth and competitiveness. Since the start of economic reform in 1978, the provincial governments in China have gained much autonomy, which has led to the co-existence of multi-level innovation systems, national innovation system and regional (provincial) innovation system. With the economic development and social progress, the disparities in innovative capacity (IC) among regions in China are becoming increasingly larger. Considering the unique innovation context of China and drawing upon the research on IC, this paper proposed to employ theories of embedded autonomy and governed interdependence, which was developed to explain the institutional relationships based on newly industrialized Asia countries, to investigate the reason of variations of regional innovative capacity in China.

Introduction

Innovation is widely considered as the core driver of economic growth and nations' competitiveness. Since the concept of national innovation system (NIS) first used by Freeman (2004) in 1982, it has become substantial field of research. Up till now, important theoretical and empirical research on NIS has been published focusing on comparing the structures and dynamics of NIS. With the development of NIS, researchers found that studies of innovation system (IS) at regional level was also important (Cooke, Uranga, & Etxebarria, 1997), and to large countries, regional innovation system (RIS) approach is even more useful. With the

surge in regional innovation policies and the emergence of regionally identifiable nodes, the regional level is favoured in examining the learning economies (Asheim & Isaksen, 1997).

Draw on the concept of NIS, lots of comparative case studies were conducted (Freeman, 2002; Lundvall, 1992; Nelson, 1993), and quantitative approaches were employed as well (Nasierowski & Arcelus, 1999). Driven by understanding the underlying drivers of innovation processes and the impact of country-level policy on innovation, Stern, Porter, and Furman (Stern, Porter, & Furman, 2000) introduced a framework based on the concept of national innovative capacity (NIC) to capture the differences of NIS by observable measures of variation. While the NIS approach tended to rely on rich qualitative descriptions of differences of ISs across countries, the NIC framework tries to investigate the drivers of the variations from a quantitative way.

In the global economy, the region is more important than the nation, and has become a focal point of economic activities (Ohmae, 1995). Therefore, to understand the drivers of NIC, it is better to understand the drivers of regional innovative capacity (RIC). However, except several studies took place at regional level, such as in European regions (Fritsch, 2002), most studies were undertaken to investigate the determinants of IC at the national level since the concept of NIC was brought out (Furman & Hayes, 2004; Furman, Porter, & Scott, 2002; Hu & Mathews, 2005). There is not much research done to systematically explore the phenomenon at the regional level within a nation, especially in transition economies.

With the rapid growth and the influence on global economy, China attracts much attention from IS researchers. Studies on China's NIS found that the roles of innovative actors are different in China from in other countries due to its special transitional stage (Hu & Mathews, 2008; Liu & White, 2001; Motohashi & Yun, 2007). As one of the biggest developing countries in the world, China has been transitioning and transforming from centrally planned

regime to market-oriented system since the economic reform started in 1978. Its environment for innovation has produced a dynamic tension between old and new, between foreign and indigenous, and between values and practice (Baark, 2007). Although there existed some studies on China's RIS and RIC (Guan & Liu, 2005; Ji & Zhao, 2008; Li, 2006, 2009; Sigurdson, 2005), the variations in patterns of RIC development are not understood.

Interactions between system components are the core of RIS and RIC (Carlsson, Jacobsson, Holmen, & Rickne, 2002; Iammarino, 2005). Due to the uniqueness of China's context, as explained in the next section, the interactions between government and industry in China are different from in other countries. The literature of NIS/RIS and NIC/RIC developed in developed economies cannot fully explain the phenomena of RIC in China; accordingly, the literature of embedded autonomy, which was developed in emerging economies to explain the growth of state capacity (Evans, 1989, 1994; Weiss, 1998; Weiss & Hobson, 1995), is employed. Embedded autonomy was used to investigate the distinctive government-business relationship and can be used to explain the role of government in economic development (Weiss, 1998; Weiss & Hobson, 1995). Hence, it is appropriate to explain the complex institutional relationships between the components of RIS.

Taking the above situations into account, this paper will integrate the theory of embedded autonomy with the phenomenon of RIC in China. The following will first look through the context of China's IS, then discuss how embedded autonomy can explain RIC in China.

The Context of China

Context is the basis for theorising (Child, 2000). It is difficult to adapt experiences and theories developed in other countries to China directly because special historical

accumulation and development path lead to the uniqueness of China's context. Consequently, it is essential to know the context first before exploring any phenomena in China, which is true for RIC studies. In addition, acknowledging the context will show the nature of RIC.

Transition of China's economy

China's economic reform process was gradual (Bagnai & Ospina, 2009; Chow, 2004), therefore it is useful to distinguish between two periods in China since its foundation. The crucial shift was in 1978 when Xiaoping Deng initiated economy reform and the opening of the economy to the international world. The first period was under a centrally planned economic regime and the second was with market-oriented reforms and economic transition under the guidance of central government. Since the implementation of the open policy and economic reforms, the performance of China grew extraordinarily, as shown in Table 1, and the structure of economy has been changed as well.

Table 1: Growth Rate of China's Economy 1952-2007 (At constant prices)

	1952-1978	1986-1990	1991-1995	1996-2000	2001-2007	1979-2007
GDP	4.4	7.9	12.0	8.3	10.2	9.8
Primary Industry	2.2	4.2	4.2	3.5	4.1	4.6
Secondary Industry	8.4	9.0	17.4	9.8	11.4	11.4
Tertiary Industry	4.5	9.4	10.0	8.2	10.8	10.8

Source: Gu & Lundvall (2006), China Statistic Yearbook 2001, 2008

Note: Data for the period of 1979-1985 are missing in the table as I cannot access them.

Primary Industry includes agriculture.

Secondary Industry includes mining, manufacturing, and production and distribution of electricity, gas, and water.

Tertiary industry includes transportation, finances, education, and other services industries.

As shown in Figure 1, in the early foundation of the People's Republic of China (PRC), about 60% of GDP was generated by the primary industry. The second period was dominated by industrialization, rather than the post-industrialization which took place in developed countries after WWII (Gu & Lundvall, 2006). As a result, China is now highly industrialized. Since the economic reform, the contribution of primary industry to GDP shrank from the highest of 31.9% in 1981 to the lowest of 11.3% in 2007 continuously; the secondary industry did not change a lot during the second period, it was fluctuating from 41.8% to 48.6%; however, the tertiary industry increased from 23.9% in 1978 to 40.1% in 2007. The activities led to these changes were all under the guidance of the development plans developed by the central government, which were the director and interventionist of economic development in China.

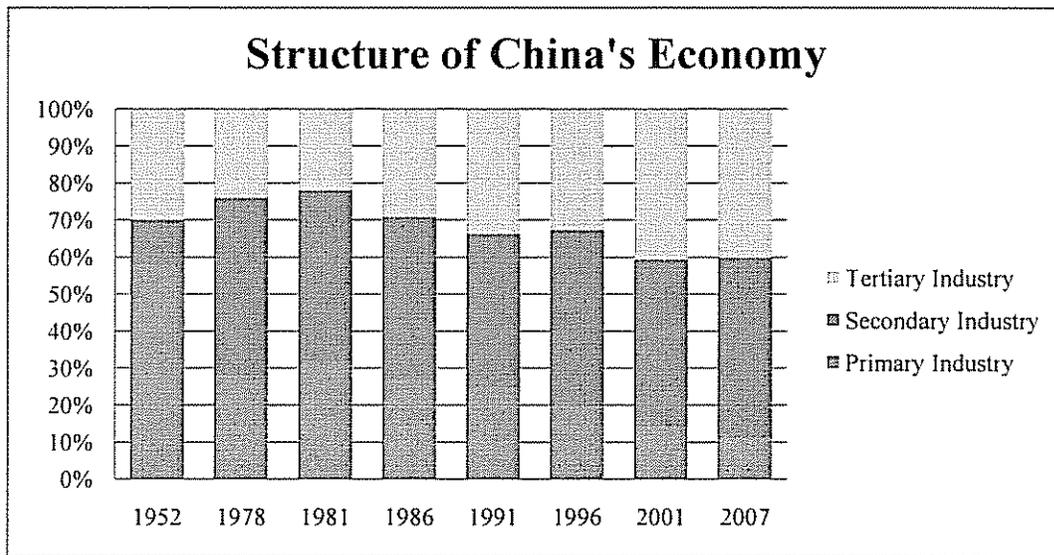


Figure 1: GDP structure of China's economy at constant prices

Source: Gu & Lundvall (2006), China Statistic Yearbook 2008

Transition of China's NIS

During the transition of Chinese economy from centrally planned regime to a market-oriented economy, China's NIS and RISs are also transforming. Along with the economic reforms, the

development of China's NIS can be divided into three periods. The first one was from the foundation of PRC to the beginning of economic reform in 1978. During this period, the nation was the driving force of innovation, and governments, especially the central government, funded and controlled all innovative activities. One character of this period was the main focus on the development of military technologies, which was separated from the civilian, and another was there were few interactions among industries, universities, and public research institutes (Sun, 2002). The evolution of China's NIS in this period was summarized as a process alternating between a professional-bureaucratic and an ideological model (Suttmeier, 1980).

The second period was from 1979 to 1992. This was the early stage of economic reform and the role of government in innovation was transferring from mandatory to directing. The emphases of this period were technology transformation and reshaping the relationship between knowledge producers and users and their relationship with the government. The crucial event for NIS reform was the Decision of Reforms on Science and Technology System initiated by the Central Committee of the Communist Party of China in 1985. The main points of the Decision were establishing technology markets to facilitate the commercialisation of R&D outputs, introducing the excellence-based allocation mechanism to allocate public R&D funds. However, the market approach failed to achieve the expected results.

The third period is from 1993 up to now. In 1993, the "Decision on Various Issues to Build a Socialist Market Economy" was made, which shifted the emphasis from technology transfer to technological innovation in industrial enterprises. Since the 1997 Asian finance crisis, China has intensified efforts to shift the pattern of economic development from an extensive mode based on growth of material inputs to an intensive mode based on technological improvements (Sun, 2002). In 1999, the "Decision on Strengthening Technological Innovation,

Developing High-Tech Firms, and Realizing Commercialisation of New Technologies” was issued. It realized the complicated relationships among reforms in the economy, science and technology, education, and innovation (Zhong & Yang, 2007).

As can be seen from the above, during the whole process of transformation, the government was in an important position no matter it was mandatory or directing, which resulted in the different roles of innovative actors in innovation development between China and western countries. For example, public research institutes occupied a far more central position while universities played a far less significant role in China than in western countries (Sun, 2002). China is still in the transition process and Chinese institutions are converging to those of market economies with Chinese characteristics (Bagnai & Ospina, 2009). It has a long way to go to improve NIS and the government will continue its significant impact.

Disparity of China’s RIS

In transitional China, dual innovation systems exist. As Tylecote (2006) argued, there are always dual technology systems in transitional countries. One is upper level innovation system which focuses on advanced technology and the other is lower level innovation system which is locally embedded. In China, the duality is evident in most regions. As one factor of economic environment, industry structure will affect the development of IC (Furman et al., 2002; Stern et al., 2000). Figure 2, Figure 3, and Figure 4 reveal the different industry structures of 30 administrative regions in China with the distribution of gross output shares. Consistent with the trend of national industry structure, secondary industries contribute the most to the regional GDP in most regions, but there are some exceptions. For example, in Hainan, the contributions of the three industries are almost even now, while in Beijing and Shanghai, the tertiary industries occupy more than 70% and 50% respectively. Besides, the regional high-tech industries, as one of the priorities of current economic development (*The*

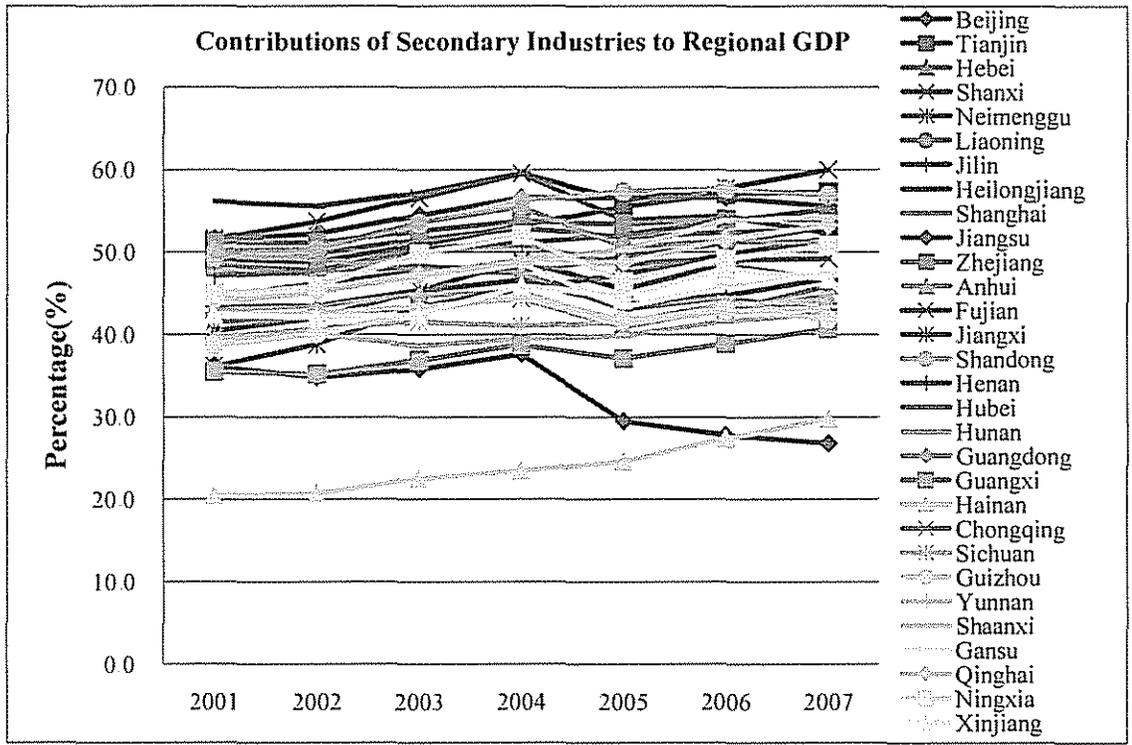


Figure 3 Contributions of Secondary Industries to Regional GDP

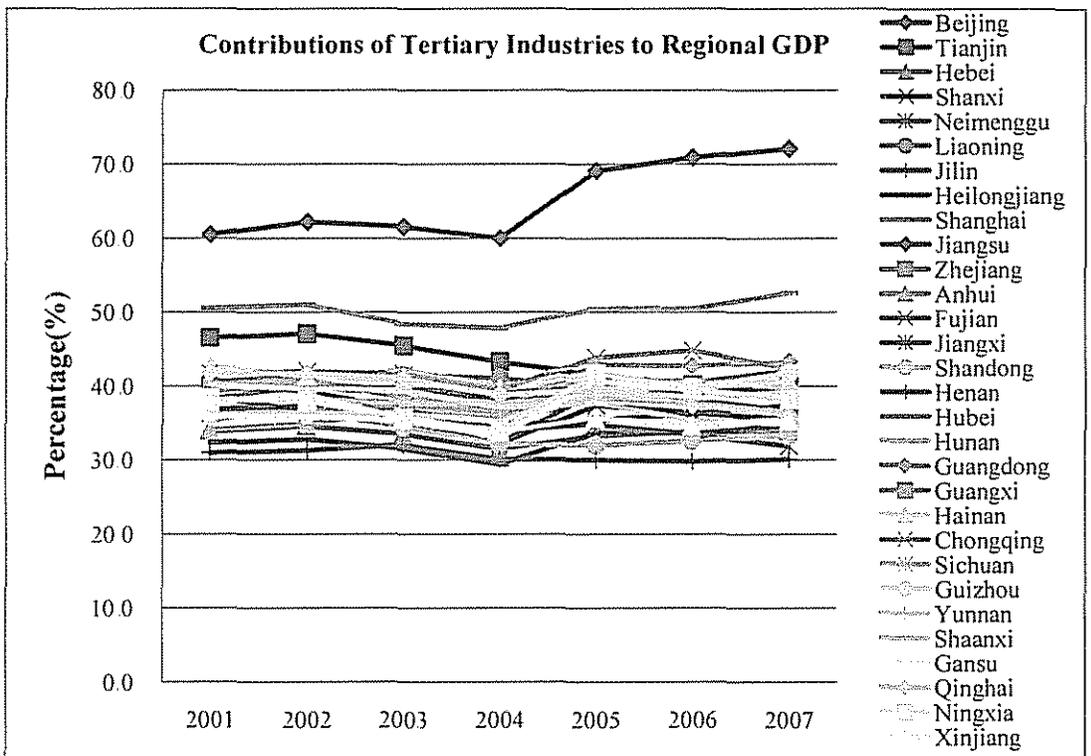


Figure 4 Contributions of Tertiary Industries to Regional GDP

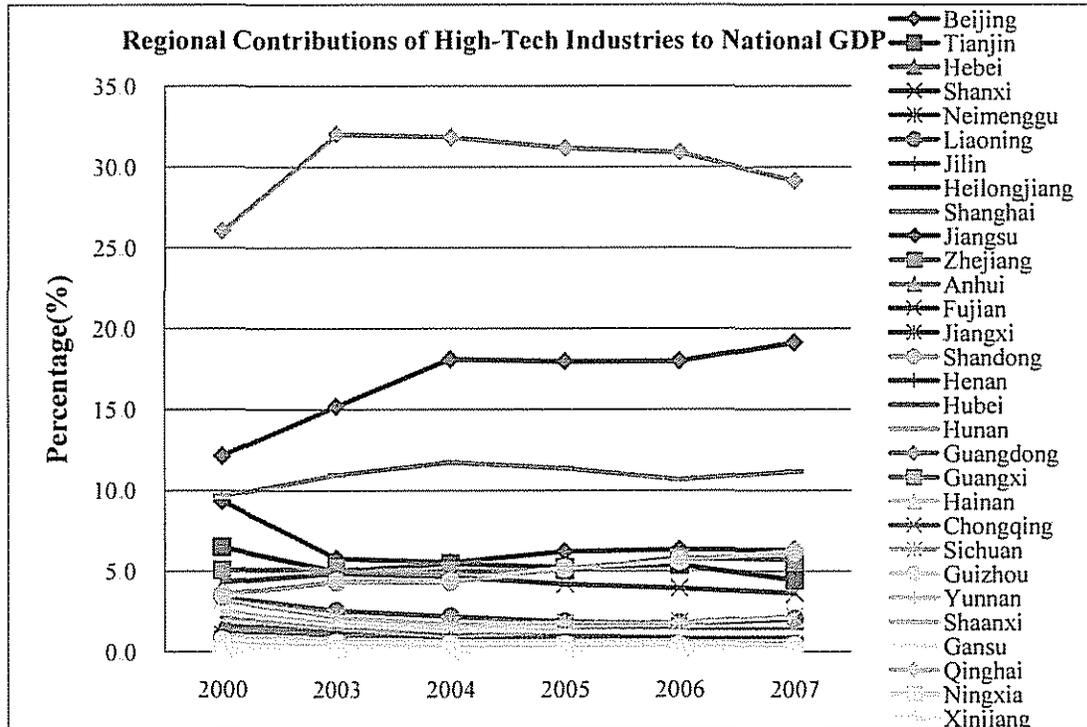


Figure 5 Regional Contributions of High-Tech Industries to National GDP

With the rapid economic development and reform of NIS in China, the innovation output has become more concentrated on some highly innovative regions (See Figure 6 and Figure 7, which depict the proportions of non-individual invention application and grants of regions in national counts). In 1991, the most innovative five regions accounted for about 40 percent of non-individual invention applications while in 2007, more than 60 percent are from the five most innovative regions. The disparity of non-individual invention grants is not so large between 1991 and 2007, which is around 45% and 55% respectively. Meanwhile, the five most innovative regions are changing according to non-individual invention applications. In 1991, they were Beijing, Liaoning, Shandong, Sichuan, and Jiangsu, and in 2007, they were Guangdong, Beijing, Shanghai, Jiangsu, and Zhejiang. One reason for the changes would be the uneven development of innovative infrastructure which was addressed above a bit.

In line with the transformation of RIS, changes of RIC have occurred in China as well. It can be seen also from Figure 6 and Figure 7 that there are great variations of IC among regions in

China and the disparities are becoming larger. From 1991 to 2007, the contribution of Guangdong in non-individual invention application and non-individual invention grants increased most, from 4.4% to 20.9% and 1.8% to 12.3% respectively. The second region that increased most is Shanghai, fluctuated from 5.3% to 12.5% in application and from 8.1% to 12.3% in grants. However, the contribution of Liaoning decreased both in applications, from 8.2% to 2.9%, and in grants, from 7.9% to 3.2%. Beijing held the first position in the whole period of grants and decreased from first to second position in application. Considering that all the regions are under the same national context, why the RICs are changing in different directions?

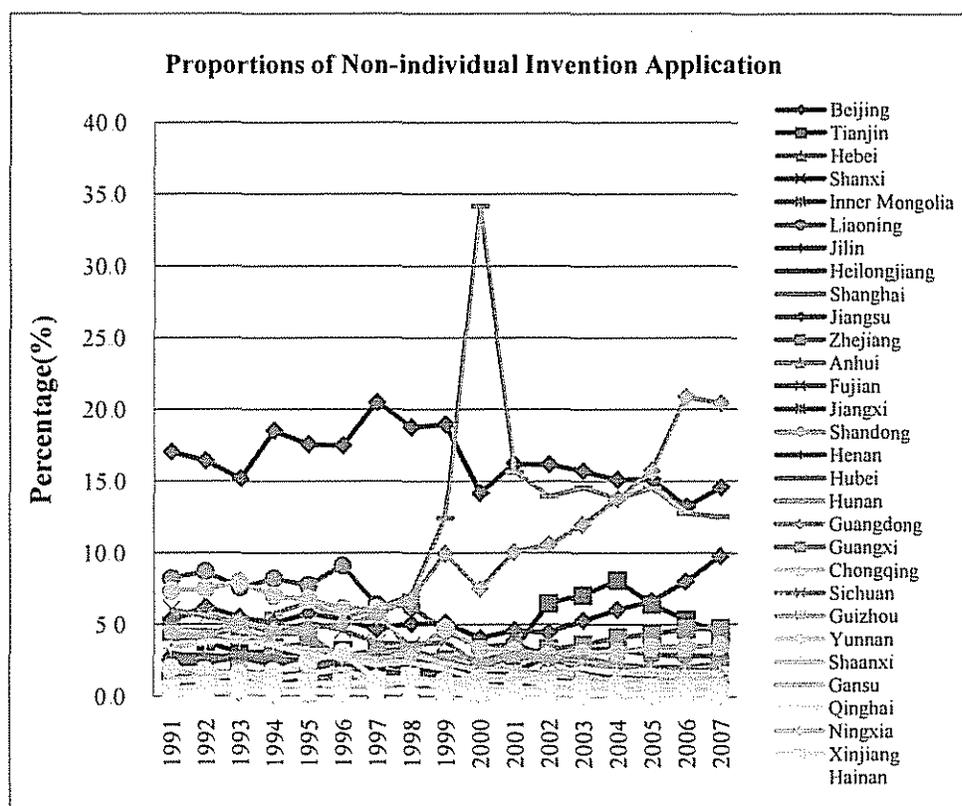


Figure 6 Proportions of non-individual invention application

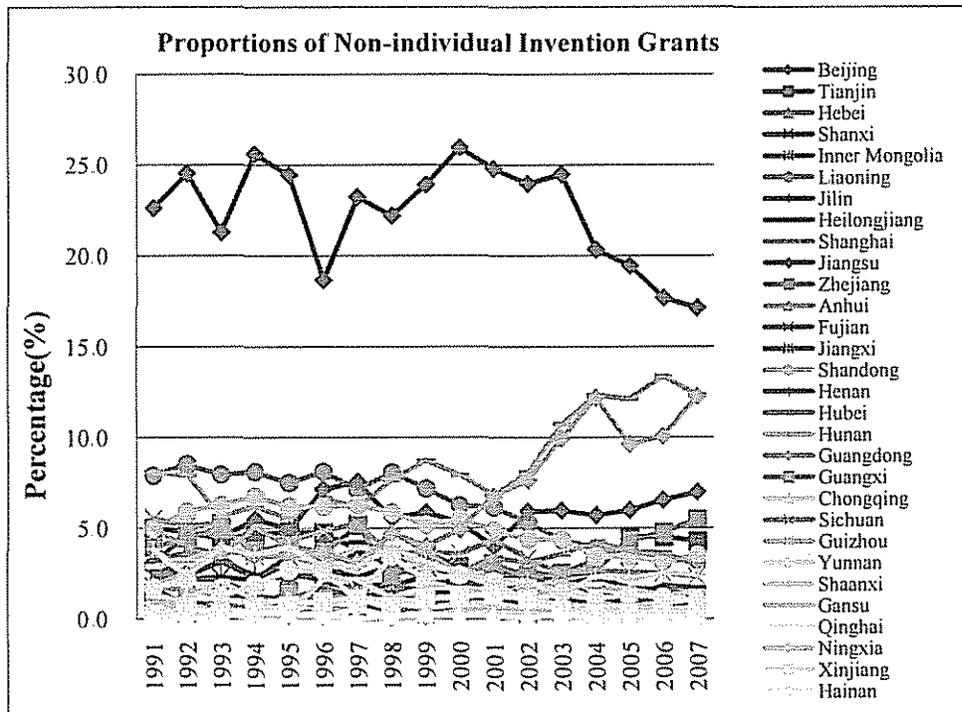


Figure 7 Proportions of non-individual invention grants

As seen from the brief illustration of China’s context of RIC, the government plays an influential role of economic development and there are significant regional variations of IC in China. Given such situation, the stories behind the variations become the focus of this study.

Embedded Autonomy and the Role of Government in RIC Development

Determinants of RIC

RIC stems from the concept of NIC, and it is the application of NIC to the regional level. Draw on Romer’s (1990) endogenous growth theory, Porter’s (1990) cluster theory of national industrial competitive advantage, and Nelson’s (1993) research on NIS, Stern, Porter, and Furman (2000) put forward a framework of NIC, in which “potential” and “commercialisation” are at the centre (p. 1). Based on the definition of NIC, Tura and Harmaakorpi (2005) considered RIC as the joint innovation capability of the firms and other

organisations in a region. Taking the approach of RIS into consideration, RIC here means the ability of innovative actors within a specific region to produce a stream of commercially relevant innovations in the long run.

In previous studies on IC, which based on OECD countries and some Asian countries, it was proved that, both at national and regional level, IC would be affected by innovative input (Furman et al., 2002; Hu & Mathews, 2005, 2008; Li, 2006, 2009), innovation environment (Furman et al., 2002; Hu & Mathews, 2005, 2008), innovation efficiency (Li, 2009), availability of resources for innovation (Furman & Hayes, 2004), public policies (Furman et al., 2002). Some scholars pointed out Regions differ not only according to the performance of the actors, but also with respect to the density of systemic interactions (Iammarino, 2005) and RIC was determined to a great extent by the interaction among actors and between actors and the innovative environment (Guan & Liu, 2005). Because the interactive activities, such as collaboration, competition, transaction, and networking lead to information flow, knowledge flow, capital flow, and personnel mobility, which will directly affect the innovation process (Chang & Shih, 2004; Cooke et al., 1997; Edquist, 2004).

Embedded autonomy and the role of government in RIC development in China

Interactions are the key activities in innovation processes. In China, they are different from western countries as China is in the process of transformation and at a special stage that its economy is different from pure planned economy and market economy. Important dimensions of the interactions which affect RIC are those associated with government-industry relations. As a developmental country, which means an interventionist government that conjoin private ownership with government guidance (Woo-Cumings, 1999), closely cooperate between public and private sectors with the intervention of government (Johnson, 1982), the government of China is an important agent in shaping its innovation system (IS)

and is an indispensable variable in understanding China's IS (Sun, 2002). Besides, during the gradual reform process, China emphasized the role of the government (Sun, 2002).

A state is a set of institutions with the authority to make binding rules for people and organisation located in a particular territory and to implement these rules sometimes with force (Mann, 1994; Rueschemeyer & Evans, 1985). In the studies of state capacity of economic development in East Asia countries, state was mentioned at the national level (Evans, Rueschemeyer, & Skocpol, 1985; Weiss, 1998, 1999; Weiss & Hobson, 1995), but for China, it is necessary to extend to the local level, such as provinces, municipalities, and autonomous regions, which play an key role and even benefited more than the central state during the reform process (Zhu, 2003). The significant role of the state at the local level is an important part of the uniqueness of the Chinese context which will allow for new theory development regarding the role of the state and state-industry relations in RIC.

In the experiences of East Asia growth miracle, government policy played crucial roles (Rodrik, 1997). The manner that the states deal with industries or private sectors was called "embedded autonomy" by Evans (1995, pp. 12-13) and "governed interdependence" (GI) by Weiss (1998, p. 48). Embedded autonomy highlights the complex of institutional linkages through policy networks that the state forms (Evans, 1989), and it depends on the contradictory combination of bureaucratic insulation with intense immersion in the surrounding social structure (Evans, 1994). Embedded autonomy applies to some extent to most contemporary industrial countries, and all industrialized countries have developed a generalized embeddedness (Weiss, 1998). Embeddedness is necessary for information gathering and policy implementation because policies must respond to the perceived problems of people and organisations and rely in the end on them for implementation (Evans, 1994). For developmental countries, the embeddedness of autonomy is selective (Evans, 1994; Weiss, 1998).

Governed interdependence theory was developed to explain the phenomenon of state capacity of economic development in the world economy based on the East Asia newly industrialized countries, especially Japan, by Weiss and Robson (1995). In East Asian countries, most are in a transitional economy which is neither purely state-centred nor market-centred and the interdependence between government and industry was sponsored by the country through construction of policy networks (Weiss & Hobson, 1995). The key point of GI theory is “whether the state is able to use its autonomy to consult and to elicit cooperative responses from the private sector” (Weiss, 1998, p. 49), which stressed the importance of conversion ability of autonomy into capacity.

One reason of the East Asia growth miracle is the distinctive kind of government-business relationship (Weiss, 1998), but the development path and role of the government differs in different countries. Take the four tigers (South Korea, Singapore, Taiwan, and Hong Kong) as examples. Although they all followed the outward-looking, export-led development strategies and policies to promote competition among firms, South Korea was relatively closed to foreign investment and depended on small number of large conglomerates of its industrial development, while Singapore relied heavily on direct foreign investment and Taiwan depended on locally-owned small and medium-sized firms. Hong Kong is an exception of the four as it pursued a free market approach for its development, but the other three relied on strong state intervention (Hobday, 1995). Even though, the governments played different roles in the three. The South Korean government played a leading role, which was collaborative and even coercive in relations with the private sector while the Taiwan government was in a supportive role rather than interventionist (Park, 1990). In Singapore, a strongly private enterprise economy, the government was both supportive and interventionist, depending on in which area (Huff, 1995).

China's situation is more complex due to its uneven development across different the country. During the pre-reform era, the central government was the driving force of economic performance as well as innovation and all activities were organized on the basis of a "top-down" approach (Sun, 2002). With the implementation of open policy since 1978, the provincial government have much autonomy to make and implement their own policies under the guidance of central government. What is special in China is that the authority is always given to some specific provinces or cities or even districts. If it facilitates economic development or achieves the original goal for providing the authority, it will be promoted in more regions or the whole nation. For example, a special economic zone, Shenzhen, was first opened to the world, following by Zhuhai, Shantou, Xiamen, and Hainan, then 14 coastal cities such as Shanghai, Tianjin were opened to the world. After that, the open area was extended to six coastal economic open zones, for example, Yangtze River delta and Pearl River Delta.

The process of innovation development is similar to that of economic development. Although the development of innovation capacity was facilitated by the central government, the emphases of each region differ in different periods. During 1991 and 1995, the coastal regions were encouraged to develop industries with relative high techniques according to capital, technical, personnel advantages while inland China was encouraged to develop resources based manufacturing industries (*The Outline of the Eighth Five-Year Plan of the National Economy and Social Development (1991-1995)*). From 1996 to 2000, East China was asked to improve technologies for industries and products, and technical cooperation was facilitated between East China and Middle and West China in order to improve the technical development of Middle and West China (*The Outline of the Ninth Five-Year Plan of the National Economy and Social Development (1996-2000)*). During 2001 and 2005, high-tech industry was promoted in East China and economic and technical cooperation East China and

Middle and West China was enhanced (*The Outline of the Tenth Five-Year Plan of the National Economy and Social Development (2001-2005)*). In the latest Five-Year Plan, East China are called to take the lead in enhancing innovation capacity (*The Outline of the Eleventh Five-Year Plan of the National Economy and Social Development (2006-2010)*). Most regions follow the progress of innovation capacity development as from introducing things new to the region, to integrative innovation, to interdependent innovation. According to the emphases of regions in each period, it is obvious that regions in China are at different stages of innovation capacity development.

In light of what Mahmood and Rufin (2005) argued, the role of government, in its economical and political dimensions, varies over the innovation development process. A country can grow fast by imitating from more advanced countries and the government can facilitate economic development through intervention in economic activity when it is far from the word technological frontier, but as it approaches the technological frontier, economic and political freedom are needed (Mahmood & Rufin, 2005). In the context of China, each province can be considered as a sub-country, some regions are in the China's technological frontier while some are far from the frontier. Hence, the role of each regional government should be different. At this point, the embedded autonomy and governed interdependence theory can be brought into the regional level in investigating China's RIC.

To become an innovative economy, institutional environment is important, such as an appropriate legal framework (Wolff, 2007) and preferential taxation policies (Lin, Yang, & Liou, 2010). As policies and laws are two kinds of instruments that the government uses for governing the interdependences among economic actors, analyzing them at the regional level will be helpful for finding out the reasons of variations in RIC. Accordingly, governed interdependence theory, which emphasizes governing the relationship between governments and private sectors, is useful in explaining the phenomenon of China's RIC. Meanwhile,

Weiss (1998) argued that in advanced countries, the more cohesive the organisation of industry and the executive bureaucracy, and the tighter the links between the two, the greater the capacity for innovation. Therefore, embedded autonomy, which means a combination of internal coherence and external connectedness, can help in examining innovation capacity.

Embedded autonomy and governed interdependence were used in studies of state capacity, applying them into innovation capacity investigation through public policies at a regional level not only brings a new perspective of looking at the phenomenon of innovation capacity but also extends these two theories.

Conclusion

To improve the development of RIC, it is important to understand the determinants of RIC. In this paper, it was proposed to investigate the phenomenon of China's RIC with the theory of embedded autonomy and governed interdependence by examining public policies. In previous research on IC, the commonly used definition was brought out by Stern, Porter and Furman (2000), which was based on three bodies of literature, endogenous growth theory, cluster theory of national industrial competitive advantage, and research on NIS. Besides, since the concept of NIC came out, researchers tried to replicate Furman, Porter and Scott's study (Furman et al., 2002) which employed a quantitative approach. But when applying this study to the context of China, the phenomenon cannot be fully explained, for example, how the innovative actors interact with the institutional environment and how the governments intervene with innovation processes. Although some studies were taken in Asia countries such as Japan, Korea, Singapore, and Taiwan, the results still cannot be adjusted to China directly because of the uniqueness of China's context. Therefore, studies on RIC in China are needed.

Public policy is an important determinant of RIC (Furman et al., 2002; Hu & Mathews, 2005) and it is also an important instrument that government uses to guide and constrain the interactions between economic actors. Embedded autonomy and governed interdependence, which were developed to explain the complex institutional relationships relying on qualitative approach based on the newly industrialized countries in Asia, would be suitable new perspectives for studying RIC in China. By analysing how public policies affect RIC according to these two theories, the variations of RIC among China's regions can be explained a bit and the role of government in RIC development will be clearer. Moreover, these two theories will be extended and developed by applying to the unique context of China.

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