Papers in Evolutionary Economic Geography

11.19

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Abstract: Governance constitutes elementary supportive infrastructure for regional innovation systems. This paper extends the evolutionary lens of governance into initial industrialization phase and examines the impact of their evolution into regional innovation systems on fostering innovation activities. Drawing on the empirical substances in Shenzhen and Dongguan, China, a path-dependent nature of institutional design on supporting innovation has been discovered. The paper shows that the dirigiste globalized production system in Shenzhen in 1980s has gradually evolved to a higher level of interactive regional innovation system than the grassroots globalized production system in Dongguan, where innovation is still passively managed by global players. Finally, policy implication is discussed for the construction of regional innovation systems under different governance modalities in the initial industrialization phase.

Keywords: Regional Innovation Systems; Evolution; Dirigiste Governance; Grassroots Governance

1. Introduction

The concept of regional innovation systems, which was derived from the national innovation system literature, takes the institutional and organizational dimension on the territorial level into consideration in innovation activities (Asheim and Coenen, 2005; Cooke et al., 1997; Howells, 1999; Morgan, 2004; Revilla Diez, 2002). In the analytical framework of a regional innovation system, the institutions and organizations are extended as the governance infrastructure that facilitates cooperation, organizes interaction, reduces uncertainty and cuts transaction costs, enabling the business sector to compete more effectively (Cooke, 1992; Cooke et al., 1998; Revilla Diez, 2009).

Cooke (1992) proposes three modalities of governance supporting the business inter-relationships: grassroots governance, network governance and dirigiste governance. These three modalities of governance differ in the degree of policy intervention as well as the relationship with knowledge-intensive organizations on different scales. Cooke et al. (2004) revisit the regional innovation system first proposed in a systemic way in late 1990s (Braczyk et al., 1998) with an evolutionary perspective in the face of monumental economic shift and uncertainty. In the practice of many regional innovation systems around the world, the governance infrastructure evolves according to the needs of market change and industrial organizational restructuring, aiming at generating more dynamic regional growth mechanisms.

When this line of thinking on evolving governance infrastructure extends to the context of China, where the regional innovation system is itself burgeoning from the production system relying heavily on integration into the lower-end of global production networks facing rising factor prices and upgrading pressure, the evolutionary lens should be extended. That is to say, the focus on the evolution of

governance infrastructure should be put on the transition from governance that supports initial industrialization to governance that supports the innovation activities.

This paper aims to understand how different governance infrastructures influence the development of regional innovation systems by investigating two cities in South China where initial industrialization has been supported with different modalities of governance following the introduction of the opening policy. In Shenzhen, the governance supporting industrialization is rather dirigiste, characterized by a state-oriented involvement of economic development with ex-ante strategic policy support. In Dongugan, however, governance that supports industrialization is grassroots, characterized by flexible institutions organized mainly by town and village authorities that are favorable for overseas Chinese investment based on Guanxi (Leung, 1993; Yang, 2010).

Thanks to the state initiative to develop electronics production at the very beginning of the establishment of the special economic zone, the electronics industry gained a first mover advantage in Shenzhen compared to Dongguan. Dongguan then followed up when the electronics industry replaced the old primary textile industries in the 1990s. With the rising land and labor prices as well as the fierce competition from other low-cost areas, policy reaction was initiated at various levels of government, aiming to form a network governance to support the upgrading and innovation activities of the firms and regions.

However, the empirical analysis of an electronics firm survey conducted in late 2009 reveals different business innovation patterns in Shenzhen and Dongguan. In Shenzhen, the regional innovation system displays an interactive feature. Firms are capable of interacting with a wide range of external partners to promote innovation outcomes. In contrast, the regional innovation system in Dongguan is heavily

dependent on global lead firms, leading to a marginal improvement on innovation outcomes.

Through the inter-city comparison, a path-dependent nature of governance has been discovered. By reflecting on the competence of governance in accumulating and mobilizing the innovation-related resources from an evolutionary perspective in China, this paper contributes to the understanding of the cause of path dependence in the stream of evolutionary economic geography (Boschma and Frenken, 2006) and demonstrates that institutional design, instead of only historically contingent events (David, 1985; Arthur, 1989), impart path dependence to regional capabilities on undertaking systemic innovation.

The remainder of the paper is organized as follows. The second section elucidates governance infrastructure in production and innovation systems. Moreover, theoretical discussion from an evolutionary perspective will be provided on what facilitates or handicaps the evolution of governance infrastructure for low-end production to support of innovation. The third section presents the survey design of the comparative investigation into the feature and level of the regional innovation system under different governance modalities. The fourth section depicts the governance infrastructure in Shenzhen and Dongguan in the initial industrialization phase and the transitional phase. In the fifth section, empirical results are demonstrated based on questionnaire data from electronics firms in order to explore innovation patterns in Shenzhen and Dongguan. Finally, the paper concludes and discusses the policy implications derived from the cases in Shenzhen and Dongguan.

2. Evolutionary Regional Innovation Systems and Governance Infrastructure

2.1 Evolution of Governance Infrastructure: Content and Typology

Governance consists of relations of power and structures of decision-making to coordinate the input-output production system (Storper and Harrison, 1991). Reform of governance has been found to be the catalyst of rapid industrialization in latecomer countries (Goldsmith, 2007). In latecomer countries, the governance has been adjusted and developed to match external needs due to the great dependency on external markets and technology.

Governance aimed at launching industrialization covers three aspects, as shown by Table 1. The governance in production systems has no explicit innovation content, in which the focus is mainly on initiating the growth of production activities and supporting it with various measures. When the spatially specialized entity evolves into an innovation system, the governance should co-evolve and adjust the focus to supporting innovation activities. To secure systematic learning and innovation synergies that occur externally of the firm boundary, governance plays an important role in providing access to information, ensuring credibility, coordinating collective actions and even creating a learning atmosphere (Amin, 1999; Dalum et al., 1992; Haggard, 2004).

In accordance with the governance elements in production systems, Cooke et al. (1997) outline the governance dimension in regional innovation systems as follows (Table 1): 1) Institutional competence to organize technology transfer and launch science and technology programs; 2) Supported infrastructure to enhance the capacity of innovation and extend the scope of interactive learning; 3) Financial and budgetary capacity to reduce innovation-related uncertainty and risk as well as mobilize innovation-related resources.

Table 1 Governance Content in Production Systems and Innovation Systems

	Production Systems	Innovation Systems
Institutional competence	Capacity to design and execute industrial	Capacity to organize technology transfer (local, regional, …) science and technology

	development policies	program
Supported infrastructure	Hard infrastructure such as roads, electricity, port, etc.	Density and quality of infrastructures for innovation such as universities, research institutes, technology transfer agencies, consultants and skill-development and training agencies
	Soft infrastructure such as administrative services to assist the firms	Control or shared execution of part of strategic infrastructures
Financing & Budget	Capacity to impose taxes	Accessibility of capital market for firms
	Autonomy for public spending	High level of financial intermediaries

Source: Adjusted from COOKE *et al*. (1997)

In terms of governance content, three typologies can be drawn according to Braczyk et al. (1998): the grassroots, network and dirigiste governance modalities. In this paper, we extend its implication from regional innovation system further to cover production system.

1）Grassroots Governance

In terms of institutional competence in this modality, the initiation processes of economic development programs, urban planning and technology programs are organized at the town or district level, and the degree of supra-local co-ordination is low because of the localized nature of organization. The research competence is highly applied or near-market. Moreover, the level of technical specialization will be low, lacking finely honed expertise. Funding under grassroots governance modality comprises a mix of capital, grants and loans from local banks, local government and possibly the local Chamber of Commerce.

2）Network Governance

In terms of institutional competence in this modality, initiation processes of economic development programs, urban planning and technology programs are organized in multiple levels, encompassing the local, regional, federal and supranational levels. Also, system coordination is high because of the large number of

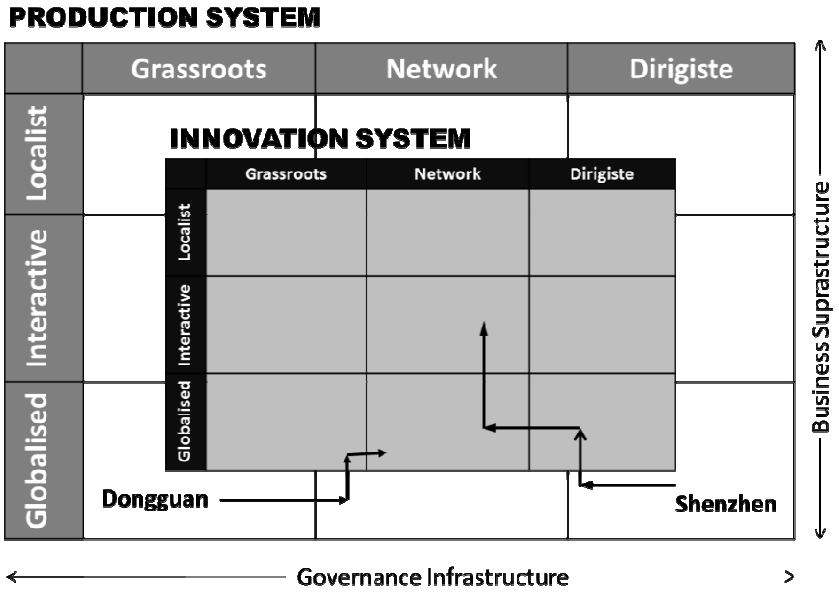
stakeholders and the presence of knowledge-intensive organizations. The research competence is a mix of both pure and applied knowledge geared to the needs of large and small firms. Funding under network governance modality is guided by agreement among banks, government agencies and firms at various levels such as national, regional and local.

3）Dirigiste Governance

In terms of institutional competence in this modality, initiation processes of economic development programs, urban planning and technology programs are a product of central government policies, leading to a high degree of coordination. Research is rather basic or fundamental and relates more to the needs of larger (possibly state-owned) firms. Funding under dirigiste governance modality is largely centrally determined, although the agencies may have decentralized locations in the regions.

The innovation-related governance supports the firms with diverse posture in the market place with producers and customers, ranging from a global to a local reach (Braczyk et al., 1998). Firms could organize production and innovation in accordance with the governance support in a localized, interactive and globalized manner. The evolutionary investigation of most case regions in Cooke et al. (2004) indicates a trend towards interactive business innovation, which responds to the emphasis on interactive learning and systematic innovation in modern innovation theories (Asheim and Coenen, 2005; Cooke et al., 1997; Howells, 1999; Lundvall, 1992). In interactive business innovation, a high degree of association has been formed vertically and horizontally with both global and local reach. In this way, innovative synergy forms gradually, hatching the knowledge spillover and spatial dynamic externalities among firms.

This paper focuses the analysis on two cities in coastal South China, where the production system in the initial industrialization phase is dominated by global corporations with a clustered supply chain of dependent SMEs. What is more, since the advent of the opening policy in the late 1970s, the central government has either been directly involved in economic development, such as establishing economic special zones, or has implicitly encouraged the bottom-up development, mainly by releasing more economic developmental autonomy to local governments. Therefore, the theoretical discussion in the following section centers around the dynamics and inertia faced by the evolution of grassroots globalized production systems and dirigiste globalized production systems towards a well-functioning innovation system. In figure 1, the evolutionary paths of the grassroots globalized production system in Dongguan towards an innovation system, as well as that of the dirigiste globalized production system in Shenzhen towards an innovation system, are shown. The following theoretical discussion and empirical investigation will justify this finding.



Note: Arrow indicates direction of system movement 1978-2009

Figure 1 Evolution from Production System to Innovation System

Source: Own draft based on Cooke *et al*. (2004)

2.2 Evolution of Governance Infrastructure: Dynamics and Inertia

Governance can refer to two interrelated aspects: institutions and organizations. Institutions are the rules of the game and organizations are embedded in the institutions, playing the game with different competences and capabilities (Cooke et al., 1998). The institution defines the behavior of organizations, and organizations have a return influence upon institutions by adjusting them to meet the needs of the changing external environment.

The dynamics of the governance evolution towards becoming innovation-supported depends on the capability of the organization. In the initial industrialization phase, when the industrial base is weak, the resource endowments of related organizations becomes an important baseline for the evolution of governance towards a well-functioning innovation system. In Porter's (1998) competitive model, local endowments such as highly specialized skills and knowledge, institutions, related businesses and demanding customers are emphasized for the construction of a competitive cluster. For a grassroots globalized production system, production capital and know-how depends heavily on foreign investment. There is no skill base in the production system either from previous accumulation or assignments from the central, absorbing the spillover from the foreign technology. In contrast, the dirigiste globalized production system is able to accumulate the skill and knowledge stock from the central assignments such as relocation of large state-owned firms and knowledge-intensive institutions. Foreign investment embedded in the local environment thus differs under these two different governance modalities, which defines the capacity of localities to process, absorb and adapt the external information and technological spillover in the future (Cohen and Levinthal, 1990; Zahra and George, 2002).

Furthermore, the capability of dirigiste governance to bring new dynamics into the economy is well reflected by the technology foresight. According to the practices in some countries such as Japan, Britain, Australia and New Zealand (Martin and Johnston, 1999), technology foresight, which is mostly conducted by government agencies or advisory boards, generates concentration on long-term development of selected trajectories and develops a level of consensus on desirable futures. Technology foresight includes the practice of selecting technology priorities, identifying new strategic industries, creating partnerships between sciences, industry and government, as well as providing incentives for multidisciplinary research. Therefore, the dirigiste approach, which is mostly initiated and governed by national level agencies with more power, is more able to draw on technology foresight to inject new dynamics into development than the grassroots approach. Especially in the time of rapid technology regeneration, a grasp of future trends and timely reactions are important for the region to keep a dynamic growth path.

Although the dirigiste globalized production system possesses more knowledge and skill endowment and is more able to draw on technological foresight than the grassroots approach, it is still insecure to leave the future of development in the hands of central authorities. Firstly, there might be misinvestment in the selection of key industries when little information is collected from the market, generating opportunity costs for the locality. Secondly, soft budget constraints are mostly likely to occur in state-owned firms, which play an important role in the dirigiste approach, causing lower efficiency and poorer performance than in private sectors (Qian and Roland, 1998). Therefore, there is an urgent need for dirigiste modalities to evolve towards network governance, involving more market mechanisms of competition. In addition, the participation of market power incentivizes the exploitation of entrepreneurial

activities on the stock of technological knowledge in dirigiste production systems with a wide range of applications, enabling the firms to undertake interactive learning to gain innovation ideas and support.

On the other hand, the evolution of grassroots governance from a production system to an innovation system carries more inertia than the dirigiste one. As argued by Easterly (2008), the grassroots approach evolves gradually within the constraint of previous institutions, while the dirigiste approach is able to start with a blank sheet or tear up the old institutional setup. This argument has two implications. Firstly, while the dirigiste governance is able to draw on technology foresight, a "competency trap" might arise in grassroots governance, as being too good at something constrains the capacity of grassroots organizations to absorb new ideas and develop new trajectories (Levitt and March, 1988). In the light of this, a mixed level of organizations should be in place to ensure breaking through the "sticky knowledge" and forming new competencies. Secondly, vested interests in organizations tend to emerge in the evolving process of grassroots governance, which might oppose the changes that undermines their current gains and positions (Boschma, 2004). Altogether, it constitutes "cognitively sunk cost", which creates a negative reinforcing cycle, impeding new development dynamics and trajectories (Leonard, 1992).

Therefore, grassroots governance in a production system with a weak industrial base tends to encounter competency traps and complex vested interests, leading to the risk of negative lock-in and sticky inertia. When governance evolution towards the one supporting innovation systems encounters inertia in the face of restructuring and upgrading, it would create systemic market and policy barriers to interactive business innovation as new development alternatives (Könnölä et al., 2006).

The theoretical overview of the governance infrastructure discussed above provides the starting point for investigating its impact on business innovation activities. The comparison of the Shenzhen and Dongguan cases should reveal a different pattern of interactive learning and systemic innovation, providing a divergent evolving path of governance infrastructure as shown by figure 1. Before addressing the innovation pattern based on empirical results, the research design will be presented, followed by the review of the evolving governance infrastructure in Shenzhen and Dongguan since the opening policy in 1978.

3. Survey Design of A Comparative Study

The comparative study has been identified by many scholars, for example Staber (2001), Doloreux (2004) and Asheim and Coenen (2005), as the most important means of fully understanding the function of RIS and capturing hidden variables that are of interest to the construction of RIS. Therefore, comparing the evolution of the regional innovation systems in Shenzhen and Dongguan, both are located in the prosperous Pearl River Delta in Guangdong Province, China, offers a unique perspective for understanding the specific contents of governance infrastructure that influence the systemic innovation in the region.

The empirical data were collected from an electronics firm questionnaire survey in Shenzhen and Dongguan, Guangdong Province, China. The investigation focuses on the electronics industry because of its great dominance and development history in the research area, which enables the inquiry into its evolutionary path. As shown in figure 2, the output value of the electronics industry in Shenzhen and Dongguan kept growing during the period between 1994 and 2009. Dongguan, which is known as the "world factory of electronics", experienced a much lower level of output value growth than Shenzhen due to the concentration of low-value processing.

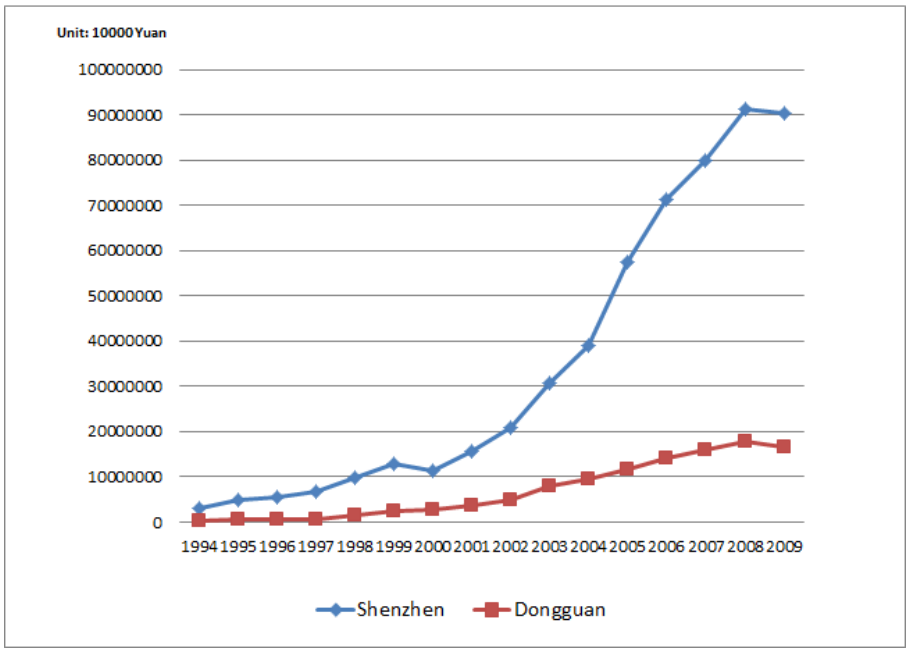


Figure 2 Output Value of the Electronics Industry 1994-2009

Source: Shenzhen Statistical Yearbooks and Dongguan Statistical Yearbooks

The questionnaire survey was conducted via telephone and mail in order to ensure the feasibility of the survey and validity of the data, and was strengthened by following-up that aimed to persuade the firms to fill out and send back the questionnaires, as well as to fill out unanswered questions after the questionnaires were returned. Additionally, in order to establish contact with more firms, a second approach was applied, namely visiting fairs. The fairs and firms visited were randomly selected. Moreover, the fairs visited have a large number of firm exhibitors, ensuring the unbiased nature of the fair-visiting result. In total, 312 Shenzhen firms and 281 Dongguan firms were contacted. In total, 167 Shenzhen firms and 177 Dongguan firms filled out the questionnaires, with the response rate in Shenzhen and Dongguan being 54% and 63% respectively.

In the sample, there are 140 innovative Shenzhen firms and 161 Dongguan firms. The core innovation questions cover the internal efforts and external interaction during the innovation process, i.e. acquiring new innovative ideas, acquiring codified

knowledge and tacit knowledge. The scope of external interaction covers various business partners, such as parent companies, foreign customers, domestic customers, universities and research institutions, as well as sales agents. In addition, the interaction mode with the partners is identified, i.e. interacting with the partners through active search strategies such as the Internet, exhibitions or sales agents, and interacting with the partners through the introduction and recommendation of long-term business partners, relatives and friends. Surveyed firms were asked as to the importance of each aspect in product innovation activities.

4. Governance in Shenzhen and Dongguan, China: An Evolutionary Overview

The institutional setups in Shenzhen and Dongguan, Guangdong Province, which have evolved since the opening policy to meet the needs of rapid industrialization, correspond to the dirigiste and grassroots governance modalities respectively. In the following analysis, the evolution process of governance will be summarized by the thorough review of the "Shenzhen Electronics Yearbook" (SECC, 2004) and the "Guangdong Electronics Yearbook" (GECC, 2002). In these two yearbooks, descriptive facts are provided for the developmental path of the electronics industry in Shenzhen and Dongguan. Moreover, an in-depth interview was conducted in late 2007 with the former chair of the Guangdong Electronic Chamber of Commerce (GECC) to gain insight into the industrial development history and changing interests of governments at various levels.

4.1 **Governance Evolution in Shenzhen since the opening policy**

4.1.1 Governance in the initial phase of industrialization

Shenzhen was a small, peripheral town before 1978. In 1979, it was selected by the central government as one of the special economic zones where the opening policy could be best brought into play. The role of the electronics industry was a focus from the very beginning of the special zone development in Shenzhen (GECC, 2002; SECC, 2004).

Governance to initiate industrial development is based on the strategy of embedding large-scale foreign investment with large state-owned firms that possess good resource endowments. Favorable policy for attracting foreign investment is designed to encourage large-scale programs with longer fund turnover periods, aiming to control short-term opportunist behavior of foreign firms.

Special financial formulas, such as joint ventures between large state-owned companies and foreign investors, are applied. These large firms were originally an important part of the national innovation system in the planned economy. They stemmed from large state-owned companies directly under the jurisdiction of state ministries and provinces, renowned universities and research institutes, as well as military-related plants that were highly specialized in heavy industry. These joint ventures were then able to introduce high-scale production lines due to the disposal of state-owned assets and scale economies of production. Moreover, the high endowment of human capital in state-owned companies enables the better absorption of imported technology (SECC, 2004).

Besides joint venture with foreign companies, there were also joint ventures between domestic state-owned firms. The alliance among these state-owned companies was always accompanied by tasks of developing a specific leading product technology. In 1986, the Shenzhen Electronics Group Company (later Saige Group), which unifies 117 of the 178 companies in Shenzhen on a voluntary basis, was

established under the approval of the Shenzhen City Government. In 1988, the Shenzhen Electronics Group Company arranged the construction of the first specialized electronic parts supply market in China, “Saige Electronics Supply Market”, which is a remarkable milestone in organizing the supply chain of the electronics industry in Shenzhen. Within this organizational arrangement, information and production opportunities are more frequently shared among member companies (SECC, 2004).

Meanwhile, network governance has been formed in multi-level organizations, encompassing China Central Ministries, the Guangdong Province and the Shenzhen City Government and industrial park authorities in the aspects of initiating technology transfer, facilitating technological absorption of domestic firms and assisting the business sector in training, quality control and customer searching.

With the support of the dirigiste governance and geographical proximity to Hong Kong, the electronics industry in Shenzhen has been developing rapidly, relying on processing operation in this period. Nevertheless, the industrial structure in electronics was concentrated in the standard consumer electronics industry (mainly telephone, TV, calculator and radio), which was faced with a saturated market and limited space of technological upgrading (SECC, 2004).

4.1.2 Governance in the transitional phase

After 1990, the electronics industry in Shenzhen faced the rising factor price and gradually lost the technological advantage in consumer electronics compared to the other regions in China. In order to achieve successful upgrading towards high-tech electronics, the Shenzhen city government has strategically drawn on the technological foresight in five industries: PC and software, telecommunication, microelectronics, optical-electro-mechanical integration and new materials. Under the

guidance of the selected industries, foreign investment was supported around the five industry fields (SECC, 2004).

Besides adjusting the institutional competence to initiate the upgrading, the Shenzhen Government implemented two primary measures in terms of financing programs. Firstly, firms were offered the accessibility to capital markets, with the first capital market being opened in Shenzhen in 1982. Secondly, the city government supported the small and medium-sized high-tech private firms, such as Huawei, with specific funding intermediaries (SECC, 2004).

Owing to Shenzhen's special background as the experimental field for opening policies in China, private firms and privatization reform of state-owned firms were encouraged and supported by various levels of government. Under this circumstance, the human capital endowment was able to be released from the old national innovation system embedded in state-owned companies, central ministries (Shenzhen Division) and research institutes (Shenzhen Division), which altogether enables the exploitation of market opportunities in technology. As a result, many private firms flourished in the 1990s, establishing the base for a wide scope of systemic innovation in the interactive regional innovation system.

4.2 **Governance Evolution in Dongguan since the opening policy**

4.2.1 Governance in the initial phase of industrialization

With the devolution of partial power of fiscal arrangements from the central government to town and village governments, the Dongguan local government has been enthusiastically devoted to economic growth. The industrialization process in Dongguan started in the garment and shoe industries during 1980s. Compensation trade, i.e. processing raw materials on clients' demands, assembling parts for the clients and process according to the clients' samples, expanded quickly in many

villages and towns. The source of orders was mostly Hong Kong, due to the cultural proximity (Interview in Dongguan, September 2007).

The Dongguan local government put great focus on encouraging the Hong Kong-Dongguanese to invest in their home town. In 1981, the office of outward processing and assembly was established to organize this important task. Moreover, the village and town governments also greatly supported the development of compensation trade by offering cheap land, favorable policies and flexible standards. The distribution of the processing earnings is negotiated between the town and village governments and foreign investors, mostly under informal frameworks such as oral agreements (Interview in Dongguan, September 2007). In this way, vested interests are taking shape among foreign firms, township and village governments, and peasants who live on the rent of the collectively owned land.

In the process of industrial development based on grassroots foreign investment attraction, infrastructure supply is directed to industry-specific and hands-on service mainly from the township and village governments, deploying the fiscal income into construction, such as factory buildings, roads, electricity and telecommunications, to improve the investment environment. This bottom-up industrialization process matched simultaneously with small-scale Hong Kong investment that feared institutional uncertainty. This leads to the scattered land use pattern and low agglomeration economy. Nevertheless, the demonstration effect of “successful small Hong Kong bosses” and the shaping of vested interests have further strengthened the governance focus on compensation trade in Dongguan.

4.2.2 Governance in the transitional phase

By 1995, the profit space of garment industries was greatly shrinking. Electronics firms, mainly led by Taiwanese firms, along with some of the Shenzhen firms, were

gradually relocating to Dongguan in the middle of the 1990s. The shift, attracted by low-cost factors in Dongguan, was systematically carried out through the clustering of Taiwanese firms with complex supplier linkages. At the beginning of the 21st century, the compensation trade in electronics in Dongguan reached its peak. However, even before its accelerating phase in the mid 1990s, the policy focus at the provincial level on electronics development was specifically placed on Shenzhen, Guangzhou and Foshan, rather than on Dongguan (GECC, 2002).

In order to attract large-scale high-tech investment in the face of industrial upgrading, the Dongguan City Government established the first city-level industrial park, with high entry standards, in 2001. Furthermore, the Dongguan City Government responded to the call from the central and provincial governments to evacuate the old low-end processing industries and attract new high-tech ones. However, this led to great resistance from the township and village governments. On the one hand, the township and village governments and the peasants rely heavily on processing firms for their major income (Yang, 2010). Therefore, vested interest has been firmly shaped from the bottom up, thus creating the inertia for structural change. On the other hand, the village and town governments not only lack the incentive, but also the experience to undertake far-sighted ex ante developmental arrangements and provide necessary infrastructure support in order to secure upgrading towards high value-added activities (Interview in Dongguan, September 2007).

Due to the weak industrial base before the rapid development, the local skilled labor market and related industrial institutions remained underdeveloped, especially in face of great profit made too rapidly by compensation trade. Statistics in 2009 show that the domestic sector was much weaker in Dongguan than in Shenzhen (Table 2).

This less endogenous development path is expected to impact on the development of the regional innovation system in Dongguan.

Table 2 Statistics of the Domestic Sector in Shenzhen and Dongguan (2009)

Firm above scale*	Shenzhen	Dongguan
Share of domestic firm units	53%	25%
Share of domestic firms' output value	37%	16%
Share of domestic firms' added value	47%	15%

* firms above scale include all state-owned firms and firm with over five million sales

Source: Shenzhen Statistical Yearbook 2010 and Dongguan Statistical Yearbook 2010

4.3 **Summary of Governance in Shenzhen and Dongguan**

From the above discussion, it can be concluded that the initial condition of institutional design, i.e. governance mode to promote industrialization in Shenzhen and Donggugan differs a lot from each other. The development of the electronics industry in Shenzhen was strongly supported by ex-ante involvement of state authorities and institutes that simultaneously echoed with the trend of the global industrial shift of the electronics industry to low-cost regions in the 1980s (Luthje, 2004). On the other hand, the institutional setup in Dongguan has repeatedly been strengthened for the aim of processing trade development with the symbiotic gain of the village and town level governments, overseas Chinese investors (mainly Hong Kong and Taiwan) and local peasants. Moreover, the support of institutional organizations is ex-post to enhance the comparative advantage of the existing developmental mode of mass low-end production.

5. Empirical Results of Interactive Innovation

After comparing the divergent evolutionary paths of governance in Shenzhen and Dongguan since the opening policy in 1978, an empirical investigation into the scope

and extent of interactive learning and systemic innovation in their leading industry, the electronics industry, was conducted in order to gain insights into the respective regional innovation systems. Before that, the general regional indicators in both cities are shown in Table 3.

The pattern of specialization in high-tech sector in Shenzhen outstands from that in Dongguan in terms of industrial output value and employment. Moreover, Shenzhen's total R&D expenditure and R&D outperforms Dongguan both in absolute and relative term, which all point to a higher level of resources and human capital that enables the well-functioning of a regional innovation system.

Table 1 General Indicators in Shenzhen and Dongguan (2009)

	Shenzhen	Dongguan
Population	8912,300	6350,000
Gross Domestic Product (billion Yuan)	820	376
Industrial Output Value (billion Yuan)	1582	676
% of High-tech manufacturing sector[1]	69%	39%
Employment	6924,853	5381,981
% of High-tech manufacturing and service sector[2]	33%	19%
Total R&D expenditures (billion Yuan)	27.97	4.14
% of GDP	3.4%	1.1%
R&D personnel	123687	18524
share of R&D personnel per 1000 employees	17.9	3.4

1. High-tech manufacturing sector refers to ordinary equipment, special purpose equipment, transport equipment, electric equipment and machinery, telecommunications, computer and other electronic equipment (only state-owned firms and firm with over five million sales are calculated).
2. High-tech manufacturing and service sector include the high-tech manufacturing sector above and service sector, i.e. information transfer, computer and software services, scientific research, technical services and geographical prospecting.

Sources: Shenzhen Statistical Yearbook 2010, Dongguan Statistical Yearbook 2010 and 2nd Investigation Report of Guangdong R&D Resources

In the econometric analysis, tobit regression was applied to examine the impact of external interaction with other business partners on firms' innovation outcomes. The dependent variable in the regression is the average score of evaluation of the degree of improvement (ranging from 0 to 5 with increasing significance of change) on function expansion and categories upgrading. Due to the censoring of the valuation towards

higher rank, tobit regression was run. Factor analysis was firstly applied to reduce the dimensions of independent variables in order to simplify the following regression. The derived factors are able to explain over 60% of the variance of the original sample. In order to avoid multicollinearity, seven variables were finally selected as the independent variables. Table 4 shows the independent variables, including the innovation behavior mainly investigated and other control variables.

Table 4 Independent variables in Product Innovation Performance Regressions

	Indicators	Description
Innovation Behavior	NPI_external partners	Interacting with *domestic customers, universities, research institutions and sales agents* to gain innovation ideas
	NPI_internal efforts	Making *internal learning efforts* such as own ideas, license purchasing and reverse engineering
	NPI_parent comp. & foreign	Relying on parent companies or foreign customers to gain innovation ideas
	NPTK_active learning	Sending staff *to business partners* for training
	NPTK_passive from customer	Receiving training and know-how from people sent *by domestic and foreign customers*
	NPTK_passive from parent comp.	Receiving training and know-how from people sent *by parent company*
	NPInteraction _informal	Interacting with innovation partners *within Guanxi networks*
Firm Characteristics	Size	Defined according to Chinese firm size standard, 1 as large firms with sales no less 300 million Yuan and no less than 2000 employee, otherwise as small and medium-sized with the value of 0
	Ownership	1 as firms with foreign participation (wholly owned or joint venture), 0 as firms with 100% domestic participation
	Age	Years since establishment of the firm
Absorptive Capacity	Educational level of technical staff	Proportion of technical staff with bachelor degree and above
	Initial technological level of main product	Defined according to International Standard Industrial Classification of all Economic Activities, Rev 3, 1 as producing low-tech products when starting business, 2 as producing medium-tech products when starting business; 3 as producing high-tech products when

		starting business

Table 5 gives the descriptive statistics for the variables and tests the variation level between Shenzhen and Dongguan. In the surveyed sample, most of the firms are small and medium-sized. The share of domestic firms in Dongguan is less than that in Shenzhen to a significant degree. Technical staff possesses significantly higher absorptive capacity in Shenzhen than that in Dongguan according to the share of above bachelor degree technicians, and Shenzhen firms also start with higher production technology than Dongguan. In terms of innovation behavior, Shenzhen firms turn more to external partners in triggering innovative ideas than Dongguan firms, but not at a significant level. On the other hand, Dongguan firms rely more on the transfer of tacit knowledge from parent companies and foreign customers, and more frequently use informal relations with friends and business partners.

Table 5 Descriptive Statistics in Shenzhen and Dongguan

	Shenzhen				**Dongguan**				***ANOVA***	
	Mean	S.D.	Min.	Max.	Mean	S.D.	Min.	Max.	*F*	*Sig.*
Firm Size (% of large firms)	0.06	0.23	0	1	0.11	0.31	0	1	2.255	0.134
Firm Ownership (% of foreign firms)	0.28	0.45	0	1	0.47	0.50	0	1	11.95	0.001
Firm Age (years)	10.4	7.6	1	57	12.2	7.1	2	51	4.30	0.039
Educational level of technical staff (%)	0.43	0.36	0	1	0.33	0.30	0	1	5.72	0.017
Initial technological level of main product	1.99	0.63	1	3	1.78	0.64	1	3	7.93	0.005
NPI_external partners	0.10	1.05	-2.05	2.53	-0.07	0.96	-2.78	1.69	2.24	0.135
NPI_internal efforts	0.02	0.89	-2.67	1.68	0.11	1.06	-2.61	7.43	0.63	0.427
NPI_parent comp. & foreign	-0.22	0.87	-1.81	2.22	0.27	1.04	-2.89	2.90	19.19	0.000
NPTK_active learning	-0.03	1.01	-2.10	2.57	0.06	0.95	-2.19	2.10	0.68	0.409
NPTK_passive from customer	-0.02	0.94	-1.95	2.08	0.10	1.04	-2.13	2.27	1.03	0.31
NPTK_passive from parent comp.	-0.04	0.98	-1.38	3.28	0.10	1.02	-1.38	3.21	1.40	0.238
NPInteraction informal	-0.14	0.95	-2.52	1.60	0.14	1.03	-2.53	1.60	6.13	0.014

Table 6 shows the result of the tobit regression on product innovation performance. Three models are run as a comparison: whole model pooling of the Shenzhen and Dongguan data, the Shenzhen model and the Dongguan model. All the models fit significantly better than an empty model, which is indicated by the significant level of the chi-square likelihood ratio. The whole model serves as an intermediate between the Shenzhen model and the Dongguan model, which reflects the difference between Shenzhen and Dongguan in a clearer way.

Table 6 Tobit Regression on innovation performance

Independent variables		*Product Innovation outcome*		
		Whole Model	**Shenzhen Model**	**Dongguan Model**
Constant		3.56*** (0.192)[1]	3.38*** (0.289)	3.70*** (0.239)
Educational Level of Technical Staff		0.004* (0.002)	0.005 (0.003)	0.002 (0.003)
Ownership		-0.30* (0.153)	-0.53* (0.268)	-0.05 (0.206)
Firm Size		0.23 (0.276)	0.32 (0.522)	0.15 (0.305)
Firm Age		0.008 (0.010)	0.03* (0.015)	-0.008 (0.013)
Initial Product Type according to technology	Medium tech vs. low tech[2]	0.15 (0.168)	0.08 (0.282)	0.16 (0.191)
	High tech vs. low tech[2]	0.37 (0.237)	0.14 (0.357)	0.60** (0.302)
NPI_external partners		0.31*** (0.091)	0.53*** (0.158)	0.12 (0.105)
NPI_internal efforts		0.20** (0.081)	0.39*** (0.135)	0.05 (0.093)
NPI_parent comp. & foreign		0.25*** (0.089)	0.21 (0.155)	0.25** (0.102)
NPTK_active learning		-0.05 (0.094)	-0.28* (0.147)	0.08 (0.118)
NPTK_passive from customer		-0.07 (0.087)	-0.43*** (0.135)	0.16 (0.103)
NPTK_passive from parent comp.		-0.08 (0.082)	-0.11 (0.133)	-0.12 (0.098)
NPInteraction_informal		-0.04 (0.083)	0.04 (0.140)	-0.07 (0.098)
Prob > F		0.0005	0.0006	0.0291
Prob > R2		0.05	0.11	0.07
Number of Observations		240	109	130

1. Standard errors in parentheses; *p<0.10, **p<0.05, ***p<0.01.
2. Initial product as low-tech as the default group, which means low-tech as 0, the others as 1;

Observing firstly the variables indicating the behavior in the various stages of the product innovation process, Shenzhen firms combine their internal absorptive capacity with external interaction with other partners to trigger innovation ideas, which eventually boosts the innovation outcomes. In a regional innovation system, the interactive learning not only contributes to effective knowledge transfer, but also triggers the innovation, enabling capitalization on new creative resources from the complementary knowledge of various players in the cluster (Capello, 1999). This indicates the strategy and capacity of Shenzhen electronics firms to capitalize on wider sources of knowledge spillover, including domestic customers, sales agents, universities and research institutes, which signify the maturing of the interactive regional innovation system in Shenzhen.

On the other hand, innovation ideas originating within strict hierarchical organizations, i.e. instructions from parent companies and foreign customers, boosts innovation outcome for Dongguan firms. Interactive learning in Dongguan is exclusively oriented to a fairly passive pattern of receiving orders to expand product functions and upgrade product categories from the organizationally proximate partners. Compared to the innovation activities in Shenzhen firms, the role of organizational proximate partners in promoting innovation is smaller (0.25 compared to 0.53). The limited capacity for drawing upon a wider scope of external sources to foster innovation reflects the bottleneck of upgrading in Dongguan, where the internal absorptive capacity and external business environment do not permit the strategic use of interactive learning in the innovation process.

Moreover, the difference of the control variables confirms the hypotheses from another point. For Shenzhen firms in the sample, older firms tend to have higher

performance in product innovation. This variable demonstrates the long history of capability accumulation related to innovation activities, such as in technological development, management optimization and market research, and contributes to higher absorptive capacity and higher effectiveness in bringing out better innovation results. In contrast, the small insignificant impact of firm age on innovation performance for Dongguan firms indicates that the firm strategy for accumulating technological and managerial capabilities around innovation activities is not conscious and systematic. However, Dongguan firms producing high-tech electronics products at the beginning, which indicates higher absorptive capacity, perform better than firms producing low tech electronics products at the beginning in a significant level of 90%. In short, firms in Dongguan rely more than Shenzhen firms on the routine accumulated gradually within the firm boundary, rather than on complementary knowledge outside the firm, leading to the lack of dynamism and incentive to trigger innovation. The innovation activities in Dongguan are rather passively led by globalized players such as parent companies and foreign firms.

6. Discussion and Conclusion

Governance perspective towards regional development and innovation is characterized by supply-side support, which aims to provide supportive resources, secure collective actions and establish the strategic goals (Hausner, 1995). By comparing Shenzhen and Dongguan from an evolutionary perspective, this paper demonstrates that dirigiste governance modality in the initial industrialization phase leads to a more mature and developed regional innovation system than the grassroots governance modality, although the two cities both started the industrialization process in the wake of the opening policy in the late 1970s.

Insights from the empirical results show that dirigiste governance in the initial industrialization phase is more competent in providing innovation-related resources and adjusting the developmental path with strategic intervention than the grassroots governance, widening the scope of interactive learning and shaping the behavioral rationalities of firms to resort more to external complementary knowledge. While the newly recognized strand of grassroots governance supports its competency to mobilize the local resources and interdependencies (Amin, 2002), the result suggests a rather contrasting pattern, indicating that this unsystematic approach in the initial phase of industrialization might lead to a negative lock-in effect in the face of restructuring and upgrading by restricting the firms within the repeated and narrow path of knowledge accumulation and generation.

As evolutionary investigation is subject to context, it should be remembered that the two cities in this study started the rapid industrialization process with a barren endowment of local skills and industrial base. In this case, the grassroots approach tends to restrain the scope of development within the disposal of less competent local authorities. On the other hand, the empirical findings on the success of dirigiste governance in shaping innovative synergies among the firms and knowledge-intensive organizations should not be viewed as arguments favoring the central planning method of development in Keynesian legacy. In fact, this initial institutional advantage was later combined with the vital market mechanism that is released by many pilot implementation of market economy reform in Shenzhen as well as the market opportunity brought about by foreign investment.

Grassroots governance in China has been widely applied since it was cost efficient for the central government and has actually mobilized the initiative of local governments to develop the economy. For clusters that developed out of grassroots

governance in the early phase of industrialization, two lessons can be learned if they aim to boost the development of the regional innovation system. Firstly, strategic planning of industrial development should be carried out to avoid negative lock-in, adjusting the developmental path to meet the changing market environment in time and identifying related new industries. Most importantly, levels of governance should be accordingly regulated and balanced to unfasten the vested interests aiming for contrasting development goals. Secondly, policy focus should be put upon enhancing the absorptive capacity of firms and related organizations, such as attracting high quality human capital and encouraging the conscious accumulation and development of technological capabilities within firms.

The comparative study between Shenzhen and Dongguan captures the governance modality in the initial industrialization phase and its evolution with market change as an important factor that leads to the competitive advantage of Shenzhen over Dongguan with respect to the level of regional innovation system development. As indicated by Cooke (2004, p.17), “regional innovation systems are evolving as their contextualization elements shift with globalization, the rise of knowledge-intensive industry and the hollowing-out of ‘Industrial Age’ industries”. Therefore, it would be useful to identify the elements of governance in relation to the business needs under the new market trends. Furthermore, more thought should be put into the question of how to keep the dynamics and prevent the inertia of governance modality in the face of necessary changes.

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